Variation of the Spectrum Access Licence for 1452-1492MHz and changes for fixed link use in the paired bands 1350-1375 MHz and 1492-1517 MHz

Consultation on a licence variation request to enable MFCN SDL (Mobile/Fixed Communication Network Supplemental downlink) in the 1452-1492 MHz band

Consultation

Publication date: 30 September 2014

Closing Date for Responses: 9 December 2014

About this document

This consultation sets out Ofcom's proposals to vary the licence for the 1452 - 1492 MHz band, currently held by Qualcomm UK Spectrum Ltd.

The proposed variation to the licence would help enable the spectrum's use for mobile or fixed communication Network Supplemental Downlink (SDL) in the UK.

SDL is a new mobile broadband technology which, using a mobile base station transmitter network, provides additional bandwidth to deliver improved capacity for consumer mobile broadband services. It can help send data at faster speeds to consumer devices, such as smartphones, tablets and laptops.

At present, Qualcomm's licence for this spectrum contains some technical conditions which limit this new technology from being optimised.

The consultation also seeks views on proposed changes to the adjacent 1492 – 1517 MHz band (paired with 1350 - 1375 MHz). This is used in the UK by fixed wireless point-to-point links to provide network infrastructure for a range of different services.

An accompanying Qualcomm technical report on the adjacent band compatibility aspects can be viewed here http://stakeholders.ofcom.org.uk/binaries/consultations/licence-variation-1.4ghz/annexes/qualcomm.pdf.

Contents

Section 1

Summary

1.1 This consultation sets out proposals to:

- vary the Spectrum Access Licence for the 1452-1492 MHz to enable the use of for Mobile/Fixed Communication Supplemental Downlink ("SDL"); and
- In light of the proposed variation, to change the way in which the adjacent 1492-1517 MHz band (paired with 1350-1375 MHz) is made available for new fixed link assignments.

1.2 In November 2013, the 1452-1492 MHz band was harmonised on a European wide basis through CEPT ECC Decision (13)03, ("the ECC Decision") for SDL. Shortly thereafter, Ofcom received a request from Qualcomm UK Spectrum limited ("Qualcomm"), the current licensee of the 1452-1492 MHz spectrum in the UK, to vary its licence to reflect the technical conditions set out in the ECC Decision.

1.3 In the UK, the upper adjacent band, 1492-1517 MHz, is used in UK by a substantial number of fixed links, the majority of which provide backhaul services for emergency services (police, fire and ambulance), links for utilities (electricity, water, oil and gas) and broadcasting. In considering the licence variation request we have therefore given careful consideration to the compatibility between the prospective use of SDL in 1452-1492 MHz and the use of fixed links in 1492-1517 MHz.

1.4 The variation request could result in high powered signals in the 1452-1492 MHz band. The presence of such a high powered SDL signal in the 1452-1492 MHz band means that:

i) fixed link receivers operating in the adjacent 1492-1517 MHz band will need to appropriately reject the SDL signal to prevent blocking of the receiver; and

ii) the out of band ("OOB") emissions from the SDL transmissions falling into the fixed link band will need to be sufficiently low so as to prevent undue interference to fixed link receivers.

1.5 At Ofcom's request, Qualcomm conducted studies to assess the interference to fixed links which may arise from the use of 1452-1492 MHz for SDL. In light of its findings we asked Qualcomm to extend its analysis and propose solutions that would address the challenges of delivering compatibility between SDL deployment in 1452-1492 MHz and existing and future fixed links in the 1492-1517 MHz band. Some aspects of the original licence variation request have been modified by Qualcomm in light of this work. We have liaised closely with Qualcomm in reviewing and refining its analysis and are publishing Qualcomm's final report alongside this consultation.

1.6 In light of this work we are now setting out a proposed licence variation to enable the use of SDL in the 1452-1492 MHz band whilst ensuring adequate protection for users of fixed links in the adjacent band. The proposed licence variation is designed to promote optimal spectrum use by enabling access to both user communities whilst ensuring sufficient interference mitigation measures are applied. Specifically we are proposing to grant the variation of this licence to enable the use of 1452-1492 MHz for SDL whilst, at the same time, ensuring the protection of existing fixed links in the adjacent 1492-1517 MHz band and enabling continued access to the 1498.5 MHz-

1517 MHz part of the band for new fixed link assignments (creating a minimum 6.5 MHz gap between new fixed link assignments and the top of the 1452-1492 MHz band). A fuller summary of the proposals on which we are consulting is given below.

1.7 The nature of the compatibility conditions means that it is not possible to enable full use of the 1452 – 1492 MHz band for SDL whilst also assigning new fixed links in the existing 1492 -1517 MHz band in the current way. We have therefore considered a number of options for allowing the use of SDL in the 1452-1492 MHz band whilst maintaining the use of 1492-1517 MHz for fixed link use. We consider that the proposals in this document will have limited impact on our ability to meet the likely demand for new fixed link assignments in this band in future whilst allowing the use of SDL in the adjacent band.

1.8 We have also considered whether any competition concerns may arise as a result of the proposed licence variation. We do not consider that there is any need for action in the context of this licence variation request at this time.

Proposed Variation to the Spectrum Access Licence for 1452-1492 MHz

Maximum in-band EIRP

1.9 The maximum base station EIRP in the 1452-1492 MHz would be limited to 68 dBm/5 MHz

Maximum Mean Out of Band EIRP[1]

1.10 The maximum mean out of band EIRP for base stations operating in 1452-1492 MHz would be as given in table 1.1:

Table 1.1: Maximum mean out of band EIRP limits

Frequency range of out of band emissions	**Maximum mean out of band EIRP** (dBm)	**Measurement Bandwidth** (MHz)
Below 1449 MHz	-20	1
1449-1452 MHz	14	3
1492-1495 MHz	14	3
1495-1498.5 MHz	-20	1
1498.5-1517 MHz	-62.5	1

Removal of Spectrum Usage Rights conditions

1.11 The new technical conditions proposed would replace the existing Spectrum Usage Rights “SURs” thereby removing the current power flux density limits and associated conditions and the limit on the maximum density of transmitters.

[1]The maximum mean OOB limits proposed for below 1449 MHz up to 1498.5 MHz are in accordance with ECC Decision (13)03. The maximum mean OOB limit proposed for 1498.5-1517 MHz is an additional technical condition as referred to in the Qualcomm study.

Limiting Transmission to the Downlink Direction

1.12 In accordance with the requested change and to ensure compatibility with adjacent use through simple procedures, the operation of radio equipment within the 1452-1492 MHz band would be limited to base station transmit[2]. Base stations would need to operate from a fixed position.

Requirement to protect the Fixed Service in the adjacent 1492-1517 MHz band

1.13 We are proposing to include a condition in the licence that requires the 1452-1492 MHz licensee to ensure that it does not cause undue interference in the adjacent fixed link band. The 1452-1492 MHz licensee would therefore be required to meet the costs of any additional measures to protect legacy fixed links (fixed links assignments in the 1492-1517 MHz band on or before the date of the licence variation) from interference (both in band and out of band) due to SDL use (e.g. use antenna down-tilt or pay for suitable filtering on the fixed link). To enable the 1452-1492 MHz licensee to comply with such obligations, we intend to make relevant information on existing fixed links available to it.

1.14 In order to meet its obligations not to cause undue interference to fixed links in the adjacent band, the 1452-1492 MHz licensee will also need to plan SDL base stations around new fixed link assignments that are made following the variation of the licence. However, we are proposing that the licensees of new (or varied) fixed link assignments should take measures to ensure that appropriate filtering is in place to improve receiver selectivity (and we will publish guidance to this effect as noted in paragraph 1.19 below). If they do not, the 1452-1492 MHz licensee would not be liable for the costs associated with retrofitting appropriate fixed link filtering in the event of interference at a later date. The minimum 6.5 MHz frequency separation requirement and SDL out-of-band mask should further reduce the risk of undue interference occurring.

Associated Changes to Interface Requirement (IR 2068)

1.15 The interface requirements will determine the way that SDL can be deployed within the 1452-1492 MHz band (as distinct from table 1.1 above which limits the out of band transmissions above 1492 MHz and below 1452 MHz). Whilst Qualcomm alone currently holds the licence for the entirety of the band, we recognise that it is possible that it may choose in the future to trade its licence to more than one party (e.g. leading to this licence being split into two blocks of 20 MHz each). We are therefore proposing to make changes to the associated interface requirements ("IR 2068") to ensure that any new licensees may coexist. The changes which we are proposing are broadly consistent with ECC Decision (13)03, In particular, the revised IR 2068 will refer to a band plan with eight 5 MHz blocks and set a block edge mask (i.e. out of block EIRP limits within the band 1452-1492 MHz per antenna) as per the limits in the ECC Decision.

Proposed Changes to Fixed Link use of the paired sub bands 1350-1375 MHz and 1492-1517 MHz ("the 1.4 GHz fixed link band")

1.16 Our proposals would enable existing licensed fixed links to continue to operate across the 1492-1517 MHz (and paired sub band 1350-1375 MHz) in accordance

[2] The operation limited to base station transmit would align with ECC Decision (13)03

with their assigned parameters. These links would have the status of legacy links on the date of the 1452-1492 MHz licence variation and would have protection from undue interference from future SDL deployments in the 1452-1492 MHz band.

1.17 Following the variation of the Spectrum Access Licence for 1452-1492 MHz, Ofcom would continue to assign new fixed links (or to vary existing assignments) but these would be limited to having access to channels in the 1498.5 – 1517 MHz range paired with the lower sub band 1356.5 -1375 MHz. This is shown in figure 1.1 below:

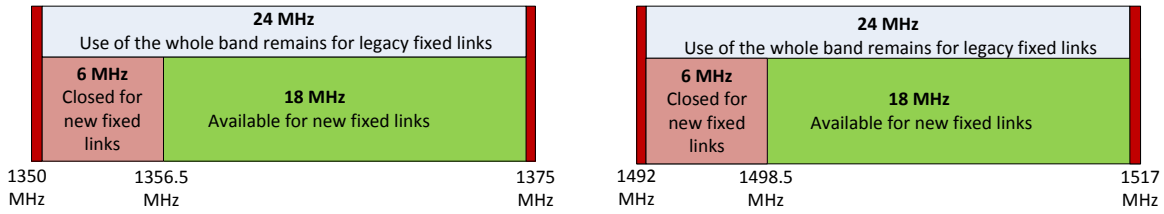

Figure 1.1: High level band diagram showing changes the to 1.4 GHz fixed link band

1.18 On the date of the licence variation, our proposal would reverse the fixed link assignment algorithm for this band to assign fixed link channels from the top of the band downwards (i.e. from 1517 MHz) rather than from the bottom up, as at present.

1.19 In light of the proposed licence variation, we intend to issue guidance to applicants for new fixed links. The guidance will make clear that fixed link licence applicants will need to ensure that they have taken appropriate action such that their intended fixed link path would be clear of SDL base stations. In practice, the fixed link operator will need to ensure that there is a clear path between the two ends of the link, as is consistent with standard line of sight link planning practice. The nature of the out-of-band limits on SDL means that this approach will be feasible, thereby avoiding the need for more complex coordination procedures involving access to SDL base station deployment data. Fixed link licensees will also need to ensure that the selectivity of their receivers (in new fixed link assignments) is able to withstand blocking due to an SDL signal in the adjacent band (from either existing or future SDL base stations) by the use of appropriate receiver filtering. This should ensure that such fixed links are able to operate without interference from SDL base stations. Should a new fixed link be installed that has not incorporated adequate selectivity filtering and it receives interference (due to inadequate selectivity) it will not be able to claim protection from the SDL base station.

1.20 Any technical variations to existing links would be treated as new fixed link assignments for these purposes.

Section 2

Background and Context

Background to the licence variation request

2.1 Qualcomm is the licence holder for the 1452-1492 MHz band in the UK. It acquired the rights to this spectrum in May 2008 in the auction conducted by Ofcom.

2.2 The technical conditions to manage the interference environment in the band are currently set out in the form of Spectrum Usage Rights, "SURs". These define the usage rights in terms of a set of in-band power flux density ("pfd") limits that should not be exceeded within a defined test area and in terms of a set of out of band power flux densities that should not be exceeded at various frequency separations from the band edge. In addition, the licence conditions impose limits on the density of transmitter deployments. The SURs distinguish between the top part (1479.5-1492 MHz) and bottom part (1452-1479.5 MHz) of the band with the top part having somewhat tighter limits on permitted pfd limits and permitted density of deployment. This difference between the two parts of the band reflects the broad form of the technical conditions agreed in CEPT ahead of the auction in 2008 when the technical conditions for use of the top part of the band were developed with an eye to the potential use of the 1479.5-1492 MHz range for satellite DAB use. Although the technical conditions set out in the 1452-1492 MHz licence are consistent with the CEPT agreement, we defined the UK licence conditions in the form of SURs in order to provide maximum flexibility in the way that the band could be used, based on the principle of service and technology neutrality.

Development of the ECC Decision

2.3 The 1452-1492 MHz band has remained unused in many European countries, including the UK, for the past decade, although harmonised for T-DAB[3] and S-DAB[4]. In 2010, the ECC therefore decided to conduct a review of this band to identify the most appropriate new services and applications that could bring substantial social and economic benefits for Europe. Following an impact analysis[5] considering a number of potential candidate uses, the ECC concluded that the 1452-1492 MHz should be identified for terrestrial Mobile/Fixed Communications Networks Supplemental Downlink[6] (MFCN SDL),"SDL".

[3] Terrestrial Digital Audio Broadcasting
[4] Satellite Digital Audio Broadcasting
[5] CEPT ECC Report 188 Criteria for impact analysis:
i) Compatibility with the current regulatory framework;
ii) Possibility to share with other applications/uses;
iii) Extent (maximisation) of social and economic benefits;
iv)Timeframe for the availability of equipment on a large scale and for application deployment - status of standardisation and;
v) Potential for economies of scale (need and potential for harmonisation within and outside CEPT)
[6] A Mobile/Fixed Communications Networks Supplemental Downlink is a mobile broadband system, which by means of base station transmitters in a network uses unpaired spectrum in the downlink direction to provide supplemental downlink capacity to carry comprehensive text, audio, images, data, sound and video content in a unicast, multicast or broadcast mode.

2.4 CEPT ECC Decision 13(03)[7] ("the ECC Decision") was approved on 8 November 2013 and set out conditions for the harmonised the use of the 1452-1492 MHz band for SDL. The harmonisation of the 1452-1492 MHz unpaired spectrum for SDL through the ECC Decision makes this band a key enabler to enhance the downlink capability of mobile broadband systems specifically to address the growing mobile data traffic asymmetry on a European wide basis.

Specific Licence Changes Requested

2.5 Qualcomm submitted its formal request in October 2013, following the ECC Decision, to have its licence varied so as to remove conditions based on SURs and replace these with harmonised conditions for SDL that align with the ECC Decision.

2.6 These changes would allow the 1452-1492 MHz spectrum to be used for deployment of SDL. Although the SURs specified in the current licence are designed to be flexible, the power flux and deployment density limits are not suitable for the type of SDL use and deployments envisaged. In addition, the inclusion of technical conditions in the licence that are broadly aligned with European harmonised conditions with additional UK specific measures would provide additional confidence to the licensee when using equipment that is designed to comply with these conditions.

2.7 After receiving its licence variation request we asked Qualcomm to carry out a detailed technical analysis of the impact of the requested changes on adjacent spectrum users. This work, in which Qualcomm has engaged closely with Ofcom, has identified the need to modify aspects of the changes first requested by Qualcomm. These changes are given below, explained in section 3 and form the basis of the proposals in section 5 on which we are now consulting.

2.8 The specific variations requested, as shown in Annex 1 of the Qualcomm study published alongside this consultation, are as follows:

i) Changing the OOB emission power flux density ("PFD") limits to OOB equivalent isotropic radiated power ("EIRP") limits as shown in table 2.1 below:

Table 2.1: Specific OOB emission limits to replace OOB pfd

Frequency range of out of band emissions	**Maximum mean out of band EIRP** (dBm)	**Measurement Bandwidth** (MHz)
Below 1449 MHz	-20	1
1449-1452 MHz	14	3
1492-1495 MHz	14	3
1495-1498.5 MHz	-20	1
1498.5-1517 MHz	-62.5	1

ii) Suppressing the in band PFD limits and defining block edge mask ("BEM") out of block EIRP limits[8] within 1452-1492 MHz in accordance with the ECC Decision

7 The harmonised use of the frequency band 1452-1492 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL)

8 The BEM out of block limits are given in Table 2 of Annex 2 to ECC Decision (13)03

iii) The addition of a maximum EIRP per base station of 68 dBm/5 MHz (reduced from the initial request of 72 dBm/5MHz);

iv) Restricting operation to base station transmit;

v) Removing the limit on the maximum number of base stations;

vi) Defining a frequency arrangement within 1452-1492 MHz in accordance with the harmonised arrangement[9] in the ECC Decision;

Uses in adjacent bands

2.9 The starting point for our consideration of the licence variation request has been to consider the potential impact on users that are immediately adjacent to the 1452-1492 MHz band, as illustrated in figure 2.1 below.

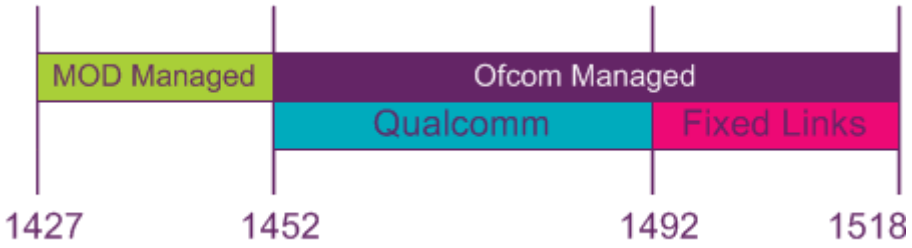

Figure 2.1: Management and use of the spectrum from 1427-1518 MHz

Lower adjacent use of the 1427-1452 MHz band for military use

2.10 The lower adjacent band to the 1452-1492 MHz is the 1427 – 1452 MHz band which is classified as 'UK2' in the UK Frequency Allocation Table, meaning it is managed by the Ministry of Defence ("MOD").

2.11 As part of the government's plans to release 500 MHz of spectrum below 5 GHz by 2020, for new sharing opportunities for public and private sector users the MOD is considering the uses of the 1427 – 1452 MHz band[10]. It has indicated that it may be able to share all or part of this band with new civil uses in some geographical areas where it does not have its own uses whilst retaining its rights to have continued use of the band.

2.12 The MOD has considered the implications of the proposed in-band power of 68dBm/ 5 MHz in the 1452-1492 MHz band and the out of band emission limits in the lower adjacent band, defined in the ECC Decision, and is broadly content with the proposed licence variation.

Upper adjacent use of 1492-1517 MHz by fixed links

2.13 The frequency range 1492-1517 MHz is paired with 1350 – 1375 MHz and open to licensing of individual point to point fixed links. Within the UK a large number of fixed point to point links (around 850) operate in the paired bands 1350 – 1375 MHz and

[9] The harmonised frequency arrangement is given in Table 1 of Annex 1 to ECC Decision(13)03
[10] https://www.gov.uk/sharing-defence-spectrum

1492 – 1517 MHz band providing low to medium capacity infrastructure to a range of licensees with significant use being for emergency services (police, fire and ambulance), utilities (electricity, water, oil and gas services) and broadcasting.

2.14 Our consideration of the licence variation request needs to address the compatibility between potential SDL use and adjacent use by the Fixed Service[11] in the 1492-1517 MHz band. Ofcom manages the technical coordination and assignment of fixed link licences in this band. There are around 70 different licensees currently (some having many individual licences and others having one or few) and the band is open for new licensees to deploy fixed links in the future. In these circumstances, it is appropriate for Ofcom to consider the impact of the licence variation request on existing and potential future fixed link users (rather than expect Qualcomm to engage directly with them).

2.15 In its consideration leading to the ECC Decision, CEPT conducted an assessment of adjacent band compatibility[12]. In light of that assessment, the ECC Decision contains least restrictive technical conditions for SDL base stations on the principle that they address interference between users. These least restrictive technical conditions are in the form of block edge mask ("BEM") and OOB emission limits.

Upper adjacent band compatibility considerations

2.16 There are two main issues that have highlighted the need for the UK to address the compatibility between the two uses:

- **SDL OOB Emission Limits:** The OOB emission limits in the ECC Decision, although least restrictive from the perspective of SDL use, do not adequately address the adjacent band compatibility between SDL and the use of 1492-1517 MHz for fixed links in the UK. The limits contained in the ECC Decision are not adequate on their own, without site by site coordination, to address adjacent band compatibility.

- **Fixed Link Receiver Selectivity**: There is also a need to establish the conditions under which fixed link receivers operating in the 1492-1517 MHz can attenuate the maximum requested 68 dBm/5MHz EIRP of the SDL in the 1452-1492 MHz. This is to avoid degradation of the fixed link receiver sensitivity due the presence of a strong "blocking" signal.

2.17 In view of the above, we asked Qualcomm to prepare a detailed technical compatibility analysis with the objective being to:

- understand the likely levels of interference into the adjacent fixed link band; and

- develop feasible and practicable technical options to balance the requirements of SDL and adjacent fixed links.

2.18 We stipulated that, in doing so, Qualcomm should base the work on realistic deployments and scenarios that were as practicable as possible using the requested varied licence terms.

[11] Radio Regulations definition: 1.20 fixed service: A radiocommunications service between two specified fixed points
[12] CEPT ECC Report 202

2.19 Throughout this exercise, which has taken place over a 9 month period, we have continued detailed interaction with Qualcomm to clarify and comment on their studies, taking into account the real world environment in order to enable a viable and pragmatic proposal to be developed. We are publishing alongside this consultation the analysis performed by Qualcomm to address the compatibility. Section 3 summarises our review of the analysis and forms the basis of our assessment of the licence variation request.

2.20 In addition, we have carried out a pre-consultation engagement exercise with stakeholders that have fixed link licences in the 1492-1517 MHz band to gain a better understanding of current and possible future use. This has informed our assessment of the potential impact of the proposed 1452-1492 MHz licence variation on future fixed link licensing. A summary of the main messages from this exercise, along with information on current use of the 1492-1517 MHz band, is given in annex 5.

European Commission (EC) mandate to CEPT on 1452-1492 MHz band

2.21 On 19th March 2014 a new EC mandate (RSCOM13-67rev3) to CEPT was adopted to perform technical studies in the 1452-1492 MHz band for its use for wireless broadband electronic communications services on a European wide basis. The requirement for studies included the consideration of the adjacent use by the Fixed Service.

2.22 Ofcom has engaged in the development of the CEPT report to the EC to highlight the UK's requirement to apply additional national measures including technical OOB limits (to those limits that were set out in the November 2013 ECC Decision) that would apply to SDL so as to enable an appropriate level of protection for the UK fixed links operating in the adjacent band. This engagement will continue both at the ECC and EC (RSC) level on the development of any EC harmonisation measures for this band following ECC's report to the Commission on its mandate.

Statutory Framework

2.23 The following paragraphs summarise the statutory background relevant to our consideration of the licence variation. We have taken full account of the statutory background and the duties to which we are subject in reaching the position set out in this document.

2.24 Section 3 of the Communications Act 2003 states the general duties of Ofcom. Under section 3(1) it is the principal duty of Ofcom in carrying out its functions:

- to further the interests of citizens in relation to communications matters; and
- to further the interests of consumers in relevant markets, where appropriate by promoting competition.

2.25 In doing so, Ofcom is required to secure, amongst others (under section 3(2)):

- the optimal use for wireless telegraphy of the electro-magnetic spectrum; and
- the availability throughout the UK of a wide range of electronic communications services.

2.26 In performing the duties referred to in paragraph 3.2, Ofcom must have regard to, amongst others, the following matters:

- the desirability of promoting competition (section 3(4)(b));
- the desirability of encouraging investment and innovation (section 3(4)(d));
- the desirability of encouraging availability and use of high speed data transfer services throughout the UK (section 3(4)(e)); and
- the different needs and interests of persons in different parts of the UK (section 3(4)(l)).

2.27 In carrying out its spectrum functions (under Section 3 of the Wireless Telegraphy Act 2006) it is the duty of Ofcom to have regard in particular to:

- the extent to which the spectrum is available for use or further use, for wireless telegraphy;
- the demand for use of that spectrum for wireless telegraphy; and
- the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy.

2.28 It is also the duty of Ofcom to have regard, in particular, to the desirability of promoting:

- the efficient management and use of the spectrum for wireless telegraphy;
- the economic and other benefits that may arise from the use of wireless telegraphy;
- the development of innovative services; and
- competition in the provision of electronic communications services.

2.29 Where it appears to Ofcom that any of its duties in section 3 of the 2006 Act conflict with one or more of its general duties under sections 3 to 6 of the 2003 Act, priority must be given to its duties under the 2003 Act.

Impact Assessment

2.30 The analysis presented in Section 5 of document represents an impact assessment, as defined in section 7 of the Communications Act 2003[13] (the Act).

2.31 Impact assessments 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. This consultation sets out the potential impacts for stakeholders and the reasons for the proposals we are making.

2.32 Ofcom is separately required by statute to assess the potential impact of all our functions, policies, projects and practices on equality. Equality Impact Assessments

[13] www.opsi.gov.uk/acts/acts2003/pdf/ukpga_20030021_en.pdf

(EIAs) also assist us in making sure that we are meeting our principal duty of furthering the interests of citizens and consumers regardless of their background or identity. We do not consider the impact of the proposals in this consultation to be to the detriment of any group within society.

Structure of this Document

2.33 The remainder of this document is structured as follows:

- Section 3 provides a summary of the technical work that has been undertaken by Qualcomm to inform our assessment of the request to grant a variation to the spectrum access licence for 1452-1492 MHz. It sets out our conclusions on conditions required in order to facilitate the use of SDL in 1452-1492 MHz band whilst, at the same time, addressing interference management concerns and allowing continued operation of existing and future fixed links in the 1492 -1517 MHz band.

- Section 4 summarises our impact assessment of the options for how the technical conditions could be implemented. It also considers whether the licence variation might give rise to competition concerns that might justify the need for action at this time in the context of licence variation.

- Section 5 sets out the details our proposals.

Section 3

Compatibility Analysis

Introduction

3.1 This section summarises the technical work that has been undertaken to inform our assessment of the request to grant a variation to the spectrum access licence for 1452-1492 MHz. The purpose of the technical assessment has been to establish an appropriate set of conditions that will facilitate the use of SDL in the 1452-1492 MHz band whilst, at the same time, and to the maximum extent possible, address interference management concerns and allow continued operation of existing and future fixed links in the 1492 -1517 MHz band. Our conclusions on the required conditions are set out at the end of this section.

3.2 To understand the extent of the compatibility issues that could arise Ofcom requested Qualcomm to conduct a detailed technical study and then to extend it to define practicable technical conditions and options that would address the compatibility issues arising. Ofcom provided guidance to Qualcomm on the fixed link technical and assignment approach used in the UK to ensure that the studies carried out reflected UK requirements.

3.3 The Qualcomm technical report is published in full alongside this consultation and sets out results for three main study areas:

i) A Minimum Coupling Loss (MCL) Analysis;

ii) A network simulation for London; and

iii) A sample rural area analysis.

3.4 For each of the study areas a 'geo-type' was defined (Dense Urban/Urban, Sub-urban and Rural) which was then used to establish the mobile base station typical technical parameters for the simulation models. The main difference between the scenarios being the SDL transmit EIRP (Urban SDL: 59 dBm/5MHz; Suburban SDL: 62 dBm/5MHz and Rural SDL 68 dBm/5MHz) and the amount of antenna down tilt used (-9°, -4° and -3° respectively).

3.5 The ECC Decision mask was used for the SDL out of band (OOB) EIRP, with a small modification based on the 3GPP [14] standard within the first 3 MHz (i.e. 1492 – 1495 MHz). This was then used to set the maximum EIRP density falling within the adjacent fixed link band for simulation purposes.

3.6 Fixed link receiver selectivity was assumed to have a standard 'generic' pre-select filter installed within the front end receiver chain, providing approximately 54 dB of additional rejection at 1479.5 MHz (in addition to the ETSI TR 101 854 Annex F report). For comparison purposes a 'high performance' band pass filter was also designed by Qualcomm which provided a very steep roll off below 1492 MHz and was also used in the simulations. MCL results are presented for each filter design.

[14] The 3rd Generation Partnership Project www.3gpp.org

3.7 The three main interference modelling approaches described above focus on the analysis of how an existing deployment of fixed links could be impacted. At our request, a further analysis was carried out to assess practicable and workable options that would allow new fixed links to be deployed whilst avoiding complex coordination procedures (that would be required if the ECC Decision was implemented without modification) and that would result in a disproportionate administrative burden on both SDL and fixed links licensees.

3.8 Our summary of the key findings from each of these studies is set out in the sections below.

Compatibility Analysis - Fixed Links and SDL Systems

Minimum Coupling Loss Analysis

3.9 Minimum Coupling Loss (MCL) is a widely used theoretical method to calculate the required isolation/separation distance between an interferer and victim for a specific deployment geometry and protection criterion. This method also provides further insight on the dominant component(s) contributing to the interference mechanisms and whether coexistence requires improvement to the interferer's OOB emissions and/or the victim's receiver Adjacent Channel Selectivity (ACS).

3.10 Section 5 of Qualcomm's report presents extensive MCL analysis between SDL base stations operating in 1472-1492 MHz (20 MHz channel) and all types[15] of fixed links deployed above 1492.5 MHz. The most realistic technical parameters[16] and conservative deployment assumptions are considered in order not to underestimate any interference risks. Two geometrical alignment cases were considered for the analysis:

i) SDL main beam to fixed link main beam coupling (Case 1); and

ii) SDL main beam to fixed link back lobe coupling (Case 2).

The analysis also covered three different operating environments (urban, suburban and rural) and different frequency separations[17] between the two systems in order to capture the diverse range of propagation and compatibility scenarios that could be likely to occur.

3.11 The results of MCL analysis are summarised in Tables 3.1 and 3.2 below with the separation distances being calculated based on generic[18] filtering assumptions for both the SDL (i.e. OOB emissions that are largely in line with the ECC Decision) and

[15] Fixed links systems can be deployed with channel bandwidths of 25 KHz, 75 KHz, 250 KHz, 500kHz, 1 MHz, 2 MHz and 3.5 MHz

[16] SDL parameters are based on the inputs from Qualcomm Engineering Services Group which contributed to the design of various European commercial LTE and UMTS networks. Fixed links technical parameters derived from typical practical operational links managed by Ofcom with reference noise floors from OFW446.

[17] "First" adjacent channels to 1492.5 MHz, "Mid" channels with a frequency separation of ~5 MHz (~1497.5 MHz) and the "Last" furthest fixed link channels from 1492.5 MHz

[18] Generic Filtering: SDL OOB emission mask as per 3GPP, ECC Decision (13)03 with an additional decay of 1 dB/MHz above 1497.0 MHz. Fixed links receiver selectivity based on ETSI standards TR 101 854, Annex F with an additional pre-select filter with a rejection capability as given in section 5.2.1.2 of Qualcomm's report.

fixed links where an improvement (the 'generic' filter) over the ETSI standard is assumed.

Table 3.1: Case 1: Worst case separation distances between SDL and fixed links

Case 1: Fixed links receive antenna pointing at the SDL transmit antenna								
		Fixed Links Types (Channel Bandwidth in MHz)						
		0.025	0.075	0.25	0.5	1	2	3.5
	Channels	Separation Distance (km)						
Urban	First	18 to 25				5 to 14		
	Mid	2.5 to 12				0.4 to 5		
	Last	0.25 to 0.5						
Suburban	First	30 to 40				20 to 28		
	Mid	18 to 27						4
	Last	5 to 15				4		
Rural	First	24 to 50						
	Mid	22 to 30						6
	Last	7 to 20						3.5

Table 3.2: Case 2: Required separation distances between SDL and fixed links where the fixed link antenna is pointing away from the SDL transmitter

Case 2: Fixed links receive antenna pointing away from SDL transmitter								
		Fixed Links Types (Channel Bandwidth in MHz)						
		0.025	0.075	0.25	0.5	1	2	3.5
	Channels	Separation Distance (km)						
Urban	First	0.4 to 1.5						
	Mid	0.6						
	Last	Protection criteria met						
Suburban	First	7 to 16						0.4 to 7
	Mid	1.5 to 5				0.3 to 3.5		
	Last	0.5 to 1				0.2 0.4		
Rural	First	9 to 22						3.6
	Mid	3.5 to 8						0.3
	Last	0.7 to 2				0.3 to 0.5		

3.12 It can be seen from the above two tables that, even though the analysis uses the improved generic filter receiver selectivity, the MCL analysis reveals the need for large separation distances up to 50km for worst case alignments. Distances are also shown for a range of scenarios including different fixed link channel numbers (for the given channel plan), in order to represent an increasing frequency separation from the band edge i.e. the first channel, at the bottom of the 1492-1517 MHz band, (worst case) and then a mid-numbered channel and the last numbered channel (nearest the top of the 1492-1517 MHz band) from the relevant channel plan. As can be seen the interference impact reduces with increased frequency separations, and non-worst case alignments. However, even then the impact does not reduce to an extent where compatibility can be achieved without substantial additional filtering for SDL transmitters and fixed link receivers.

3.13 From our assessment of the MCL analysis, it can be established that, while the interference impact is heavily dependent on the scenarios under consideration, the SDL OOB limits contained in the ECC Decision and the fixed links ACS profiles as given in ETSI TR 101 854 Annex F do not, on their own, effectively address the adjacent band compatibility between SDL and fixed links systems. Therefore, a combination of SDL planning and substantial improvements to both SDL OOB emissions and fixed link selectivity are required in order to achieve compatibility with existing fixed links.

Network Simulation for the London Area

3.14 In order to establish a more realistic assessment of how a likely SDL deployment could impact existing fixed links a network simulation approach was undertaken for the London area, as an example of an urban type scenario. Simulations were carried out to reflect a typical SDL deployment with the aim to determine more precisely the interference levels and likely scale of any mitigation measures that would need to be undertaken on real world fixed links.

3.15 For the detailed simulations, the selected area (London) contained an SDL network with over 2600 LTE base stations deployed, radiating at full power (65 dBm/20 MHz). Fixed links parameters such as site location, antenna heights and azimuth were based on operational fixed link data (extracted from Ofcom's database of actual fixed link assignments). In total 23 fixed links were analysed across the London area. The SDL network and related parameters were based on the most typical values closely mirroring an urban cellular LTE network. It was noted that the full power mobile base station assumption was at the conservative end as cellular base station transmission power in real world deployments depends on the traffic load.

3.16 A commercial cellular radio planning tool was used for the inter-system urban compatibility analysis. In undertaking such a simulation it is important to note that the results of the analyses are only valid for the SDL network simulated i.e. a different SDL network composition could lead to higher or lower set of interference levels, depending on the specific technical parameters and geometries involved. Nevertheless, it is considered that an analysis of this type provides a useful insight into the compatibility issues more likely in the real world and the required mitigation measures to protect existing fixed links. The results and details of the simulations can be found in section 6 of the Qualcomm report and are summarised below.

- The simulations showed that, for the given assumptions, the interference received by fixed links currently deployed in the London area, from a 'fully loaded' SDL network, ranged from -112.6 dBm to -176.5 dBm. When comparing this to the fixed link noise floor, in I/N terms, the results show a corresponding I/N ranging from -4.7 dB to -71 dB and that the majority of links in the London area would receive interference well below an I/N single entry interference criterion of -12 dB.[19]

- Of the 23 fixed links analysed only 3 links showed I/N exceedance of more than -12 dB. These 3 links operate on low channel numbers, close to the 1492 MHz band edge. For the majority of operational links in the London area, larger frequency separation from the band edge and / or the location of the links aids

[19] An I/N of -12 represents the apportionment of a total aggregate interference criterion of -6 dB between four individual interferers.

the mitigation of interference. So, for this specific scenario, the interference impact would be limited and additional interference remediation would only be required on the 3 identified fixed links. This remediation, as noted by Qualcomm, could involve fitting high performance filters on a few of the SDL base stations contributing the greatest amount of interference. As highlighted above a network simulation gives a more detailed understanding of a likely scenario, however, it is highly dependent on the specific locations of base stations and fixed links.

Rural Area Analysis

3.17 In the UK around 850 fixed links are currently licensed across the full 1492 – 1517 MHz band, deployed in all environments, but with the largest number deployed in rural areas. [20] The impact of potential interference generated from SDL base stations operating in the sparse, but higher transmission power rural areas, therefore needs to be considered.

3.18 To perform this analysis Qualcomm selected two fixed links that are representative of rural deployments and carried out a detailed assessment of the effects of placing SDL base stations in typical locations. The first case represented a more challenging scenario of a fixed link on a low channel number, pointing towards an SDL base station located along a motorway area. The second case represented a fixed link deployment where its antenna is pointing away from the SDL base station. Details of the analysis are given in section 7 of the Qualcomm study. This concludes that, where an interference scenario was likely, detailed planning (based on knowledge of the fixed links location and technical parameters) and the introduction of appropriate mitigation techniques, such as careful base station location planning, antenna down tilt and/or additional filtering, would be required to achieve compatibility. The exact type of mitigation technique(s) required would depend on the circumstances and geometries involved.

The implications for managing compatibility with existing fixed links

3.19 The summary of the MCL analysis and network simulations presented above identifies the potential interference risk to fixed links, with this risk being greater for the cases when a fixed link is operating at a small frequency separation from an SDL base station. This implies the potential need to implement suitable mitigation measures if the existing fixed links are to continue to operate without undue interference. It also implies a need to identify which existing fixed links might be at risk of suffering undue interference in the absence of such mitigation measures

3.20 The Qualcomm report explores ways in which interference might be mitigated in a practical environment. In addition, Qualcomm has proposed that a suitable provision is placed in the 1452-1492 MHz licence to protect all existing fixed links from undue interference. This would have the effect of making the 1452-1492 MHz licensee responsible for the costs of such mitigation. Our proposals in this consultation are based on this approach.

3.21 In order to carry out such planning for a real SDL network deployment, the SDL operator would need to have access to all existing/operational fixed link technical parameters including locations, antenna orientation and frequency separation from

[20] Number of fixed links currently deployed in the urban, suburban, rural and sea environments as defined in the Qualcomm study are 53, 273, 467 and 58, respectively.

SDL carrier which would all aid in identification of the fixed links requiring interference mitigation measures.

Assignment and Compatibility of Future Fixed Links

Required Mitigation for Uncoordinated Operation

3.22 The above analysis essentially concentrates on a scenario of existing link deployments where the SDL operator has knowledge of the existing links so that appropriate interference mitigation action can be taken. Further analysis was needed to address the additional scenario in which new fixed links can continue to be deployed without the need for the prospective fixed link licensee to engage with the SDL operator in complex coordination procedures.

3.23 This further analysis indicates that there will be a need for significant filtering through RF filters on both the SDL Base Stations and the fixed Link receivers. To do this in a cost efficient manner also requires a frequency separation between the two applications in order to allow for filter roll off to achieve the desired rejection.

3.24 To calculate the necessary filter requirements and appropriate frequency separation we asked Qualcomm to carry out further work to set out an option that would allow new fixed links to be deployed without the need for complex coordination, based on established UK assignment protection criteria. We stipulated that the protection criteria should be apportioned between the interference due to SDL OOB emissions and the interference due to fixed link receiver selectivity[21].

Selection of an appropriate frequency separation

3.25 Qualcomm's feasibility work around filter design shows that, while solutions are possible and readily available for all interference mitigation scenarios, cost effective solutions require some MHz of frequency separation for the filters' "roll-off" (absolute emissions decrease). Qualcomm's work concludes that a frequency separation range of approximately 5 to10 MHz provides enough separation for economical filters to achieve the required mitigation levels and to avoid complex coordination.

3.26 Assuming a frequency separation between 5 and10 MHz will provide for sufficient filter roll off, the optimum amount of separation was assessed by looking at the fixed link channel plan and existing distribution of fixed links. Section 8.2.2 of the Qualcomm report provides details of this analysis and proposes a frequency separation of 6.5 MHz which optimises the number of channels available for fixed links while allowing sufficient space for SDL and fixed link filter roll off. Utilising a 6.5 MHz separation placed in the fixed link band results in approximately 75% of the channels remaining available for future fixed links on all but one of UK channel plans, as shown in table 3.3.

[21] Extending the existing fixed link assignment protection of I/N=-6 dB i.e. the apportionment of interference between 4 individual interferers with a 3 dB equal distribution between the interference due to SDL OOBE and the interference due to FL Rx selectivity (I_OOBE/N=-15 dB , I_ACS/N =-15 dB) . Under these protection criteria, the interference from SDL into future FLs would not exceed I/N of -12 dB with the OOBE interference component remaining below I/N of -15 dB and the interference component due to insufficient fixed links receiver selectivity below I/N of -15 dB.

Table 3.3: Number and % of channels available above 1498.5 MHz, per CS

FL CS (kHz)	Total number of channels	Number of channels above 1498.5 MHz	% of channels available for deployment
25	960	720	75
75	320	240	75
250	96	72	75
500	48	36	75
1000	24	18	75
2000	12	9	75
3500	3	1	33

Filtering for SDL Base Station

3.27 In order to calculate the maximum mean out of band EIRP for the SDL base station an analysis of all current radio systems given in OFW 446 was carried out. The maximum permissible SDL OOB emission to meet the protection criteria was calculated using the noise floors for each system, an assumed minimum 100m clearance distance, a 17dBi typical fixed link reference antenna and taking the protection criteria as set out above for the most sensitive system. Details of the calculation are given in section 8.3.1 of Qualcomm's report and result in a maximum OOB EIRP of -62.5 dBm/MHz i.e. 42.5 dB below the value specified in the ECC Decision. Combining this figure with the frequency separation of 6.5 MHz given above gives the modified OOB emission mask shown in table 3.4.

Table 3.4: Mean maximum OOB EIRP

Frequency range of out-of- band emissions	Maximum mean out-of-band e.i.r.p. (dBm)	Measurement bandwidth (MHz)
1492 - 1495 MHz	**14**	**3**
1495 – 1498.5 MHz	**-20**	**1**
1498.5 – 1517 MHz	**-62.5**	**1**

Filtering for Fixed Link Receivers

3.28 In order for new fixed links to be deployed without the need to engage in detailed adjacent band coordination, sufficient receiver selectivity will also be required so as to prevent receiver blocking becoming a dominant interference mechanism. The maximum EIRP of an SDL base station needs to be considered in order to calculate the amount of receiver selectivity required. For the analysis this was set at 68 dBm/5MHz (the proposed licence variation level) which corresponds to 77 dBm/40MHz assuming the full 1452 -1492 MHz band is available for SDL. Again, assuming a 100m clearance distance, a typical 17dBi reference antenna the amount of receiver filtering was calculated for each radio equipment type given in OFW446. Details of the calculations are given in section 8.3.2 of Qualcomm's report and result in the additional filtering requirements as shown in table 3.5.

Table 3.5: Additional filtering requirements for fixed links

FL system type (kbit/s in kHz)	Total FL receive filtering requirement over 1452 – 1492 MHz (dB)	Additional FL filtering required in addition to the minimum equipment performance calculated by ETSI TR 101 854 Annex F (Approx 51dB)
32 in 25	150.6	99.6
64 in 25	152.7	101.7
96 in 75	139.6	88.6
192 in 75	148.7	97.7
256 in 250	126.5	75.5
512 in 250	142.7	91.7
512 in 500	142.6	91.6
704 in 500	138.6	87.6
1024 in 500	140.7	89.7
2048 in 500	137.7	86.7
1024 in 1000	139.6	88.6
2048 in 1000	137.7	86.7
2048 in 2000	136.6	85.6
4096 in 2000	134.7	83.7
4500 in 3500	133.6	82.6
9100 in 3500	134.7	83.7

3.29 In calculating these additional filtering requirements it is recognised that the real world compatibility requirement will depend on a number of factors such as the distance between the SDL transmitter and receiver, antenna orientation, terrain, SDL radiated power and frequency separation between the concerned fixed link and SDL carrier.

3.30 Performance, physical size, insertion loss and cost are all important considerations when considering the practicable aspects of introducing additional filtering. At our request Qualcomm investigated suitable filter designs and indicative costs for both existing and future potential fixed links. Details of this analysis are set out in Annexes 5, and 6 of Qualcomm's report which presents a number of different filter options, all with low insertion loss (<1 dB) in order to have a negligible impact to the assigned fixed link power budget.

Minimum clearance distance

3.31 The filtering requirements given above are based on a reference fixed link system with a 17 dBi gain antenna and a 100 m clearance distance. Given the range of antenna types used by fixed link systems, the calculated clearance distances given in table 3.6 are provided for the different antenna gains which are currently referenced on Ofcom's assignment systems. These clearance distances represent the minimum separation distance (in addition to filtering) that a new fixed link would need to be away from a SDL base station, assuming its main beam is pointing directly at a SDL base station. Given the distances are relatively short this is considered manageable in practice and would be part of the fixed link planners standard path profile planning process to have a clear line of sight link, free from obstructions.

Table 3.6: Minimum clearance distances for fixed link antenna types

Antenna Type	Antenna gain (dBi)	Clearance distance (m)
A/01/O/06/005/JB	14	70.8

A/01/O/95/030/EU	14.3	73.3
A/01/O/96/046/JB	16	89.1
A/01/H/00/095/SK	16	89.1
A/01/O/97/034/JB	16	89.1
A/01/O/97/059/EU	16.6	95.5
A/01/O/97/035/JB	16.7	96.6
A/01/O/97/058/EU	*17*	*100.0*
A/1G5/O/83/009/JB	*17*	*100.0*
A/01/S/04/001/RF	17.3	103.5
A/01/O/08/021/GA	19	125.9
A/01/H/05/011/RF	20	141.3
A/01/S/04/043/RF	20	141.3
A/01/H/11/030/GR	22.1	179.9
A/01/H/97/032/AA	22.3	184.1
A/01/H/05/007/RF	22.5	188.4
A/01/H/10/002/GA	22.6	190.5
A/01/H/98/001/AA	22.9	197.2
A/01/H/06/070/RF	23.7	216.3
A/01/S/05/014/MR	25.1	254.1
A/01/H/09/014/RF	25.7	272.3
A/01/H/97/033/AA	25.8	275.4
A/01/H/98/002/DT	26.2	288.4
A/01/H/96/051/AA	28.7	384.6

Conclusions

3.32 Given the objective to enable the operation of future SDL base stations in 1452-1492 MHz and existing and future fixed links in the adjacent band, the main implications of the analysis summarised above are as follows:

i) Specific out of band limits will need to be applied to the SDL base stations operating in the 1452-1492 MHz band to enable continued deployment of fixed links in the adjacent 1492-1517 MHz band. Specifically this limit would be -62.5dB/MHz, which represents 42.5 dB of additional attenuation over the ECC Decision limits.

ii) The study indicates that applying this -62.5dB/MHz limit from 1498.5 MHz would enable adequate filter roll off space of 6.5 MHz for the SDL transmitter and therefore enable cost effective transmitter filtering solutions. This would also avoid the need to restrict new fixed links assignments between 1498.5 MHz and 1517 MHz.

iii) The study also shows that the fixed links operating in the adjacent band would need to implement receiver filtering to attenuate the high power SDL signals in the adjacent 1452-1492 MHz band. The worst case requirement for a fixed link would be to improve its selectivity by an additional 101.7 dB of attenuation over and above the selectivity profile specified by ETSI.

iv) In addition to the implementation of filtering as described in this section, there would also need to be an appropriate separation distance between SDL base stations and fixed link stations. This would require a simple clearance approach between the 1452-1492 MHz licensee and the fixed link licensee. A number of simple engineering solutions could also be considered such as SDL antenna

down tilt, reducing the base station in-band power or implementation of additional high performance filtering.

3.33 Our conclusion is that the following conditions need to be implemented in order to facilitate the use of SDL in 1452-1492 MHz band whilst, at the same time, addressing interference management concerns and allowing continued operation of existing and future fixed links in the 1492 -1517 MHz band:

i) **Requirement for an OOB emission limit**: We consider that based on the analysis conducted by Qualcomm that the SDL base station will require an out of band limit of -62.5 dB/MHz to manage the level of emissions falling outside the 1452-1492 MHz band. This limit would be required to enable the operation of fixed links without undue interference within the fixed link band and we therefore propose to implement this as part of our proposal.

ii) **Requirement for improved fixed link selectivity:** We also consider that, based on the selectivity profile given by ETSI, fixed links would need to improve their receiver selectivity performance. However, since the study was based on worst case assumptions and since it is also possible that, in reality, the performance of fixed link radio receivers is better than that defined by ETSI, we do not consider it necessary to impose a mandatory selectivity profile for fixed links. The need will depend on many factors as discussed earlier in this section such as type of radio system used and channel of operation. We therefore propose to provide guidance on selectivity for fixed link licensees. However, in the event that improved selectivity is required, we propose to distinguish between the following:

- Legacy Fixed Links that have been licensed on or before the date of variation of the spectrum access licence for 1452-1492 MHz: these links may require additional protection from SDL deployments in the 1452-1492 MHz band with the cost of any selectivity improvement required being the responsibility of the licensee of the 1452-1492 MHz spectrum.

- New fixed links licensed after the date of licence variation. These new links would need to take into account the use in the adjacent 1452-1492 MHz band for SDL base stations and therefore need to implement improved selectivity at their own cost. Our proposal is to provide guidance for the fixed link licensee based on table 3.5.

iii) **Requirement to ensure sufficient separation between stations**: We consider that the nature of the compatibility would also require the need to conduct simple clearance checks between SDL base stations and fixed links including the need to ensure a separation distance between SDL base stations and fixed links. However, as indicated by the worst case analysis, this could depend on a number of factors and therefore we would consider this in our policy as follows:

- **Deployment of a new SDL base station**: this would require the SDL licensee to avoid undue interference to existing links (i.e. legacy fixed links and new fixed links as defined above). In order to facilitate this we consider that this would be best achieved by periodically providing the relevant information about fixed links operating in the 1492-1517 MHz to the 1452-1492 MHz licensee to enable effective planning around existing links to avoid undue interference.

- **Deployment of new fixed links:** We would provide guidance on separation distances and the need for the fixed link licensee to ensure that the path of new fixed links is clear of obstruction by an SDL base station.

iv) **The requirement for a 6.5 MHz frequency separation**: Based on the Qualcomm study we agree that a 6.5 MHz frequency separation would enable a cost effective filter solution for the SDL base station to ensure that the out of band limits would be adequate to protect adjacent band fixed links from unwanted emissions. Whilst we agree with this separation requirement, it could, in principle, be achieved by placing restrictions either on SDL deployments at the top of the 1452-1492 MHz or on new fixed link deployments at the bottom of the 1492-1517 MHz. We compare the merits of these two options in Section 4.

Question 1:
Do you agree with:
a) the technical analysis prepared by Qualcomm?
b) our assessment of the Qualcomm study and our resulting conclusions?
If not, please explain why and support your answer with detailed evidence.

Section 4

Impact Assessment

Introduction

4.1 The licence variation requested by Qualcomm would enable SDL across the whole of the 1452-1492 MHz band. However, for the reasons explained in Section 3, this could constrain the future use of the adjacent 1492-1517 MHz band by fixed links (since we would no longer make new fixed link assignments in the bottom part of this band) and could impose additional costs on new fixed link assignments in the band (due to additional filtering requirements). As a result there is potentially a trade-off (around the adjacency) between the use of these two bands for SDL and fixed links. In this section, we consider the nature of this trade-off and, in light of this, whether a modified version of the licence variation would be preferable which placed more of the restrictions on SDL use, rather than on future fixed link assignments.

4.2 As the licence variation would facilitate the use of the spectrum for the provision of mobile access, it could potentially affect competition between mobile operators. In the 4G auction, we placed constraints on the amount of spectrum that mobile operators could hold following the auction with the aim of promoting competition in the provision of mobile services. At the end of this section, we consider whether similar competition concerns might arise as a result of the proposed licence variation, which might justify the imposition of additional constraints.

Analysis of the trade-off between SDL and fixed link use

4.3 Section 3 sets out our view of the appropriate conditions to facilitate the use of SDL in the 1452-1492 MHz band whilst, at the same time, addressing interference management concerns and allowing continued operation of existing and future fixed links in the 1492-1517 MHz band. One condition is that there be a 6.5 MHz gap between the upper edge of the SDL block and the lower edge of the spectrum block that remains open for new fixed link assignments. Under current arrangements the bottom 0.5 MHz of the fixed link band is already used as a guard band, with fixed links being assigned from 1492.5 MHz upwards.

4.4 The Qualcomm licence variation request would place the additional 6 MHz gap at the bottom of the existing fixed link band between 1492.5-1498.5 MHz (this is “scenario 1” in the top part of figure 4.1 below). However, it would be possible, in principle, to leave all of the existing fixed link band open to new assignments as now and to place the additional 6 MHz gap at 1486-1492 MHz at the top of the Qualcomm licenced spectrum (as in “scenario 2” in the bottom part of figure 4.1 below).

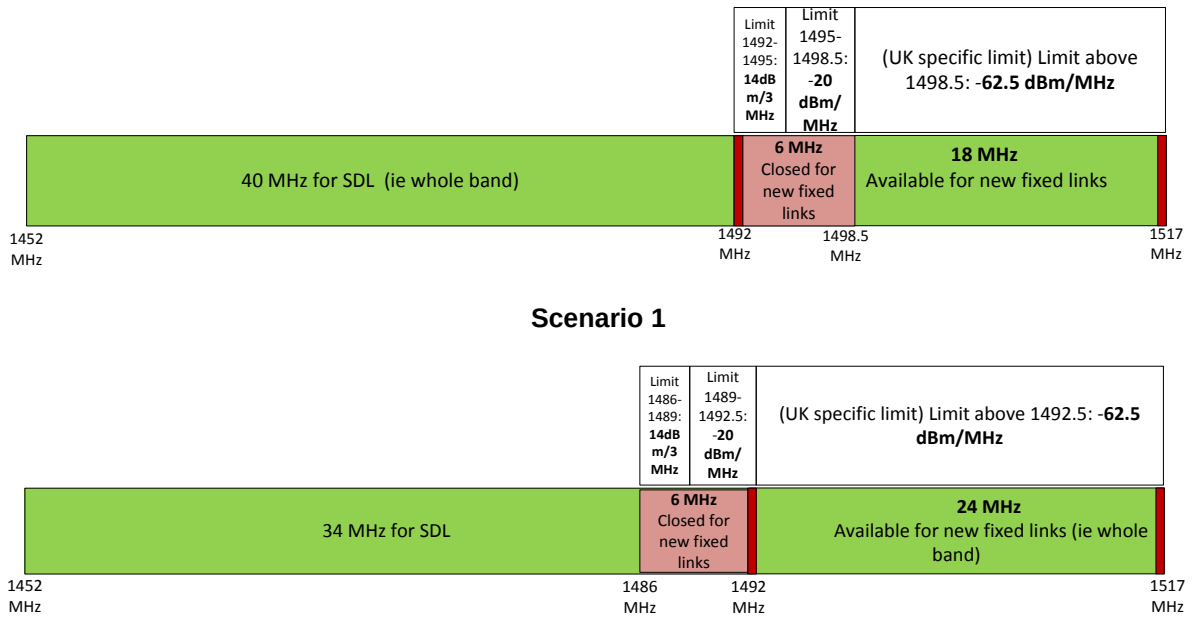

Figure 4.1: Band diagrams showing possible frequency separations

4.5 Although scenario 2 would not be consistent with the spectrum allocation implied by the ECC Decision, we consider it appropriate to assess which of these two scenarios (for the Qualcomm licence variation and associated fixed link licensing changes) is most likely to promote the optimal use of spectrum. The bulk of this section summarises this assessment. However, we comment again on the implications of potential European harmonisation in paragraphs 4.47 to 4.48 below.

4.6 We note that there are other possible licence variation scenarios which, at one extreme, would avoid any additional impact on existing fixed link licensing arrangements by making no changes to the Qualcomm licence or, at the other extreme, would limit the costs of SDL filtering requirements (by using the more relaxed OOB emission limit in the ECC Decision) at the expense of much greater restrictions on new fixed link deployments. We consider these other scenarios briefly below:

- The licence variation outlined in scenario 1, under which there are more stringent OOB emission limits than are specified in the ECC Decision, would impose additional filtering costs on SDL operators compared with a licence variation based on the ECC Decision terms. However, as explained in section 3 this is necessary to enable the continued deployment of new fixed links in the adjacent band. We consider that this benefit will be sufficiently large as to outweigh the additional filtering costs incurred as a result of tighter OOB limits.

- The licence variation outlined in scenario 2, while more restrictive of SDL than scenario 1, has significant advantages over denying the licence variation altogether, in that it would give an SDL operator the ability to use most of the band for SDL. While there are some costs to fixed links operators from enabling SDL deployment under the terms of scenario 2, we consider that these are relatively limited and would not be sufficient to justify denying the licence variation altogether.

- Other modifications of the licence variation are possible which would allow a larger frequency separation between SDL and fixed links – i.e. leading to an outcome somewhere between "no licence variation" and scenario 2. This would reduce the filtering and coordination costs incurred by fixed links operators, by increasing the distance in frequency between their receivers and SDL transmissions. However, this would also reduce the amount of the 1452-1492 MHz band available for SDL, and hence the value that could be achieved from this use. On balance, we do not consider that an outcome somewhere between no licence variation and scenario 2 is likely to deliver a higher net benefit than scenario 2.

4.7 As a result, in the remainder of this section we focus on assessing whether the net benefit of scenario 1 outweighs the net benefit of scenario 2. There are three factors that we need to consider in order to assess the trade-off between these scenarios:

- The benefits of additional SDL in scenario 1 (as compared to scenario 2);
- The opportunity cost of reduced spectrum access for new fixed link deployments in scenario 1 (as compared to scenario 2); and
- The additional costs of filtering and coordination in scenario 1 (as compared to scenario 2).

4.8 We consider these in turn below. Note that other costs of managing compatibility, such as simple coordination between SDL and fixed links operators, are common to both scenarios.

Table 4.1: Summary of the trade-off between scenarios 1 and 2

Benefits of scenario 1	Additional 6 MHz of spectrum (1486 to 1492 MHz) available for SDL deployment, allowing a total of 40 MHz.
Opportunity cost of scenario 1	No new fixed link deployments in the 1492.5 to 1498.5 MHz range.
Additional direct costs under scenario 1	Coexistence costs for SDL operators; admin costs associated with closing part of the fixed links band to new deployments.

Benefits of additional SDL spectrum access

4.9 SDL has the potential to deliver significant value through enhancing capacity of mobile networks to carry rich multimedia services (data, video, TV, gaming etc.) by providing additional downlink capacity to an MNO's main coverage network.

4.10 The incremental benefit of scenario 1 over scenario 2 is the additional value that is generated by enabling the full use of the 1452-1492 MHz band for SDL, over and above that which accrues when the top 6 MHz of this band is subject to additional power restrictions (i.e. allocated as a frequency separation). Under scenario 2 at least 6 MHz of the band will be unavailable to mobile operators for SDL. If mobile operators are unwilling to purchase a block of spectrum which is less than 5 MHz, it

is possible that 10 MHz of the band would be useless for SDL as a result of the frequency separation.

4.11 At this stage, the value of 6 to 10 MHz of spectrum for SDL is highly uncertain, and we do not consider that we can quantify it with confidence. However, the following sources provide some possible reference points for the potential value of SDL:

- A June 2011 study by Plum Consulting (Plum) on the benefits of 1452-1492 MHz for SDL;
- Our August 2014 consultation on Annual Licence Fees (ALF) for 900 MHz and 1800 MHz spectrum, in which we estimated the market value of 1800 MHz spectrum;
- Our May 2014 consultation on future use of the 700 MHz band, including the potential for SDL deployment in the centre gap; and
- The price of unpaired 2.6 GHz spectrum in the 2013 UK 4G auction (from the August 2014 ALF consultation).

4.12 These studies adopt different methods and each concerns a different spectrum band. While these studies could provide an indication of the possible value of SDL in the 1452-1492 MHz band, we do not consider that they allow us to infer a specific estimate of the value.

Plum report on the benefits of 1452-1492 MHz for SDL

4.13 Ericsson and Qualcomm asked Plum to produce a study quantifying the benefits of harmonising and using the 1452-1492 MHz band on a European-wide basis.[22]

4.14 To do this, Plum assumed that 1.4 GHz SDL would be ready for deployment across Europe by 2014, and that operators would be using it to supplement their assigned paired spectrum (to increase capacity and enhance user experience with faster data rates). It then calculated the net present value of the benefits of SDL in 1452-1492 MHz over a 10 year period from 2014 onwards, as the sum of:

- The avoided costs from using the SDL to meet rising demand for mobile broadband rather than investing in additional base stations; and
- The net benefits to consumers that arise from implementing SDL at 1.4 GHz, including faster download speeds in urban and suburban areas.

4.15 Plum's European-wide low and high valuations of the benefits of allowing SDL in the 1452-1492 MHz band correspond to a UK-equivalent range of £36m-£149m / MHz.

4.16 We have not verified the methodology used by Plum. We note that this study may have some limitations in informing the value of SDL in the UK in this band. For example, Plum estimates the average benefit of making the Qualcomm band available across Europe, rather than the specific impact on the UK. In addition Plum

[22] *Economic Study of the benefits from use of 1452-1492 MHz for a supplemental mobile downlink for enhanced multimedia and broadband services,* Plum Consulting (June 2011), http://www.plumconsulting.co.uk/pdfs/Plum_June2011_Benefits_of_1.4GHz_spectrum_for_multimedia_services.pdf

assumes operational deployment of SDL in 2014/15. However, as Plum acknowledges (page 20) device chipsets need to be developed to support operation in the 1.4 GHz band before this can occur and, although Qualcomm plans to make these available by 2015,[23] device manufacturers will not necessarily adopt the technology until a critical mass is reached.

Value of 1800 MHz spectrum in the August 2014 ALF consultation

4.17 In our August 2014 consultation on Annual Licence Fees for *paired* spectrum in the 900 MHz and 1800 MHz bands, we estimated the market value of 1800 MHz spectrum in the UK to be £14m per MHz.[24] If 1 MHz of SDL was deemed to have the same value as 1 MHz of FDD spectrum, then this might indicate a value of £14m per MHz for SDL (specifically, this would be for a hypothetical SDL allocation in the 1800 MHz band).

4.18 This number might provide some information about the value of SDL deployment in the 1452-1492 MHz band, in that the 1800 MHz and 1.4 GHz spectrum bands have similar propagation characteristics. However, the two bands are not directly comparable for a number of reasons. In particular, 1800 MHz spectrum is paired FDD spectrum and has a well-developed LTE ecosystem whereas the 1.4 GHz band is unpaired SDL spectrum and it may take time for its equipment ecosystem to develop.

Value of 700 MHz centre-gap for SDL in the 700 MHz consultation

4.19 In our May 2014 consultation on the future of the 700 MHz band, we considered the benefits of using 15 MHz of 700 MHz spectrum (part of the "centre-gap") for SDL.[25] We estimated the total benefit of using this spectrum for SDL to be between £60m and £110m. This estimate was based on a working assumption that 1 MHz of SDL was equal in value to 2x1 MHz of paired spectrum, giving a range of £4m to £7m per MHz.[26] Alternatively, if we were to assume that 1 MHz of SDL was worth only half as much as 2x1 MHz of paired spectrum, this would halve the range, to £2m – £3.5m per MHz.

4.20 Again, there are a number of reasons why this valuation is not directly applicable to SDL deployment in the 1452-1492 MHz band. Firstly, it relates to sub-1 GHz spectrum. Secondly, the model assumes a 700 MHz award in 2022; we would expect Qualcomm to trade its spectrum much earlier than this should the licence variation be granted. Thirdly, as highlighted in the 700 MHz consultation, the spectrum would be used in a subset of devices whereas the estimate is based on harmonised paired spectrum.

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[23] Qualcomm response to Ofcom's consultation on Mobile Data Strategy, January 2014, http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-data-strategy/responses/Qualcomm.pdf

[24] Paragraph 3.82, Ofcom, Further consultation on Annual Licence Fees for 900 MHz and 1800 MHz spectrum (August 2014), http://stakeholders.ofcom.org.uk/binaries/consultations/annual-licence-fees-900-MHz-1800-MHz/summary/condoc.pdf. We also estimated the market value of the 800 MHz (£32.63m per MHz) and 900 MHz (£23m per MHz) bands in this consultation. We considered each of these three figures to represent conservative estimates of market value.

[25] Pages 30-31, Ofcom, *Consultation on future use of the 700 MHz band* (May 2014), http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/summary/main.pdf

[26] Note that if we applied a similar assumption to our estimated value of hypothetical SDL spectrum in the 1800 MHz band (paragraph 4.17 above), this would suggest a value of £28m/MHz for SDL (i.e. equal to the value of 2x1 MHz for FDD).

Price of unpaired 2.6 GHz spectrum in the 2013 UK 4G auction

4.21 In a package auction, such as the UK 4G auction in 2013, prices for individual spectrum bands are not always observable. However for one of the winners of unpaired 2.6 GHz spectrum (Vodafone) we have been able to identify the price it paid for that spectrum at £0.49m per MHz.[27] The auction prices reflect the opportunity cost (value to losing bidders) of that unpaired 2.6 GHz spectrum in the 4G auction.

4.22 Although it is not equivalent to SDL, TDD spectrum is to some degree comparable in the sense that it can be used for more downlink than uplink, depending on the operator's needs. This figure therefore carries some applicability to estimating the benefits of a spectrum band which is utilised for SDL. Having said this, the 2.6 GHz and 1.4 GHz bands have substantially different propagation characteristics which may affect their values.

Summary of relevant spectrum valuations

4.23 The table below summarises the spectrum valuations outlined above. These vary according to the basis of measurement, and also the extent to which they take into account operator deployment and / or coexistence costs:

Table 4.2: Summary of relevant spectrum valuations

	Estimated value / MHz	Basis of measurement	Source	Spectrum concerned
1	£36m-£149m	Network cost savings and enhanced user experience	Plum	1.4 GHz SDL
2	£14m	Market value	Ofcom	1800 MHz paired FDD
3	£2m-£3.5m	Network cost savings	Ofcom, based on a model by Analysys Mason	700 MHz paired FDD
4	£0.5m	Auction price (Vodafone)	Ofcom	2.6 GHz TDD

Note: Plum's estimate is based on net present value over a ten year period. The other estimates assume a 20 year period.

[27] See Table A6.6 in the August 2014 ALF consultation. For the other winner of unpaired 2.6 GHz spectrum, Niche (BT), we have only been able to identify a range between £0.239m and £1.663m per MHz. There are a number of other ways of assessing the value of spectrum in the 2013 auction, as discussed in Section 2 and Annex 6 in the August 2014 ALF consultation.

Opportunity cost of reduced spectrum access for future fixed links deployments

4.24 Scenario 1 involves closing the 1492.5-1498.5 MHz portion of the fixed links band to new fixed link assignments. If, as a result of this, the 1492-1517 MHz band was unable to accommodate some of the future demand for fixed links in the band, this would represent the 'opportunity cost' of locating the frequency separation at the bottom of the fixed links band. The likelihood and scale of any such cost depends on:

- Future demand for fixed links. If demand is set to grow, there is a larger risk that some fixed links, which would otherwise be accommodated in this band, cannot be assigned; and

- The cost of alternative solutions if future fixed links cannot be accommodated in the remaining 1498.5-1517 MHz frequencies. If there are no cheap substitutes for a 1.4 GHz fixed link, this will raise the cost for fixed links operators. In some cases a service might not be provided due to the higher cost, leading to a loss in the value that could be generated from the service.

Future demand

4.25 There are currently over 850 live fixed links in the 1492-1517 MHz band operated by more than 70 licensees. The emergency services and utilities sectors are majority users of this band. The number of links in this band has grown since the early 1990s but has been relatively stable in recent years.

4.26 We have considered how overall demand for fixed links in the 1492-1517 MHz band might change in the future, drawing on discussions with stakeholders which are summarised in annex 5. These suggest that most users do not anticipate a reduction in usage of this band and that demand could increase moderately over the next 5-10 years. However, the impact of these future developments remains uncertain.

4.27 The following potential demand drivers could lead to an increase in demand:

- KiloStream: BT's KiloStream service, which provides dedicated and permanently connected digital voice or data circuits between designated sites, is being removed in March 2018. This may increase demand for fixed links as a substitute for KiloStream. One stakeholder said that it is building a microwave-based network to replace its 2000 KiloStream links by 2016, and that some of these links will operate at 1.4 GHz. The stakeholder estimates that this may generate a need for 200 additional fixed links in the 1492-1517 MHz band, both for its own use and for the provision of services to other utilities;[28]

- "SmartGrid" technologies: The introduction of SmartGrid technologies may further increase demand for telemetry links, for which 1492-1517 MHz is a suitable band. One stakeholder indicated that SmartGrid could result in a substantial increase in the number of links in this band, but noted that it is highly dependent on the availability of UHF spectrum, which is a preferred alternative;

- DAB rollout: In a November 2011 review of fixed wireless services, Aegis suggested, on the back of discussions with stakeholders, that there could be

[28] We note that some of the impact of KiloStream being phased out may have already occurred; for example, one stakeholder has installed 10 new 1.4 GHz links in response to this.

additional future demand driven by the expansion of DAB coverage. These would be for larger channel sizes due to bandwidth requirements (2 Mbps compared to 50 kbps), albeit that demand would be concentrated in rural areas.[29] However, in recent discussions with stakeholders DAB was not referred to as a major driver of demand for this band and, therefore, our current view is that DAB is unlikely to be a significant driver of future 1.4 GHz fixed links demand; and

- Manufacturers are developing equipment with higher order modulation schemes to increase capacity within the existing channel sizes. It is not clear whether it would be practical to accommodate this type of equipment in the band because of the impact on other fixed link deployment in the band. But, if it were practical to do so, this may increase the range of applications for which the 1492-1517 MHz band could be suitable and lead to higher demand for fixed links in this band. There is, however, considerable uncertainty about this possibility.

4.28 One development that may have the opposite effect (tending to reduce demand for fixed links in the band) is that the use of fixed links in the 1.4 GHz band for emergency services will cease if the provision of emergency services communications migrates away from the current TETRA network to an LTE-based solution. The Home Office has just launched a competitive tender for contracts for the provision of new emergency service communications.[30]

4.29 The significance of an increase in demand for fixed links in this band (should it occur) depends on our ability to accommodate any increase in the 1498.5-1517 MHz range that will remain open for new fixed link assignments (under both scenarios). An important consideration in this context is that fixed links have, until now, been assigned in the 1492-1517 MHz band from the bottom upwards. As a result, around half of existing fixed links (417) are located in the bottom 6 MHz band of the band (see annex 5). The higher density of fixed links in this part of the band (particularly for the 0.25 MHz and 0.5 MHz channel sizes) means that there is more scope to accommodate new fixed links in the remaining 18 MHz (above 1498.5 MHz) range, where there remains a substantial amount of capacity.

4.30 Some stakeholders raised the possibility that some services could not be provided without access to the 1492-1517 MHz band. For example, one stakeholder suggested that the absence of new 1.4 GHz links may lead to a withdrawal of service coverage from some remote communities as provision by other means would be prohibitively expensive. Similarly, another voiced concerns that their remote PSTN link usage was only possible in this band because of the availability of suitable equipment. However, we are proposing to protect existing fixed link assignments and only proposing to close 6 MHz of the band to new assignments. In the case of PSTN usage, this only relates to a small number of links and so it is very unlikely that these could not be accommodated especially in rural locations, where there are likely to be fewer assignment difficulties.

4.31 Overall, it is difficult to predict precisely how demand for 1.4 GHz fixed links will develop in the future. However, there is a reasonable prospect that the upper 18 MHz of the 1492-1517 MHz band should be able to accommodate the majority of future new fixed links assignment requests over the next ten years. Moreover, if demand

[29] Page 95, *Frequency band review for fixed wireless service,* Aegis (prepared for Ofcom), http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-review/annexes/report.pdf
[30] https://www.gov.uk/government/publications/the-emergency-services-mobile-communications-programme

did grow very significantly to a point that new assignments could not be accommodated in this 18 MHz, it is not clear that the prospects of successful assignment would be materially improved by keeping the bottom 6 MHz open as well for new assignments (since this bottom end of the band is already extensively used as noted above). Together, these considerations suggest that the opportunity cost of preventing future fixed link deployment (in scenario 1 as compared with scenario 2) is likely to be limited.

Cost of alternative solutions

4.32 There are a number of alternative options available to prospective licensees in the event that, the above considerations notwithstanding, there were to be excess demand for 1.4 GHz fixed links which would have been satisfied absent the use of 1492.5-1498.5 MHz as a frequency separation, albeit at increased cost.

4.33 For example, fixed links also operate in higher frequency bands such as 4 GHz, 6 GHz and 7.5 GHz. However, many operators prefer the 1.4 GHz band for a number of reasons:

- It enables them to use smaller, cheaper antennas (e.g. Yagi or flat plate antennas). These antennas also have lower mounting costs, as smaller masts have cheaper tower rental and less onerous structural requirements. Many stakeholders reported low equipment costs and easy equipment maintenance as drivers of demand for 1.4 GHz links;

- These antennas have other favourable properties, namely greater durability in poor weather conditions (e.g. limited signal interference due to rain) and easy alignment due to a relatively wide beamwidth; and

- Lower frequencies generally mean fewer hops as signals can cover long distances and it is possible to operate over more challenging paths (although Aegis said in its November 2011 review (p. 6) that the relatively low antenna gain of smaller antennas compared with other equipment limits the hop length that can be achieved, limiting the size of this advantage over higher frequency links).

4.34 Overall, these features of the 1.4 GHz band mean that while it might be technically possible to relocate fixed links users to higher frequencies, a number would likely experience a reduced level of service and / or face significant upgrade costs.[31]

Additional filtering and coordination costs

4.35 There are three parties which would potentially incur additional direct costs following the location of the additional 6 MHz frequency separation in the fixed links band instead of the 1452-1492 MHz band: SDL operators; fixed link operators; and Ofcom. We consider these in turn.

[31] Satellite links are another possible alternative to fixed links. However, stakeholders generally agreed that this technology would introduce too much latency for their applications and that, even if this technical constraint could be overcome, this solution would be very expensive to implement. For these reasons they indicated that satellite links were likely to be considered only on an exceptional basis.

Additional costs to SDL operators

4.36 Under both scenarios, SDL operators would be required to avoid undue interference to existing fixed link assignments (for example by techniques such as reduced in-band power, fitting increased filtering on the fixed links and/or utilising base station antenna down tilt).

4.37 The cost of protecting existing fixed links is likely to be higher under scenario 1, compared with scenario 2. This is because SDL operators would be transmitting right up to the frequency band boundary, in very close proximity (in frequency terms) to the 417 existing links which are located at the bottom of the 1492-1517 MHz band. Under scenario 2 there would be a minimum of 6.5 MHz separating SDL and (existing) fixed links frequencies. Although this does not eliminate coexistence costs, it would likely reduce the costs associated with protecting existing fixed links from interference.

4.38 We have not quantified the additional costs borne by SDL operators under scenario 1. We note that, if the commercial benefits of SDL deployment do not exceed these costs, operators would not acquire spectrum in the 1452-1492 MHz band.

4.39 Finally, we note that SDL operators would also be required to conform to additional restrictions on OOB emissions, in order to ensure compatibility with existing and future fixed links. However, these restrictions apply under scenarios 1 and 2. To the extent that this reduces the value of the 1452-1492 MHz band to SDL operators, therefore, it does so independently of the choice of scenarios.

Additional costs to fixed link licensees

4.40 Existing fixed link licensees may incur some costs in engaging with the 1492-1517 MHz licensee as part of the clearance process. Although there might be a need for slightly more engagement in scenario 1 than scenario 2, the associated costs are likely to be very limited.

4.41 Following a licence variation, new fixed link licensees in the 1492-1517 MHz band would be required to implement filtering and to conduct simple clearance checks.[32] We consider that these costs would arise both in scenarios 1 and 2, and would not be materially affected by the location of the frequency separation. As a result we do not consider that future fixed links licensees would incur significantly more direct costs in obtaining an assignment under scenario 1 than scenario 2.

Additional costs to Ofcom

4.42 The costs to Ofcom associated with managing compatibility issues between SDL and fixed links would be almost identical under scenarios 1 and 2. The only additional requirement incurred under scenario 1 would be to make operational changes to ensure that the bottom 6.5 MHz of this band is closed to new assignments. We consider that this cost would only be one-off, and would be relatively small.

4.43 It is also somewhat mitigated by the fact that, under scenario 2, we would need to make similar (but not identical) operational changes to the 1452-1492 MHz band to establish and enforce the frequency separation, incurring some costs in the process.

[32] Technical variations to legacy fixed links would be treated as new links following this date, and so would also be subject to this requirement.

Implications and proposal

4.44 A summary of the potential impact of varying Qualcomm's licence based on scenario 1 (as opposed to scenario 2) is presented in Table 4.3 below:

Table 4.3: Summary of the potential impact of the licence variation

	Benefits	Direct costs	Opportunity costs
MNOs	Additional spectrum for SDL deployment	Coexistence costs with existing fixed links	
Fixed links operators			Use of 6 MHz of spectrum for deployment of new fixed links
Ofcom		Admin costs	

4.45 Having assessed these costs and benefits, we consider that:

- The additional benefits of SDL associated with scenario 1 could be substantial, with indicative valuations ranging from £0.5m per MHz upwards. Estimates of spectrum values in the 700 MHz and 2.6 GHz bands suggest that an additional 6 MHz of SDL spectrum in the 1.4 GHz band could at least have a value of between £3 million and £12 million in total[33], while our estimate of the value of 1800 MHz spectrum, and the study by Plum, are consistent with higher values for 1.4 GHz SDL;

- The opportunity cost associated with closing part of the fixed links band to new fixed links (which scenario 1 would entail) is likely to be limited. This is because we do not anticipate that the closure of the bottom 6 MHz of the band to new links would materially alter the prospects of being able to accommodate plausible growth in demand for 1.4 GHz fixed links over the next ten years (noting that the "bottom up" nature of frequency assignments to date means that most of the capacity for new assignments is above, rather than in, the bottom 6 MHz of the band); and

- The additional administrative costs to Ofcom from scenario 1 are very limited.

4.46 Based on the above assessment, we consider that the total additional costs associated with scenario 1 are likely to be significantly lower than the value of additional SDL. Simple coordination and administrative costs are very limited, while filtering costs are likely to be similar under both scenarios. There is considerable uncertainty surrounding the impact of closing 6 MHz of the fixed links band to new assignments, particularly in terms of the possible alternative solutions that operators would pursue in the absence of an assignment in this band. However, given the

[33] This is based on per MHz estimates of £0.5m for 2.6 GHz unpaired and £2m for 700 MHz. If the loss of spectrum for SDL was 10 MHz, as explained in paragraph 4.10, the additional benefits based on these estimates would be £5-20m.

limited number of links that would likely be affected, we consider that the costs of moving to an alternative solution would need to be implausibly large to raise overall costs above the prospective additional benefits associated with scenario 1.

4.47 In addition, we also note that there is ongoing work at the ECC and EC (RSC) level to develop harmonisation measures for the 1452-1492 MHz band. The conditions outlined in scenario 2, whereby 1486-1492 MHz is allocated as a frequency separation, would likely be incompatible with any future mandatory EC measure to harmonise this band for wireless broadband on a European-wide basis.

4.48 Overall, therefore, we consider that scenario 1 will deliver a greater net benefit than scenario 2 (and other possible scenarios). On this basis we propose to make a variation to Qualcomm's Spectrum Access Licence for 1452-1492 MHz under the terms outlined in scenario 1.

Competition issues

4.49 If the licence is varied as proposed then this spectrum could be used for providing mobile access. Qualcomm has signalled its intention to seek a buyer for the spectrum and it could be acquired by one or more of the MNOs. This raises a question as to whether the prospective trade could raise concerns for competition in the mobile market of the type that led us to impose restrictions in the 4G award.[34]

4.50 Currently any trade of Qualcomm's licence would be subject to the provisions of the Wireless Telegraphy (Spectrum Trading) Regulations 2012 ("the General Trading Regulations"). Under the General Trading Regulations, a trade of the licence is not subject to Ofcom's consent and therefore any trade could take place regardless of any competition concerns which Ofcom may identify. This is different to spectrum that is subject to the Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011 ("the Mobile Trading Regulations") where Ofcom's consent is required before any trade may take place and, in deciding whether to give consent, Ofcom can take into account whether competition is likely to be distorted as a result of the trade. The spectrum covered by the Mobile Trading Regulations is the relevant spectrum at 800 MHz, 900 MHz, 1800 MHz, 2100 MHz and 2600 MHz.

4.51 As the 1.4 GHz spectrum could be used for providing mobile access in the future, we have considered the extent to which a trade might give rise to competition concerns and what action, if any, it might be appropriate to take at the current time.

4.52 In the 4G award, we identified competition concerns where there were significant asymmetries in spectrum holdings between MNOs. We imposed an overall spectrum cap on spectrum falling within the Mobile Trading Regulations and also a cap on holdings of sub 1 GHz spectrum.

4.53 Below we first consider whether a trade of the 1.4 GHz spectrum could raise competition concerns due to asymmetries in overall mobile spectrum holdings. We then turn to consider where there are concerns due to the 1.4 GHz spectrum being lower frequency than some mobile spectrum bands.

[34] http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/statement.pdf

Asymmetries in overall mobile spectrum holdings

4.54 If we took the proportion of mobile spectrum an operator could hold under the overall cap from the 4G award (around 37%) and extended it to cover holdings in the 1.4 GHz band, then it would constrain the amount of spectrum EE (but no others) could acquire in this band. This is because EE would be over the limit of such a cap if it acquired 40 MHz of 1.4 GHz spectrum, while other operators would be sufficiently below the cap for 40 MHz of 1.4 GHz not to push them over the limit.[35]

4.55 The 1.4 GHz band is a nascent band for mobile services. It does not have the same scale of ecosystem (i.e. compatible mobile devices in the market) as the existing UK mobile bands, and is unlikely to do so for some years (at least). There are also other bands likely to be relevant for mobile access in the future. Specifically, the 2.3 GHz band and the 3.4 GHz band are currently more advanced than the 1.4 GHz band in terms of end user device availability, and there will shortly be at least 230 MHz of additional spectrum available in these three bands together. We therefore believe that it is appropriate to consider the extent to which the holding of 40 MHz of 1.4 GHz spectrum by an MNO could give rise to competition concerns as part of our consideration of competition issues in relation to the award of spectrum in the 2.3 GHz and 3.4 GHz bands. Given the imminent release of additional spectrum for mobile services, our view is that a trade of the 1.4 GHz band, even if it were all acquired by one operator, would not give rise to competition concerns about asymmetries in overall mobile spectrum holdings.

4.56 We will be consulting shortly on the auction design for the award of spectrum in the 2.3 GHz and 3.4 GHz bands. If the requested variation is granted and the 1.4 GHz spectrum is available for mobile use, we anticipate that it will be included in any spectrum caps imposed in relation to that auction. The consultation document will set out in more detail the basis for such an inclusion including the specific nature of the concerns giving rise to the need for inclusion within any proposed cap.

Lower frequency of 1.4 GHz spectrum

4.57 In the 4G award we concluded that sub-1GHz spectrum in the 800MHz and 900MHz bands had particular characteristics which made it appropriate to also impose a cap on the maximum amount of sub-1GHz spectrum which might be held by a single operator (in addition to the overall spectrum cap). This raises the question of whether, in the context of 1.4 GHz, there may be competition concerns relating to asymmetries in holdings of lower frequency spectrum, apart from the potential concerns we have just considered about overall spectrum holdings.

4.58 We do not consider that there are material competition concerns relating to 1.4 GHz spectrum at this time which would warrant further action by Ofcom. The following considerations contribute to this view:

- While 1.4 GHz spectrum is lower frequency than other mobile spectrum expected to come to market in the near term, it is not as low as the 800 MHz and 900 MHz spectrum (indeed, it is closer in frequency to the 1800 MHz band which was not included in the low frequency cap in the 4G auction), albeit that the proposed licence conditions would allow it to be used at higher power than in other mobile bands (subject to coordination obligations). At least some of the importance of

[35] In this case, EE would be limited to acquiring around 15 MHz; if the spectrum were packaged in 10 MHz lots it could only acquire one lot.

the 800 MHz and 900 MHz spectrum is derived from its two-way communication nature involving uplink as well as downlink (FDD), which is not the case with SDL.

- There is uncertainty about the relative importance of 1.4 GHz spectrum for mobile access. While we expect it will be used for mobile access, the pace of development of the associated equipment ecosystem is unclear. It is very unlikely to be as important a mobile band as the 800 MHz and 900 MHz spectrum and whilst it could become more important over time, the extent to which this might be so is uncertain.

- If, the above comments notwithstanding, any competition concerns did materialise relating to 1.4 GHz spectrum having particular advantages associated with being lower frequency, this would not be for some years. We are currently consulting on making 700 MHz spectrum available for mobile use. Although any auction of 700 MHz spectrum is not likely to take place for some years, it is likely to be more appropriate to consider any potential issues around the low frequency spectrum at that time.

Section 5

Proposed Changes

Introduction

5.1 In light of the analysis summarised in sections 3 and 4 this section sets out our proposals to enable the 1452-1492 MHz band to be used for SDL. We summarise in turn the changes that we are proposing to:

5.1.1 The 1452-92 MHz licence itself, together with the consequential changes to the associated Interface Requirements; and

5.1.2 The arrangements for licensing new (and varied) licences for fixed, point-to-point links in the 1492-1517 MHz band.

Proposed Variation to the Spectrum Access Licence for 1452-1492 MHz

5.2 The revisions to the 1452-1492 MHz Spectrum Access Licence that we are proposing are shown in annex 6. These are shown in the form of revisions and deletions against the current licence. The main features of the licence revision are as follows.

Maximum in-band EIRP

5.3 The maximum base station EIRP in the 1452-1492 MHz would be limited to 68 dBm/5 MHz.

Maximum Mean Out of Band EIRP[36]

5.4 The maximum mean out of band EIRP for base stations operating in 1452-1492 MHz would be as given in table 5.1:

Table 5.1: Maximum mean out of band EIRP limits

Frequency range of out of band emissions	**Maximum mean out of band EIRP** (dBm)	**Measurement Bandwidth** (MHz)
Below 1449 MHz	-20	1
1449-1452 MHz	14	3
1492-1495 MHz	14	3
1495-1498.5 MHz	-20	1
1498.5-1517 MHz	-62.5	1

[36]The maximum mean OOB limits proposed for below 1449 MHz up to 1498.5 MHz are in accordance with ECC Decision (13)03. The maximum mean OOB limit proposed for 1498.5-1517 MHz is an additional technical condition as referred to in the Qualcomm study.

Removal of Spectrum Usage Rights conditions

5.5 The new technical conditions proposed would replace the existing Spectrum Usage Rights "SURs" thereby removing the current power flux density limits and associated conditions and the limit on the maximum density of transmitters. This condition has been requested by Qualcomm and would align with the ECC Decision.

Limiting Transmission to the Downlink Direction

5.6 In accordance with the requested change, and to ensure compatibility with adjacent use through simple procedures, the operation of radio equipment within the 1452-1492 MHz band would be limited to base station transmit[37]. Base stations would need to operate from a fixed position.[38]

Requirement to protect Fixed Links in the adjacent 1492-1517 MHz band from undue interference

5.7 The varied licence would place a requirement on the 1452-1492 MHz licensee (as stated in revised clause 4 of the licence) to protect fixed links in the adjacent 1492-1517 MHz from undue interference as follows:

5.7.1 The 1452-1492 MHz licensee would need to plan base station deployment around legacy fixed links (these are fixed links licensed on or before the date[39] of the licence variation). The 1452-1492 MHz band licensee will be responsible for avoiding undue interference to these legacy links, including the costs of any additional measures required to protect these legacy fixed links from interference (e.g. use antenna down-tilt or pay for suitable filtering on the fixed link in order to reduce the constraints on SDL base station deployment).

5.7.2 The 1452-1492 MHz licensee would also need, when siting new SDL base stations, to avoid undue interference into fixed links that have been licensed (or varied) after the date of the 1452-1492 MHz licence variation itself. However, if part of the means of avoiding undue interference is to retrofit the receivers of new (or varied) fixed links with additional filtering, then the 1452-1492 MHz band licensee would not be responsible for the associated costs of this.

5.8 To enable the 1452-1492 MHz licensee to comply with the above requirements, we intend to make relevant information on existing fixed links available to it. We intend to disclose this information for the purposes of fulfilling our functions of facilitating and managing the use of spectrum for wireless telegraphy. We have a wide range of functions and duties in relation to the management of the radio spectrum set out in the Wireless Telegraphy Act 2006 and the Communications Act 2003, in particular, a duty to secure the optimal use for wireless telegraphy of the electromagnetic spectrum (section 3(2)(a) Communications Act 2003). In our view, the disclosure of

[37] The operation limited to base station transmit would align with ECC Decision (13)03

[38] We do not intend to restrict unnecessarily the flexibility with which this spectrum might be used in future. For example, if the licensee wished to enable TDD use in future (which would require both downlink and uplink use of this spectrum) then we would, at that time, need to consider the relevant compatibility issues alongside the further changes to the licence and licence exemption regulations that might be required to enable this.

[39] This is the date of variation of the Spectrum Access licence for the 1452-1492 MHz to enable the use of SDL

the information set out in annex 9 is necessary to fulfil this duty since it will ensure that the holder of the 1452-1492 MHz licence is able to assess and manage the interference potential effectively with holders of licences for fixed links in the adjacent band so as to minimise the risk of undue interference. [40]

Associated Changes to Interface Requirement (IR 2068)

5.9 The interface requirements will determine the way that SDL can be deployed within the 1452-1492 MHz band (as distinct from table 5.1 above which limits the out of band transmissions above 1492 MHz and below 1452 MHz). Whilst Qualcomm alone currently holds the licence for the entirety of the band, we recognise that it is possible that it may choose in the future to trade its licence to more than one party (e.g. leading to this licence being split into two blocks of 20 MHz each). We are therefore proposing to make changes to the associated interface requirements ("IR 2068") to ensure that any new licensees may coexist. The changes which we are proposing are broadly consistent with ECC Decision (13)03, In particular, the revised IR 2068 will refer to a band plan with eight 5 MHz blocks and set a block edge mask (i.e. out of block EIRP limits within the band 1452-1492 MHz per antenna) as per the limits in the ECC Decision.

Proposed Changes to Fixed Link use of the paired sub bands 1350-1375 MHz and 1492-1517 MHz ("the 1.4 GHz fixed link band")

5.10 Our proposals would enable existing licensed fixed links to continue to operate across the 1492-1517 MHz (and paired sub band 1350-1375 MHz) in accordance with their assigned parameters. These links would have the status of legacy links on the date of the 1452-1492 MHz licence variation and would have protection from undue interference from future SDL deployments in the 1452-1492 MHz band.

5.11 Following the variation of the Spectrum Access Licence for 1452-1492 MHz, Ofcom would continue to assign new fixed links (or to vary existing assignments) but these would be limited to having access to channels in the 1498.5 – 1517 MHz range paired with the lower sub band 1356.5 -1375 MHz. This is shown in figure 5.1 below, whilst table 5.2 shows the number of channels that would remain available.

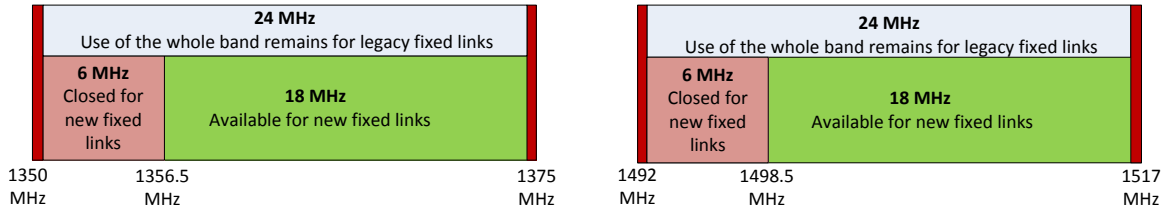

Figure 5.1: High level band diagram showing changes to the 1.4 GHz fixed link band

[40] We will not provide information on fixed links that have been identified and agreed as not suitable for disclosure under arrangements for management of information relating to critical national infrastructure; we will instead contact those relevant licensees to discuss alternative arrangements.

Table 5.2: Channels that would be available for fixed link assignment from the date of variation

Channel Size (MHz)	Number of channels available	Channel Numbers
0.025	720	241-960
0.075	240	81-320
0.25	72	25-96
0.5	36	13-48
1	18	7-24
2	9	4-12
3.5	1	3

5.12 On the date of the licence variation, our proposal would reverse the fixed link assignment algorithm for this band to assign fixed link channels from the top of the band downwards (i.e. from 1517 MHz) rather than from the bottom up, as at present.

5.13 In light of the proposed licence variation, we intend to issue guidance to applicants for new fixed links (an example is shown in annex 8). The guidance will make clear that fixed link licence applicants will be responsible for ensuring that they have taken appropriate action such that their intended fixed link path would be clear of SDL base stations. In practice, this would require the fixed link operator to ensure that there is a clear path between the two ends of the link, as is consistent with standard line of sight link planning practice. The nature of the out-of-band limits on SDL means that this approach will be feasible, thereby avoiding the need for more complex coordination procedures involving access to SDL base station deployment data. Fixed link licensees will also need to ensure that the selectivity of their receivers (in new fixed link assignments) is able to withstand blocking due to an SDL signal in the adjacent band (from either existing or future SDL base stations) by the use of appropriate receiver filtering. This should ensure that such fixed links are able to operate without interference from SDL base stations. Should a new fixed link be installed that has not incorporated adequate selectivity filtering and it receives interference (due to inadequate selectivity) it will not be able to claim protection from the SDL base station.

5.14 Any technical variations to existing links would be treated as new fixed link assignments for these purposes.

Question 2:
a) Do you agree with our proposal to grant the variation request as set out in this consultation?

b) Do you agree with our proposal to continue the use of the adjacent 1492-1517 MHz and 1350-1375 MHz for legacy fixed links and retain 1356.5-1375 MHz and 1498.5 -1517 MHz for new fixed links from the date of the licence variation?

c) Are the technical parameters listed in Annex 9 sufficient to enable the 1452-1492 MHz licensee to assess and manage the interference potential from base stations operating in the 1452-1492 MHz band to fixed point to point links? Should Ofcom consider presenting additional parameters? If so, which parameters and why?

Annex 1

Consultation Questions

Question 1:
Do you agree with:
a) the technical analysis prepared by Qualcomm?
b) our assessment of the Qualcomm study and our resulting conclusions?
If not, please explain why and support your answer with detailed evidence.

Question 2:
a) Do you agree with our proposal to grant the variation request as set out in this consultation?

b) Do you agree with our proposal to continue the use of the adjacent 1492-1517 MHz and 1350-1375 MHz for legacy fixed links and retain 1356.5-1375 MHz and 1498.5 -1517 MHz for new fixed links from the date of the licence variation?

c) Are the technical parameters listed in Annex 9 sufficient to enable the 1452-1492 MHz licensee to assess and manage the interference potential from base stations operating in the 1452-1492 MHz band to fixed point to point links? Should Ofcom consider presenting additional parameters? If so, which parameters and why?

Annex 2

Responding to this consultation

How to respond

A2.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 9 December 2014**.

A2.2 Ofcom strongly prefers to receive responses using the online web form at http://stakeholders.ofcom.org.uk/consultations/licence-variation-1.4ghz/howtorespond/form, 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 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A2.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email mrinal.patel@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A2.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Mrinal Patel
Spectrum Policy Group
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 7981 3208

A2.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A2.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 1. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A2.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Mrinal Patel on 020 7981 3127.

Confidentiality

A2.8 We believe 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. If you think your response should be kept confidential, can you please specify what part or whether

all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A2.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A2.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/terms-of-use/

Next steps

A2.11 Following the end of the consultation period, Ofcom intends to publish a statement in January 2015.

A2.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/email-updates/

Ofcom's consultation processes

A2.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 3.

A2.14 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 those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A2.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Graham Howell, Secretary to the Corporation, who is Ofcom's consultation champion:

Graham Howell
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email Graham.Howell@ofcom.org.uk

Annex 3

Ofcom's consultation principles

A3.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A3.2 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

A3.3 We will be clear about who we are consulting, why, on what questions and for how long.

A3.4 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 Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A3.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A3.6 A person within Ofcom 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. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A3.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A3.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 4

Consultation response cover sheet

A4.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A4.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A4.3 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 coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A4.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at http://stakeholders.ofcom.org.uk/consultations/consultation-response-coversheet/.

A4.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. 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:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

If you want part of your response, your name or your organisation not to be published, 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 that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. 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 5

Adjacent band use by fixed links in 1492-1517 MHz

A5.1 This annex provides information on the use of the 1492-1517 MHz band taken from Ofcom's database of fixed link assignments. It also summarises the main points from a pre-consultation engagement exercise that we carried out with the fixed link stakeholder community, the aim of which has been to gather further information on the nature of current fixed link use and to understand the likely future demand for this band.

Information on fixed link assignments in 1492-1517 MHz band

A5.2 In the UK the 1492-1517 MHz paired with 1350-1375 MHz is referred to as the 1.4 GHz band, ("the 1.4 GHz fixed link band"). It is used and available for point to point fixed links. The band is managed by Ofcom and fixed links are technically coordinated and licensed on a first come first served basis. We set the technical frequency assignment criteria ("TFAC") in consultation with stakeholders and we use these to coordinate links to prevent undue interference within the band. The pairing of the sub bands enable "go" and "return" transmission paths for each link under frequency division duplexed ("FDD") arrangement. The channelisation within the band is based on arrangements defined by CEPT[41].

A5.3 The number of fixed links within this band has grown from a few hundreds of links over a 20 year period to around 850 links currently in operation, although the overall number of links has been stable in recent years.[42] The approximate activity within the band over the last year has indicated 100 new assignments, 150 variations and 70 cancellations.

A5.4 There are currently over 70 different licensees that hold the 850 live fixed links operating this band (with the largest licensee having just under 200 links at one end of the scale, and a long tail of licensees have a few links only). The paired 2 x 24 MHz of spectrum is used by a variety of sectors as follows:

- **Emergency Services**: These services utilise the band for infrastructure links to support the communications networks of the police, fire and ambulance services.
- **Utilities**: The electricity, water, oil and gas services that utilise this band for the provision of communications links as well as network and substation monitoring provision, including offshore.
- **Broadcasting**: Transmitter feeds for local and digital audio broadcasting and for connecting and interconnecting broadcast studios.
- **Telecommunications services**: For the provision of PSTN[43] circuits.

[41] CEPT Recommendation T/R 13-01 Annex A
[42] There were around 870 links at the end of 2010.
[43] Public Switched Telephone Network

- **Other**: A significant proportion of licensees have low numbers (less than 5) of links the use of which have not been specified.

A5.5 The Emergency Services and Utilities sectors are majority users of this band.

A5.6 Below is a map of the UK showing the deployment of fixed links operating the 1.4 GHz fixed link band. It shows that fixed links are deployed across the country as opposed to being concentrated in certain areas.

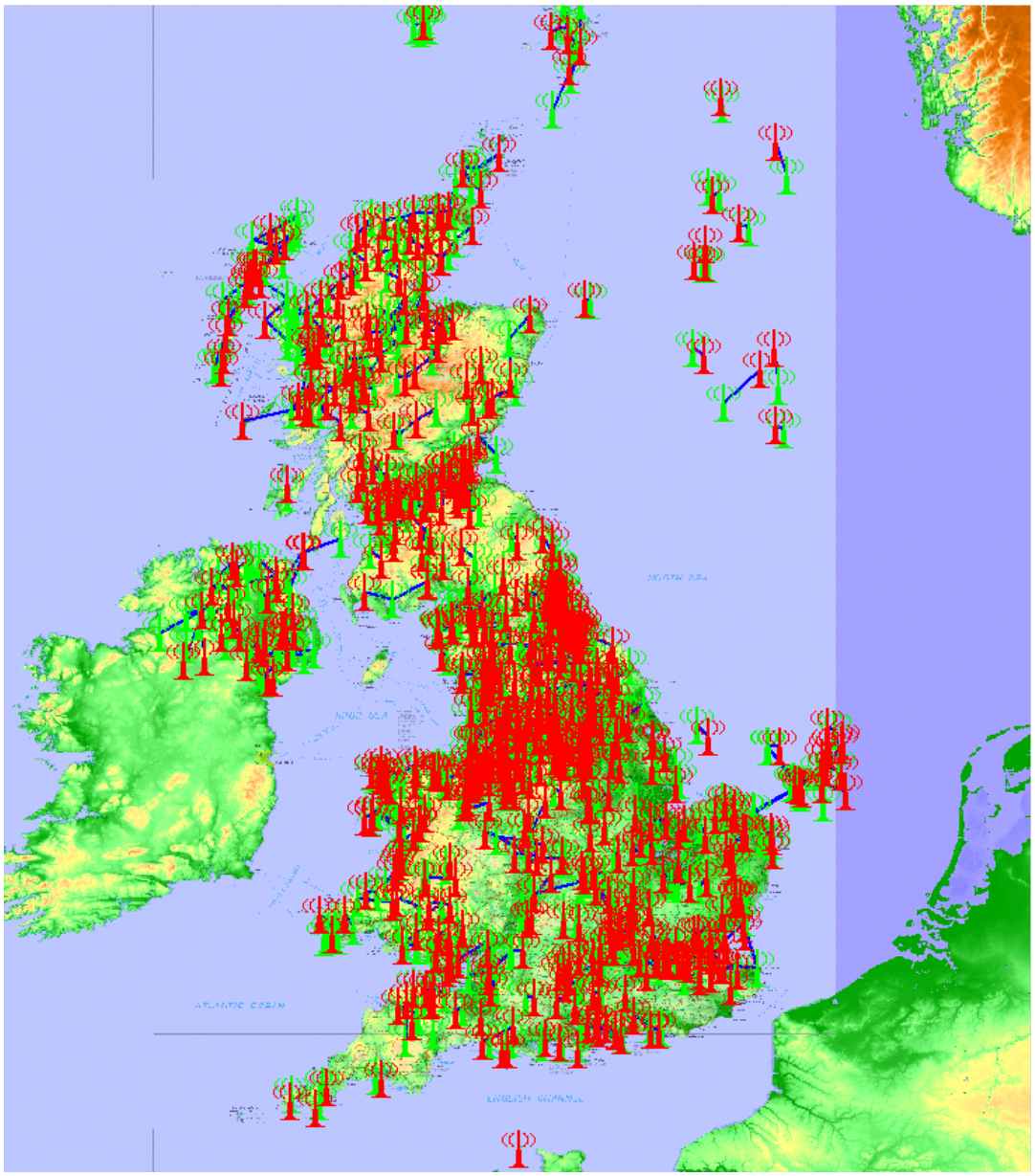

Figure A5.1: current deployment of fixed link in the 1.4 GHz fixed link band

A5.7 The diagrams below show the total number of UK fixed links per channel size and in accordance with CEPT channel arrangement T/R 13-01 Annex A. The greatest number of links have channel widths of 500 kHz or 2 MHz. The diagrams show that the majority of the links fall in the lower half of the band (except in the case of the 2 MHz channel width where the spread is even).This reflects the historic assignment policy in which links are assigned to the lowest available frequency in the band. The fact that the majority of the links are in the lower part of the band suggests that

there is still capacity to accommodate additional low capacity fixed links in the band, should there be demand for them.

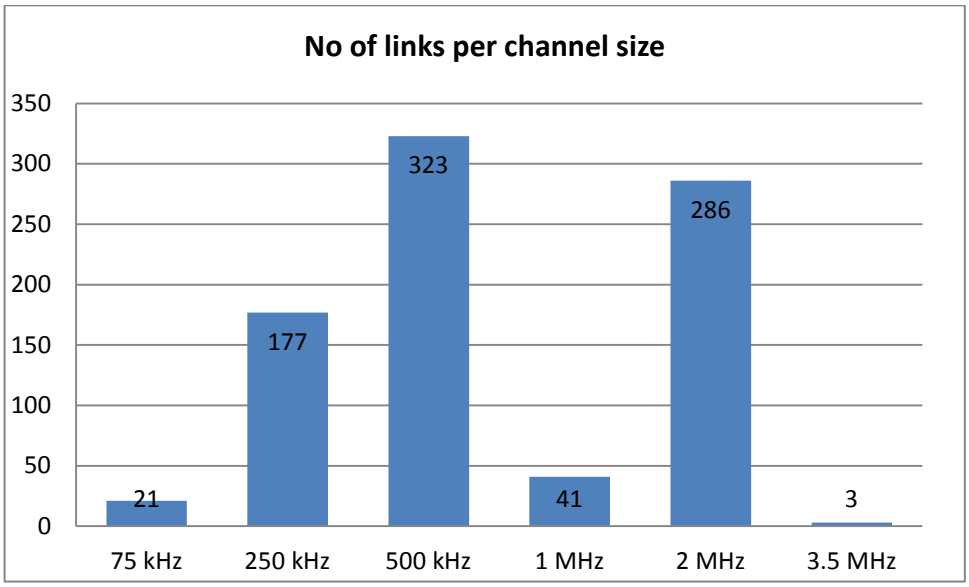

Fig 5.2: Number links by channel size

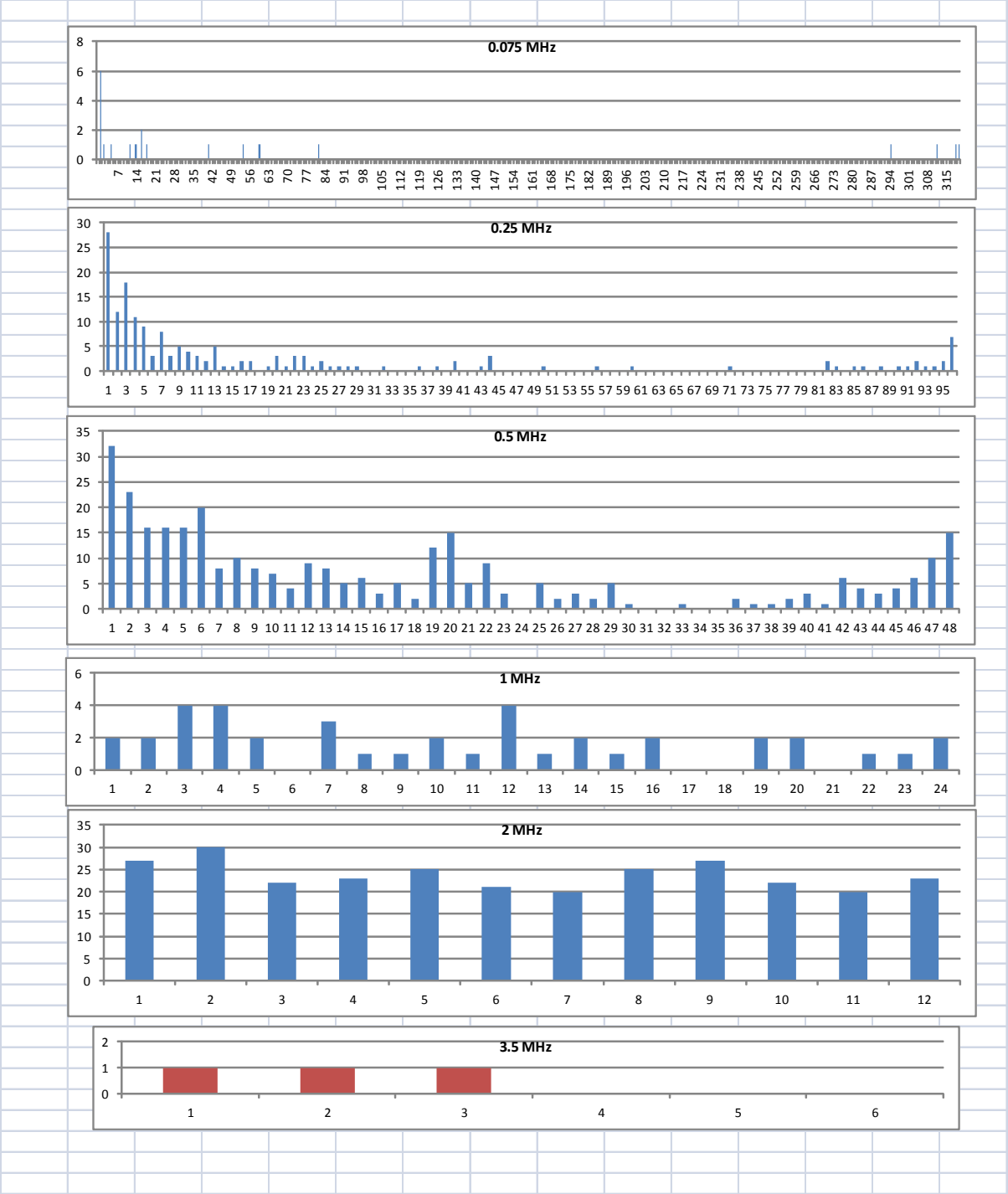

Figure A5.3 No of links per channel shown for each raster

Stakeholder Engagement and Future Demand

A5.8 In developing our proposals set out in this consultation, we provided the Fixed Wireless Industry Liaison Forum ("FWILF") with an overview of the nature of the international developments that have led to the request for variation and the need address the adjacent band compatibility. We also invited existing fixed link licensees and vendors of the 1.4 GHz fixed link band to engage with us on a one to one basis to inform our understanding of current use and future demand for the

1492-1517 MHz band. Below we provide a high level summary of the main points which we covered and issues that emerged in our discussions with stakeholders:

- **Why licensees choose the 1.4 GHz fixed link band**

  The common theme was that the applications that utilise this spectrum require low capacity (narrow bandwidth) and long range. In addition, low equipment cost, easy equipment maintenance, low cost antennas and subsequently low cost mounting, reduced tower loading and low licence fees were all cited as drivers for using this band. Although not always a band of first choice, the 1.4 GHz fixed link band does provide some useful characteristics such as negligible impact of rain fade, resistance to vegetation blocking the line of sight path, and antennas that are easy to align due to relatively wide beamwidth to those commonly used.

- **Future demand for the 1.4 GHz fixed link band**

  Use of this band for emergency service applications will continue for so long as this service is provided using the current TETRA system. However, it is possible that this will be replaced by an LTE based solution (the Home Office is currently conducting a new competitive procurement exercise). If so, then this factor could lead to a significant reduction in number of associated fixed links in this band.

  The support for BT's low capacity "KiloStream"[44] leased line service will cease in 2018 which has led to a number of stakeholders migrating to this band and, as a result, they expect to increase their number of 1.4 GHz links over the next few years. Stakeholders also indicated that the move to "SmartGrid" is also expected to increase the demand for telemetry links which are often deployed in this band.

  Aside from the above factors, the majority of users do not foresee a material change in overall usage of this band over the next 5 years or so.

  Manufacturers reported strong sales for both "upgrades" and new links. Manufacturers are innovating in the band and developing equipment with higher order modulation schemes to increase capacity within the existing channel sizes. However, these higher order modulation profiles are currently not defined in either the ETSI standards or our TFAC (OfW446) and would be more challenging to assign given increased protection requirements and the larger 3.5 MHz channels required.

- **Product Life**

  The life of products in this band was indicated to be typically 10-15 years, although most stakeholders commented that the equipment is robust and 20 years is not uncommon with very little maintenance required. These numbers were quoted by almost all stakeholders we spoke to.

- **What if the 1.4GHz fixed link band was no longer available?**

  We asked stakeholders what they would do if, hypothetically, they were unable to access the 1.4 GHz band for new fixed link deployments.

44 https://www.btwholesale.com/pages/static/Products/Data_and_IP_Connectivity/KiloStream/index.htm

Stakeholders indicated that higher frequency microwave bands often involve extra hops and the use of more expensive antennas with attendant higher mounting costs (tower rental and more substantial structural requirements) and that higher frequency bands currently do not cater for links that require low data rates. Therefore, although a move to higher frequency bands might be technically feasible, all stakeholders we engaged with were of the view that this would increase costs.

Whilst satellite (VSAT) is considered by some, its latency makes it unattractive for the majority of applications that use this band. Concerns were voiced about not being able to provide coverage in remote locations as increased expense of alternative solutions would be too high. Concerns were also expressed regarding the provision of remote PSTN link which are only possible in this band because of availability of suitable equipment.

One stakeholder mentioned that some telemetry could be relocated to UHF if the spectrum was made available and that the preference for utilities would be to move lower in frequency range below 1 GHz.

- **CEPT narrow channels in 6 GHz and 10 GHz bands.**

  In our discussions we referred to the CEPT work on enabling smaller channels within the gaps of the 6 GHz sand 10 GHz band plans. This was interesting to some, but the concerns over costs and antenna issues remained, with some indicating that they would have to withdraw service provision if the cost became too high. There were also questions over the timescales for this being available and, in particular, over equipment availability.

- **Antennas**

  Although a wide range of antennas are used in this band, shrouded Yagis and flat panels were indicated as preferred antennas due to their lightweight nature and low visual impact, making installation easy and low cost.

- **Additional Filtering**

  Some equipment is claimed to have a much higher filtering performance than others. Concerns were expressed over who would bear the cost of any retrospective filer fitment. Some stakeholders also expressed concern as to whether additional filtering would be possible as their link budget had little room for extra losses caused by the insertion of extra filters.

A5.9 In addition, one stakeholder indicated that should Ofcom choose to propose an approach to ensure adjacent band compatibility, then it would be preferred that such an approach be provided as guidance rather than mandated as there could be various ways in which compatibility would be possible using practical engineering solutions. In its view, a mandatory approach could unnecessarily and unintentionally constrain the use of the band for fixed links.

Summary and emerging issues from the discussions

A5.10 The overall impression from the pre-consultation engagement is that capacity demand for the 1.4 GHz fixed link band from applications that already utilise this spectrum is likely to remain steady. These services are not expecting the data rate

requirement to increase in the future in a way which would lead to a requirement to significantly upgrade the capacity of a link.

A5.11 We also note that the sectors that are the largest users of the band are planning on the expectation that it will be available over the next 10 years with use unlikely to reduce for at least the next 5 or so years. For all other uses, the demand will either remain static or decline. However, there are two drivers that could increase the potential for additional demand for spectrum in this band for fixed links are:

- "KiloStream" leased line replacement links. The withdrawal of this service could create a demand for this band that is yet unknown.

- The "SmartGrid" could potentially drive demand in this band in the absence of suitable sub 1 GHz spectrum available, albeit demand would be limited to low date rate links.

A5.12 In reference to using alternative spectrum for the sectors that currently utilise the 1.4 GHz fixed link band, some stakeholders expressed interest in the smaller channels in higher bands, however they questioned the practicality of using the higher bands for the types of services offered and referred to the significant increase in cost of service provision with some indicating that they would have to withdraw service provision if the cost became too high.

Annex 6

Draft Revised Licence

Wireless Telegraphy Act 2006
Office of Communications (Ofcom)

SPECTRUM ACCESS LICENCE 1452.000 to 1492.000 MHz Band

Licence no: **309189**

Date of Issue: **16 May 2008**

1. The Office of Communications (Ofcom) grants this licence to

Qualcomm UK Spectrum Limited
Company Reg No: 208194
(the "Licensee")
c/o Maples Corporate Services Limited
PO Box 309, Ugland House
Grand Cayman
KY1 – 1104
Cayman Islands

to establish, install and use radio transmitting and receiving stations and/or radio apparatus as described in Schedule(s) (the "Radio Equipment") subject to the terms, set out below.

Licence Term

2. This Licence shall continue in force until revoked by Ofcom in accordance with Paragraph 3 below or surrendered by the Licensee.

Licence Variation and Revocation

3. Pursuant to Schedule 1, paragraph 8 of the Wireless Telegraphy Act 2006 (the "Act"), Ofcom may not revoke this Licence under Schedule 1, paragraph 6 of the Act except:

(a) at the request of, or with the consent of, the Licensee;

(b) in accordance with paragraph 8 of this Licence;

(c) if there has been a breach of a term of the Licence;

(d) if, in connection with the transfer or proposed transfer of rights and obligations arising by virtue of the Licence, there has been a breach of any provision of Regulations made by Ofcom under the powers conferred by section 30(1) and (3) of the Act [45];

(e) if the Licensee has been found to the reasonable satisfaction of Ofcom to have been involved in any act, or omission of any act, constituting a material breach of the Wireless Telegraphy (Licence Award) Regulations 2008 (the "Regulations");

(f) in accordance with Paragraph 8(5) of Schedule 1 to the Act;

(g) if it appears to Ofcom to be necessary or expedient to revoke the Licence for the purposes of complying with a direction by the Secretary of State given to Ofcom under section 5 of the Act or section 5 of the Communications Act 2003; or

(h) for reasons related to the management of the radio spectrum, provided that in such case:

(i) this power to revoke may only be exercised after at least five (5) year's notice is given in writing to the Licensee; and

(ii) such notice must expire after fifteen (15) years from the date of this Licence.

4. Ofcom may only revoke or vary this Licence by notification in writing to the Licensee and in accordance with Schedule 1, paragraphs 6 and 7 of the Act.

Changes

5. This Licence is not transferable. The transfer of rights and obligations arising by virtue of this Licence may however be authorised in accordance with regulations made by Ofcom under powers conferred by section 30(1) and (3) of the Act[46].

6. The Licensee must give prior notice to Ofcom in writing of any proposed change to the Licensee's name and address from that recorded in the Licence.

Fees

7. The licence fee in respect of this Licence is **£8,334,000** which for the avoidance of doubt is exclusive of any VAT which may ultimately be payable.

8. On or after the expiry of fifteen (15) years from the date this Licence was granted, the Licensee shall pay to Ofcom such sum(s) as may be provided for in regulations made by Ofcom under sections 12 and 13(2) of the Act, failing which Ofcom may revoke this Licence.

[45] These are regulations on spectrum trading.
[46] See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

9. The Licensee shall also pay interest to Ofcom on any amount which is due under the terms of this Licence or provided for in any Regulations made by Ofcom under sections 12 and 32(2) of the Act from the date such amount falls due until the date of payment, calculated with reference to the Bank of England base rate from time to time. In accordance with section 15 of the Act any such amount and any such interest is recoverable by Ofcom.

10. If the Licence is surrendered or revoked, no refund, whether in whole or in part of any amount which is due under the terms of this Licence or provided for in any Regulations made by Ofcom under sections 12 and 13(2) of the Act will be made, except at the absolute discretion of Ofcom in accordance with regulation 57 of the Regulations.

Radio Equipment Use

11. The Licensee must ensure that the Radio Equipment is established, installed and used only in accordance with the provisions specified in Schedules 1 and 2 of this Licence. Any proposal to amend any detail specified in Schedules 1 and 2 of this Licence must be agreed with Ofcom in advance and implemented only after this Licence has been varied or reissued accordingly.

12. The Licensee must ensure that the Radio Equipment is operated in compliance with the terms of this Licence and is used only by persons who have been authorised in writing by the Licensee to do so and that such persons are made aware of, and of the requirement to comply with, the terms of this Licence.

Access and Inspection

13. The Licensee shall permit a person authorised by Ofcom:

(a) to have access to the Radio Equipment; and

(b) to inspect this Licence and to inspect, examine and test the Radio Equipment,

at any and all reasonable times or, when in the opinion of that person an urgent situation exists, at any time to ensure the Radio Equipment is being used in accordance with the terms of this Licence.

Modification, Restriction and Closedown

14. A person authorised by Ofcom may require any of the radio stations or radio apparatus that comprise the Radio Equipment to be modified or restricted in use, or temporarily or permanently closed down immediately if in the opinion of the person authorised by Ofcom:

(a) a breach of a term of the Licence has occurred; and/or

(b) the use of the Radio Equipment is causing or contributing to undue interference to the use of other authorised radio equipment.

15. Ofcom may require any of the radio stations or radio apparatus that comprise the Radio Equipment to be modified or restricted in use, or temporarily closed down either immediately or on the expiry of such period as may be specified in the event of a national or local state of emergency being declared. Ofcom may only exercise this power after a written notice is served on the Licensee or a general notice applicable to holders of a named class of Licence is published.

Geographical Boundaries

16. This Licence authorises the Licensee to establish, install and use the Radio Equipment only in the United Kingdom.

Interpretation

17. In this Licence:

(a) the establishment, installation and use of the Radio Equipment shall be interpreted as establishment or use of wireless telegraphy stations and installation or use of wireless telegraphy apparatus as specified in section 8 of the Act; and

(b) the expressions "interference", shall have the meaning given by section 115 of the Act;

(c) the expressions “wireless telegraphy apparatus” and “wireless telegraphy station” shall have the meanings given by section 117 of the Act.

18. The schedules to this Licence form part of this Licence together with any subsequent schedules which Ofcom may issue as a variation to this Licence at a later date.

19. The Interpretation Act 1978 shall apply to this Licence as it applies to an Act of Parliament.

Issued by Ofcom

Signed by

For the Office of Communications

SCHEDULE 1 TO LICENCE NUMBER: *309189*

Schedule Date: **16 May 2008**

Licence Category: **Spectrum Access Licence 1452.000 to 1492.000 ~~1479.500~~ MHz Band**

1. Description of Radio Equipment Licensed

The Radio Equipment means any radio transmitting ~~and receiving~~ base station~~s~~ ~~and/or any radio apparatus~~ that transmits in accordance with the requirements of paragraphs 6, 7~~,~~ and 8~~, 9 and 10~~ of this schedule.

2. Interface Requirements for the Radio Equipment use

Use of the Radio Equipment shall be in accordance with the following Interface Requirement:

IR 2068[47] for Spectrum Access in the Band 1452 – 1492 MHz

3. Special Conditions relating to the Operation of the Radio Equipment

(a) During the period that this Licence remains in force and for six (6) months thereafter, unless consent has otherwise been given by Ofcom, the Licensee shall compile and maintain accurate written records of:

(i) the following details relating to the Radio Equipment:

a) postal address;

b) National Grid Reference (to 100 Metres resolution);

c) antenna height (above ground level) and type, bearing east of true north; and

d) radio frequencies used by the Radio Equipment; and

~~(ii) a statement of the~~ number ~~of subscribing customers;~~

(~~ii~~iii) the operational details of base station sites required in Schedule 2~~3 Paragraph 5 required to establish compliance in any particular area~~;

and the Licensee must produce these records if requested by a person authorised by Ofcom.

(b) The Licensee shall inform Ofcom of the address of the premises at which this Licence and the information detailed at sub-paragraph 3(a) above shall be kept.

(c) The Licensee must submit to Ofcom copies of the records detailed in sub-paragraph 3(a) above at such intervals as Ofcom shall notify to the Licensee.

[47] Available from the Ofcom website at http://www.ofcom.org.uk

(d) The Licensee must also submit to Ofcom in such manner and at such times, all information relating to the establishment, installation or use of the Radio Equipment, whether stored in hard copy or electronic form, as reasonably requested for the purposes of verifying compliance with this Licence or for statistical purposes.

(e) The Licensee must ensure that the Radio Equipment is established and installed only for terrestrial use.

4. Code of Practice on Engineering Coordination

(a) The Licensee shall use best endeavours to agree within six months of the date of first issue of this Licence, with the Notified Licensees, engineering coordination principles (to be set out in an industry Code of Practice on Engineering Coordination).

(b) The objective of the Code of Practice on Engineering Coordination shall be to secure the efficient use of the radio spectrum such that the establishment, installation and use of Radio Equipment will allow other services, whether similar, competing or otherwise, (including those offered by the Notified Licensees) to be established without undue interference.

(c) In developing the Code of Practice on Engineering Coordination the Licensee and the Notified Licensees shall at a minimum consider principles relating to:

(i) Efficient frequency use of the radio spectrum;

(ii) Limiting transmission power to that which is no greater than necessary to effectively provide service;

(iii) Selection of sites and siting radio equipment in a manner that will minimise the probability of interference arising;

(iv) Arrangements for communicating information between Notified Licensees to facilitate engineering coordination.

The Code of Practice on Engineering Coordination, when agreed, shall be provided to Ofcom.

(d) The Licensee shall use its best endeavours to adhere to the agreed Code of Practice when establishing and using stations for wireless telegraphy and installing and using apparatus for wireless telegraphy.

(e) If a Code of Practice on Engineering Coordination containing such engineering coordination principles is not agreed within six months as required by sub-paragraph (a), or, where at any time the objective described in sub-paragraph (b) is in Ofcom's sole opinion not being secured, Ofcom shall require that the Licensee and the Notified Licensees shall adhere to the terms of a Code of Practice containing such principles as Ofcom in its sole discretion deems necessary for the achievement of the objective.

(f) Any breach of the principles in a Code of Practice on Engineering Coordination imposed by Ofcom under sub-paragraph (e) above shall constitute a breach of this Licence.

(g) The Licensee and the Notified Licensees may agree changes to the Code of Practice on Engineering Coordination which was provided to Ofcom under sub-paragraph (c). When agreed, such a revised Code of Practice must be provided to Ofcom as soon

~~as is practical. Where at any time the objective described in sub-paragraph (b) is not being secured by the revised Code of Practice Ofcom shall require that the Licensee and the Notified Licensees shall adhere to the terms of a Code of Practice containing such principles as Ofcom in its sole discretion deems necessary for the achievement of the objective.~~

4. Avoidance of Undue Interference

(a) The Licensee must ensure that the establishment, installation and use of Radio Equipment will allow services established by the Notified Licensees to be operated without undue interference.

(b) In complying with its obligations under sub-paragraph 4(a), the Licensee must, in particular pay to an Existing Notified Licensee all costs which may be reasonably incurred by it to mitigate the risk of undue interference from Radio Equipment established by the Licensee but shall not be responsible for the payment of any such costs incurred by a New Notified Licensee.

(c) Ofcom shall supply the Licensee with such information in relation to the Notified Licensees as Ofcom may consider appropriate for the purposes of enabling the Licensee to fulfil its obligations under sub-paragraph 4(a).

5. Cross-border coordination

The Licensee must ensure that the Radio Equipment is operated in compliance with such cross-border coordination and sharing procedures as may be notified to the Licensee by Ofcom.

6. Permitted Frequencies

Subject to the out of ~~block~~ band emissions permitted under Paragraph ~~10~~8, the Radio Equipment must only transmit ~~and/or receive~~ on the following frequencies (the "Permitted Frequencies"):

(i) 1452.000 MHz – 1492.000 ~~1479.500~~ MHz

7. Maximum permissible e.i.r.p. within the Permitted Frequencies

~~No limit.~~

The power transmitted in any direction in the Permitted Frequencies by the Radio Equipment shall not exceed 68dBm/5MHz e.i.r.p in respect of any given radio transmitting station.

8. Maximum power outside the Permitted Frequencies

The e.i.r.p. emanating from the Radio Equipment transmissions at any frequency outside the Permitted Frequencies shall not exceed

Frequency range	Maximum mean e.i.r.p.	Measurement bandwidth
Below 1449 MHz	-20 dBm	1 MHz
1449 – 1452 MHz	14 dBm	3 MHz
1492 – 1495 MHz	14 dBm	3 MHz
1495 – 1498.5 MHz	-20 dBm	1 MHz
Above 1498.5 MHz	-62.5 dBm	1 MHz

8. Maximum permissible transmitter density

The number of transmitters, excluding indoor transmitters with an e.i.r.p. not greater than 2 Watts per 1.7 MHz, in any 50km x 50km square centred on the intersection of 1km OS grid lines within the licensed area must not exceed 150.

9. Maximum permissible aggregate PFD

The maximum aggregate PFD in the Permitted Frequency(s) specified in paragraph 6(i) shall not exceed -48 dBW/m^2/MHz at a height of 1.5m above ground level at more than 95% of locations within a test area as defined in Paragraph 12.

The maximum aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency(s) as specified in Paragraph 6(i).

10. Permissible Out of Block aggregate PFD

The maximum aggregate PFD outside the Permitted Frequency(s) specified in Paragraph 6(i) shall not exceed:

Offset from relevant block edge ΔF	Maximum aggregate PFD At a receive antenna height of 1.5 m above ground level (dBW/m^2/MHz)
0.0 to 0.2 MHz	-77
0.2 to 0.4 MHz	-101
0.4 to 0.6 MHz	-110
0.6 to 0.8 MHz	-119
0.8 to 1.0 MHz	-127
1.0 to 4.2 MHz	-128

at a height of 1.5m above ground level at more than 95% of locations within a test area as defined in Paragraph 12.

The permissible out of block aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency(s) as specified in Paragraph 6(i).

Where: Δ_F is the frequency offset from the relevant block edge (in MHz)
The lower block edge being 1452.000 MHz
The upper block edge being 1479.500 MHz

11. Compliance with PFD conditions

For the purpose of establishing compliance with the PFD conditions set out in Paragraphs 9 and 10 a methodology based on radio-frequency propagation modelling shall be used. This methodology is set out in Schedule 3 to this licence.

12. Definition of a test area

The test area is a square area including at least ten transmitters. Its location is defined by the (4-figure) National Grid Reference of the bottom left corner. The appropriate test area is the

~~smallest of the following areas, 1 km^2, 4 km^2, 25 km^2, 100 km^2, 400 km^2, 2500 km^2 or 10000 km^2, which includes at least ten transmitters.~~

~~All test points that occur above a water feature (e.g. sea, lake or river) will be ignored. PFD levels at these points will not contribute to establishing compliance.~~

~~13~~9. Interpretation

In this Schedule:

(a) "e.i.r.p." means the equivalent isotropically radiated power. This is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain);

~~(b) "e.r.p." means the effective radiated power. This is the power fed to the antenna multiplied by the maximum gain of the antenna with respect to a half-wave dipole.~~

(b~~c~~) "dBm" means the power level in decibels (logarithmic scale) referenced against 1 milliWatt (i.e. a value of 0 dBm is 1mW);

~~(d) "dBW" means the power level in decibels (logarithmic scale) referenced against 1 Watt (i.e. a value of 0 dBw is 1 W).~~

(c~~e~~) "out of block emissions" means radio frequency emissions generated by the Radio Equipment and radiated into the frequency(s) adjacent (in terms of frequency) to the Licensee's Permitted Frequency(s).

(d~~f~~) "Base station" means a radio transmitter not intended to be used while in motion to provide a communications service, typically used in mobile or broadcasting radio systems.

(e) "Existing Notified Licensee" means a Notified Licensee whose licence was granted on or before [DATE]

(f) "New Notified Licensee" means a Notified Licensee whose licence was granted after [DATE]

(g) "Notified Licensee" means a holder of a wireless telegraphy licence (which relate to a frequency within the band 1492 – 1517 MHz) which is notified to the Licensee by Ofcom in accordance with paragraph 4(c).

~~(g) "Mobile station" means a radio transmitter intended to be used while in motion or during halts at unspecified locations.~~

~~(h) "PFD" means power flux density and is a measure of the power received per unit area per unit frequency. For the purposes of this licence it is expressed in the following units dBW/m^2/MHz.~~

~~(i) "aggregate PFD" means the combined PFD caused by all transmitters authorised by this licence within the test area defined in Schedule 1, Paragraph 12.~~

~~(j) "Notified Licensees" means the holders of wireless telegraphy licences (which relate to the frequency band 1452 – 1492 MHz) which are notified to the Licensee by Ofcom.~~

SCHEDULE 2 TO LICENCE NUMBER: 309189

Schedule Date: **16 May 2008**

Licence Category: **Spectrum Access Licence 1479.500 to 1492.000 MHz Band**

1. Description of Radio Equipment Licensed

The Radio Equipment means any radio transmitting and receiving stations and/or any radio apparatus that transmits in accordance with the requirements of paragraphs 6, 7, 8, 9 and 10 of this schedule..

2. Interface Requirements for the Radio Equipment use

Use of the Radio Equipment shall be in accordance with the following Interface Requirement:

IR 2068[48] for Spectrum Access in the Band 1452 – 1492 MHz

3. Special Conditions relating to the Operation of the Radio Equipment

(a) During the period that this Licence remains in force and for six (6) months thereafter, unless consent has otherwise been given by Ofcom, the Licensee shall compile and maintain accurate written records of:

(i) the following details relating to the Radio Equipment:

a) postal address;

b) National Grid Reference (to 100 Metres resolution);

c) antenna height (above ground level) and type, bearing east of true north; and

d) radio frequencies used by the Radio Equipment; and

(ii) a statement of the number of subscribing customers;

(iii) the operational details of base station sites required in Schedule 3 Paragraph 5 required to establish compliance in any particular area;

and the Licensee must produce these records if requested by a person authorised by Ofcom.

(b) The Licensee shall inform Ofcom of the address of the premises at which this Licence and the information detailed at sub-paragraph 3(a) above shall be kept.

(c) The Licensee must submit to Ofcom copies of the records detailed in sub-paragraph 3(a) above at such intervals as Ofcom shall notify to the Licensee.

[48] Available from the Ofcom website at http://www.ofcom.org.uk

(d) The Licensee must also submit to Ofcom in such manner and at such times, all information relating to the establishment, installation or use of the Radio Equipment, whether stored in hard copy or electronic form, as reasonably requested for the purposes of verifying compliance with this Licence or for statistical purposes.

(e) The Licensee must ensure that the Radio Equipment is established and installed only for terrestrial use.

4. Code of Practice on Engineering Coordination

(a) The Licensee shall use best endeavours to agree within six months of the date of first issue of this Licence, with the Notified Licensees, engineering coordination principles (to be set out in an industry Code of Practice on Engineering Coordination).

(b) The objective of the Code of Practice on Engineering Coordination shall be to secure the efficient use of the radio spectrum such that the establishment, installation and use of Radio Equipment will allow other services, whether similar, competing or otherwise, (including those offered by the Notified Licensees) to be established without undue interference.

(c) In developing the Code of Practice on Engineering Coordination the Licensee and the Notified Licensees shall at a minimum consider principles relating to:

(i) Efficient frequency use of the radio spectrum;

(ii) Limiting transmission power to that which is no greater than necessary to effectively provide service;

(iii) Selection of sites and siting radio equipment in a manner that will minimise the probability of interference arising;

(iv) Arrangements for communicating information between Notified Licensees to facilitate engineering coordination.

The Code of Practice on Engineering Coordination, when agreed, shall be provided to Ofcom.

(d) The Licensee shall use its best endeavours to adhere to the agreed Code of Practice when establishing and using stations for wireless telegraphy and installing and using apparatus for wireless telegraphy.

(e) If a Code of Practice on Engineering Coordination containing such engineering coordination principles is not agreed within six months as required by sub-paragraph (a), or, where at any time the objective described

in sub-paragraph (b) is in Ofcom's sole opinion not being secured, Ofcom shall require that the Licensee and the Notified Licensees shall adhere to the terms of a Code of Practice containing such principles as Ofcom in its sole discretion deems necessary for the achievement of the objective.

(f) Any breach of the principles in a Code of Practice on Engineering Coordination imposed by Ofcom under sub-paragraph (e) above shall constitute a breach of this Licence.

(g) The Licensee and the Notified Licensees may agree changes to the Code of Practice on Engineering Coordination which was provided to Ofcom under sub-paragraph (c). When agreed, such a revised Code of Practice must be provided to Ofcom as soon as is practical. Where at any time the objective described in sub-paragraph (b) is not being secured by the revised Code of Practice Ofcom shall require that the Licensee

and the Notified Licensees shall adhere to the terms of a Code of Practice containing such principles as Ofcom in its sole discretion deems necessary for the achievement of the objective.

5. Cross-border coordination

The Licensee must ensure that the Radio Equipment is operated in compliance with such cross-border coordination and sharing procedures as may be notified to the Licensee by Ofcom.

6. Permitted Frequencies

Subject to the out of block emissions permitted under Paragraph 10, the Radio Equipment must only transmit and/or receive on the following frequency(s) (the "Permitted Frequencies"):

(i) 1479.500 to 1492.000 MHz

7. Maximum permissible e.i.r.p

No limit.

8. Maximum permissible transmitter density

The number of transmitters using frequencies in the range 1479.500 MHz to 1482.900 MHz in any 50km x 50km square centred on the intersection of 1km OS grid lines within the licensed area, excluding indoor transmitters with an e.i.r.p. not greater than 2 Watts per 1.7 MHz, must not exceed 150.

There is no limit on the density of transmitters using frequencies solely in the range 1482.900 MHz to 1492.000 MHz.

9. Maximum permissible aggregate PFD

The maximum aggregate PFD in the Permitted Frequency(s) specified in paragraph 6(i) shall not exceed -96.7 dBW/m^2/MHz at a height of 1.5m above ground level at more than 95% of locations within a test area as defined in Paragraph 12.

The maximum aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency(s) as specified in Paragraph 6(i).

10. Permissible Out of Block aggregate PFD

The maximum aggregate PFD outside the Permitted Frequency(s) specified in Paragraph 6(i) shall not exceed:

Offset from block edge ΔF	Maximum aggregate PFD At a receive antenna height of 1.5 m above ground level (dBW/m^2/MHz)
6.250 to 6.000 MHz	-121

6.000 to 5.400 MHz	-120
5.400 to 5.000 MHz	-119
5.000 to 4.600 MHz	-118
4.600 to 4.200 MHz	-117
4.200 to 3.800 MHz	-116
3.800 to 3.400 MHz	-115
3.400 to 3.000 MHz	-114
3.000 to 2.800 MHz	-113
2.800 to 2.600 MHz	-112
2.600 to 2.200 MHz	-111
2.200 to 2.000 MHz	-110
2.000 to 1.800 MHz	-109
1.800 to 1.600 MHz	-108
1.600 to 1.400 MHz	-107
1.400 to 1.200 MHz	-106
1.200 to 1.000 MHz	-105
1.000 to 0.800 MHz	-104
0.800 to 0.600 MHz	-102
0.600 to 0.400 MHz	-101
0.400 to 0.200 MHz	-99
0.200 to 0.000 MHz	-97

at a height of 1.5m above ground level at more than 95% of locations within a test area as defined in Paragraph 12.

The permissible out of block aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency(s) as specified in Paragraph 6(i).

Where: Δ_F is the frequency offset from the block edge (in MHz)
The lower block edge being 1479.500 MHz
The upper block edge being 1492.000 MHz

11. Compliance with PFD conditions

For the purpose of establishing compliance with the PFD conditions set out in Paragraphs 9 and 10 a methodology based on radio-frequency propagation modelling shall be used. This methodology is set out in Schedule 3 to this licence.

12. Definition of a test area

The test area is a square area including at least ten transmitters. Its location is defined by the (4-figure) National Grid Reference of the bottom left corner. The appropriate test area is the smallest of the following areas, 1 km^2, 4 km^2, 25 km^2, 100 km^2, 400 km^2, 2500 km^2 or 10000 km^2, which includes at least ten transmitters.

All test points that occur over a water feature (e.g. sea, lake or river) will be ignored. PFD levels at these points will not contribute to establishing compliance.

13. Interpretation

In this Schedule:

(a) "e.i.r.p." means the equivalent isotropically radiated power. This is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain);

(b) "e.r.p." means the effective radiated power. This is the power fed to the antenna multiplied by the maximum gain of the antenna with respect to a half-wave dipole.

(c) "dBm" means the power level in decibels (logarithmic scale) referenced against 1 milliWatt (i.e. a value of 0 dBm is 1mW);

(d) "dBW" means the power level in decibels (logarithmic scale) referenced against 1 Watt (i.e. a value of 0 dBw is 1 W).

(e) "out of block emissions" means radio frequency emissions generated by the Radio Equipment and radiated into the frequency bands adjacent (in terms of frequency) to the Licensee's Permitted Frequencies.

(f) "Base station" means a radio transmitter not intended to be used while in motion to provide a communications service, typically used in mobile or broadcasting radio systems.

(g) "Mobile station" means a radio transmitter intended to be used while in motion or during halts at unspecified locations.

(h) "PFD" means power-flux density and is a measure of the power received per unit area per unit frequency. For the purposes of this licence it is expressed in the following units dBW/m^2/MHz.

(i) "aggregate PFD" means the combined PFD caused by all transmitters authorised by this licence within the test area defined in Schedule 2, Paragraph 12.

(j) "Notified Licensees" means the holders of wireless telegraphy licences (which relate to the frequency band 1452 – 1492 MHz) which are notified to the Licensee by Ofcom.

SCHEDULE 23 TO LICENCE NUMBER: *309189*

Schedule Date: **16 May 2008**

Licence Category: **Spectrum Access Licence 1452.000 to 1492.000 MHz Band**

High Power Network

1. Radio-frequency propagation model

For the purpose of radio-frequency propagation modelling ITU-R Recommendation P.1546-3 (P.1546) shall be used.

2. Terrain data

Ordnance Survey "Panorama DTM" 50 m resolution digital terrain map data shall be used.

3. Clutter data

The 50 m resolution clutter database produced by Infoterra shall be used.

This database identifies 10 different clutter categories. For the purposes of incorporation into P.1546 these categories are mapped to the categories noted in P.1546, namely: urban, dense urban, suburban, sea, open. The mapping that will be used is shown in Table A1.

Code	Clutter Database Category	P.1546 category	Reference Antenna Height (m)
1	**Dense urban**	Dense Urban	30
2	**Urban**	Urban	20
3	**Industrial**	Suburban	10
4	**Suburban**	Suburban	10
5	**Village**	Suburban	10
6	**Parks/recreation**	Open	10
7	**Open**	Open	10
8	**Open in urban**	Urban	20
9	**Forest**	Open	10
10	**Water**	Sea	10

Table A1. Mapping of clutter categories

4. Calculation methodology

To verify compliance, field strength values will be calculated using any suitable radio-frequency software planning tool implementing the radio-frequency propagation model and terrain and clutter data sets described in Paragraphs 1, 2 and 3.

Compliance to the licence terms is established if the aggregate field strength values predicted by the radio-frequency software planning tool are no greater than those given in Schedule(s), Paragraphs 9 and 10 for the specified percentage of locations (pixels) within the test area.

Detailed specification of the methodology is given below:

a) **Pixel Size.** The test area defined in Schedule(s), Paragraph 12 will be divided into square pixels of size 50m by 50m.

b) **Summation of signals from transmitters**. The aggregate field strength at a pixel will be defined to be the summation of the predicted field strengths for each outdoor transmitter (expressed in linear units) on an r.m.s. basis (linear addition of power density).

c) **Excluded pixels.** Aggregate field strength will not be calculated for pixels which contain a transmitter. Pixels containing a transmitter will not be considered in determining compliance. Pixels which are of P.1546 clutter type 'Sea' will not be considered in determining compliance.

The term "adjacent to sea" as described in P.1546, Annex 5, Section 9 is interpreted as "located over the sea". These pixels will therefore not be considered in determining compliance.

d) **Path profile extraction.** Both terrain height and clutter height will be assumed to be constant over the area of a pixel. No interpolation of heights will be undertaken. The path profile will be extracted using the Bresenham algorithm. Ofcom will publish an example of modelling compliance for a reference network against which licence holders can verify their own compliance modelling software.

e) **P.1546 location variability.** Field strengths will be predicted for a 50% location variability

f) **P.1546 time variability**. Field strengths will be predicted for a 50% time variability**.**

g) **P.1546 field-strength predictions for distances less than 1 km.** For path lengths of less than 1 km, the method described in P.1546, Annex 5, Section 14 will be used.

h) **Receiving/mobile antenna height.** Field strengths will be calculated at the height specified in Schedule 1 Paragraphs 9 and 10.

i) **P.1546 correction for receiving/mobile antenna height.** For pixels which are classified as P.1546 categories "dense urban", "urban" or "suburban

~~environment", equation 27a of P.1546 shall be used to determine the correction for receiving/mobile antenna height. For pixels which are classified as P.1546~~

~~categories "open" or "sea", equation 27b shall be used to determine the correction for receiving/mobile height.~~

~~j) **Terrain Clearance Angle.** Terrain Clearance Angle correction as described in P.1546, Annex 5, Section 11 will be used.~~

~~k) **P.1546 Correction for short urban/suburban paths.** (P.1546, Annex 5, Section 10,). No correction for short urban/suburban paths will be applied.~~

~~l) **P.1546 Land paths shorter than 15 km.** For paths less than 15 km in length, as described in P.1546, Appendix 5, Section 3.1, equation 6 of P.1546, Annex 5 will be used to determine *h1* in all cases. In using this equation the actual value of path length *d* will be used, including cases when *d* is less than 1 km.~~

m) ~~**Transmit antenna gain**. The transmit e.i.r.p. assumed will be that in the direction of the reference receiver at the clutter height~~

~~5.~~ Operational details of transmitting stations

The operational details of all transmitting stations ~~within the area for which compliance is to be established will be entered into the radio-frequency software planning tool, excluding indoor transmitting stations with an e.i.r.p. not greater than 2 Watts per 1.7 MHz. These details may include~~ including:

(a) the National Grid Reference to ten (10) metres resolution of each transmitting site;

(b) the height above ground level of each transmitting antenna to an accuracy of 1 metre;

(c) the azimuth of each transmitting antenna on each site;

(d) the horizontal and vertical profile of each transmitting antenna on each site (without taking into account any down-tilt);

(e) the down-tilt (physical and electrical) of each transmitting antenna;

(f) Class of Emission of the radiated signal;

(g) the ~~mean~~ operational e.i.r.p. per MHz over the permitted frequency(s) given in Schedule(s) Paragraph 6~~, averaged over a specified 3 minute interval~~ for each transmitting antenna; and

~~(h) the out of block emission profile in e.i.r.p. per MHz to a maximum of 4 MHz either side of the permitted frequency(s) given in Schedule(s) Paragraph 6 of each transmitting antenna.~~

(h) the out of band emission profile in e.i.r.p. per MHz to a maximum of 25 MHz either side of the permitted frequency(s) given in Schedule 1 Paragraph 6 of each transmitting antenna.

Annex 7

Draft Revised IR 2068

OFFICE OF COMMUNICATIONS

UK Interface Requirement 2068

For Spectrum Access in the Band 1452 – 1492 MHz

Publication date: [DATE]~~March 2008~~
98/34/EC Notification number: ~~[2007/412/UK]~~

Contents

References

These references are included for information purposes only. Compliance with these standards is not mandatory.

1.1 ETSI EN 302 077 Title: Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Terrestrial - Digital Audio Broadcasting (T- DAB) service; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive.

1.2 ETSI EN 302 296 Title: Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the digital television broadcast service, Terrestrial (DVB-T); Harmonized EN under article 3.2 of the R&TTE Directive

1.3 ETSI TS 102 428 Title: Digital Audio Broadcasting (DAB); DMB video service; User Application Specification

1.4 ETSI EN 302 304 Title: Digital Video Broadcasting (DVB);Transmission System for Handheld Terminals (DVB-H)

1.5 ETSI TR 102 377 Title: Digital Video Broadcasting (DVB);DVB-H Implementation Guidelines

1.6 The Maastricht, 2002, Special Arrangement, as revised in Constanţa, 2007

1.7 Electronic Communications Committee Decision ECC/DEC/(03)02 on the designation of the frequency band 1479.5 – 1492 MHz for use by Satellite Digital Audio Broadcasting systems

1.8 Electronic Communications Committee Decision ECC Decision (13)03 on the harmonised use of the frequency band 1452-1492 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL).

Forward

2.1 The Radio Equipment and Telecommunications Terminal Equipment Directive 99/5/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 2000, Statutory Instrument 2000 No. 730. In accordance with Articles 4.1 and 7.2 of Directive 1999/5/EC, this UK Interface Requirement contains the requirements for the licensing and use of radio equipment in the specified frequency bands.

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

2.3 It is required by the Wireless Telegraphy Act 2006 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 Ofcom. It is a condition of such a licence or exemption regulations as appropriate that, in order to be installed or used in the UK, the equipment must meet the minimum requirements specified in this UK Interface Requirement for the stated equipment types and for the stated frequency bands. Nothing in this UK Interface Requirement shall preclude equipment from being placed on the market in the UK that complies with the 'essential requirements' specified in Directive 1999/5/EC.

2.4 The requirements given in the main body of this UK Radio Interface Requirement will apply to the licensing of radio equipment in the band 1452 – 1492 MHz.

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

i) current technology developments for reasons related to the effective and appropriate use of the spectrum in particular maximising spectrum utilisation; and

ii) changes to the available spectrum allocated for spectrum access in the band 1452 – 1492 MHz.

2.6 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 web-site at http://www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/.

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

Minimum requirements for operation within the UK

3.1 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.

3.2 This UK Radio Interface Requirement gives a high level description of how the spectrum in the UK is used for spectrum access in the band 1452 – 1492 MHz. It does not prescribe technical interpretation of the 'essential requirements' of Directive 1999/5/EC.

3.3 This UK Radio Interface Requirement therefore stipulates the necessary equipment parameters for the licensing of radio equipment in the band 1452 – 1492 MHz in the UK. Table 3.1 contains the relevant equipment parameters. These taken together with the 'essential requirements' detailed in Article 3.2 of Directive 1999/5/EC constitute the minimum requirements for radio equipment in the band 1452 – 1492 MHz within the UK. Nothing in this UK Interface Requirement shall preclude equipment from being placed on the market in the UK that complies with the 'essential requirements' specified in Directive 1999/5/EC.

3.4 The technical parameters specified in the UK Radio Interface Requirement are applied to achieve the desired level of compatibility within the band 1452 – 1492 MHz and with other radiocommunications services, whilst promoting enterprise, innovation and competition.

3.5 This UK Radio Interface requirement provides the necessary technical information which facilitates access to the 1452 – 1492 MHz spectrum by making clear the assumptions that are made in planning the use of the relevant spectrum 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 de facto product requirement.

Table 3.1: Minimum requirements for the use of: - radio equipment operating in the 1452 - 1492 MHz band			
Mandatory (1-9)			
1	**Frequency / Bands**	1452 – 1492 MHz	
2	**Radio service**	Any	
3	**Application**	Any	
4	**Channelling / modulation**	~~Any~~Yes, See Table 3.1.1 below	
5	**Maximum transmit power limit**	None68dBm/5MHz **Note-1**	
6	**Channel occupation rules**	N/A	
7	**Duplex type / separation**	N/A	
8	**Licensing Regime**	Yes	
9	**Additional essential requirements**	~~N/A~~ Yes, See Table 3.1.2 below for MFCN SDL base station out of block limits within the band 1452-1492MHz	
Informative (10-13)			
10	Frequency planning assumptions	-	
11	Reference	-	
12	Remarks	**Note-1**	Co-ordination and site clearance considerations may impose additional restrictions on the maximum system eirp allowed on specific frequencies, directions and locations.
13	Notification Number	2007/412/UK	

Table 3.1.1: Band plan for the 1452-1492 MHz							
1452 - 1457	1457- 1462	1462- 1467	1467- 1472	1472- 1477	1477- 1482	1482- 1487	1487- 1492
Downlink (base station transmit)							
40 MHz (8 blocks of 5 MHz)							

Table 3.1.2: MFCN SDL Base Station out-of-block EIRP limits within the band 1452-1492 MHz		
Frequency range of out-of-block emissions	**Maximum mean out-of-band e.i.r.p. (dBm)**	**Measurement Bandwidth**
–10 to –5 MHz from lower block edge	11	5
–5 to 0 MHz from lower block edge	16.3 dBm	5
0 to +5 MHz from upper block edge	16.3 dBm	5
+5 to +10 MHz from upper block edge	11	5
Remaining MFCN SDL frequencies	9 dBm	5

Additional performance parameters

(informative)

None specified

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Document history

Version	Date	Changes
1.0	09 Nov 2007	Draft published
1.1	07 Mar 2008	Final reversion published
1.2	[XX YY 2014]	Licence variation consequential changes: Introduction of a maximum transmit EIRP and alignment of the band plan and the out of block EIRP limits with ECC Decision(13)03.

Annex 8

Example Draft Guidance Notes

Guidance for fixed link assignment requests in the 1.4 GHz band from <insert licence variation date> - Mitigation measures to achieve compatibility between base stations in 1452-1452 MHz and fixed links in 1498.5-1517 MHz

Please read this guidance note before you apply for a licence to operate a fixed point to point link in the 1356.5 MHz-1375MHz and 1498.5-1517 MHz band "1.4 GHz fixed link band"

About this Document

This document offers guidance to applicants for a licence to operate fixed point to point links in the 1.4 GHz fixed link band on the necessary pre-application requirements that would need to be addressed by that applicant.

Ofcom has made changes to the technical conditions in the adjacent 1452-1492 MHz to enable optimal use of this band for MFCN SDL (Mobile/Fixed Communication Network Supplemental Downlink) "SDL". These changes are intended to enhance the mobile data services available to citizens in the UK.

These changes will require necessary management of the interference environment between adjacent uses. To address this:

- The receivers of fixed links operating in the 1.4 GHz fixed link band will need to take into account the presence of base station transmissions in the adjacent 1452-1492 MHz and will need to take necessary action to address this prior to submitting their application for a fixed link in the 1.4 GHz band.

- Ofcom is placing additional conditions to limit the out of band emissions from the base station operating in the 1452-1492 MHz band to ensure protection of fixed point to point links operating in the 1.4 GHz fixed link band.

Technical Conditions applicable to SDL stations operating in the 1452-1492 MHz band

The detailed background to our policy development and implementation is given the following documents:

i) Consultation <*insert link to this consultation*>

ii) Statement <*insert link the statement following this consultation*>

In summary the following conditions now apply to SDL base stations operating in the adjacent band:

- A maximum base station EIRP limit in the 1452-1492 MHz band is 68dBm/5MHz

- The maximum mean out of band emission limits for SDL base stations operating in 1452-1492 MHz are as follows:

Frequency Range of out of band emissions	Maximum mean out of band EIRP (dBm)	Measurement bandwidth (MHz)
Below 1449 MHz	-20	1
1449-1452	14	3
1492-1495 MHz	14	3
1495-1498.5 MHz	-20	1
1498.5-1517 MHz	-62.5	1

Requirements for applicants of fixed link licenses in the 1.4 GHz band

The presence of a high power signal in the adjacent will require fixed links intending to operate in the upper sub band of the 1.4 GHz band to take necessary action as follows:

1. **Filtering**
   Fixed links receiving in the upper sub band of the 1.4 GHz fixed link band will need to ensure that receivers are fitted with filters to address the effect of blocking due to the high power transmissions in the adjacent 1452-1492 MHz band. The indicative receiver filtering requirements for current fixed link system types are given in the table below.

Fixed link system type (kbit/s in kHz)	**Total fixed link receive filtering requirement over 1452 – 1492 MHz (dB)**	**Additional fixed link filtering required in addition to the minimum equipment performance specified in ETSI standard (dB)**
32 in 25	150.6	99.6
64 in 25	152.7	101.7
96 in 75	139.6	88.6
192 in 75	148.7	97.7
256 in 250	126.5	75.5
512 in 250	142.7	91.7
512 in 500	142.6	91.6
704 in 500	138.6	87.6
1024 in 500	140.7	89.7
2048 in 500	137.7	86.7
1024 in 1000	139.6	88.6
2048 in 1000	137.7	86.7
2048 in 2000	136.6	85.6
4096 in 2000	134.7	83.7
4500 in 3500	133.6	82.6
9100 in 3500	134.7	83.7

2. **Minimum Clearance Distance**
   Applicants will also need to ensure that their planned fixed link path is clear of base stations in the main beam of that fixed link. A minimum clearance distance between the main beam of a fixed link and SDL base station will depend of the fixed link antenna used. In practice, a fixed link operator will need to ensure that there is a clear path between the two ends of the link as with consistent standard link planning practice. Indicative minimum clearance distances for current antenna types are given in the table below.

Antenna Type	**Antenna gain (dBi)**	**Indicative Minimum clearance distance (m)**
A/01/O/06/005/JB	14	70.8
A/01/O/95/030/EU	14.3	73.3
A/01/O/96/046/JB	16	89.1
A/01/H/00/095/SK	16	89.1
A/01/O/97/034/JB	16	89.1
A/01/O/97/059/EU	16.6	95.5
A/01/O/97/035/JB	16.7	96.6
A/01/O/97/058/EU	*17*	*100.0*
A/1G5/O/83/009/JB	*17*	*100.0*
A/01/S/04/001/RF	17.3	103.5
A/01/O/08/021/GA	19	125.9
A/01/H/05/011/RF	20	141.3
A/01/S/04/043/RF	20	141.3
A/01/H/11/030/GR	22.1	179.9
A/01/H/97/032/AA	22.3	184.1
A/01/H/05/007/RF	22.5	188.4
A/01/H/10/002/GA	22.6	190.5
A/01/H/98/001/AA	22.9	197.2
A/01/H/06/070/RF	23.7	216.3
A/01/S/05/014/MR	25.1	254.1
A/01/H/09/014/RF	25.7	272.3
A/01/H/97/033/AA	25.8	275.4
A/01/H/98/002/DT	26.2	288.4
A/01/H/96/051/AA	28.7	384.6

We are not mandating the conditions contained in the above tables as in some cases, the licensee of the 1452-1492 MHz and the fixed link operator could come to an arrangement to ensure compatibility though other site engineering solutions such as antenna tilting at the base station site.

Legacy links operating in the 1.4 GHz

Legacy links are those links that were operating in the 1492-1517 MHz band prior to implementation of our policy change to the technical conditions to enable SDL use in 1452-1492 MHz band. Specifically this would cover all fixed links licensed by Ofcom on or before the date of variation of the spectrum access licence for 1452-1492 MHz that would implement the changes as given in our Statement.

Information Provision

To enable the protection of legacy fixed links and the consideration of new fixed links by the 1452-1492 MHz licensee, Ofcom will disclose to this licensee the details of all assigned fixed links, including licensee details to avoid the risk of undue interference.

Annex 9

Fixed Link Data Provision

List data fields that will be provided to the 1452-1492 MHz licensee

A9.1 The following are the fixed link data fields that we are proposing to make available to the 1452-1492 MHz licence holder:

- Licence number
- Licence holder number
- Licence number
- Licence holder name
- Licence contact name
- Licence contact Telephone number
- Licence contact Email address
- Transmitter Frequency (GHz)
- Transmitter channel number
- Transmitter bandwidth (MHz)
- Transmitter Radiated Power EIRP (dBW)
- Transmitter location NGR
- Transmitter Antenna code
- Transmitter Antenna Gain (dBi)
- Transmitter Antenna Height AGL (m)
- Transmitter Antenna Elevation Angle (degrees)
- Transmitter Antenna Azimuth Angle (degrees)
- Transmitter Branch Loss (dB)
- Transmitter Feeder Loss (dB)
- Receiver Frequency (GHz)
- Receiver channel number
- Receiver bandwidth (MHz)
- Receiver location NGR
- Receiver Antenna code
- Receiver Antenna Gain (dBi)
- Receiver Antenna Height AGL (m)
- Receiver Antenna Elevation Angle (degrees)
- Receiver Antenna Azimuth Angle (degrees)
- Receiver Branch Loss (dB)
- Receiver Feeder Loss (dB)
- Receiver Sensitivity Level (dBm)
- Wanted/Unwanted (dB)
- Path Length (Km)
- Link Polarisation
- Link Availability (%)
- Link Fade Margin (dB)