



Variation of 1800 MHz mobile licences to increase power limit

A statement on requests for an increase of 3 dB in
the maximum permissible base station power

Statement

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About this document

This document sets out our decision to vary the licences for mobile services in the 1800 MHz band, held by EE, H3G, Telefónica and Vodafone.

The variations increase the maximum permitted power by 3 dB for Universal Mobile Telecommunications (UMTS), Long Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX) technologies for the Frequency Division Duplex (FDD) downlink (base station transmit) spectrum in these licences.

This document also sets out the background to the requests for variation of the licences and explains Ofcom's assessment of issues raised in the responses to the consultation and our reasons for granting the requests.

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Section 1

Summary

- 1.1 On 31 March 2014 we published a consultation document¹ (the “consultation”) assessing requests to increase the maximum permissible base station transmit power (e.i.r.p.) in the 1800 MHz Public Wireless Network licences. The request was for an increase of 3 dB to 65 dBm per carrier for Universal Mobile Telecommunications System (UMTS) and to 65 dBm per 5 MHz for Long Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX).
- 1.2 EE Limited (“EE”), Hutchison 3G UK Limited (“H3G”), Telefónica UK Limited (“Telefónica”) and Vodafone Limited (“Vodafone”) all requested that their 1800 MHz licences be varied to allow this power increase.

Background to licence variation requests

- 1.3 There are four mobile cellular licencees who hold licences for the use of downlink spectrum in the 1800 MHz band (1805 -1876.7 MHz). They are EE, H3G, Vodafone and Telefónica.
- 1.4 The licence held by EE, including spectrum subsequently traded to H3G, was liberalised to include 4G technologies in 2012. Other mobile licences, including for the 1800 MHz spectrum held by Vodafone and Telefónica, were similarly varied in 2013 following consultation. At that time, a request for a power increase was considered for the 900 MHz band and this was granted.
- 1.5 H3G and EE requested in their responses that consideration also be given to an increase in maximum power for the 1800 MHz licences. Before proceeding with this consultation, we confirmed with Vodafone and Telefónica that they wished to apply for the same variation to their 1800 MHz licences.

Considering a licence variation request

- 1.6 The process for considering a licence variation request is set out in European and domestic legislation (see paragraphs 2.7 – 2.20 below).
- 1.7 When considering a licence variation request, we apply an analytical framework which reflects our relevant regulatory objectives and our statutory duties (see paragraphs 2.21 – 2.28 below). Of particular relevance to our assessment are our principal duties, which are, amongst other things, to further the interests of citizens in relation to communications matters; to further the interests of consumers in relevant markets, where appropriate, by promoting competition; and to promote optimal use of spectrum.
- 1.8 In considering whether to grant these variation requests, we considered the potential benefits or detriment to consumers of varying the licences, including the potential impact on competition. We also considered the potential impact on users operating in the same or adjacent band to the 1800 MHz licensees. We consulted publicly on the proposed variation and took careful account of the responses to the consultation before reaching a decision.

¹ [Variation of 1800 MHz mobile licences - A consultation on requests for an increase of 3 dB in the maximum permissible base station power](#)

Consultation proposal

- 1.9 In the consultation, we proposed to vary the 1800 MHz Public Wireless Network licences to increase the maximum permissible downlink transmit power (e.i.r.p.) by 3 dB from 62 dBm per carrier to 65 dBm per carrier for UMTS and by 3 dB from 62 dBm per 5 MHz to 65 dBm per 5 MHz for LTE and WiMAX technologies. We asked respondents if they agreed with our proposal.

Consultation responses

- 1.10 We received five responses, one of which was confidential. Four responses, including the confidential response, supported the proposal to grant the variation.
- 1.11 One respondent, the Low Power Radio Association, objected to granting the variation, expressing concern for radio microphone use in the adjacent frequency band. We have considered their comments (see paragraphs 3.41-3.43 below) and remain of the view that a 3 dB increase in the permitted maximum power will not meaningfully increase the risk of harmful interference to adjacent users.

Our decision

- 1.12 Having considered stakeholders' responses, we have decided to grant the variation to increase the maximum permitted power in the FDD downlink (base transmit) frequencies by 3 dB for UMTS, LTE and WiMAX technologies in the 1800 MHz licences.
- 1.13 We have considered the extent to which varying the licences would further the interests of consumers, and/or give rise to a material risk of distortion of competition which could be to the detriment of consumers. We consider that granting the requested variations has the potential to provide benefits for consumers through improved mobile coverage and/or capacity, deeper in-building penetration and greater network engineering flexibility. We have not found any material risk of a distortion of competition to the detriment of consumers.
- 1.14 We have also considered the potential impact on spectrum management, and in particular, whether an increase in the maximum permitted power would be consistent with the minimum restrictions necessary to provide adequate protection against harmful interference to users in the same band or adjacent to the 1800 MHz band. We have concluded that there is unlikely to be a significant change in the existing interference environment experienced by current radio services operating in the same band or adjacent to the 1800 MHz licensees if we allow a 3 dB power increase.
- 1.15 This decision does not set a precedent for future variations in other frequency bands as each band is subject to its own adjacencies and coordination conditions, requiring separate consideration.

Section 2

Background and legal framework

Introduction

- 2.1 Licences for use of the 1800 MHz downlink band (1805 - 1876.7 MHz) are held by:
- Telefónica: 1805.1 to 1810.9 MHz
 - Vodafone: 1810.9 to 1816.7 MHz
 - H3G: 1816.7 to 1826.7 MHz (plus 1826.7-1831.7 from October 2015)
 - EE: 1831.7 to 1876.7 MHz (plus 1826.7-1831.7 until September 2015)
- 2.2 Spectrum in the 1800 MHz band was first licensed to mobile network operators in the early 1990s. Following consultation² on a licence variation request, Ofcom published its Decision³ on 21 August 2012 to grant a variation to EE to allow the use of LTE and WiMAX (4G) technology. Following that variation, EE traded some of its 1800 MHz spectrum to H3G⁴.
- 2.3 In February 2013, Ofcom consulted⁵ on the liberalisation of mobile spectrum in the 900 MHz, 1800 MHz and 2100 MHz frequency bands to allow the use of 4G technology. This consultation also included a proposal to increase the power limit of the 900 MHz licences by 3 dB for UMTS and 4G technology.
- 2.4 In their responses to this consultation, EE and H3G requested that their 1800 MHz licences also be varied so as to increase the maximum permissible base station transmit power of their 1800 MHz Public Wireless Network licences, by 3 dB to 65 dBm per carrier for UMTS and 65 dBm per 5 MHz for LTE and WiMAX.
- 2.5 On 9 July 2013, Ofcom published its Decision⁶ to permit the use of 4G technology in the 900 MHz, 1800 MHz and 2100 MHz frequency bands and to increase the maximum permitted power in the 900 MHz licences by 3 dB for UMTS and 4G technology. We said in the same statement that we would consider the requests from EE and H3G to increase the maximum permitted power of their 1800 MHz licences by 3 dB as part of a subsequent consultation.
- 2.6 Having received formal requests from EE and H3G, we asked Telefónica and Vodafone if they wished to request the same variation in respect of their licensed 1800 MHz spectrum. They both confirmed that they are requesting this same variation.

² <http://stakeholders.ofcom.org.uk/consultations/variation-1800mhz-lte-wimax/summary>

³ <http://stakeholders.ofcom.org.uk/consultations/variation-1800-MHz-lte-wimax/statement>

⁴ EE uses the frequencies 1826.7-1831.7 MHz until 30 September 2015, when those frequencies will transfer to H3G under the spectrum trade agreed between the parties in 2012.

⁵ <http://stakeholders.ofcom.org.uk/consultations/variation-900-1800-2100/>

⁶ <http://stakeholders.ofcom.org.uk/binaries/consultations/variation-900-1800-2100/statement/statement.pdf>

Legal Framework

- 2.7 The applicable legal framework derives from our duties under both European and domestic legislation, specifically from:
- the Common Regulatory Framework⁷ for electronic communications networks and services, in particular, the Framework Directive and the Authorisation Directive – together with a number of Decisions that apply to these specific spectrum bands; and
 - the Communications Act 2003 (the “2003 Act”) and the Wireless Telegraphy Act 2006 (the “2006 Act”) which transpose the provisions of those directives into national law.

European Law

- 2.8 There are a number of European Directives and Decisions that relate specifically to the 1800 MHz frequency band.
- 2.9 Article 14 of the Authorisation Directive requires that rights of use (in this case a wireless telegraphy licence) “may only be amended in objectively justified cases and in a proportionate manner, taking into consideration, where appropriate, the specific conditions applicable to transferable rights of use for radio frequencies”.
- 2.10 More generally, in carrying out our regulatory tasks, including considering the case for amending rights of use, we are required to take all reasonable measures which are aimed at achieving the objectives set out in Article 8 of the Framework Directive. Article 8 requires national regulatory authorities:
- to promote competition in the provision of electronic communications networks and services by, amongst other things ensuring that there is no distortion or restriction of competition in the electronic communications sector and by encouraging efficient use and ensuring the effective management of radio frequencies; and
 - to contribute to the development of the internal market by, amongst other things, removing obstacles to the provision of electronic communications networks and services at a European level and encouraging the interoperability of pan-European services.

The 2003 Act and the 2006 Act

Duties

- 2.11 The requirements of Article 8 of the Framework Directive are given effect to by our duties under the 2003 Act (in particular section 3 and 4) and the 2006 Act (in particular section 3).

⁷ The Common Regulatory Framework comprises the Framework Directive (Directive 2002/21/EC), the Authorisation Directive (Directive 2002/20/EC), the Access Directive (Directive 2002/19/EC), the Universal Service Directive (Directive 2002/22/EC) and the Directive on privacy and electronic communications (Directive 2002/58/EC), as amended by the Better Regulation Directive (Directive 2009/140/EC).

- 2.12 Our principal duty under the 2003 Act is to further the interests of citizens in communications matters, and the interests of consumers in relevant markets, where appropriate by promoting competition.
- 2.13 By virtue of our principal duty, we are required to secure (amongst other things) the optimal use for wireless telegraphy of the electro-magnetic spectrum, and the wide availability throughout the UK of a wide range of electronic communications services.
- 2.14 In performing those duties, we are also required to have regard to various matters where they appear to us to be relevant in the circumstances, including the desirability of promoting competition in relevant markets, the desirability of encouraging investment and innovation in relevant markets, and the desirability of encouraging the availability and use of high speed data transfer services throughout the UK.
- 2.15 In furthering the interests of consumers, we must have regard in particular to the interests of those consumers in respect of choice, price, quality of service and value for money.
- 2.16 In performing our principal duty, we must have regard in all cases to the principles under which regulatory activities must be transparent, proportionate, consistent and targeted only at cases in which action is needed.
- 2.17 The 2006 Act requires us, amongst other things, to have regard to the desirability of promoting the efficient management and use of the part of the electromagnetic spectrum available for wireless telegraphy. It also requires us to ensure that wireless telegraphy licence conditions are objectively justified in relation to the networks and services to which they relate, non-discriminatory, proportionate and transparent.

Powers

- 2.18 Section 9 of the 2006 Act gives Ofcom the power to grant wireless telegraphy licences subject to such terms as Ofcom thinks fit.
- 2.19 Schedule 1(6) of the 2006 Act gives Ofcom a general discretion to vary wireless telegraphy licences and sets out the process that Ofcom must follow.
- 2.20 Ofcom has a broad discretion under Schedule 1(6) of the 2006 Act to agree to vary licences but there are some limitations on that discretion. These include the following:
- UK obligations under EU law or international agreements where use of spectrum has been harmonised: Ofcom will not agree to remove restrictions from licences or other changes that would conflict with the UK's obligations under international law;
 - Ofcom must comply with any direction from the Secretary of State under section 5 of the 2003 Act or section 5 of the 2006 Act;
 - Ofcom must act in accordance with its statutory duties, including the duty to ensure optimal use of the spectrum;
 - General legal principles, which include the duties to act reasonably and rationally when making decisions and to take account of any legitimate expectations;
 - Any restrictions on variation contained in the relevant licences themselves, subject Schedule 1(8)(5) of the 2006 Act.

Process for considering licence variation requests

- 2.21 Article 14 of the Authorisation Directive requires that Member States must ensure that, except where proposed amendments are minor and have been agreed with the licensee:
- notice of the proposed change is given in an appropriate manner; and
 - interested parties, including users and consumers, are allowed a sufficient period of time to express their views on the proposed amendments (such time to be no less than four weeks except in exceptional cases).
- 2.22 Section 7 of the 2003 Act provides that where we are proposing to do anything for the purposes of or in connection with the carrying out of our functions, and it appears to us that the proposal is important, then we are required to carry out and publish an assessment of the likely impact of implementing the proposal, or a statement setting out our reasons for thinking that it is unnecessary to carry out such an assessment. Where we publish such an assessment, stakeholders must have an opportunity to make representations to us about the proposal to which the assessment relates.
- 2.23 The 2006 Act sets out in Schedule 1 a process for the variation of wireless telegraphy licences. In the case where a variation is proposed by the licensee, we are under no obligation (under the 2006 Act) to consult on the proposal.
- 2.24 The variation of licences in the 1800 MHz bands to allow an increase in the maximum permissible base station transmit power may not be considered to be a minor variation by interested third parties. On that basis, we published our proposal to vary these licences for consultation to give interested third parties an opportunity to make representations, and our assessment of the likely impact of doing so.

Framework for analysis of licence variation requests

- 2.25 When considering the requests for licence variations, we use an analytical framework which reflects our relevant regulatory objectives and our statutory duties. Of particular relevance to our assessment are our principal duties, which are to further the interests of citizens in relation to communications matters; to further the interests of consumers in relevant markets, where appropriate, by promoting competition; and to promote optimal use of spectrum.
- 2.26 In considering whether to grant the variation requests, we considered both the likely impact on competition of granting those variations and the likely impact on spectrum management, in particular the impact on existing licensed users in the same band or adjacent to the 1800 MHz band.

The interests of consumers

- 2.27 In deciding whether to vary the relevant licences as requested, we considered the extent to which varying those licences would:

- further the interests of consumers by, for example, encouraging innovation, investment and the availability and use of mobile services throughout the UK; and result in better choice, price, quality of service and value for money; and/or
- give rise to a material risk of a distortion of competition to the detriment of consumers such that any benefits to consumers resulting from varying those licences without delay would be outweighed by the detriment to consumers resulting from such a distortion of competition.

Impact on spectrum management

2.28 Ofcom's general policy is to set technical restrictions that are the minimum necessary to provide adequate protection against harmful interference. This is because optimal use of the radio spectrum is more likely to be secured if users decide, rather than Ofcom dictates, the way in which technology is used or a service is provided in a particular frequency band. Imposing the minimum necessary constraints will increase users' flexibility and freedom to respond to changing conditions and to make best use of the valuable spectrum resource. Following on from this, we have considered whether varying the relevant licences would be consistent with the minimum necessary to provide adequate protection against harmful interference.

Section 3

Assessment of the impact of the proposed variation, responses and decision

Considering the licence variation proposal

- 3.1 In the consultation, we considered whether the likely benefits to consumers from varying the 1800 MHz licences to increase the maximum permitted base station transmit power were likely to be outweighed by any negative effects on consumers as a result of a reduction in competition. For the reasons explained below, we did not consider that allowing a higher maximum permitted base station transmit power would result in any detriment to competition or other spectrum use. Accordingly, we did not consider that the proposed variation should result in any consumer detriment.

The interests of consumers

- 3.2 There are a number of potential benefits that an increase in maximum power could bring for an operator in providing service to consumers, including:
- improving coverage and/or capacity;
 - improving the ability to penetrate deeper into buildings; and
 - providing flexibility to coverage and traffic management, load balancing and efficient handovers between different network layers.
- 3.3 We understand that base stations, for the most part, operate at lower power than the maximum transmit powers contained in the licences. This reflects the fact that the base stations' transmit power is one of the key parameters used when optimising network performance. The optimal level will vary from site to site dependant on a number of factors including cell size, site distribution and traffic loading. Allowing a higher maximum permitted base station transmit power gives operators greater flexibility to organise their networks to meet customer demands and expectations.
- 3.4 To the extent that the additional flexibility provided by the increase may enable operators to provide improved quality of service and / or reduce the cost of providing a given level of service, our provisional conclusion in the consultation was that this may benefit consumers over time.

Competition considerations

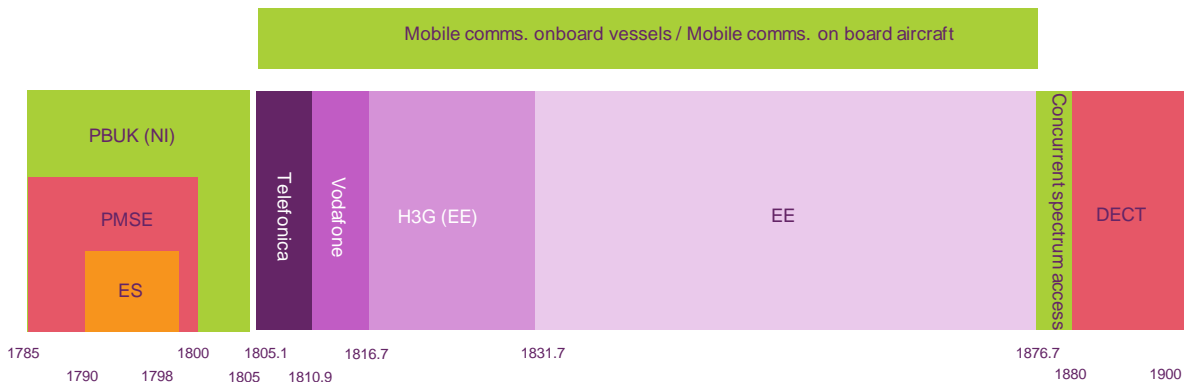
- 3.5 The 1800 MHz band is one of a number of frequency bands used by operators to provide mobile services to customers. We have previously granted similar licence variation requests to increase the maximum permitted power in the 900 MHz and 2100 MHz bands from 62 dBm per 5 MHz (or carrier) to 65 dBm per 5 MHz (or carrier). The effect of the change we proposed would be to increase the maximum permitted power in the 1800 MHz licence to the same level as that which already applies to the 900 MHz and 2100 MHz licences.
- 3.6 Accordingly, we provisionally considered that the increase at 1800 MHz is unlikely to distort competition in a way that harms consumers, noting also that, whether or not they are currently deploying (or intending to deploy) 4G services in this particular

band, all of the current national wholesale operators also have access to 3G/4G capable spectrum in several bands. Moreover, all four current national wholesale operators hold 1800 MHz licences and all four have requested that their licences be varied to increase the maximum permitted power.

Impact on spectrum management

- 3.7 We considered the impact on spectrum management; in particular whether varying the licence would be consistent with setting the technical conditions at the minimum necessary to provide adequate protection to potentially affected spectrum users (outlined in Figure 1) in, and adjacent to, the 1800 MHz base station downlink band against harmful interference. We provisionally concluded that there is unlikely to be a significant change in the existing interference environment experienced by current radio users operating in the same or adjacent band to the 1800 MHz band licensees if we allow a 3dB maximum power increase. Our analysis of the potential impact on these spectrum users is set out below. The detailed technical assessment we carried out for the consultation is at Annex 3.

Figure 1: Spectrum users currently authorised in 1785 - 1900 MHz



Northern Ireland licensee in 1785 – 1805 MHz

- 3.8 The band 1785 – 1805 MHz was awarded under a coordinated auction in Northern Ireland and Ireland in May 2007 to Personal Broadband UK (“PBUK”) on an unpaired and technology neutral basis.
- 3.9 Our assessment is that the minimal PBUK network deployment to date will not be impacted by the proposed 3 dB e.i.r.p. increase and our expectation is that current coordination arrangements would continue for future sites.

Programme Making and Special Events (PMSE) at 1785 – 1805 MHz

- 3.10 The band 1785 – 1800 MHz is available for licensed use by PMSE, primarily for wireless microphones. Currently, there is very limited PMSE assignment in this band. However, in March 2013, CEPT approved Report 50⁸ which deals with the technical conditions for the use of the bands 821 - 832 MHz and 1785 - 1805 MHz for wireless radio microphones, including the technical conditions to facilitate the use of PMSE equipment for EU-wide operations. This Report was developed in response to a mandate to CEPT from the European Commission on “Technical Conditions Regarding Spectrum Harmonisation Options for Wireless Radio Microphones and

⁸ CEPT Report 50, “Technical conditions for the use of the bands 821-832 MHz and 1785-1805 MHz for wireless radio microphones in the EU, March 2013”:

<http://www.eroocdb.dk/Docs/doc98/official/pdf/CEPTREP050.PDF>

Cordless Video-Cameras (PMSE Equipment).” Subsequently the European Commission has concluded that the bands 821-832 MHz and 1785-1805 MHz are to be harmonised for use by PMSE. Under an Implementing Decision to be published later this year, Member States will be required to ‘designate and make available, on a non-interference and non-protected basis, 823 to 832 MHz and 1785 to 1805 MHz for wireless audio PMSE’.

- 3.11 This may increase uptake of wireless microphones in the 1785 -1805 MHz band in the future. However, it is unclear to what extent these bands will provide additional capacity for wireless audio applications even though we will extend the authorisation of PMSE up to 1805 MHz on a non-interference, non-protected basis. We note that the use of these applications closer to the boundary with mobile services at 1805.1 MHz is at significant risk of interference under existing mobile licence conditions.
- 3.12 The dominant interference mechanism into PMSE from mobile services using the 1800 MHz licences is associated with indoor pico-cells, given that these have the potential to operate in close proximity to indoor wireless microphones, and not with macro-cells (this analysis is set out in CEPT ECC Report 191). Given that the proposed increase in permitted maximum power is not relevant to pico-cell operation (as these operate well below the current maximum permitted power level) we do not consider that an increase in the maximum permitted power level will impact materially on the interference environment for PMSE.
- 3.13 Nevertheless, we have assessed the impact of a 3 dB e.i.r.p. increase on wireless microphone receivers using a minimum coupling loss (MCL) analysis (detailed in Annex 3). This derives a required separation distance between macro base station and PMSE receiver for satisfactory operations both indoors and outdoors. It uses worst case assumptions in that the PMSE system is assumed to be operating at the edge of its own coverage; it also assumes that the PMSE device is operating in the first (licensed) channel adjacent to 1800MHz. The assessment covers both rural and urban environments to capture the two extremes of radio wave propagation conditions.
- 3.14 The results of our analysis (Table A5 in Annex 3) suggest that:
 - for urban deployment scenarios, the worst case separation distance when e.i.r.p. increases by 3 dB compared to current limits remains small i.e. from ~100 m to ~115 m (~15%) for indoor PMSE receivers and from ~185 m to ~225 m (~ 22%) for outdoor PMSE receivers;
 - for rural deployment scenarios, the worst case separation distance is larger than in urban cases (~1510 m at the current limit). With a 3 dB power increase the worst case separation distance increases to ~1835 m (~22%) in the outdoor case. These separation distances are still relatively small compared to cell range in rural environment which is typically 10-20 km¹⁰. More significantly, the probability of a PMSE system operating at the edge of its own coverage whilst also being closer (than the above separation distances) to a macro base station would be small. In addition, PMSE could implement mitigation measures such as moving to other channels which are further away in frequency from the mobile base station (than the first adjacent channel to 1800 MHz).

⁹ ECC Report 191, “Adjacent band compatibility between MFCN and PMSE audio applications in the 1785-1805 MHz frequency range, September 2013”:

<http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP191.PDF>

¹⁰ H. Holma, A. Toskala, John Wiley & Sons Ltd., 2009, “LTE for UMTS: OFDMA and SC-FDMA based radio access”

- 3.15 Our provisional conclusion was that there would be no significant impact on current and future PMSE use in 1800 MHz band if we allow a 3 dB increase in maximum e.i.r.p. of mobile base stations.

Emergency services at 1790 – 1798 MHz

- 3.16 The Home Office is currently using the 1790 – 1798 MHz band for emergency services. Our discussions with the Home Office indicate that any potential impact of the 3 dB e.i.r.p. increase will be managed by bilateral discussion between Home Office and the relevant 1800 MHz licensees.

Concurrent spectrum access (CSA) licensees at 1876.7 – 1880 MHz

- 3.17 The paired 1781.7 – 1785 MHz (uplink) and 1876.7 - 1880 MHz bands (downlink) (also referred to as “the DECT Guard band”) were awarded to 12 licensees for CSA in April 2006 on a technology neutral basis.
- 3.18 The technical licence conditions were set based on GSM spectrum emission mask and are feasible for low power (pico-cells) deployments. We understand that current deployments in the 1876.7 - 1880 MHz are based on GSM technology.
- 3.19 As the coexistence between different cellular network technologies is dealt with by the relevant technology standard organisation¹¹, the impact to CSA downlink at 1876.7 - 1880 MHz due to 1800 MHz base station e.i.r.p. increase will not be any greater than the impact to 1800 MHz base stations downlink operating adjacent to another 1800 MHz licensee (and implementing a power increase) when both are operating on an uncoordinated basis. The same considerations would apply if the technology used in the DECT Guard band were to change from GSM to LTE.
- 3.20 Therefore, our provisional conclusion was that there will be no significant additional impact to CSA licensees in 1876.7 - 1880 MHz band if we allow a 3 dB increase in maximum e.i.r.p. of 1800 MHz base stations.

Digitally Enhanced Cordless Telephones (DECT) at 1880 – 1900 MHz band

- 3.21 The band 1880 – 1900 MHz is authorised on a licensed exempt basis for DECT for private self-provided communication implementing Commission Decision of 9th July 1997 on a common technical regulation for DECT.
- 3.22 We have conducted minimum coupling loss analysis as outlined in Annex 3 to compare the increase in required separation distance between macro base station and DECT receivers operating both indoors and outdoors with a 3 dB e.i.r.p. increase as compared to existing limit.
- 3.23 The results of our analysis for the first adjacent DECT carrier (Table A7 of Annex 3) suggest that:
- for urban deployment scenarios with a 3 dB higher e.i.r.p., the worst case separation distance remains small i.e. increases by ~15% (from ~100 m to ~115 m) for DECT outdoor use;
 - for rural deployment scenarios, the worst case separation distance increases by ~22% (from ~800 m to ~975 m) with a 3 dB higher e.i.r.p. for DECT outdoor use. This suggests that DECT outdoor use could be impacted with the current as well

¹¹ <http://www.3gpp.org/>

as the requested higher e.i.r.p. (although the separation distance of ~975 m is still very small compared to cell range in a rural environment which is typically 10-20 km⁷ and the probability of macro base station and DECT systems operating in such close proximity would be small). In practice, the impact is likely to be minimal for the reasons below.

- 3.24 The typical use of DECT is indoors and the ability to use DECT outdoors is primarily governed by the coverage of the DECT transmitters inside the house. The worst case separation distance for the first one or two adjacent DECT carriers may suggest a reduction in DECT reception range on these carriers. In such occurrences, the dynamic channel allocation feature of DECT enables detection of interference on these carriers and should shift the DECT operation to any of the eight distant carriers, thereby operating at its maximum range and without loss in capacity. Moreover, as indicated in CEPT Report 41, the potential for interference is likely to exist from indoor pico-cells which have the potential to operate in close proximity to indoor DECT operating in the adjacent channel.
- 3.25 It should also be noted that the assumptions we have used for DECT receiver selectivity err on the conservative side and that actual systems are likely to have better selectivity than used in our analysis as highlighted in literature review (see Annex 3).
- 3.26 Our provisional conclusion was that a 3 dB increase in maximum e.i.r.p. of base stations has no additional significant impact on the operation of DECT as compared to the current limit.

Mobile communication services on-board vessels (MCV) and aircraft (MCA)

- 3.27 MCV and MCA services are currently authorised to operate on a licence exempt basis in the 1800 MHz band to provide mobile communication on-board ships and aircraft.
- 3.28 MCV provides mobile connectivity from vessel based base station where coverage from land based base stations end. Similarly, MCA provides mobile connectivity on-board aircrafts at altitudes above 3000 meters.
- 3.29 Due to the nature of operation and separation distances between these services and terrestrial mobile base stations, there is unlikely to be any impact of the proposed 3 dB e.i.r.p. increase on MCV and MCA.

Emissions from cellular base stations

- 3.30 Emissions near to mobile base stations¹² have been consistently found to be only a small fraction of the safety levels for exposure published by Public Health England¹³ (formerly the UK Health Protection Agency) which refer to levels set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). No installation tested by us has exceeded 0.5% of the specified emission safety level (i.e. the highest measurement was still a factor of 200 times smaller than the ICNIRP limit) and in recent years, the results¹⁴ have been consistently found to be significantly less than this.
- 3.31 In our Statement⁴ on the requests for the variation of 900, 1800, 2100 MHz mobile licences published on 9 July 2013 (para 4.5 and footnote 17), we considered that the

¹² <http://stakeholders.ofcom.org.uk/sitefinder/audit-info>

¹³ <http://www.hpa.org.uk/>

¹⁴ <http://stakeholders.ofcom.org.uk/sitefinder/mobile-base-station-audits/>

power flux density that could be created by a site with multiple antennas operating simultaneously at different frequencies with the maximum permissible power levels increased by 3 dB at all frequencies represented a very small proportion of the ICNIRP limit.

Provisional conclusion

3.32 Based on the above, our provisional conclusion was that there is unlikely to be a significant change in the existing interference environment experienced by current radio services operating in the same band or adjacent to the 1800 MHz licensees if we allow a 3 dB increase in the maximum e.i.r.p. of base stations.

3.33 In addition, the following points are also of relevance:

- the primary use of PMSE (wireless microphone) and DECT is mainly indoors and the associated building penetration losses provide adequate protection from outdoor macro base station located in close proximity;
- the 3 dB higher e.i.r.p. is only relevant for macro base stations and it is unlikely that these higher powers will be used on all base stations and at all times (in fact, we note that the majority of macro base stations operate at significantly less than the current, maximum permissible power level);
- the assumptions that we have used for DECT receiver characteristics are quite conservative and the actual systems are likely to have better selectivity than used in our analysis as highlighted by literature review;
- additional factors such as minimal use and availability of multiple PMSE channels in 1800 MHz band and DECT's inherent interference avoidance feature (by channel switching) further minimises wider compatibility and coexistence issues.

Consultation proposal

3.34 In the consultation, we proposed to vary the 1800 MHz Public Wireless Network licences of EE, H3G, Telefónica and Vodafone to increase the maximum permissible base station transmit power from 62 dBm per carrier to 65 dBm per carrier for UMTS and from 62 dBm per 5 MHz to 65 dBm per 5 MHz for LTE and WiMAX in the 1800 MHz band.

3.35 We asked stakeholders to consider the following question:

Question 1 : Do you agree with the proposal to vary the 1800 MHz Public Wireless Network licences to increase the maximum permissible downlink transmit power (e.i.r.p.) by 3 dB from 62 dBm per carrier to 65 dBm per carrier for UMTS and from 62 dBm per 5 MHz to 65 dBm per 5 MHz for LTE and WiMAX technologies?

Responses to the consultation

3.36 We received five responses including one submitted on a confidential basis. The non-confidential responses, from an individual, EE, H3G and the Low Power Radio Association (LPRA) were published on our website¹⁵.

3.37 The individual respondent, EE and H3G supported the proposal to vary the licences, as did the confidential response.

¹⁵ [Responses](#)

- 3.38 EE supported the analysis set out in the consultation document and observed that Ofcom's analysis assumed a worst case, widest LTE channel (20 MHz). EE stated that their *"...own supplier discussions suggest macro equipment adjacent channel emissions performance sufficiently exceeds minimum 3GPP requirements not to be of concern on a 3dB increase in maximum permissible base station power"*.
- 3.39 H3G referred to the detail supplied in its original variation request which noted that potential benefits (also identified in the previous consultation for increasing the maximum permissible power for 900 MHz licences) included improved coverage and capacity, improved indoor coverage and greater ability to manage handover between network layers operating at different frequencies. H3G further observed that several European countries (including Germany, Portugal, Finland) do not set specific maximum power limits while others (such as Sweden) set a limit that is substantially higher than that proposed by this consultation, stating that to grant the variation *"...would not be inconsistent with existing European practices"*. H3G also noted that as the maximum power would align with similar levels in other frequency bands (such as 2100 MHz), the proposed increase *"...is unlikely to make a material change in the emission level..."* relative to the emission safety levels published by the Public Health England.
- 3.40 The LPRA did not agree with the proposal. The LPRA referred to short range device (SRD) equipment in the 863-868 MHz band, and said that the performance of this equipment was being compromised by interference from LTE equipment in the 832-862 MHz band. It noted ongoing work in European standards bodies (CENELEC and ETSI) to investigate reasons for the interference and make proposals to mitigate it. Until that work has been concluded the LPRA said it considered it inappropriate to increase the maximum power for another LTE band (ie the 1800 MHz band), which is also adjacent to SRD equipment.
- 3.41 We are aware of work in ETSI and CENELEC aimed at supporting introduction of LTE services in the 800 MHz band. The main issue, described in draft ECC Report 207¹⁶, is the probability of close proximity between SRDs (including wireless microphones), operating in 863-870 MHz, and directly adjacent LTE user equipment (eg handsets), operating below 862 MHz. The ETSI-CENELEC working group has not yet published its conclusions.
- 3.42 The situation is different for the 1800 MHz band. The mobile spectrum starting at 1805.1 MHz is used for the base station transmit signal (not for handset transmit as in the case of the adjacency at 863 MHz to which the LPRA refers). In addition, the main interference mechanism into PMSE from mobile services above 1805.1 MHz will be from pico-cells and not from macro-cells because pico-cells will operate in closer physical proximity to PMSE devices. By definition, the operation of pico cells will not be altered by an increase in the maximum permitted power in the licence (since they operate well below the current maximum anyway). The potential impact on licensed PMSE use from a power increase at mobile base stations was considered in the consultation and is discussed at paragraphs 3.10 – 3.15 above and Annex 3.
- 3.43 As set out above, we provisionally concluded that there is no significant impact to current and future PMSE use adjacent to the 1800 MHz band if we allow a 3 dB increase in maximum e.i.r.p. of mobile base stations. The LPRA response does not challenge that technical assessment and we do not consider that work on interference from LTE user equipment in the 800 MHz band is directly relevant to the

¹⁶ *Adjacent band co-existence of SRDs in the band 863-870 MHz in light of the LTE usage below 862 MHz*,
<http://www.erodocdb.dk/doks/filedownload.aspx?fileid=4035&fileurl=http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP207.PDF>

consideration of an increase to the in-band power levels for base stations in the 1800 MHz band.

Decision

- 3.44 We have carefully considered the responses to the consultation. None of the responses have given us reason to change our provisional conclusions, set out in the consultation.
- 3.45 We have therefore decided to grant the request to vary the 1800 MHz licences to permit a maximum base transmit power in the FDD portion of the 1800 MHz spectrum of 65 dBm for UMTS; and 65 dBm per 5 MHz for LTE and WiMAX technologies.
- 3.46 We will apply the variation to licence schedules as soon as practicable by substituting these values in the relevant tables of power limits. The finalised variation is at Annex 2.

Glossary

ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
CENELEC	European Committee for Electrotechnical Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
CSA	Concurrent Spectrum Access
dB	Decibel
DECT	Digitally Enhanced Cordless Telephones
e.i.r.p	Effective Isotropic Radiated Power
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
GSM	Global System for Mobile Communications
LPRA	Low Power Radio Association
LTE	Long Term Evolution
MCA	Mobile communication services on-board aircraft
MCL	Minimum coupling loss
MCV	Mobile communication services on-board vessels
MHz	Megahertz
OOB	Out of band
PMSE	Programme-making and special events
SRD	Short Range Device
UMTS	Universal Mobile Telecommunications System
WiMAX	Worldwide Interoperability for Microwave Access

Annex 2

Variation to 1800 MHz licences

A2.1 We now intend to replace the table of values for the maximum permissible downlink transmit power in Schedule 1 of each of EE, H3G, Telefónica and Vodafone's Public Wireless Network Licences to reflect the decision to allow an increase of the maximum permitted power.

A2.2 The amended table is shown below:

Maximum Permissible Downlink Transmit Power

The power transmitted (in e.i.r.p.) in any direction on the downlink frequencies of the Permitted Frequency Blocks by the Radio Equipment shall not exceed:

Technology	900 MHz spectrum	1800 MHz spectrum
for GSM	62 dBm per carrier	62 dBm per carrier
for UMTS	65 dBm per carrier	65 dBm per carrier
for LTE	65 dBm per 5 MHz	65 dBm per 5 MHz
for WiMAX	65 dBm per 5 MHz	65 dBm per 5 MHz

Detailed technical assessment

Introduction

- A3.1 This annex presents the technical assessment relating to the impact of a 3 dB increase in e.i.r.p. of 1800 MHz mobile base stations on PMSE and DECT systems operating adjacent to the 1800 MHz band.
- A3.2 The maximum permissible e.i.r.p. currently allowed in the 1800 MHz licences for UMTS is 62 dBm per carrier and 62 dBm per 5 MHz for LTE and WiMAX systems.
- A3.3 In our assessment, the following two mechanisms¹⁷ have been considered that may be used to achieve a 3 dB increase in e.i.r.p.:
- higher gain antennas; or
 - higher transmission power.
- A3.4 We first reviewed the previous relevant compatibility studies carried out in CEPT on this subject and noted that the results of these studies may not be directly applicable to our technical analysis. The main differences being the assumed maximum e.i.r.p. of mobile base stations and frequency offsets between base stations and PMSE/DECT systems.
- A3.5 We have conducted further analysis with revised assumptions that are in line with UK's deployment scenarios. Also, some of the key parameters such as ACS of victim systems (PMSE and DECT) and ACLR of mobile base stations are modified to reflect practical values and frequency offsets applicable to UK spectrum allocation.
- A3.6 This annex is structured as follows:
- Review of previous CEPT studies
 - System modelling and technical parameters
 - Methodology and results
 - Provisional conclusion

¹⁷ This will have impact on the out of band emissions of base stations and therefore the resulting ACLR. This is further explained in A6.25.

Review of previous CEPT studies

A3.7 In this section, we revisit the findings of relevant previous compatibility studies carried out in CEPT between mobile base station and PMSE/DECT systems, particularly for the scenario of outdoor macro base stations where a 3 dB increase in e.i.r.p. would be applicable.

PMSE

A3.8 The most recent and relevant study on the adjacent band compatibility between mobile base station and PMSE systems (wireless microphones) is ECC Report 191⁸. All possible deployment scenarios between wireless microphones in 1785 - 1805 MHz and LTE/GSM base stations operating in adjacent 1805 - 1880 MHz band are studied.

A3.9 For PMSE outdoor operations in the presence of outdoor base stations, the report concludes that:

- a separation distance of 100 m is sufficient to ensure that PMSE has the possibility to find an operational channel;
- the impact of base stations is negligible for frequency offsets larger than 1 MHz and 100 m separation distance.

A3.10 For PMSE indoor operations, the probability of interference is considerably low due to building/wall penetration losses.

DECT

A3.11 We have reviewed ERC Report 100¹⁸, ECC Report 96¹⁹ and CEPT Report 41²⁰ that present the compatibility evaluation of GSM, UMTS, LTE/WiMAX technologies and DECT systems, respectively.

A3.12 ERC Report 100 deals with the interference of GSM1800 base stations to DECT systems operating in the adjacent band. Interference scenarios evaluated include macro base station to indoor and outdoor (below roof-top installations) DECT systems. The report concludes that:

- in most cases, the base station interference to DECT systems only affect one or two of the available ten DECT carriers. However, dynamic channel allocation mechanism allows DECT to avoid this interference with negligible impact on capacity;
- the report also notes that actual DECT receivers may have a 6-10 dB better blocking performance than the minimum specifications in ETSI standards.

A3.13 ECC Report 96 extends the findings of ERC Report 100 to UMTS systems by using a statistical modelling approach. It also notes that actual GSM1800 MHz deployment

¹⁸ ERC Report 100, "Evaluation of DECT/GSM1800 compatibility, February 2000":

<http://www.eroocdb.dk/Docs/doc98/official/pdf/REP100.PDF>

¹⁹ ECC Report 96, "Compatibility between UMTS 900/1800 and systems operating in adjacent bands, April 2007": <http://www.eroocdb.dk/Docs/doc98/official/pdf/ECCREP096.PDF>

²⁰ CEPT Report 41, "Compatibility between LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands) and systems operating in adjacent bands, November 2010":

<http://www.eroocdb.dk/docs/doc98/official/pdf/CEPTRep041.pdf>

required no additional measures for protection of DECT systems. The report concludes that:

- for DECT indoor operations, in the presence of outdoor UMTS base stations, separation distance of 700 m is required for the interference probability to be within acceptable limits ($\leq 5\%$).

A3.14 CEPT Report 41 extends the compatibility study to LTE and WiMAX technologies and notes compatibility issues to be similar with GSM and UMTS technologies. It concludes that:

- results presented in ERC Report 100 and ECC Report 96 are also valid for LTE and WiMAX technologies;
- dynamic channel allocation mechanism enables DECT to detect interference on closest carrier(s) and escape to more distant carrier(s) hence, no guard band is required between LTE/WiMAX and DECT allocations.

Summary of review

A3.15 Review of recent literature suggests that PMSE and DECT systems have in general a good compatibility with mobile base stations. However, we also note that the results of these studies may not be directly applicable to our technical analysis. The main differences are:

- assumed maximum e.i.r.p. of base stations is less than the 65 dBm per 5 MHz that is relevant to our assessment;
- assumed frequency offsets between base stations and PMSE/ DECT systems are less than those actually deployed in the UK;
- assumed base station heights are much greater than average cellular network deployment in the UK.

A3.16 Therefore, we have revised the above assumptions and conducted minimum coupling loss analysis to assess the impact with a 3 dB increase in e.i.r.p. of macro base stations. We have also revised the ACS of PMSE/ DECT receivers and ACLR of mobile base stations to reflect practical values and frequency offsets applicable to UK.

System modelling and technical parameters

A3.17 In this section, we provide the relevant band plans, system parameters and key assumptions used in our technical analysis.

Band plan

A3.18 PMSE and DECT band plans with their respective adjacency to mobile base stations downlink allocation are illustrated in Figure A1 and A2, respectively.

Figure A1: PMSE band plan

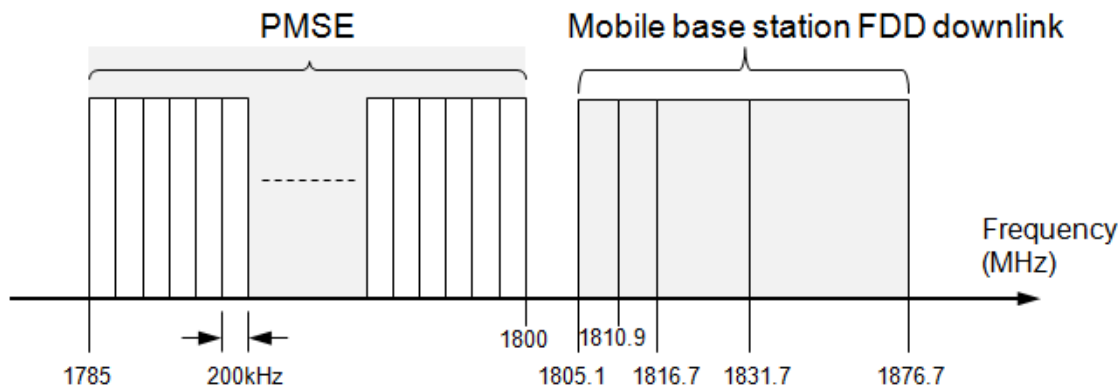
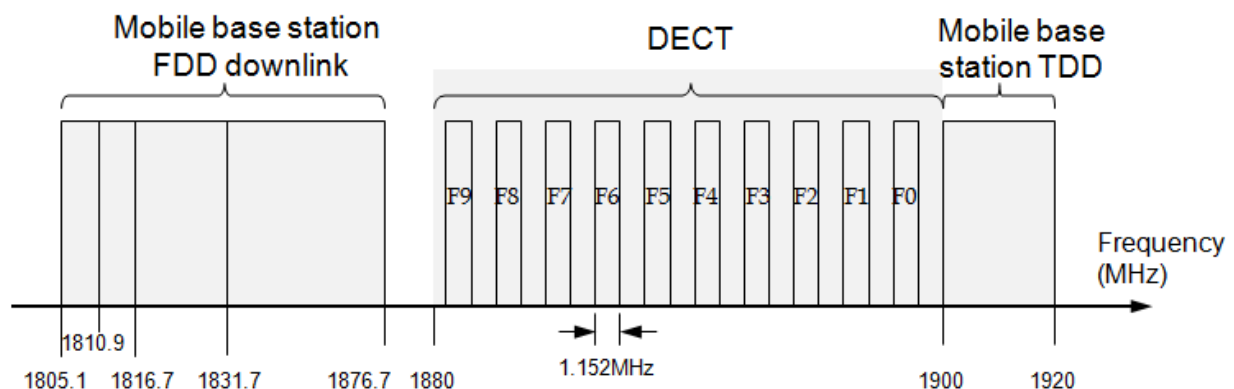


Figure A2: DECT band plan



PMSE and DECT receiver parameters

A3.19 The primary use of PMSE in 1785 - 1800 MHz is wireless microphones. These are either handheld or body worn PMSE wireless microphones with integrated or body worn transmitters.

A3.20 DECT is mainly used for providing local cordless phone coverage in both home and corporate environments. DECT base stations are normally located indoors however few that are installed outdoors are typically positioned below rooftops.

A3.21 PMSE and DECT parameters used in our technical assessment are listed in Table A1. For PMSE, these have been extracted from ECC Report 191 while ETSI TR 103 089²¹ has been used for DECT parameters.

²¹ ETSI TR 103 089 v1.1.1, "Digital Enhanced Cordless Telecommunications (DECT); DECT properties and radio parameters relevant for studies on compatibility with cellular technologies

Table A1: PMSE (wireless microphone) and DECT receiver parameters

Parameter	PMSE		DECT	
Receive Bandwidth	0.2 MHz		1.152 (~1) MHz	
Reference sensitivity	-90 dBm		-93 dBm	
Thermal noise level	-121 dBm		-114 dBm	
Noise figure	6 dB		11 dB	
Noise floor	-115 dBm		-103 dBm	
Interference protection level	-115 dBm		-103 dBm	
Antenna height	3 m		1.5 m	
Antenna gain	0 dBi		0 dBi	
ACS (edge-to-edge frequency offset)	=1 MHz	> 5MHz	= 3.3 MHz (F9)	>3.3 MHz (F8-F0)
	60 dB	70 dB ²²	63 dB ²³	64 dB ¹⁹

Base stations parameters

- A3.22 The mobile base station out of band (OOB) emission limits are defined in the relevant technology standards. For LTE, WiMAX and UMTS technologies, these limits are set in 3GPP TS36.104²⁴, IEEE 802.16²⁵ and 3GPP TS25.104²⁶, respectively. For the commonly deployed channel bandwidths of 5, 10, 15 and 20 MHz, these limits are identical, thereby making the technical analysis presented in this annex equally applicable to LTE, WiMAX and UMTS technologies.
- A3.23 The base stations OOB emission limits used in ECC Report 191 which deals with PMSE compatibility also takes into account the improved attenuation due to duplex filters at a frequency offset more than 4 MHz from channel edge. Considering the natural/realistic decay of OOB emission²⁷, we have used the same attenuation in our technical analysis when deriving the ACLR for both PMSE and DECT receiver bandwidths.

operating on frequency blocks adjacent to the DECT frequency band. January 2013”:

http://www.etsi.org/deliver/etsi_tr/103000_103099/103089/01.01.01_60/tr_103089v010101p.pdf

²² Table A5.6 in Ofcom Technical Report, “TV white spaces: approach to coexistence, September 2013”: <http://stakeholders.ofcom.org.uk/binaries/consultations/white-space-coexistence/annexes/technical-report.pdf>

²³ We have used the improved blocking performance of 6 dB as compared to the value derived from ETSI standard and used in CEPT Report 41. This is based on the practical tests results in ERC Report 100 which indicated that measured DECT device has blocking performance 6 to 17 dB better than the values in the ETSI standard.

²⁴ 3GPP TS 36.104 v.12.2.0, “Technical Specification Group Radio Access Network; E-UTRA; Base station (BS) radio transmission and reception (Release 12), January 2014”:

<http://www.3gpp.org/DynaReport/36104.htm>

²⁵ IEEE 802.16, “IEEE Standard for Air Interface for Broadband Wireless Access Systems, 2012”:

<http://standards.ieee.org/about/get/802/802.16.html>

²⁶ 3GPP TS 25.104 v12.2.0 (2013-12), “Technical Specification Group Radio Access Network; Base station (BS) radio transmission and reception (FDD) (Release 12), December 2013”:

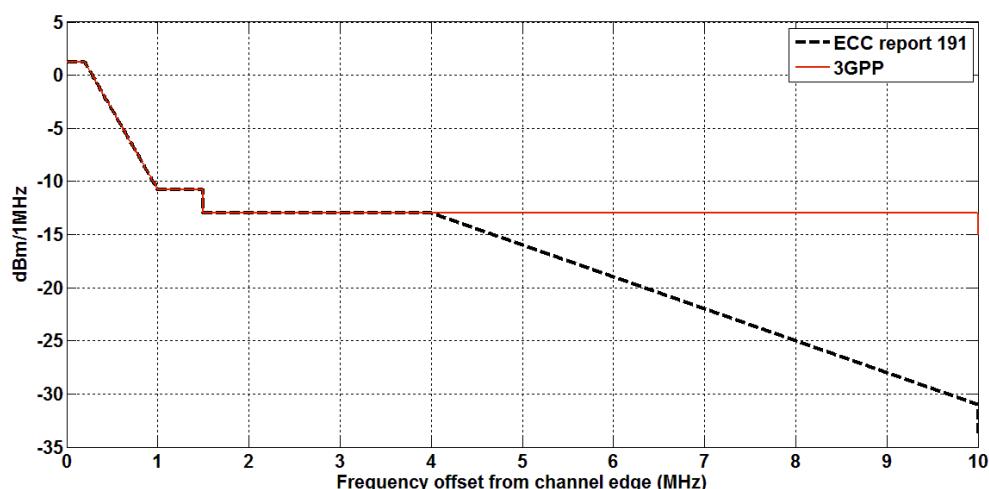
<http://www.3gpp.org/DynaReport/25104.htm>

²⁷ Para 5.21 in Ofcom Technical Report, “Technical analysis of interference from mobile network base stations in the 800 MHz band to digital terrestrial television - Further modelling, 23 February 2012”:

<http://stakeholders.ofcom.org.uk/binaries/consultations/949731/annexes/DTTCo-existence.pdf>

A3.24 A comparison of OOB emission limits based on 3GPP standard and ECC Report 191 is shown in Figure A3.

Figure A3: Comparison of spectrum emission mask for macro base stations



A3.25 As indicated earlier, we have modelled the impact of 3 dB increase in e.i.r.p. that could be implemented using two mechanisms (higher gain antennas or higher transmission power). These have different impacts on the resulting ACLR:

- **higher gain antennas** - deployment of antennas with higher gain results in higher in-band and out-of-band e.i.r.p. Hence, antennas with 3 dB higher gain than currently used will increase both the in-band and out-of-band e.i.r.p. by 3 dB. Therefore, the ACLR remains the same as with the current limits;
- **higher transmission power** - the in-band e.i.r.p. can be increased by providing higher transmission power at the antenna port. Contrary to higher gain antennas, this method does not affect the absolute out-of-band power limits specified in the 3GPP standard and therefore maximum out-of-band e.i.r.p. remains the same. This results in a 3dB increase in ACLR.

A3.26 Table A2 lists the LTE macro base station parameters that have been used in our technical assessment.

Table A2: LTE macro base station parameters

Parameter	Current limits	3 dB e.i.r.p. increase	
		Higher gain antennas	Higher transmission power
Maximum transmit power	47 dBm	47 dBm	50 dBm
Antenna gain include losses	15 dBi	18 dBi	15 dBi
Antenna height	20 m ²⁸		
Bandwidth	5 MHz		

Methodology and Results

A3.27 We have used Minimum Coupling Loss (MCL) approach for the technical assessment. MCL is the required isolation (in dB) between a mobile base station

²⁸ UK contribution to ITU-R WP5D, "Base station antenna heights for IMT-Advanced systems, July 2013": <http://www.itu.int/md/R12-WP5D.AR-C-0274/en>

(interferer) and DECT/PMSE (victim) receiver to meet the required interference threshold.

- A3.28 The required isolation is then converted to a minimum separation distance for the interfering base station to victim receiver link by using appropriate propagation models. In our analysis, we have used Extended Hata²⁹ urban and rural propagation model. MCL approach can be summarised as:

$$isolation\ (dB) = P_{INT} + G_{VICT} + G_{INT} - I_{VICT} - ACIR$$

where:

P_{INT} is the maximum transmit power of the interferer;

G_{VICT} and G_{INT} are the net antenna gain (including feeder loss) of victim and interferer, respectively;

I_{VICT} is the interference protection level at the victim receiver;

$ACIR$ is given by $ACIR^{-1} = ACLR^{-1} + ACS^{-1}$ (linear).

- A3.29 In our analysis, three cases relating to the maximum e.i.r.p. of macro base station are considered and listed in Table A3 below. These cases apply to both PMSE and DECT results.

Table A3: Considered cases for macro base station maximum e.i.r.p.

Case	Description	Maximum e.i.r.p. (dBm / 5MHz) (transmit power + antenna gain)
A	Current licence e.i.r.p. limit	47 dBm+15 dBi
B	e.i.r.p.increase via higher gain antennas	47 dBm+ 18 dBi
C	e.i.r.p. increase via higher transmit power	50 dBm +15 dBi

- A3.30 The predominant use of PMSE and DECT is indoors. However, for completeness, both indoor and outdoor deployment scenarios have been considered. For each case listed in Table A3, results are produced for rural and urban environments to model the two extremes of propagation conditions:

- urban: outdoor base station and indoor PMSE/DECT receiver (**urban indoor**);
- urban: outdoor base station and outdoor PMSE/DECT receiver (**urban outdoor**);
- rural: outdoor base station and indoor PMSE/DECT receiver (**rural indoor**);
- rural: outdoor base station and outdoor PMSE/DECT receiver (**rural outdoor**).

- A3.31 A 10 dB building attenuation³⁰ is assumed when the victim receiver is indoors and interfering transmitter is outdoors.

²⁹ European Radiocommunication Office (ERO), “The COST231-Hata SE21 model, SEAMCAT implementation of Extended Hata and Extended Hata-SRD models”:
http://tractool.seamcat.org/raw-attachment/wiki/Manual/PropagationModels/ExtendedHata/Hata-and-Hata-SRD-implementation_v1.pdf

³⁰ Based on value used in ECC Report 191. This value is within the range of the building penetration loss value considered in Ofcom Technical Report, “Assessment of future mobile competition and award of 800 MHz and 2.6 GHz, Annex 7-12, 24 July 2012”:
<http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/Annexes7-12.pdf>

Results

PMSE

A3.32 Table A4 and A5 show the required isolation and separation distances for the three cases of macro base station e.i.r.p. limits, respectively.

A3.33 The frequency separation (MHz) refers to the gap between the PMSE channel edge and the band edge of the mobile base station. To illustrate the most critical case, we have considered the first PMSE adjacent channel that is centred at 1879.9 MHz; resulting in a 5.1 MHz of edge-to-edge frequency separation.

Table A4: Required isolation between PMSE and macro base station

Frequency separation (MHz)	Case	ACS (dB)	ACLR (dB)	ACIR (dB)	Required isolation (dB)	
					Indoor	Outdoor
5.1	A	70	70.3	67.1	99.9	109.9
5.1	B	70	70.3	67.1	102.9	112.9
5.1	C	70	73.3	68.3	101.7	111.7

Table A5: Separation distance for PMSE channel closest to mobile base station band

Frequency separation (MHz)	Case	Urban (m)		Rural (m)	
		Indoor	Outdoor	Indoor	Outdoor
5.1	A	~100	~185	~785	~1510
5.1	B	~115	~225	~955	~1835
5.1	C	~100	~210	~880	~1700

A3.34 For the urban cases, it can be seen that there is a small increase in required separation distances when e.i.r.p. increases by 3 dB compared to current limits. The distance increases by ~15 m and ~40 m for urban indoor and outdoor, respectively.

A3.35 For the rural cases, the increase in separation distances is relatively large as compared to urban cases. The distance increases by ~170 m and ~325 m for rural indoors and outdoors, respectively. This is in line with the much larger cell ranges in rural environments due to better propagation conditions than urban environments (i.e. 10-20 km in rural as compared to 1-2 km in urban⁷).

DECT

A3.36 DECT supports ten carriers each about 1 MHz as illustrated in Figure A2. The ACLR of mobile base station and ACS of DECT receiver for all carriers (F9-F0) is given in Table A6. These have been calculated by using the spectrum emission mask of Figure A3 for both 5 MHz and 20 MHz channel bandwidths.

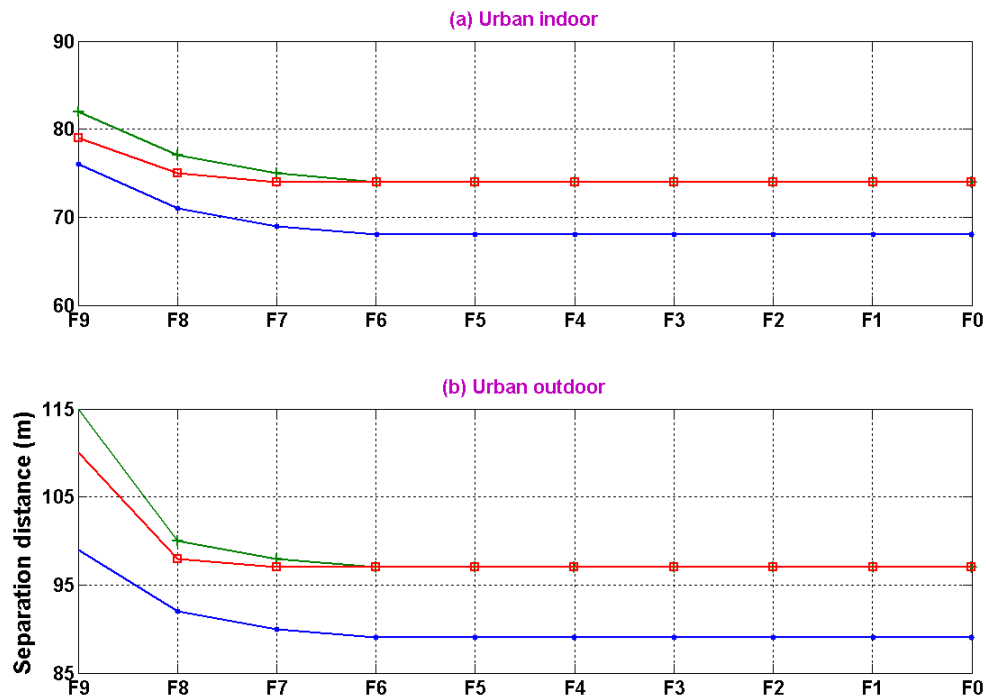
Table A6: ACS (DECT) and ACLR (mobile base station) for all DECT carriers

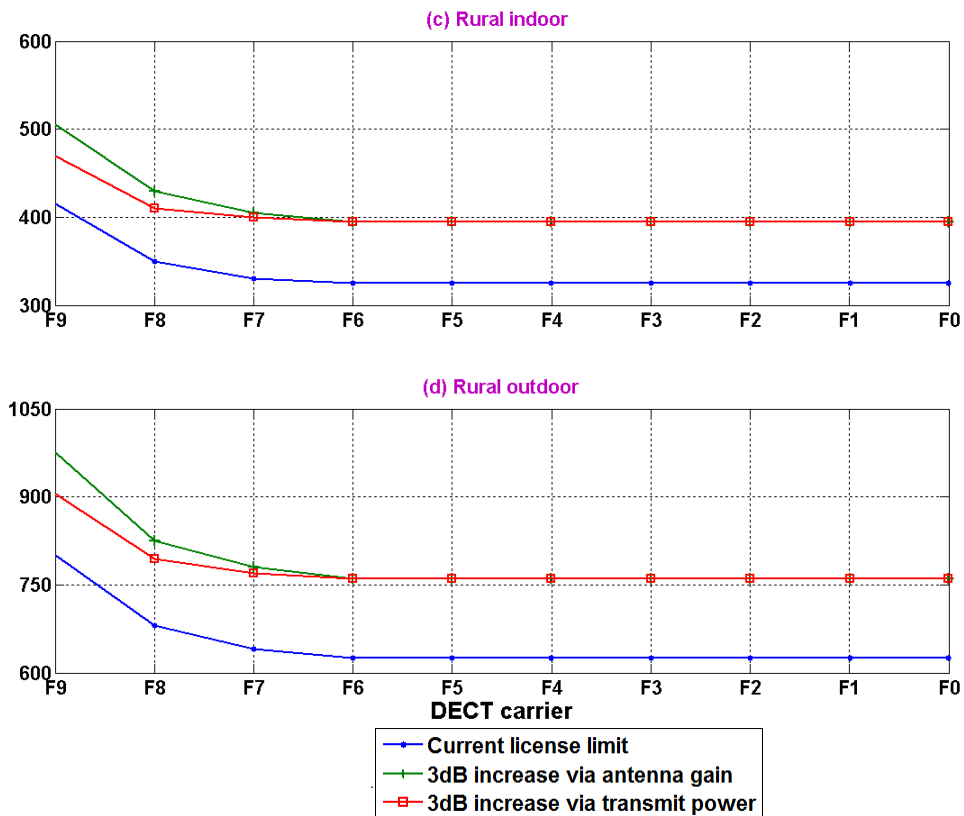
DECT carrier index	DECT carrier frequency (MHz)	ACS (dB)	ACLR (dB) Case A		ACLR (dB) Case B		ACLR (dB) Case C	
			5 MHz	20 MHz	5 MHz	20 MHz	5 MHz	20 MHz
F9	1881.792	63	63.3	69.3	63.3	69.3	66.3	72.3
F8	1883.52	64	68.5	74.5	68.5	74.5	71.5	77.5
F7	1885.248	64	73.6	79.6	73.6	79.6	76.6	82.6
F6	1886.976	64	81.8	87.8	81.8	87.8	84.8	90.8
F5	1888.704	64	86.8	92.8	86.8	92.8	89.8	95.8
F4	1890.432	64	91.81	97.81	91.81	97.81	94.81	100.81
F3	1892.16	64	96.8	102.8	96.8	102.8	99.8	105.8
F2	1893.888	64	101.8	107.8	101.8	107.8	104.8	110.8
F1	1895.616	64	106.9	112.9	106.9	112.9	109.9	115.9
F0	1897.344	64	134	140	134	140	137	143

MCL results for mobile base stations with 5 MHz channel bandwidth

A3.37 The minimum separation distances required between macro base station (5 MHz bandwidth) and DECT receiver using extended Hata propagation model for all DECT carriers are shown in Figure A4. The three cases of maximum macro base station emission limits of Table A3 have been examined for four deployment scenarios (urban indoor, urban outdoor, rural indoor and rural outdoor).

Figure A4: Separation distances for DECT carriers





- A3.38 Similar to PMSE results, the MCL analysis for DECT shows that in general, the separation distances marginally increase for all DECT carriers as compared to current e.i.r.p. limits. Another clearly visible trend is that for carriers F7-F0, there is very small difference in required separation distance when power increase is implemented through increase in antenna gain or increase in transmit power. Interference is dominated by ACS of DECT receivers.
- A3.39 More specifically, for urban outdoor scenario with a 3 dB increase, a separation distance of ~115 m is required between the interferer transmitter and the victim receiver for the first adjacent carrier F9 and this further reduces to ~100 m from carrier F6 onwards.
- A3.40 As expected, the separation distances for rural environment with a 3 dB e.i.r.p. increase are relatively large as compared to urban cases with the first adjacent DECT carrier F9 requiring ~505 m and ~975 m of separation for indoors and outdoors deployments, respectively.
- A3.41 Table A7 summarises the percentage increase in separation distances from current licence limit as compared to a 3 dB power increase via antenna gain for the DECT carrier F9, which is closest to the mobile base station band and most vulnerable compared to other carriers. This worst case increase in separation distance is around ~15% and ~22% for urban and rural cases, respectively.

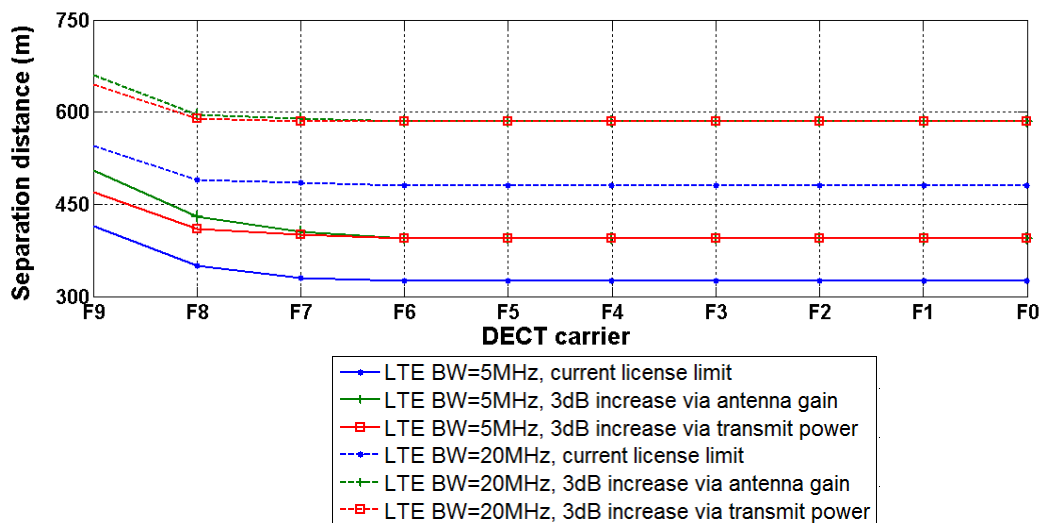
Table A7: Increase in separation distance (%) current vs. 3 dB increase for carrier F9

Deployment scenarios	Increase in separation distance
Urban indoor	from ~75 m to ~80 m (~7%)
Urban outdoor	from ~100 m to ~115 m (~15%)
Rural indoor	from ~415 m to ~505 m (~22%)
Rural outdoor	from ~800 m to ~975 m (~22%)

MCL results for mobile base stations with 20 MHz channel bandwidth

- A3.42 We have extended the MCL analysis to mobile base station employing 20 MHz of channel bandwidth noting the fact that the first adjacent 1800 MHz licensee has 45 MHz of downlink spectrum and may deploy channel bandwidths wider than 5 MHz.
- A3.43 Figure A5 compares the minimum separation distance between DECT receiver with 5 MHz and 20 MHz mobile base station interferer in a rural indoor environment. A 3 dB e.i.r.p. increase for 20 MHz macro base station increases the separation distance by around ~21% (~545 m - ~660 m) for carrier F9 in a rural indoor scenario compared to current limit.

Figure A5: Comparison between 5 and 20 MHz bandwidths in rural indoor scenario



- A3.44 The above MCL results for mobile base station employing 5 or 20 MHz channel bandwidths may suggest that DECT may be impacted with the current as well as the requested higher e.i.r.p. in the rural environment. Again, the required separation distance is very small compared to cell range in rural environment which is typically 10-20 km⁷. The probability of macro base station and DECT systems operating in such close proximity would be small.
- A3.45 The worst case separation distance for the first one or two adjacent DECT carriers may suggest a reduction in DECT reception range on these carriers. In such occurrences, DECT dynamic channel allocation mechanism enables to detect interference on these carriers and shift to any of the distant carriers (F7-F0), thereby operating at its maximum range and without loss in capacity.

Provisional conclusion

- A3.46 Results of impact assessment presented in this annex in conjunction with the extensive studies conducted in CEPT show that a 3 dB increase in e.i.r.p. of base stations would have no material impact on the operation of DECT and PMSE systems.
- A3.47 The interference environment these systems are currently experiencing will change marginally with the 3 dB increase in e.i.r.p. but not to an extent where it will be difficult for these systems to co-exist with mobile networks in adjacent bands. The following points are also of relevance to our provisional conclusion:

- the primary use of PMSE (wireless microphone) and DECT is mainly indoors and the associated building penetration losses provide adequate protection from outdoor macro base station located in close proximity;
- the 3 dB higher e.i.r.p is only valid for macro base stations and it is unlikely that these higher powers will be used on all base stations and even if these were to be used, not all base station will operate at maximum power at all times;
- the assumptions that we have used for DECT receiver characteristics are quite conservative and the actual systems is likely to have better selectivity than used in our analysis as highlighted by literature review;
- additional factors such as minimal use and availability of multiple PMSE channels in 1800 MHz band and DECT's inherent interference avoidance (*by channel switching*) feature further minimises wider compatibility and coexistence issues.