



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

Statement

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About this document

This document sets out Ofcom's decision to vary the 1452 – 1492 MHz licence held by Qualcomm UK Spectrum Ltd, to enable its 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. Improved capacity can help service providers send more data to consumer devices, such as smartphones, tablets and laptops, at faster speeds.

The decision also sets out the changes we are making to the adjacent 1492 – 1517 MHz band, which is paired with 1350 – 1375 MHz. This is used in the UK by fixed wireless point-to-point links.

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Section 1

Summary

- 1.1 This statement sets out Ofcom’s decision to:
- i) vary the Spectrum Access Licence for the 1452-1492 MHz (“1.4 GHz Spectrum Access Licence”) to enable the use of for Mobile/Fixed Communication Supplemental Downlink (“SDL”); and
 - ii) change the way in which the adjacent 1492-1517 MHz band (paired with 1350-1375 MHz) is made available for new fixed link assignments by implementing measures to ensure adjacent band compatibility between SDL use in the 1452-1492 MHz band and adjacent fixed link use in the 1492-1517 MHz band.
- 1.2 This decision follows our consideration of responses to our September 2014 consultation (the “Variation Consultation”) in which we considered the request for variation submitted by the current licence holder for this spectrum, Qualcomm UK Spectrum Limited (“Qualcomm”).
- 1.3 Since the Variation Consultation, in March 2015, the European Commission has made a mandatory binding decision (the “RSC Decision”) to harmonise the 1452-1492 MHz band for terrestrial systems capable of providing electronic services in the European Union. The decision set out in this statement implements this RSC Decision.
- 1.4 The main changes to the 1.4 GHz Spectrum Access Licence relate to the technical conditions where we are replacing the existing Spectrum Usage Rights with new technical conditions which include an in-band block edge mask, maximum mean out of band EIRP limits and which limit operation to base stations with downlink only transmission. These new technical conditions are in line with the RSC Decision. As permitted under the RSC Decision, we are also placing a maximum in block EIRP limit of 68 dBm/5 MHz for base stations and a maximum mean out of band limit of -62.5 dBm/MHz requirement between 1498.5 MHz-1518 MHz in order to ensure compatibility with fixed link use in the adjacent 1492-1517 MHz band.
- 1.5 As a consequence of the licence variation, and to avoid the need for complex coordination arrangements, from today we are making changes to the use of the adjacent fixed link band 1492-1517 MHz (paired with 1350-1375 MHz) by limiting new links to 1489.5-1517 MHz (paired with 1356.5-1375 MHz) as illustrated in figure 1.1 below.

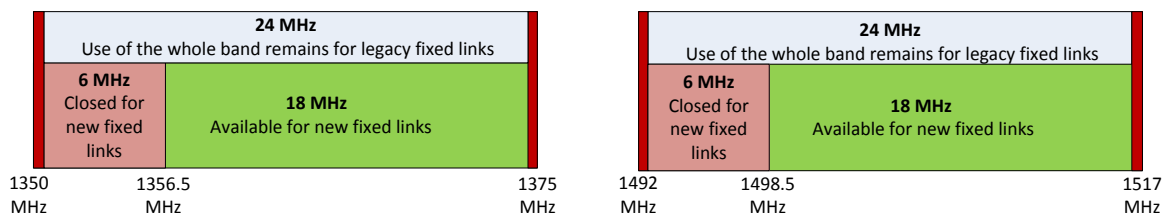


Figure 1.1 High level band diagram showing changes to the 1.4 GHz fixed link band

- 1.6 To ensure compatibility with SDL use, licensees of new fixed links who wish to mitigate against the possibility of interference, will need to ensure that suitable receiver filtering is incorporated into the link installation and that appropriate site

clearance checks have been conducted so that there is a sufficient separation distance between fixed link receivers and SDL base stations. Similarly the 1.4 GHz Spectrum Access licensee(s) will, as part of their licence conditions, be required to plan new base stations so as to avoid undue interference to fixed links in the 1492-1517 MHz band. In the case of legacy links, any changes required to protect fixed links will be at the cost of the 1.4 GHz Spectrum Access licensee(s). To facilitate this planning, Ofcom will provide the 1.4 GHz Spectrum Access licensee(s) with the necessary data on fixed link licences.

- 1.7 The full details of our decision are set out in Section 4 of this statement.
- 1.8 In parallel with this statement on the 1.4 GHz Spectrum Access Licence variation we are also publishing today our statement on bringing the 1452-1492 MHz, 2350-2390 MHz and 3410-3600 MHz bands under Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011 (“the Mobile Trading Regulations”). The Regulations required to give effect to this decision will come into effect on 19 June.
- 1.9 The 1.4 GHz Spectrum Access Licence will be varied on 19 June when the frequencies covered by the 1.4 GHz Spectrum Access Licence are brought within the Mobile Trading Regulations. The changes to the fixed link licensing arrangements come into force today.

Section 2

Introduction and Background

- 2.1 The 1452-1492 MHz Spectrum Access Licence (“1.4 GHz Spectrum Access Licence” or “SDL licensee” once the licence is varied) is held by Qualcomm UK Spectrum Limited (“Qualcomm”) who acquired it in May 2008 in the auction conducted by Ofcom. In October 2013, Qualcomm submitted a request to have the 1452-1492 MHz Spectrum Access Licence varied so as to enable the use of SDL in the frequencies covered by the 1452-1492 MHz Spectrum Access Licence. SDL is a new mobile broadband technology which, using a mobile base station transmitter network, provides bandwidth to deliver additional download capacity for consumer mobile broadband services.
- 2.2 In its licence variation request Qualcomm asked for the technical conditions to be aligned with the CEPT ECC Decision 13(03) (the “ECC Decision”) that was formally approved by the ECC in November 2013.
- 2.3 After receiving its licence variation request we asked Qualcomm to carry out a detailed technical analysis of the impact of the requested changes on the adjacent fixed link spectrum users and to suggest options for interference mitigation. This work took place over several months and involved a significant amount of technical modelling and interaction between ourselves and Qualcomm as we reviewed the work in progress and requested changes to aspects of the assumptions and analysis to ensure it was representative of UK requirements. The final technical report was completed in August 2014.
- 2.4 After considering the completed technical analysis and some changes put forward by Qualcomm to their original licence variation request (including a reduced SDL EIRP¹ value and an additional SDL out of band EIRP limit), we developed a set of proposals that were designed to help enable the use of SDL in the 1452-1492 MHz spectrum band while ensuring adequate protection for users of fixed links in the adjacent 1492 -1517 MHz band.
- 2.5 On 30 September 2014, Ofcom issued a consultation (“the Variation Consultation”) on a proposed variation to the 1.4 GHz Spectrum Access licence that would enable the spectrum to be used optimally for Mobile or Fixed Communication Network Supplemental Downlink (“SDL”) in the UK. The consultation also proposed changes to the way the adjacent fixed link band 1492-1517 MHz paired with 1350-1375 MHz would be available for fixed links should we vary the 1.4 GHz Spectrum Access Licence.
- 2.6 To enable compatibility with the adjacent uses, we proposed technical limits broadly in accordance with ECC Decision 13(03), but combined the limits given in this decision with an additional out of band EIRP limit on SDL base stations above 1498.5 MHz. We also proposed the introduction of simple site engineering / clearance checks to avoid the need to introduce detailed co-ordination procedures between the adjacent band services. As detailed in the Variation Consultation, the proposed changes included technical requirements as follows:

¹ Equivalent Isotropically Radiated Power

- For SDL base stations an additional out of band (OOB) EIRP limit, above 1498.5 MHz, to that given in the ECC Decision, to ensure that SDL base station transmissions falling outside of the 1452-1492 MHz band would be sufficiently low to prevent undue interference to fixed link receivers;
- For fixed link receivers the need to include additional filtering measures in order to appropriately reject the SDL signals in the 1452-1492 MHz band to prevent “blocking” of the fixed link receiver. In addition, we proposed that the bottom 6 MHz of the fixed link band 1492-1517 MHz (paired with 1350-1375 MHz) be closed to new fixed links assignments as new links in this frequency range would be vulnerable to interference from SDL deployments, even those with larger separation distances (and notwithstanding the tighter OOB EIRP limits on SDL which would apply above 1498.5 MHz and additional receiver filtering on fixed links referred to above). For existing fixed links, we also proposed that all existing fixed links assignments be protected, including the links in the 1492-1498.5 MHz range, with any interference mitigation measures needed to avoid undue interference to these links, from new SDL base stations, being the responsibility of the SDL licensee.

2.7 The diagram in figure 2.1 below shows the resulting high level band plan.

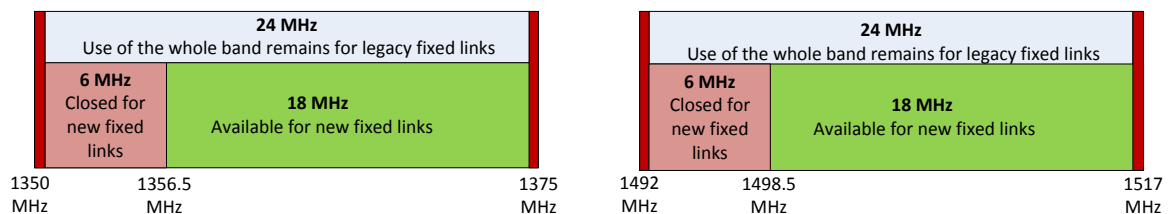


Figure 2.1: High level band plan for the 1.4 GHz fixed link band (1350-1375 MHz paired with 1492-1517 MHz)

RSC Decision

2.8 In March 2015, following the completion of a technical report (CEPT Report 54)² prepared by the European Conference of Postal and Telecommunications Administrations (CEPT) in response to an EC mandate, the European Commission’s Radio Spectrum Committee (RSC) adopted a binding Implementing Decision on the harmonisation of the 1452-1492 MHz band for terrestrial systems capable of providing electronic services in the European Union (the “RSC decision”). The RSC decision sets out the conditions for the harmonised use of the 1452 – 1492 MHz spectrum band for SDL. This Decision has recently been published in the European Union’s Official Journal³ and is binding on the UK.

2.9 The technical conditions contained within the RSC decision are the same as those set out in ECC Decision however, the RSC decision also allows for additional

² CEPT Report 54; <http://www.erodocdb.dk/Docs/doc98/official/pdf/CEPTREP054.PDF>

³ European Commission Implementing Decision (EU) 2015/750 of 8 May 2015 on the harmonisation of the 1452-1492 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Union; http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1431416821549&uri=OJ:JOL_2015_119_R_0006

technical or procedural measures⁴, or both, to be applied at a national level to ensure coexistence with services and applications in the adjacent bands, referred to in the decision as 1427-1452 MHz and 1492-1518 MHz (See figure 2.2 which shows the high level band diagram showing the adjacent uses in the UK).

- 2.10 The proposals in our September 2014 Variation Consultation are consistent with the new RSC Decision.

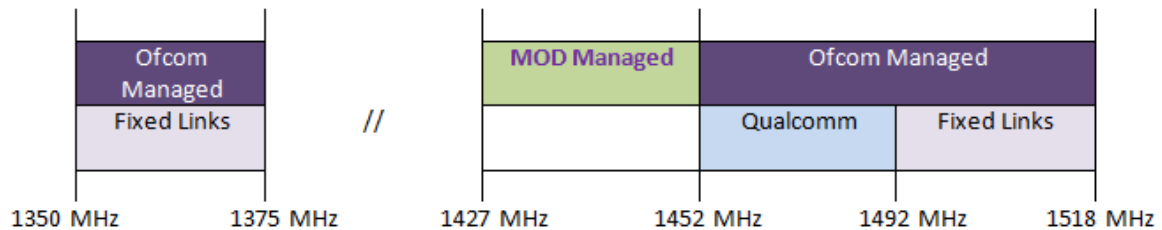


Figure 2.2: Management and use of the spectrum in the UK showing immediate adjacent band uses and the lower fixed sub band (diagram not to scale)

Consultation on including the 1452-1492 MHz band in the Mobile Trading Regulations

- 2.11 The Variation Consultation and the subsequent PSSR Auction Consultation⁵ considered competition issues in relation to the 1452-1492 MHz band. They proposed that we bring the 1452-1492 MHz spectrum (along with spectrum in the 2.3 GHz and 3.4 GHz bands) under the Mobile Trading Regulations and that we do so shortly before the auction of the 2.3 GHz and 3.4 GHz bands. We received a number of responses to these consultations on the question of timing. Following our consideration of these responses we published a new consultation on 8 April 2015⁶ setting out revised proposals on the time at which these spectrum bands should be brought under the Mobile Trading Regulations.
- 2.12 We have today published a statement⁷ setting out our decision to include the 1452-1492 MHz spectrum (along with spectrum in the 2.3 GHz and 3.4 GHz bands) in the Mobile Trading Regulations and to do so at the same time that we vary the 1452-1492 MHz Spectrum Access Licence. We have also, today, made the necessary regulations to give effect to this decision.

⁴ For instance, one or more of the following: frequency planning coordination, site coordination, more stringent in-band power limits for base stations, more stringent out-of-band equivalent isotropically radiated power limits for base stations than stipulated in the decision

⁵ *Public Sector Spectrum Release (PSSR) Award of the 2.3 GHz and 3.4 GHz bands*, Ofcom, 7 November 2014, http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz-auction-design/summary/2_3_and_3_4_ghz_award.pdf

⁶ http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-trading-regs-apr-15/summary/trading_regs_consultation.pdf

⁷ <http://stakeholders.ofcom.org.uk/consultations/mobile-trading-regs-apr-15/statement/>

Statutory Framework

- 2.13 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.
- 2.14 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.
- 2.15 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.
- 2.16 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)).
- 2.17 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.
- 2.18 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.

2.19 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

2.20 The analysis presented in this document represents an impact assessment, as defined in section 7 of the Communications Act 2003⁸ (the Act).

2.21 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.

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

⁸ www.opsi.gov.uk/acts/acts2003/pdf/ukpga_20030021_en.pdf

Section 3

Issues raised in the Variation Consultation

Overview of responses

- 3.1 We received 13 responses to the Variation Consultation of which, 3 were non confidential, 7 were confidential in full; 3 respondents made part confidential submissions. No respondents objected to the principle of the spectrum band being used for mobile access using SDL, even where they objected to certain aspects of the proposals. Qualcomm, as the current licensee, strongly supported the proposals. Two respondents with fixed link interests (JRC and Westica), although not opposed to SDL use in principle, objected to the way in which our proposals sought to ensure compatibility with adjacent fixed links. Most other respondents either broadly accepted our proposals, but with specific comments on the detail (from either the SDL or fixed link perspective) or were not in favour of certain aspects of our proposals.
- 3.2 In this section we address the key elements of stakeholder feedback received during the consultation that are of a more substantive nature and where further consideration or explanation of our proposals is appropriate. A summary of other points raised in responses is given in Annex 2.
- 3.3 The main issues raised in responses are considered in this section under the following headings:
- Filtering requirements;
 - The clearance approach between fixed link receivers and SDL base stations;
 - Timing of the proposed changes;
 - The cost benefit analysis.
- 3.4 Two respondents also raised competition concerns in relation to trading the 1452-1492 MHz spectrum following licence variation. As noted in Section 2, following consideration of these responses, we issued a new and separate consultation⁹ on the proposal to bring this spectrum under the Mobile Trading Regulations. Those responses have been considered in the context of that consultation.
- 3.5 The recent RSC Decision, referred to in Section 2, also requires Ofcom to vary the Qualcomm licence in a way that implements that Decision. This is a new development since stakeholders submitted their responses and we note below where this is relevant to the issues under consideration.

Issues raised in relation to filtering requirements

- 3.6 The Variation Consultation recognised that the 1452-1492 MHz band could be used for high powered SDL signals. Consequentially, to ensure adjacent band compatibility it indicated that:

⁹ <http://stakeholders.ofcom.org.uk/consultations/mobile-trading-regs-apr-15/>

- fixed link receivers operating in the adjacent 1492-1517 MHz band would need to appropriately reject SDL signals to prevent blocking of the receiver; and
 - the out of band (OOB) emissions from the SDL transmissions falling into the adjacent fixed link band would need to be sufficiently low so as to prevent undue interference to fixed link receivers.
- 3.7 We therefore proposed that filtering would need to be applied to improve both fixed link receiver selectivity and to improve (reduce) out of band emissions from mobile base stations, these two additional filtering aspects being required as a critical part of the technical policy to enable compatibility between the two adjacent uses.
- 3.8 These proposals drew comments from both the fixed link and SDL perspective which we address in turn below.

Requirements to improve fixed link receiver selectivity

The requirement for a notch type filter

- 3.9 BT and Westica raised practical concerns regarding the requirements to improve fixed link receiver selectivity. In essence, they argued that our proposals were based on the insertion of a band pass filter¹⁰ to improve the fixed link receiver selectivity, whereas existing equipment would need to be fitted with a notch¹¹ filter, rather than a band pass filter in order for it to function properly.
- 3.10 The reason for this was that, in all their radios currently installed, the transmit and receive frequencies are on the same antenna port and the fixed link transceiver is fully contained with an internal duplexer. Hence, the only convenient means to insert a band pass filter would be between the output port of the transceiver and the antenna. However, given that a fixed link receiving in the 1492-1517 MHz band would use the paired 1350-1375 MHz band for its transmit frequency, the installation of a band pass filter at the antenna port would have the effect of attenuating the transmit signal of the paired duplex in 1350-1375 MHz as well as attenuating the unwanted transmissions in the adjacent SDL band i.e. 1492-1517 MHz would pass through the filter but the 1350-1375 MHz would be filtered out. A “band stop” or “notch” filter would therefore be required to avoid this problem.

Ofcom’s response

- 3.11 We agree with the respondents that current equipment with a single antenna port for the transmit and receive frequencies will need a notch filter rather than a band pass filter i.e. it will need a filter solution that passes both fixed link sub bands whilst attenuating the 1452-1492 MHz band.
- 3.12 The technical report from Qualcomm, while focussing on band pass type filters, also made reference (in Annex 6 of the report) to the filtering requirements for fixed link radio configurations requiring an Rx/Tx duplexer filter i.e. for fixed link radios with a single antenna port; and, while the internal circuit configuration of a notch filter will be different to a band pass filter, this will not prevent a filter solution being implemented

¹⁰ A band pass filter passes signals between two specific frequencies, but attenuates signals at other frequencies to very low levels.

¹¹ A notch filter is a filter that passes most frequencies unaltered, but attenuates those in a specific narrow range to very low levels

in practice. In this case an external notch type filter would need to be connected between the fixed link radio and the antenna via an appropriate connector lead.

Filter insertion loss

- 3.13 BT and Westica raised the issue of filter insertion loss that would result from the introduction of the filter to the fixed link receiver (indicated as 1dB in the Qualcomm study) and the impact this would have on the assigned fixed link EIRP. They observed that this loss would degrade the fixed link budget and so require an increase in the assigned EIRP to compensate for the filter insertion loss. If so, then this could require a variation to a legacy link assignment. Their specific concern was for legacy links because, under our proposal, technical variations to legacy links would not be able to retain legacy status (under which the cost of mitigation measures would be the responsibility of the SDL licensee).

Ofcom's response

- 3.14 We understand that an issue could arise if an existing link was operating to the limit of its link budget prior to a filter being retrofitted. We have therefore considered fixed link receiver sensitivity levels (RSL)¹², looking specifically at the difference between manufacturer quoted numbers for RSL and the corresponding ETSI standard. This is relevant to an assessment of the issue since the RSLs used in our assignment approach (from which the link budget is derived) are taken from the ETSI standards. In general the manufacturer's quoted values are often better than the ETSI standard, a point also noted by the JRC in their response. Accordingly, there is likely to be a difference in favour of the fixed link assignment such that an increased EIRP is already a feature of the link assignment process (given that the RSL values used in the assignment process are likely to be higher than the actual values). Whilst we accept that this way of considering the issue will slightly squeeze the overall interference budget from a theoretical perspective, it is unlikely in practice that this will have any material impact on a real world link.
- 3.15 We also note that the figure of approximately 1 dB for the insertion loss was given as a design maximum in Qualcomm's specifications for a fixed link filter solution and a lower insertion loss figure could be expected in practice.
- 3.16 Taken together, these considerations mean that it is highly unlikely in practice that the addition of a filter to an existing link (with an insertion loss of up to 1dB) would undermine the operation of a real world assignment or require a licence variation.
- 3.17 Moreover, the Variation Consultation proposed that the SDL licensee be required to protect legacy links. So, in the unlikely event that the installation of an SDL base station required a fixed link operator to request a technical variation in order to compensate for filter insertion loss (the above points notwithstanding), then the SDL operator would be responsible for the cost of implementing that solution.
- 3.18 The above comments address the issue in relation to legacy links. We note that new links could, if considered necessary, include in their licence application a small loss factor (within the system losses) to be taken into account when assigning the link, thus achieving a small uplift in EIRP.

¹² Receiver Sensitivity Level (RSL) is the lowest power level at which the receiver can detect an RF signal and demodulate data to enable it to operate effectively within its application.

Requirement for SDL to improve/reduce out of band emissions

Out of band emissions from 1452-1492 MHz in the adjacent fixed link band 1492-1517 MHz

- 3.19 One respondent suggested that the additional 42.5 dB filtering requirement on the SDL operator may be problematic as this would require mobile operators to implement a different solution in the UK to in other countries in Europe. In particular, this might require the SDL operator to purchase non-standard equipment or to implement external filtering which, in the respondent's view, would be undesirable and would introduce additional cost and complexity. The respondent instead proposed that fixed links should be re-tuned away from the lower part of the fixed link band as a first step so as to lower the coexistence burden for the SDL operator.

Ofcom's response

- 3.20 Retuning fixed links to the higher part of the fixed link band (thereby introducing a guard band between deployments of SDL and fixed links) would not, on its own, address the compatibility issue. Additional attenuation of the SDL OOB EIRP limits beyond that specified in the ECC Decision¹³ would still be required in order to ensure the adjacent uses are compatible and to reduce the coordination burden for both SDL and fixed link licensees. The need for this additional attenuation would still require the purchase of equipment with different filtering requirements to countries in Europe that follow the OOB conditions in the ECC Decision.
- 3.21 To the extent that the additional filtering requirement imposes costs on the SDL licensee, it is reasonable to assume that these costs will be manageable since these OOB limits were proposed by Qualcomm, the current licensee for the Spectrum Access licence for 1452-1492 MHz. We also note that these requirements can be taken into account by SDL manufacturers in their equipment specification – i.e. they do not need to be retrofitted to existing equipment. We also note that the respondent did not provide evidence to suggest that 6.5 MHz of filter roll off space (for the additional filtering) places an unreasonable burden on the 1452-1492 MHz licensee.

The out of band emissions from 1452-1492 MHz falling in the lower fixed link sub band 1350-1375 MHz

- 3.22 The 1492-1518 MHz sub band is duplexed with the 1350-1375 MHz sub band to enable the fixed point to point bidirectional transmit and receive signal pairing. Westica expressed a concern that we had not considered the impact of an SDL OOB limit of -20 dBm/MHz below 1452 MHz on the lower duplex fixed link sub band (1350-1375 MHz).

Ofcom's response

- 3.23 Our revised technical conditions do not include an SDL OOB limit of -20 dBm/MHz reaching down as far as the 1350-1375 MHz sub band (the OOB limit is specified down to 1427 MHz – see table 4.1). Any transmissions from the 1452-1492 MHz band that did fall into the 1350-1375 MHz range would therefore be governed by the spurious emission regulations and as set out in ETSI standards.

¹³ ECC Decision 13(03) (November 2013)

- 3.24 There is a 77 MHz gap between the edges of the lower fixed link sub-band and the SDL band (1375 MHz to 1452 MHz). We consider this is a sufficient frequency separation to allow spectral roll off to attenuate any spurious emissions falling within the 1350 – 1375MHz band.
- 3.25 We note that, when making spectrum management decisions, it is standard practice to consider OOB limits extending up to +/-250% (of channel bandwidth) from the centre of the channel to which the OOB limits apply - but not to put OOB limits over large frequency separations. We would only depart from this standard practice where there was a very particular reason to do so. However, we do not consider that there is any reason to do so in this case.

Issues raised in relation to the fixed link clearance approach

- 3.26 Our proposals for addressing compatibility included a requirement to ensure that there is a minimum clearance distance between the main beam of the fixed link and an SDL base station. We proposed that, following the licence variation, we would publish guidance for applicants for new fixed links. The guidance would make clear that fixed link licence applicants would be responsible for taking appropriate action to ensure that their intended fixed link path would be clear of SDL base stations within a specified distance from their fixed link receiver. We indicated that, in practice, this could be included as part of the standard link planning process where the fixed link operator would ensure that there is a clear line of sight path between the two ends of the link free from obstructions, as is consistent with standard line of sight link planning practice.
- 3.27 Westica and JRC raised concerns regarding the requirement to avoid SDL base stations when planning their fixed links by ensuring line of sight operation. Both indicated that they thought it unreasonable to require fixed link planners to ensure that there is no SDL station in the path of their fixed link when planning a new link. JRC also proposed that for each fixed link antenna a clearance distance for each relevant offset angle (to the main beam), in addition to the worst case main beam scenario, should be established and documented as part of the guidance for fixed link operators.

Ofcom's response

- 3.28 We believe that this is a misunderstanding of our proposal. We therefore clarify that our proposals would not require the fixed link operator to ensure that there is no SDL base station anywhere in the entire fixed link path (which could be many kilometres). Instead, our proposals would advise the fixed link operator to ensure that there is no SDL station in the fixed link path within a relatively short guidance distance (only) from the fixed link station. The guidance will advise that the fixed link operator check that an existing SDL base station distance is not located within 100m (typical) in its main beam, up to a maximum of 385m (worst case).
- 3.29 We consider this clearance advice represents a practicable and sensible approach that will enable the SDL and fixed link stations to operate in adjacent bands without the need for more cumbersome coordination procedures. Indeed, our proposals on filtering requirements and frequency separation, coupled with minimal site clearance checks, are designed, in part, to avoid the need for a full and detailed coordination approach which we consider would be impractical.
- 3.30 Regarding the request to establish and document the different offset angle clearance distances for each fixed link antenna type, we believe that this is not necessary given

the main beam clearance distances are small in the first place (this clearance distance could also be used as a means of checking the surrounding site). Given the small clearance distances involved, it is unlikely that a mobile base station would go unnoticed in practice; the fixed link installer will be able to use their knowledge of the antenna type and surrounding location to avoid any risk of interference during the site survey and clearance procedure. Should fixed link operators wish to carry out clearance distance calculations in addition to the main beam ones that we provided in Table 3.6 of the Variation Consultation (i.e. to reduce the clearance distances for side-lobes) then the guidance notes include a distance formula that can be used for this purpose.

Timing of proposed changes

Requirement for fixed links to implement appropriate filtering at the time of the 1.4 GHz Spectrum Access licence variation decision

- 3.31 In the Variation Consultation, we proposed to implement our policy changes associated with fixed link band at the same time as varying the 1452-1492 MHz Spectrum Access licence.
- 3.32 Westica raised concerns about the requirement for new fixed links to meet additional receiver selectivity requirements immediately post our decision to vary the licence. These concerns relate to the time required to design and test a new filter and to design and rebuild equipment and the consequent implications for making existing products on the market obsolete. Westica also commented that users and potential users of 1.4GHz fixed links would be left with little or no choice of product solutions immediately following the technical variation which, it said, would seem to fail to meet the objective of protecting the ongoing use of the 1.4GHz band.

Ofcom's response

- 3.33 While the implementation of additional filtering on new fixed links is an integral part of the interference management approach, it is not a mandatory licence requirement on fixed links. Therefore, this does not prevent a fixed link planner installing a new link without a filter until such a time that a filter becomes available and SDL starts to roll out. Given that SDL deployment is unlikely to be rolled out immediately, this will allow sufficient time for fixed links to be fitted with additional receiver filters. We therefore do not consider that our proposals would make existing fixed link equipment obsolete. While we consider it is important to address the practical issues associated with the addition of a filter, we consider that it is possible to insert additional external filtering without compromising the radio or the operation of the link. Therefore, we believe that there will be no need to redesign existing fixed link radios unless a manufacturer specifically wished to do this (i.e. incorporate additional enhanced filtering as part of their radio design).

The loss of 6 MHz of spectrum to fixed links before SDL roll-out

- 3.34 The JRC requested that the fixed link licensing changes are not implemented until the imminent rollout of SDL systems, noting that the 1452-1492 MHz spectrum has been unused for many years. It argued that if the 1452 – 1492 MHz band was subsequently not used for the proposed purpose that this approach would minimise the risk that the bottom 6 MHz of fixed link spectrum would be made unavailable to new links unnecessarily.

Ofcom's response

- 3.35 The 1452-1492 MHz licence is being varied to enable its use for SDL at the request of the licensee who expects it to be brought into use for this purpose. In addition the RSC decision harmonises the use of this spectrum to enable SDL use in Europe. In these circumstances, the fact that it has remained unused for many years is not relevant to the prospect of it being brought into use in the coming years. But, in any case, we consider that a reasonable portion of the fixed link band will still remain available to accommodate the requirements for the fixed service in the future, notwithstanding the loss of 6 MHz of this band for new fixed links. We therefore do not consider it appropriate to defer the implementation of the changes to the fixed link assignment approach until there is evidence of imminent SDL deployment since this would risk creating a larger number of legacy links with what, looking forward, would be deployed with inadequate selectivity.

Comments on the Cost Benefit Analysis

- 3.36 The cost-benefit analysis in our consultation considered the implications of the need to have an additional frequency separation of 6 MHz between SDL and new fixed link deployments. It set out our view that the benefit of an incremental 6 MHz to 10 MHz of SDL spectrum (that would be lost by placing the frequency separation at 1486-1492 MHz as opposed to placing it above 1492.5 MHz¹⁴) was likely to be greater than the combination of opportunity costs and direct costs of placing the frequency separation in the adjacent fixed link band. In particular we noted (paragraph 4.45) that:
- a) 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 (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). If the loss of spectrum for SDL was 10 MHz, as explained in paragraph 4.10, the opportunity cost of this loss would be £5-20m, based on these estimates.
 - b) The opportunity cost associated with closing part of the fixed links band to new fixed links (as under our proposals) 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 "from the bottom of the band" 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); meanwhile, the additional administrative costs to Ofcom (associated with our proposals) are very limited.

Scope of assessment

- 3.37 Both Westica and JRC commented on the location of the 6 MHz frequency separation between SDL and new fixed link deployments. Westica argued that we should consider a different split of the frequency separation which would be to take 1 MHz from the fixed link band and 5 MHz from the SDL band (thereby leaving 35 MHz for SDL deployment). Similarly JRC argued that "the guard band must be contained with the band where the new service resides, not carved out of adjacent bands. Any

¹⁴ Note that there is an existing guard band of 0.5 MHz already (at 1492-1492.5 MHz)

change of use of the band 1452-1492 MHz must not be to the detriment of services in the adjacent bands which must be fully protected.”

- 3.38 One stakeholder also argued that there was no analysis of the marginal impact of using lower EIRP limits on SDL, or of an approach in which SDL use was restricted to urban areas below the clutter-line.
- 3.39 Conversely another stakeholder argued that we had not provided any quantification of the costs to SDL operators of imposing filtering requirements which go beyond the specification in the ECC Decision.

Ofcom's response

- 3.40 In our consultation (paragraph 4.47), we noted the ongoing work at the ECC and EC (RSC) level to develop harmonisation measures for the 1452-1492 MHz band. We said that allocating 1486-1492 MHz 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. As noted in paragraph 2.8, the RSC has now adopted a binding Implementing Decision on the harmonisation of the 1452-1492 MHz band for terrestrial systems capable of providing electronic services in the European Union. Placing the frequency separation below 1492 MHz or restricting its use to urban areas would be inconsistent with this decision which sets out the conditions for the harmonised use of the 1452 – 1492 MHz spectrum band for SDL. Accordingly, a number of the above responses have, in effect, been overtaken by the fact of the new EC RSC Decision.
- 3.41 We appreciate that the suggestions raised in the responses were submitted before the RSC Decision was made. However, we do not consider that our assessment of the balance of cost and benefits would have led us to a different conclusion. In particular, we consider that:
- the opportunity cost of reducing the usable SDL spectrum by 5 MHz (as implied by Westica's suggestion of locating 5 MHz of the 6 MHz frequency separation below 1492 MHz) would be greater than the opportunity cost of closing a part of the fixed link band to new fixed link assignments for the reasons summarised above:
 - using lower EIRP limits would not remove the need for a frequency separation, or for improvements in receiver selectivity performance, unless the EIRP limits were set at a level that would make the SDL band practically unusable.
 - limiting SDL to urban areas below the clutter-line would reduce the benefits of the licence variation, as we expect these benefits are likely to be largely associated with provision of SDL on a wide area basis.
- 3.42 Paragraphs 3.20 - 3.21 above discuss the implications of SDL operators being required to include filtering that meets OOB limits which go beyond the specification in the ECC Decision. In essence, we have no reason to consider that the costs of meeting the tighter OOB limits will be excessive. In addition to the points made in paragraphs 3.20 - 3.21, we note that the separation distances which would be required in the absence of these filtering requirements would be very large and would have a major adverse impact on the provision of fixed links. It would therefore be inappropriate to use the OOB limit in the ECC Decision, even if this were to impose some additional cost on the SDL licensee than would otherwise be the case.

Consideration of impact of fixed link use

3.43 Stakeholders made a number of points about demand for fixed link use:

- we did not analyse “the benefits of use of 1.4GHz fixed links, particularly by Emergency Services and Utilities who currently rely on this band to provide mission critical services in rural areas”.
- the 1492 to 1498.5 MHz frequency range is not currently fully utilised, and removing the use of this range will limit future fixed link assignments.
- the possible loss of the TETRA network need not imply that the associated 1.4GHz links would be relinquished. The incumbent TETRA operator could seek to make use of the fixed links network for additional purposes such as selling capacity to third-party applications; the successful bidder for the provision of new emergency services, whether the current TETRA operator or another bidder, could also use 1.4GHz links.

Ofcom's response

3.44 There is no need to analyse the benefits of emergency services and utilities which currently use fixed links as their existing links will be protected under our proposed conditions (and they will retain the ability to deploy new links if needed).

3.45 Our proposal did not rely on an assumption that the 1492 to 1498.5 MHz frequency range is currently fully utilised – our position is that the opportunity cost of putting the frequency separation in the fixed links band is limited for the reasons set out in paragraph 3.36(b) above.

3.46 We considered the possibility that migration of emergency services from the exiting TETRA network might reduce the number of fixed links in the band (and so increase the spectrum available for new fixed link applications), but our proposal did not rely on an assumption that this would be the case.

Commercial impact

3.47 Stakeholders made points about the commercial impact of the proposed changes as follows:

- the change would put the 1.4G fixed link band at a competitive disadvantage to other fixed links frequency bands.
- Given that the variation to the 1452-1492 MHz licence was likely to lead to commercial gain by the licence holder (Qualcomm), it was unfair that the changes would impose costs on 1.4GHz users
- a proportion of what one stakeholder referred to as a windfall gain to Qualcomm ought to be recovered for the benefit of UK taxpayers with this proportion being at least as large as the financial gain to Qualcomm from having the 6 MHz frequency separation located in the adjacent band.

Ofcom's response

3.48 We recognise the possibility that these changes may reduce the attraction of the 1.4 GHz band relative to other fixed link bands, and this may have a negative impact on

vendors of fixed link solutions in this band. However, as described in paragraph 4.33 of the Variation Consultation, 1.4 GHz also has some offsetting advantages relative to higher-frequency bands. We do not consider that this change will lead to a significant reduction in competition between vendors of fixed link solutions.

- 3.49 We recognise that Qualcomm is likely to gain commercial benefit from the future use of this band for SDL (e.g. through sale proceeds if it trades the spectrum). However, use of the band for SDL is likely to have wider benefits through improvements to mobile services. Absent the licence variation, these improvements either would not occur (to the detriment of mobile service users) or would entail real resource costs associated with network build (land, equipment and labour). We consider that the spectrum should be employed in its highest value use, and our impact assessment indicates that this is likely to be for SDL provision.¹⁵
- 3.50 We agree that the changes to fixed link licensing arrangements will mean that new fixed link licensees (i.e. licensees that do not exist today) will incur some additional costs of filtering (by comparison with the position that would pertain in the absence of these changes). But we consider that this strikes an appropriate balance between the interests of prospective, adjacent licensees (noting also that the SDL licensee may incur additional filtering costs than would otherwise be the case in order to protect adjacent fixed link users). As regards existing fixed link licensees, they will not have a cost exposure on account of the new licensing arrangements as they have been given a protected legacy status.
- 3.51 Qualcomm won this spectrum in open competition and is entitled to enjoy any value arising from its use at least for the initial period of the licence (which runs until 2023) during which time we cannot revoke the licence or charge spectrum fees. This entitlement is an important aspect of a market based spectrum approach which is designed to promote innovation and efficient use of spectrum. It would not be appropriate for us to seek to claw back any of this value for UK taxpayers. We do have the ability to introduce spectrum fees after the initial period; the market value of the spectrum is likely to be relevant to our consideration of spectrum fees at that time.

Longer term use of the 1492-1517 MHz band for Fixed Links

- 3.52 In addition, two responses to the consultation highlighted current international discussions surrounding the potential identification of the 1492 – 1518 MHz band for mobile broadband / IMT¹⁶ and the associated impact on the longer term availability of the band for fixed links.
- 3.53 The longer term use of the 1492 – 1518 MHz band is discussed in Ofcom's Mobile Data Strategy statement¹⁷. At the time of preparing this licence variation statement a draft European Common Proposal (ECP) has also been developed in CEPT as part of the WRC-15 Agenda item 1.1 preparations. The ECP includes the 1492-1518MHz band for proposed IMT identification. This proposal is supported by Ofcom in order to support future development of the device ecosystem in Europe through wider international harmonisation. It could also increase future options for use of this spectrum in the UK; however, we note that this band is used extensively for fixed

¹⁵ We note that the available evidence we have used to inform our assessment of benefits largely relates to the private value of spectrum to operators. However, we consider that this provides some indication of the minimum value to society as a whole of using the 1452-1492 MHz band for SDL services.

¹⁶ IMT: International Mobile Telecommunications

¹⁷ Ofcom Mobile Data Strategy: <http://stakeholders.ofcom.org.uk/consultations/mobile-data-strategy/>

links in the UK and this fact would need to be recognised in any assessment of the case for changing the use of this band to mobile broadband in future.

Conclusion

3.54 In light of our consideration of the issues raised in responses (both above and in Annex 2) we have decided to go ahead with our proposals with some minor alterations (listed in paragraph 4.13) to align our approach with the RSC decision and clarify some licence conditions. We believe that this will help enable the deployment of SDL and fixed links in a manner that will enable both existing users and intended new users in the most pragmatic way. The variation also implements the RSC decision. The details of our decision are set out in Section 4.

Section 4

Our Decision

- 4.1 This section sets out details of our decision to vary the spectrum access licence for the 1452-1492 MHz band. It sets out the changes to:
- The 1452-1492 MHz Spectrum Access licence itself, together with the associated changes to the Interface Requirements; and
 - The arrangements for licensing new (and varied) licences for fixed, point-to-point links in the 1492-1517 MHz and 1350-1375 MHz sub bands.
- 4.2 This decision is broadly as proposed in the Variation Consultation. However, we have made some minor changes to our proposals (listed in paragraph 4.13 below) so as to fully align it with the RSC decision along with some minor licence condition changes and clarifications. The licence will be varied at the same time as the amended Mobile Trading Regulations come into effect on 19 June 2015. The changes in policy for fixed link licensing will take effect from today.

Variation of the Spectrum Access Licence for 1452-1492 MHz

- 4.3 The changes to the 1452-1492 MHz Spectrum Access Licence are shown in Annex 3. These are shown in the form of revisions and deletions against the current licence. The main features of the licence changes are detailed below and are consistent with the RSC decision.

Maximum in-band EIRP

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

Maximum Mean Out of Band EIRP

- 4.5 The maximum mean out of band EIRP for base stations operating in 1452-1492 MHz will be as given in table 4.1 below:

Table 4.1: Maximum mean out of band EIRP limits

Frequency range of out of band emissions	Maximum mean out of band EIRP (dBm)	Measurement Bandwidth (MHz)
1427-1449 MHz	-20	1
1449-1452 MHz	14	3
1492-1495 MHz	14	3
1495-1498.5 MHz	-20	1
1498.5-1518 MHz	-62.5	1

- 4.6 In order to fully align the adjacent bands with the RSC decision we have also now specified the adjacent band edges which were not specifically detailed before i.e. 1427 MHz and 1518 MHz.

- 4.7 The maximum mean OOB EIRP limit for the 1498.5-1518 MHz band is the additional technical condition as referred to in the Qualcomm study published alongside the Variation Consultation.

Removal of Spectrum Usage Rights conditions

- 4.8 The new technical conditions will 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 was requested by Qualcomm and aligns with the RSC Decision.

Limiting Transmission to the Downlink Direction

- 4.9 In accordance with the requested change, the RSC Decision and to ensure compatibility with adjacent use through simple procedures, the operation of radio equipment within the 1452-1492 MHz band will be limited to base station transmit¹⁸.

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

- 4.10 The varied licence will place a requirement on the 1452-1492 MHz licensee (set out in revised clause 4 of the licence) to protect fixed links in the adjacent 1492-1517 MHz from undue interference as follows:
- The 1452-1492 MHz licensee will need to plan base station deployment around legacy fixed links (these are fixed links licensed before the date of this policy statement). 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 of SDL antenna down-tilt or paying for suitable filtering on the fixed link in order to reduce the constraints on SDL base station deployment).
 - The 1452-1492 MHz licensee will 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 this policy statement. 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 will not be responsible for the associated costs of this.
- 4.11 To enable the 1452-1492 MHz licensee to comply with the above requirements, we will make relevant information on existing and new or varied fixed link licences available to it¹⁹. We will 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 the information set out in Annex 4 is necessary²⁰ to fulfil this duty

¹⁸ The operation limited to base station transmit aligns with the RSC Decision.

¹⁹ Most of this information is already available through the Wireless Telegraphy Act Register. However, we will provide some additional technical details, notably on receiver characteristics.

²⁰ In the variation consultation we included the fixed link fade margin as a parameter to provide. However, this parameter is a calculated parameter and not readily available as part of our data extract facility so will not be included; should the fade margin be required, it can be calculated from the information provided.

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.

- 4.12 For 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 provide the holder of the 1452 – 1492 MHz licence with contact information for these licensees to make suitable arrangements so that these links can also be taken into account.²¹

Changes to proposals in our Variation Consultation

- 4.13 In addition to the main changes that we proposed in our Variation Consultation we have also made some minor changes in the revised licence to:
- Align the adjacent band edges with the RSC decision (covered in 4.6 above)
 - Specify a 1 metre resolution for the Mobile base station NGRs to ensure more precise location information is kept for spectrum management purposes.
 - Add the date of base station installation to the list of records kept for spectrum management purposes.
 - Add a licence provision to allow for the specification of additional procedures to manage interference mitigation should the need arise.
 - Make clearer that the avoidance of undue interference is with respect to licensed fixed links
 - Clarify the policy in relation to operation, repair, maintenance or other recurring costs associated with an existing licensed fixed link.
 - Clarify the policy in terms of existing licensed fixed links that are subsequently varied.
 - Clarify position with regards to the reissue of traded licences and how this is to be taken into account.
 - Clarify position with regards to situations where fixed link licensees do not follow guidance provided by Ofcom.

Associated Changes to Interface Requirement (IR 2068)

- 4.14 The interface requirements will determine the way that SDL can be deployed within the 1452-1492 MHz band. 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, for example into two blocks of 20 MHz each). We are therefore making changes to the associated interface requirements (“IR 2068”) to ensure that any new licensees may coexist. The changes which we are making are consistent with the RSC Decision. In particular, the revised IR 2068 will refer to a band plan with eight 5 MHz blocks and

²¹ Following the publication of this statement we will contact the relevant licensees to set out the detail of these specific arrangements

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 RSC Decision.

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

- 4.15 Our decision enables fixed links operating under licences issued before the date of this statement to continue to operate across the 1492-1517 MHz (and paired sub band 1350-1375 MHz) in accordance with their assigned parameters. These links will have the status of legacy ‘existing licensed links’ which accords them with protection from undue interference from future SDL deployments in the 1452-1492 MHz band.
- 4.16 From today, Ofcom will continue to assign new fixed links (or to vary existing assignments) with 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 4.2 below. Table 4.3 shows the number of channels that will remain available (together with the corresponding channel numbers for the different channel spacing’s. Further information on current usage of the different channel spacing’s can be found in the Variation Consultation in Annex 5.

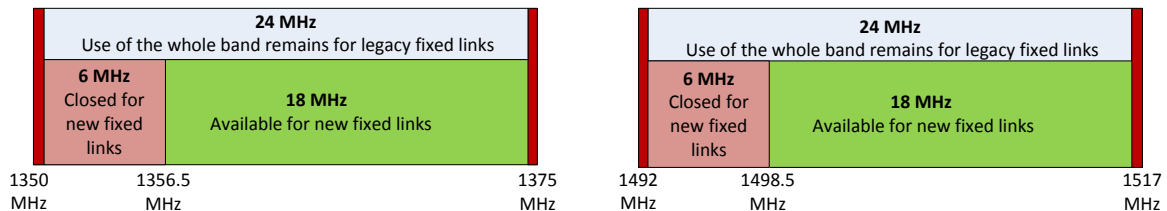


Figure 4.2: High level band diagram showing changes to the 1.4 GHz fixed link band

Table 4.3: Channels that will continue to be available for fixed link assignment from 29 May 2015

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

- 4.17 We will also reverse the fixed link assignment algorithm for this band so as to assign fixed link channels from the top of the band downwards (i.e. from 1517 MHz) rather than from the bottom up, as happens at present.
- 4.18 In light of this licence variation decision, we have also today published guidance to applicants for new fixed links on our website. The guidance clarifies that fixed link licence applicants will be responsible for ensuring that they have taken appropriate action to ensure that their intended fixed link path will be clear of SDL base stations within a minimum guidance distance.

- 4.19 Fixed link licensees will also need to ensure that the fixed link receiver performance (for new fixed link assignments) will be able to sufficiently reject SDL signals from the 1452 – 1492 MHz band in order to avoid receiver blocking (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 undue interference from SDL base stations. It should be noted that the need for additional receiver filtering is not a mandatory requirement however should a new fixed link be installed that has not followed the guidance and has not incorporated adequate receiver filtering and it receives interference (due to inadequate selectivity) it will not be able to claim protection from the SDL base station.
- 4.20 Any technical variations to existing legacy links will be treated as new fixed link assignments for these purposes and will no longer be eligible for legacy 'existing licensed link' status. In addition, any technical variations that are requested to links that currently fall within the lower 6 MHz of the 1.4 GHz fixed link band will be required to be reassigned to a channel further up the band (above 1498.5 MHz and associated lower duplex frequency) in line with the overall new policy.
- 4.21 If any of the legacy links are traded, then these will continue to operate under the same technical conditions and will therefore continue to be part of the legacy links as described in paragraph 4.15 above. Noting that traded links will have a new licence number and a new issued date, we will also include a trading flag in the data provided to the SDL Licensee, which will indicate which links have been traded so that the links can easily be identified.

Annex 1

List of Non Confidential Responses

A1.1 We received 13 responses to the Variation Consultation of which, 3 were non confidential, 7 were confidential in full; 3 respondents made part confidential submissions.

List of non-confidential respondents

Arqiva

BT

Inmarsat

Joint Radio Company

Qualcomm

Westica Communications

Annex 2

Issues Raised in Responses to the Variation Consultation

A2.1 In this section we provide a summary of the issues raised by respondents beyond those covered in section 3. The summary is set out in the table below on an issue by issue basis (rather than being organised with reference to the questions asked in the Variation Consultation – this is because not all respondents responded to the specific questions of the consultation and some raised additional issues). Responses related to competition issues are covered in the consultation and statement on the Mobile Trading Regulations.

Responses related to fixed link assignment and licensing	
Issue Raised	Ofcom Response
Westica was of the view that the reduced access to the fixed link band would limit possibilities for fixed links and was not a fair proposal.	A frequency separation of 6 MHz is a practical requirement in order to secure compatibility between adjacent use of SDL and new fixed links. As explained in section 3, the RSC decision requires us to make the full 1452 – 1492 MHz band available for SDL which means that the bottom 6 MHz (of the adjacent fixed link band) needs to be closed to new fixed links in order to create this frequency separation. However, we consider that a reasonable portion of the fixed link band will remain available to accommodate the requirements for the fixed service in the future.
A respondent indicated that the end of BT Kilostream services would largely be accommodated within the smaller fixed link channels as the majority of the demand due to the end of the Kilostream service would be for narrowband systems.	This is helpful information regarding the future planned use of the band which we have noted.
A respondent requested Ofcom to consider the provision of further 3.5 MHz channels in the 1.4GHz band. This, in the respondents view, would be required as the next available fixed link band, where 3.5 MHz channels are available, is at 13 GHz; at this higher frequency it would not be possible to make a longer link connection without an additional hop or repeater site which would incur network planning problems and would be more costly to install	Under the new policy one 3.5 MHz channel will remain available in the 1.4 GHz fixed link band and there are currently no plans to increase this. We note that there are currently only 3 links deployed in the UK utilising this channel size in the 1.4 GHz fixed link band and our pre consultation discussions with stakeholders did not indicate any strong requirement to increase the number of 3.5 MHz channels. However, should the demand arise for higher capacity links on this channel spacing that can not be accommodated in the one 3.5 MHz channel

Responses related to fixed link assignment and licensing	
Issue Raised	Ofcom Response
	still available, then we will consider this issue further. Such consideration would need to take account of the potential impact on the availability of other, smaller channel sizes and the overall demand requirements for the band.
BT indicated that it wanted the ability to install new fixed links and that it was essential that new assignments should continue to be made in as much of the fixed link band as possible.	Our decision enables the ability to continue to install new fixed links in the 1498.5-1517 MHz and paired band 1356.5 -1375 MHz.
Inmarsat indicated that they would prefer that the fixed links assignment algorithm was not changed to assign channels from the top of the fixed link band which is adjacent to the MSS 1.4 GHz band as this would create an increased density of fixed links at the top of the fixed link band. This, in Inmarsat's view, could lead to increased interference with MSS.	Our proposals are not making changes to the type of fixed link applications that are permitted in the 1492-1517 MHz band and fixed links are already deployed across the full band. Moreover, we do not consider that this is likely to cause a material problem in practice.

Responses related to compatibility and technical conditions of the 1.4 GHz Spectrum Access Licence	
Issue Raised	Ofcom Response
Westica highlighted that it is invalid to assume that generic preselect filters are designed to filter TDAB in the adjacent band. Equipment is designed instead to meet ETSI standards.	The generic preselect filter used by Qualcomm in the technical studies was an estimate based on available information. While it is noted that preselect filters are likely to vary in terms of their performance, depending on the radio product, preselect filters are likely to be better in practice than the ETSI specifications, a point also noted by Westica. This means that the filtering / selectivity performance of the fixed link radio (i.e. the ability to reject out of band signals) will in practice be better than the ETSI specifications. Our assumption when calculating the additional filtering required over the 1452 – 1492 MHz band was based on ETSI TR 101 854 Annex F which gives approximately 51dB of attenuation. So any improvement over this in real world radios will assist in terms of the overall filtering required as given in table 3.5 of the Variation

Responses related to compatibility and technical conditions of the 1.4 GHz Spectrum Access Licence	
Issue Raised	Ofcom Response
	<p>Consultation document. We also note that the filter model chosen will only be required when assessing potential interference to legacy fixed links. Since the SDL Licensee has a responsibility to protect these legacy links, it will need to model the interference environment appropriately in order to protect the existing fixed links from undue interference.</p>
<p>Westica highlighted that it is incorrect to assume that filters could filter out groups of channels (as equipment is designed and supplied to cover the whole band to facilitate easy stock and spares holding).</p>	<p>Regarding the ability to filter groups of channels we agree that where radios have the ability to operate across the full band, installation of a filter tuned for a specific set of channels will have a limiting effect on the overall tune range of the radio. However, fixed link radio links, by their nature, do not need to change channels once they are assigned. Indeed, it is an important aspect of fixed link assignments and co-ordination that they are fixed in location and fixed in frequency once assigned.</p>
<p>Westica raised a concern that intermodulation products were mentioned but not considered further in the report. Westica would like to see field trials with SDL equipment to assess real performance of the 1.4 GHz fixed links in the presence of the SDL interferer.</p>	<p>Passive intermodulation is associated with non-linearities of a radio's front end (e.g. antenna elements, connectors and filters), where signals can then mix and create an unwanted interfering signal. However, this is primarily a site engineering issue and would be very specific to a given radio installation, the power levels used, the non-linearities of the equipment and the surrounding RF environment. Should mixing of signals occur to create this phenomena then this would need to be investigated and dealt with on a case by case basis as this is outside of standard frequency assignment planning.</p>
<p>Arqiva suggested that the location (NGR) of fixed links (in the information provided to the SDL licensee) should be specified to an accuracy of 10m to enable accurate site identification.</p>	<p>We agree that it will be important for accurate site identification and our current fixed link site location NGR data is specified to a resolution of 1m. This will be supplied to the SDL licensee as part of the licence data.</p>

Responses related to compatibility and technical conditions of the 1.4 GHz Spectrum Access Licence	
Issue Raised	Ofcom Response
<p>Arqiva urged Ofcom to make clear that incumbents would not be liable for any costs associated with interference mitigation.</p>	<p>Our decision introduces measures to enable compatibility between adjacent uses and places a clear requirement on the SDL Licensee to protect existing fixed links from undue interference and pay for necessary interference avoidance solutions to existing legacy fixed links, as a condition of the licence. We consider that these measures are sufficient.</p>
<p>Arqiva wanted an approach / provision whereby the 1452-1492 MHz licensee would give 30 days' notice of any SDL base station to be deployed within 1km of a fixed link end.</p>	<p>We believe this is unnecessary, given the licence condition to protect links and the detailed technical fixed link assignment data we will be providing. However, should difficulties arise we have also included in the licence, provisions to allow Ofcom to specify coordination or any other procedures relating to the mitigation of interference, should this be required.</p>

Responses related to compatibility and technical conditions of the 1.4 GHz Spectrum Access Licence	
Issue Raised	Ofcom Response
BT indicated that they would look to Ofcom for reassurance that appropriate measures would also be applied to SDL base stations to protect fixed links (in particular where the SDL base station would need to implement adequate filtering).	We agree that appropriate measures are required to ensure compatibility between both uses. We have addressed the requirement to protect existing fixed links by introducing appropriate technical conditions and provisions for the protection of fixed links in the licence as shown in Annex 3.
A respondent referred to the technical study conducted by Qualcomm, and highlighted that, in its view, the SDL base station power levels of 59dBm/5MHz and 62 dBm/5MHz used in the technical analysis for the urban and suburban areas, were unrealistically low. The respondent indicated that additional work would be required to consider levels of up to 65dBm/5MHz to account for parity with uplink in higher and lower bands.	It is correct that the base station EIRPs used in Qualcomm's technical analysis were based on different geo types, along with an associated assumed EIRP. However, the analysis used to determine the filtering and compatibility requirements was ultimately based on a mobile base station transmitting at the higher and maximum permitted base station power level of 68 dBm/5 MHz. It should also be noted that while the base station EIRP may vary for the different location circumstances this has no bearing, from a simulation perspective, on the base station OOB levels as these are specified as a fixed EIRP levels not to be exceeded. We therefore consider that while carrying out further simulations would be interesting it is not necessary.
JRC considered that there was the possibility that a planned new 1.4 GHz fixed link site could unknowingly be in close proximity to SDL sites, but not within the line-of-sight between its two ends. JRC therefore proposed that a database of the locations of SDL stations should be created and updated on a weekly basis (to a location accuracy of 1m resolution).	Our solution to ensure compatibility relies on simple site clearance and planning procedures rather than overly complex and burdensome coordination methods. This is possible because the restrictions to SDL base station out of band EIRP means that the required separation distances are small. We consider that the provision of a database of SDL stations is not necessary.
JRC wanted to understand how the SDL licensee(s) would co-ordinate with existing 1.4 GHz fixed links to be certain that any proposed SDL system would not cause harmful interference to a 'faded' 1.4 GHz fixed link signal.	The SDL licensee has a mandatory requirement to protect fixed links from undue interference. To facilitate this, Ofcom will provide the necessary data of licensed fixed links including the contact details of fixed link licensees so that arrangements can be made between the two parties as required.
JRC suggested that the horizontal and vertical polarisation patterns of the various 1.4 GHz transmitter antenna codes needed	Fixed link antenna codes and link polarisation information will be provided as part of the technical information available to

Responses related to compatibility and technical conditions of the 1.4 GHz Spectrum Access Licence	
Issue Raised	Ofcom Response
to be detailed by Ofcom. This in the JRCs view should ensure that during system co-ordination there would be no misunderstanding by the SDL operator(s) and the 1.4 GHz fixed link operators of a fixed link antenna's off-bore-sight rejection properties.	the SDL licensee. Specific gain values (both for co-polar and cross polar) can be determined from this information and is already available on Ofcom's website in the published list of antenna reference codes.
Inmarsat indicated that, while it considered the OOB limits proposed could cause harmful interference to MSS systems operating above 1518MHz and in the vicinity of SDL, it could accept the OOB limit above 1498.5 MHz of -62.5 dBm/MHz but would be concerned with any relaxation of this limit.	Our decision maintains the proposed limit of -62.5 dBm/MHz above 1498.5 MHz. This limit is specified to apply between 1498.5-1518 MHz as the upper adjacent band specified in the RSC decision.
<p>Qualcomm proposed to change the payment provision clause (in the 1452-1492 MHz spectrum access licence) to make clear that the SDL licensee would not be responsible to pay recurring costs of a fixed link licensee (e.g. operational, maintenance, repair or any other recurring costs).</p> <p>Qualcomm also proposed that it should be made clear that the SDL licensee should not be responsible for any fixed link licensee that did not operate new fixed links in accordance with Ofcom's guidance notes.</p>	We agree with these points and have revised the licence to reflect this change.

Responses related to spectrum management and other issues	
Issue Raised	Ofcom Response
A respondent agreed with technical analysis but did not agree with the proposal to grant a variation as in its view, Qualcomm has hoarded the spectrum. The respondent also wanted specific requirements to be placed on the licensee of the 1452-1492 MHz band to share the spectrum with other users.	Qualcomm acquired the 1452-1492 MHz licence through auction and is entitled to the benefit of the licence under the terms of that licence (which does not have a “use it or lose it” provision). The anticipated SDL application is unlikely to be conducive to sharing with other applications although we note that the licence is tradable (which could include outright or concurrent trading of access rights in a particular area).
A respondent raised the importance of maintaining flexibility in the 1.4 GHz spectrum access licence and considered that the band as very suitable for TD-LTE and eLTE. The respondent made reference to the consultation footnote on pg. 38 indicating that the consultation proposals would not restrict future use of the spectrum to SDL and Ofcom would remain open to further requests for variation to the licence for example to enable TDD.	Our general policy is sympathetic to providing licence flexibility (subject to the consideration of the impact on adjacent users). We recognise that, whilst the current expectation is that this spectrum will be used for SDL, it is possible that, at some point in the future, the licensee(s) might wish to use it for TD-LTE instead. We would consider a future licence variation request to enable TD-LTE at the point such a request was made. However, since this would require a change to the current RSC decision, such a request would need to be taken forward with that in mind.
Westica preferred a coordinated approach managed by Ofcom which, in its view, was a far more suitable approach and would allow for protection of fixed links.	We do not consider that a full coordination approach managed by Ofcom for adjacent uses would be an appropriate way to address adjacent band compatibility. It would introduce significant, additional regulatory burden and costs and is not necessary in view of the arrangements we are putting in place.

Annex 3

Varied 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 Act²²;
 - (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 Act²³.
- 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.

²² These are regulations on spectrum trading.

²³ See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

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.
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: 309189Schedule 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 stations ~~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 2068²⁴ 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; ~~and~~

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

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

~~eb) 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 ~~23~~ 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.

²⁴ Available from the Ofcom website at <http://www.ofcom.org.uk>

- (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.
- (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 Notified Licensed Links (to the extent that such Notified Licensed Links are operated in accordance with such guidance as Ofcom may issue from time to time) to be operated without undue interference.
- (b) In complying with its obligations under sub-paragraph 4(a), the Licensee must:
- (i) in respect of an Existing Licensed Link, pay to the licensee of such Existing Licensed Link all costs which may be reasonably incurred by that licensee to mitigate the risk of undue interference with such Existing Licensed Link from Radio Equipment established by the Licensee; and
 - (ii) in respect of a New Licensed Link, take appropriate measures to avoid the risk of undue interference with such New Licensed Link from Radio Equipment established by the Licensee.
- (c) The Licensee shall not be responsible for the payment of:
- (i) any operation, repair, maintenance or other recurring costs associated with an Existing Licensed Link; and
 - (i) any costs incurred in respect of a New Licensed Link to mitigate the risk of undue interference from Radio Equipment established by the Licensee.
- (c) Ofcom shall supply the Licensee with such information in relation to Wireless Telegraphy Licences relating to a frequency within the band 1492-1517 MHz

as Ofcom may consider appropriate for the purposes of enabling the Licensee to fulfil its obligations under sub-paragraph 4(a).

5. Co-ordination at frequency and geographical boundaries and compliance with other procedures relating to interference

The Licensee shall ensure that the Radio Equipment is operated in compliance with such co-ordination procedures as may be notified to the Licensee by Ofcom from time to time. The Licensee shall also ensure that it complies with any other procedures relating to the mitigation of interference as may be notified to the Licensee by Ofcom from time to time.

56. 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.

67. Permitted Frequencies

Subject to the out of ~~block-band~~ emissions permitted under Paragraph 109, 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

78. 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.

9. 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
1427 – 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
1498.5 – 1518 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/m²/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: ΔF 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 km², 4 km², 25 km², 100 km², 400 km², 2500 km² or 10000 km², 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.

1310. 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.
- (be) "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).
- (ce) "out of block band 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).
- (df) "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 Licensed Link" means each of an Existing Link and an Existing Traded Link.
- (f) "Existing Link" means a Notified Licensed Link operating in accordance with a Wireless Telegraphy Licence granted before 29 May 2015 which has not been varied on or after 29 May 2015 other than in respect of the details of the holder of the licence.
- (g) "Existing Traded Link" means a Notified Licensed Link which:
 - (i) was operated in accordance with a Wireless Telegraphy Licence granted before 29 May 2015; but
 - (ii) is subsequently operated in accordance with a Wireless Telegraphy Licence granted on or after 29 May 2015 following a transfer of such licence.
- (h) "New Licensed Link" means each of a New Link and a Varied Link.
- (i) "New Link" means a Notified Licensed Link which is not an Existing Traded Link operating in accordance with a Wireless Telegraphy Licence granted on or after 29 May 2015;

- (j) "Notified Licensed Links" means Radio Equipment operating in accordance with a Wireless Telegraphy Licence which is notified to the Licensee by Ofcom in accordance with paragraph 4(c).
- (k) "Varied Link" means a Notified Licensed Link operating in accordance with a Wireless Telegraphy Licence granted before 29 May 2015 and varied on or after 29 May 2015 in respect of any matters other than the details of the holder of the licence.
- (l) "Wireless Telegraphy Licence" means a licence granted by Ofcom under the Wireless Telegraphy Act 2006 relating to a frequency within the band 1492 – 1517 MHz.
- (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/m²/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 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.

(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 (e). 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/m²/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	-124
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 km², 4 km², 25 km², 100 km², 400 km², 2500 km² or 10000 km², 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/m²/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)~~ a one (1) metres resolution of each transmitting site;
- (b) the date on which each transmitting station is brought into operation;
- (c) the height above ground level of each transmitting antenna to an accuracy of 1 metre;
- (d) the azimuth of each transmitting antenna on each site;
- (e) the horizontal and vertical profile of each transmitting antenna on each site (without taking into account any down-tilt);
- (f) the down-tilt (physical and electrical) of each transmitting antenna;
- (g) Class of Emission of the radiated signal;
- (h) the mean operational e.i.r.p. per MHz over the Permitted Frequencies permitted frequency(s) given in Schedule(s) Paragraph 6, averaged over a specified 3 minute interval for each transmitting antenna; and
- (i) 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.
- (i) the out of band emission profile in e.i.r.p. per MHz to a maximum of 25 MHz either side of the Permitted Frequencies for each transmitting antenna.

Annex 4

Fixed Link Data Provision

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

A4.1 The following are the fixed link data fields that we will 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 above ground level (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 above ground level (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 ratio (dB)
- Path length (km)
- Link polarisation
- Link availability (%)
- Trading reference