



Variation of Concurrent Spectrum Access 1781 MHz Licence

A statement on a request for variation of a Spectrum
Access licence in the concurrent spectrum bands 1781.7-
1785 MHz paired with 1876.7-1880 MHz

Statement

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About this document

This document sets out our decision to agree to a licence variation request submitted by TalkTalk PLC in relation to its Concurrent Spectrum Access licence for the use of spectrum in the 1781.7 to 1785 MHz and 1876.7 to 1880 MHz frequency bands. The variation will facilitate the deployment of low-powered LTE (a 4G technology) apparatus to provide citizens and consumers with 4G services.

TalkTalk is one of twelve licensees authorised to use the Concurrent Spectrum Access spectrum (also known as 'the DECT Guard band') that was awarded by Ofcom in 2006 on an equal access basis. As per most awarded licences these were issued on a technology neutral basis with a restriction for low-powered use.

Following a request submitted by TalkTalk in October 2015, we consulted on proposals to modify the permitted out-of-block emission limits. After considering the comments raised, we decided to go ahead with our proposals to modify the out-of-block transmission limits. We will offer the same variation to all the current holders of a Concurrent Spectrum Access 1781 MHz licence.

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Section 1

Executive Summary

- 1.1 This document sets out our decision to agree to a licence variation request submitted by TalkTalk in relation to its Concurrent Spectrum Access licence. The variation will facilitate the deployment of low-powered LTE (a 4G technology) apparatus. This decision follows our consultation “Variation of Concurrent Spectrum Access 1781 MHz Licence” published on 29 April 2016¹ (the ‘Consultation’).
- 1.2 TalkTalk is one of twelve licensees authorised to use 6.6 MHz of spectrum in the 1781.7-1785 MHz and 1876.7-1880 MHz frequency bands on an equal access basis. In 2006, Ofcom held an auction² to allocate the spectrum to a number of users, each sharing access to the band on a coordinated basis. The coordination process was set out in a code of practice agreed by the licensees.
- 1.3 The award licences were issued on a technology neutral basis and had to adhere to technical conditions set out in the licence and Interface Requirements IR2014 (GSM) or IR2045 (Concurrent Spectrum Access band). These contained a restriction for to low-powered use and limits regarding the out-of-block emissions that the devices could transmit at.
- 1.4 TalkTalk has submitted a request for a variation to its Concurrent Spectrum Access, requesting that these out-of-block limit restrictions be liberalised in order for them to use currently available LTE femtocell technology. The current out-of-block emission limits set out in the licence would require readily available LTE equipment to be modified with additional filtering in order to meet these limits.
- 1.5 On 29 April 2016, we published the Consultation in which we assessed the request from TalkTalk and outlined the proposed change to the permissible out-of-block emission limits. The Consultation closed on 31 May 2016. We received twelve responses. Non-confidential versions of the responses are available on our website.
- 1.6 The majority of respondents agreed with our proposal to vary the licence to allow 4G services. A couple of responses suggested an in-band power limit of 23 dBm in order to protect GSM users in the band and the adjacent DECT technology. Although we noted the comments our consultation focussed solely on the permitted out-of-block limits, which are the licence conditions for which TalkTalk requested a variation. Based on the technical studies undertaken we maintain our belief that the variation would not prejudice the continued and future use of GSM in the Concurrent Spectrum Access band and that the impact on DECT would be no worse than it currently subject to. It is our view that coordination / coexistence issues between technologies within the band (if any) can be resolved through licensees cooperating with each other and can be set out in an update Engineering Code of Practice.

¹ <http://stakeholders.ofcom.org.uk/consultations/talk-talk-licence-variation/>

² http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/awards-archive/completed-awards/award_1781/

- 1.7 Two other respondents questioned whether the current authorisation approach is suitable for the band and whether there is an opportunity to further liberalise the use of the band for low-power technologies. Although out of scope for this consultation we are today publishing a separate consultation on the wider issues associated with the Concurrent Spectrum Access band. This consultation will cover the future of the spectrum and licences, including the number of licences authorised to share the spectrum and the level of fees that may be charged for licences. We invite stakeholders to provide any comment they might have by responding to that consultation.
- 1.8 After considering the points raised by stakeholders we have decided to proceed with the variation as set out in the Consultation. We believe that this decision is in line with the duties placed on Ofcom and would provide benefits to citizens and consumers in the UK. In the interests of fairness, Ofcom will offer the same variation to any eligible holder of a licence in this category.

Section 2

Background to this statement

Concurrent Spectrum Access licences

- 2.1 In 2006 Ofcom held an auction for the spectrum 1781.7 – 1785.0 MHz paired with 1876.7 – 1880.0 MHz³. Twelve licences were awarded, each having equal rights to share the whole spectrum range, subject to coordination with other licensees. The licences were granted on a technology neutral basis providing they complied with the technical limits set out in the licence and Interface Requirements IR 2014 (GSM)⁴ and IR 2045 (Concurrent Spectrum Access)⁵.
- 2.2 The 2006 award was held before Long Term Evolution (LTE) was standardised in 3GPP and therefore the licence and Interface Requirements reflected current technology. Although wideband technology such as CDMA2000 (a 3G technology) was considered and is allowed, the permissible out-of-block (OOB) emissions specified in the licence are derived from 3GPP TS 05-05 – the standard for GERAN (GSM/EDGE Radio Access Network) systems.
- 2.3 A condition in the licences required the development of an industry Engineering Code of Practice (ECoP) to facilitate sharing within the band. The licence stated that if a ECoP was not agreed, Ofcom would impose a code under the licence. The ECoP was finally developed by the “Mobile 200 Group” which was formed by the industry in connection with the Federation of Communications Services (FCS). The version of the ECoP adopted, by the majority of licensees, was version 1.2 dated 9 September 2008. A registration process for new installations, to manage the coordination of sites, was also created.
- 2.4 The ECoP sets out engineering assumptions based on the deployment of GSM technology, which some licensees have done. The ECoP also sets guidelines for assessing compatibility when introducing alternative technologies into the band, including an obligation to use a Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT®) to study and address compatibility issues.
- 2.5 The licence requires each licensee to “...use its best endeavours to adhere to...” the ECoP. However, the ECoP recognises that “...where there are inconsistencies or contradictions between [the] ECoP and the Licences the Licence shall take precedence”.

³ http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/awards-archive/completed-awards/award_1781/

⁴ <http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/spectrum-management/research-guidelines-tech-info/interface-requirements/ir2014.pdf>

⁵ <http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/spectrum-management/research-guidelines-tech-info/interface-requirements/ir2045.pdf>

Consultation on the proposal for licence variation

- 2.6 On 29 April 2016 we published a consultation document (the ‘Consultation’) assessing a request from TalkTalk to change the technical parameters of the OOB emissions as set out in the licence. This was in order to allow TalkTalk to use currently available LTE femtocell technology without the need for the equipment to have additional filtering installed in order to meet the current OOB limits in the current licence terms. TalkTalk’s request was supported by technical studies that TalkTalk commissioned from Real Wireless, which considered the impact of the OOB emission changes on other users in and adjacent to the band. These technical studies were published alongside the Consultation (Annex 5).
- 2.7 The technical changes for the requested variation were to the permissible OOB emission limits in the downlink frequencies (1876.7 to 1880 MHz) which would amend two of the tables in the schedule to the licence. In the Consultation, we set out the proposed OOB changes, which are shown in Tables 1 and 2 below.

Table 1: Permitted frequency band 1876.7 – 1880.0 MHz

Frequency range as measured from the lower frequency of the frequency band	Maximum mean EIRP density dBm/kHz
-6.2 to -3.2 MHz	-55
-3.2 to 0.0 MHz	$-45 + 10 \times (\Delta_{FL}^* - 0.2)/3$
-0.0 to -0.1 MHz	$-33.6 + 153.3 \times \Delta_{FL}^*$
-0.1 to -0.3 MHz	$-49 + 20 \times (\Delta_{FL}^* + 0.1)$
-0.3 to -0.9 MHz	-53
-0.9 to -1.5 MHz	-56
-1.5 to -5.7 MHz	-74

* Note: Δ_{FL} is the offset from the lower edge of the relevant Permitted Frequency Band in MHz (it has values between 0 and - 0.3 MHz).

Table 2: Permitted frequency band 1876.7 – 1880.0 MHz

Frequency range as measured from the higher frequency of the frequency band	Maximum mean EIRP density dBm/kHz
0.0 to 0.05 MHz	$-23 - 60 \times \Delta_{FH}^*$
0.05 to 0.1 MHz	$-26 - 153.3 \times (\Delta_{FH}^* - 0.05)$
0.1 to 2.8 MHz	$-45 - 10 \times (\Delta_{FH}^* - 0.2)/3$
2.8 to 5.8 MHz	-55
0.05 to 0.2 MHz	$-26 - 153.3 \times (\Delta_{FH}^* - 0.05)$
0.2 to 0.4 MHz	$-49 - 20 \times (\Delta_{FH}^* - 0.2)$
0.4 to 1.0 MHz	-53
1.0 to 1.6 MHz	-56
1.6 to 5.8 MHz	-74

* Note: Δ_{FH} is the offset from the upper edge of the relevant Permitted Frequency Band in MHz (it has values between 0 and + 0.4 MHz).

Legal Framework

- 2.8 The applicable legal framework derives from our duties under both domestic and European legislation, specifically from:
- the Communications Act 2003 (the “2003 Act”) and the Wireless Telegraphy Act 2006 (the “2006 Act”); and
 - the European Common Regulatory Framework⁶ for electronic communications networks and services, in particular, the Framework Directive and the Authorisation Directive – together with a number of Decisions that apply to these specific spectrum bands.

European Law

- 2.9 There are a number of European Directives and Decisions that relate specifically to the 1800 MHz frequency band.
- 2.10 Article 14 of the Authorisation Directive requires that rights of use (in this case a wireless telegraphy licence) “may only be amended in objectively justified cases and

⁶ The European Common Regulatory Framework comprises the Framework Directive (Directive 2002/21/EC), the Authorisation Directive (Directive 2002/20/EC), the Access Directive (Directive 2002/19/EC), the Universal Service Directive (Directive 2002/22/EC) and the Directive on privacy and electronic communications (Directive 2002/58/EC), as amended.

in a proportionate manner, taking into consideration, where appropriate, the specific conditions applicable to transferable rights of use for radio frequencies”.

- 2.11 More generally, in carrying out our regulatory tasks, including considering the case for amending rights of use, we are required to take all reasonable measures which are aimed at achieving the objectives set out in Article 8 of the Framework Directive. Article 8 requires national regulatory authorities:
- to promote competition in the provision of electronic communications networks and services by, amongst other things by ensuring that there is no distortion or restriction of competition in the electronic communications sector and by encouraging efficient use and ensuring the effective management of radio frequencies; and
 - to contribute to the development of the internal market by, amongst other things, removing obstacles to the provision of electronic communications networks and services at a European level and encouraging the interoperability of pan-European services.

The 2003 Act and the 2006 Act

Duties

- 2.12 The requirements of Article 8 of the Framework Directive are given effect to by our duties under the 2003 Act (in particular section 3 and 4) and the 2006 Act (in particular section 3).
- 2.13 Our principal duty under the 2003 Act is to further the interests of citizens in communications matters, and the interests of consumers in relevant markets, where appropriate by promoting competition.
- 2.14 By virtue of our principal duty, we are required to secure (amongst other things) the optimal use for wireless telegraphy of the electro-magnetic spectrum, and the wide availability throughout the UK of a wide range of electronic communications services.
- 2.15 In performing those duties, we are also required to have regard to various matters where they appear to us to be relevant in the circumstances, including the desirability of promoting competition in relevant markets, the desirability of encouraging investment and innovation in relevant markets, and the desirability of encouraging the availability and use of high speed data transfer services throughout the UK.
- 2.16 In furthering the interests of consumers, we must have regard in particular to the interests of those consumers in respect of choice, price, quality of service and value for money.
- 2.17 In performing our principal duty, we must have regard in all cases to the principles under which regulatory activities must be transparent, proportionate, consistent and targeted only at cases in which action is needed.
- 2.18 The 2006 Act requires us, amongst other things, to have regard to the desirability of promoting the efficient management and use of the part of the electromagnetic spectrum available for wireless telegraphy. It also requires us to ensure that wireless telegraphy licence conditions are objectively justified in relation to the networks and services to which they relate, non-discriminatory, proportionate and transparent.

Powers

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

Process for considering a licence variation request

- 2.22 In terms of process, Article 14 of the Authorisation Directive requires that Member States must ensure that, except where proposed amendments are minor and have been agreed with the licensee:
- notice of the proposed change is given in an appropriate manner; and
 - interested parties, including users and consumers, are allowed a sufficient period of time to express their views on the proposed amendments (such time to be no less than four weeks except in exceptional cases).
- 2.23 The 2006 Act sets out in Schedule 1 a process for the variation of wireless telegraphy licences. In the case where a variation is proposed by the licensee, we are under no obligation (under the 2006 Act) to consult on the proposal.

Framework for analysis of licence variation requests

- 2.24 In section 4 of the Consultation, the analytical framework we applied in considering this variation request reflected our relevant regulatory objectives and our statutory duties, as set out above. Of particular relevance to our assessment were our principal duties, which are to further the interests of citizens in relation to communications matters; to further the interests of consumers in relevant markets,

where appropriate, by promoting competition; and to promote optimal use of spectrum.

- 2.25 In the Consultation we considered both the likely impact on competition of granting the variation and the likely impact on spectrum management, in particular the impact on existing licensed or exempted use of adjacent spectrum.

Impact of proposed licence changes on competition, innovation and investment

- 2.26 In deciding whether to vary TalkTalk's licence as requested, we considered the extent to which varying the licence would:
- further the interests of consumers by, for example, encouraging innovation, investment and the availability and use of mobile services throughout the UK; and result in better choice, price, quality of service and value for money; and/or
 - give rise to a material risk of a distortion of competition to the detriment of consumers such that any benefits to consumers resulting from varying those licences without delay would be outweighed by the detriment to consumers resulting from such a distortion of competition.

Impact of proposed licence changes on other users of the radio spectrum: in-band and out-of-band

- 2.27 Ofcom's general policy is to set technical restrictions that are the minimum necessary to provide adequate protection against harmful interference. This is because optimal use of the radio spectrum is more likely to be secured if users decide, rather than Ofcom dictates, the way in which technology is used or a service is provided in a particular frequency band.
- 2.28 Imposing the minimum necessary constraints will increase users' flexibility and freedom to respond to changing conditions and to make best use of the valuable spectrum resource.
- 2.29 Following on from this, we considered whether granting the variation would be consistent with the minimum necessary to provide adequate protection against harmful interference.
- 2.30 With regard to our assessment of harmful interference, we considered separately the in-band and out-of-band interference.
- 2.31 As well as our consideration of the proposed variation and technical assessment, we attach in Annexes 5, 6 and 7 of the Consultation evidence provided by TalkTalk in technical reports prepared by Real Wireless.

Our provisional assessment of the variation request

- 2.32 In the Consultation we considered TalkTalk's variation request in accordance with our regulatory objectives and statutory duties. The main findings of our provisional assessment were that:
- Based on the technical evidence presented by Talk Talk/Real Wireless and also CEPT Report 40 recommendations, our provisional conclusion was that the

proposed licence conditions to facilitate the use of LTE technology in the Concurrent Spectrum Access band has no additional significant impact on the operation of licensed mobile spectrum below 1876.7 MHz (licensed to EE Ltd) (paragraphs 4.9 to 4.13 of the Consultation);

- Taking together the findings of TalkTalk/ Real Wireless compatibility studies, coexistence measurements and CEPT Report 41 recommendations, our provisional conclusion was that any additional interference caused by adopting the proposed OOB emissions would not cause any significant impairment to the operation of DECT systems in the adjacent band (paragraphs 4.14 to 4.19 of the Consultation);
- Granting the variation would not prejudice the continued and future use of GSM in the Concurrent Spectrum Access band. However, not granting the variation would be likely to stifle innovation and impede the opportunity for next-generation services to develop in the band (paragraphs 5.1 to 5.5 of the Consultation);
- On the ECoP, we stated that the choice of technology should not be a critical factor as the shared nature of the spectrum is inherent in this licensing arrangement and, with low-power use, coordination distances are likely to be relatively short. The key issue is to ensure that the registration and coordination of assignments is appropriate to minimise the risk of interference to previously deployed systems (paragraphs 5.6 to 5.10 of the Consultation);
- Having considered our duties under the 2003 and 2006 Acts our provisional conclusion was that it is appropriate for us to grant TalkTalk's variation request. The same licence variation would be available on request to any holder of a Concurrent Spectrum Access 1781 MHz licence (paragraphs 6.8 to 6.9 of the Consultation); and
- We considered that the existing engineering principles under the current ECoP are sufficient to enable roll-out of LTE services in the band. We recommended that the industry should review and update the ECoP to ensure that in future the objective referred to in the Licence Schedule 1, paragraph 5 (b) continues to be secured. We noted that, should these principles not be sufficient in future to avoid in-band interference between licensees, Ofcom has the existing right under the Licences Schedule 1, paragraph 5(g) to impose a new set of principles necessary for achievement of that objective (paragraph 6.10 of the Consultation).

2.33 We asked stakeholders to consider the following questions when responding to the consultation:

Question 1) Do you have any comments on Ofcom's proposal to grant the variation request?

Question 2) Do you have any comments on Ofcom's proposal to recommend the development of a new or revised coordination process?

- 2.34 We received twelve responses, three of which were confidential with one respondent providing a redacted version for publication. All non-confidential responses are published on our website⁷.

⁷ <http://stakeholders.ofcom.org.uk/consultations/talk-talk-licence-variation/?showResponses=true>

Section 3

Ofcom's decision

- 3.1 In this section, we consider the points that were raised in response to the Consultation and set out our final decision on whether to grant the licence variation. Our assessment took into consideration the impact this may have on spectrum management and competition, innovation and investment.
- 3.2 Overall the majority of responses expressed support in favour of granting the variation, although some commented on the details such as the power levels and the need to ensure protection of adjacent services. Many of the responses were from holders of Concurrent Spectrum Access licences, some of whom expressed interest in the possibility of using LTE in the bands and requesting that the variation, if granted, would be applied also to their licences.

Spectrum management

In-band interference potential

- 3.3 BT said in its response that sharing between wideband and narrowband technologies introduces new challenges and that coordination between existing and new low power GSM deployments and LTE deployments is more problematic. BT stated that:

“Whilst the separation distance between GSM and LTE access points may be half that between GSM to GSM access points, in the case of LTE the whole spectrum will be used at the location rather than a fraction of it as is typically the case with GSM technology today”.

- 3.4 BT argued that the presence of wideband transmissions in the Concurrent Spectrum Access band would cause increased interference to GSM users that are trying to co-exist across the same band. In BT's view, this means co-located installations would be very problematic.
- 3.5 BT suggested that increased coordination restrictions would be necessary. Specifically, BT proposed a limitation of the LTE femtocell power to 24 dBm, possibly rising to 31 dBm with agreement / coordination, in order to protect shared GSM use in the band. According to BT, these increased coordination restrictions “*would to an extent diminish the value of the spectrum and would therefore to an extent offset increase in value that might arise from the possibility to use new technologies*”.
- 3.6 Shyam Telecom UK in its response suggested raising the power permitted for GSM users.

Ofcom's response

- 3.7 The Consultation focussed on the permitted OOB limits, which are the licence conditions for which TalkTalk requested a variation. We have not considered either limiting or increasing the “in-band” power level for any technology and therefore this matter does not fall within the scope of the Consultation. Our understanding is that the femtocell use indicated by TalkTalk will use powers up to 24 dBm.

- 3.8 Based on our provisional assessment and considering responses received, we maintain our belief that the variation would not prejudice the continued and future use of GSM in the Concurrent Spectrum Access band. It is our view that coordination / coexistence issues between technologies within the band (if any) are a matter for licensees to resolve via the ECoP.

Adjacent band interference

Spectrum below 1876.7 MHz

- 3.9 We received no comments on our assessment based on the technical evidence presented by TalkTalk/Real Wireless and European Conference of Postal and Telecommunication Administrations (CEPT) Report 40⁸ recommendations. Our conclusion therefore remains that the changes to the licence conditions to facilitate the use of LTE technology in the Concurrent Spectrum Access band has no additional significant impact on the operation of licensed mobile spectrum below 1876.7 MHz (licensed to EE Ltd).

Spectrum above 1880 MHz used for DECT

- 3.10 BT in its response said that the impact to DECT from either GSM or LTE is dominated by blocking or adjacent channel rejection, since the Concurrent Spectrum Access band is off to the side the DECT band. According to BT, the impact of LTE will be greater than GSM, because (a) DECT has ARQ and hopping schemes that somewhat work around the frame structure of the GSM transmissions and (b) LTE being a wideband will generate greater power in the adjacent channel. BT proposed limiting LTE femtocells to 24dBm would substantially limit the risk of a wideband signal to cause blocking of DECT.
- 3.11 BT said that it was finding it difficult to have a high degree of confidence in the tests carried out by Real Wireless that TalkTalk provided as evidence because the transmission powers used for the text were lower than the existing or proposed licence limit and BT could not find certain information in the report⁹.
- 3.12 The DECT Forum supported the suggestion made by BT for a limitation of the LTE femtocell power to 24 dBm, possibly rising to 31 dBm. However, in its response, the DECT Forum noted that the spectrum was already widely used for LTE in a number of European countries, indicating no major issues for indoor DECT use and only a few examples of outdoor systems being affected.
- 3.13 John Gilliver suggested introducing a licence requirement that the licensee should be liable to replace any DECT equipment affected by LTE deployment.

⁸ <http://www.erodocdb.dk/Docs/doc98/official/pdf/CEPTREP040.PDF>

⁹ See BT's response, p. 5.

Ofcom's response

- 3.14 Our provisional assessment was based not only on the supporting evidence supplied by TalkTalk from Real Wireless but also the findings of CEPT Report 41¹⁰. As pointed out by the DECT Forum, LTE use in this band has already been permitted and rolled out in a number of European countries, in some (such as Germany) at higher power than currently authorised in the UK with no evidence of significant detriment to DECT use.
- 3.15 As regards the comment made by Mr Gilliver, we consider that in the event of interference being experienced, any replacement DECT apparatus might be subject to similar interference effects. However, as set out above, the likelihood that DECT apparatus would be affected by the LTE use is minimal.
- 3.16 Considering the responses to the Consultation and our own initial assessment that took into account the findings of TalkTalk/ Real Wireless compatibility studies, coexistence measurements and CEPT Report 41 recommendations, our conclusion remains that any additional interference caused by adopting the proposed OOB emissions would not cause any significant impairment to the operation of DECT systems in the adjacent band.

Other issues raised by stakeholders

Coordination and Engineering Code of Practice (ECoP)

- 3.17 A number of respondents made comments and raised concerns over the Engineering Code of Practice (ECoP) currently in place.
- 3.18 In BT's view, the ECoP should include a maximum base station EIRP of 24/31dBm for LTE equipment, along with the separation distance that must be respected around existing GSM deployments. BT also proposed that in situations where existing deployment makes GSM/LTE sharing unfeasible, the LTE signal should be limited to 50% of the band. According to BT, this limitation would allow the deployment of a 1.4MHz LTE carrier to be used and leave space for several GSM carriers.
- 3.19 UK Broadband and the Scottish Government raised concerns over the current process. Both stated that they believed the current process to be too complex, not easy to use and should be made simpler like other Ofcom light licences. UK Broadband said that it would welcome a more transparent database through which it is easier to ascertain where other operators currently have deployments.
- 3.20 BT suggested a change to the process of registration of a base station location. BT stated that the process should have a requirement that proposed sites should be brought into service within sixty days of registering and that there should be a requirement to remove terminated sites from the register once no longer in use.
- 3.21 FMS Solutions argued that the 100% consensus currently required to make changes (a requirement developed by industry in the original ECoP) is unworkable in practice and suggested that a majority decision should be accepted. FMS Solutions said that the development of the existing ECoP was made particularly difficult by Ofcom's

¹⁰ <http://www.erodocdb.dk/Docs/doc98/official/pdf/CEPTREP041.PDF>

requirement for unanimity. In its view, “*with many silent licence holders making it may be difficult to obtain unanimity*”.

Ofcom’s response

- 3.22 We note the comments on the current coordination process and as an industry code of practice agreed by the licensees we believe it is the responsibility of all licensees to engage fully in revising and maintaining the ECoP. We understand that TalkTalk is taking forward discussions with other licensees with a view to revising / replacing the ECoP coordination procedure and we would encourage all to take part.
- 3.23 On reaching a consensus on the updating the ECoP, we recommend that the industry should work together in order to update, agree on and implement the revised ECoP. However, if it becomes apparent that the objective of promoting the efficient use of spectrum is not being delivered through a voluntary industry process, we note that Ofcom has an existing right under the licences to require the licensees to adhere to the terms of a Code containing such principles as Ofcom in its sole discretion deems necessary for the achievement of that objective.

Timing of variation

- 3.24 BT’ made the following comment:

“Given the critical dependency on the revised ECoP for ensuring the management of potential interference between new and existing deployments and securing a harmonious growth in use of the band by all licensees, we would propose that licence variations are not formally granted until the revised ECoP has been drafted to Ofcom’s satisfaction and circulated for approval by the licensees. The associated database of deployed equipment is also important and should remain an integral part of the coordination arrangements.”

- 3.25 Shyam Telecom UK said that the licence variation must be applicable in a symmetrical and synchronized manner for all players in the Concurrent Spectrum Access band.

Ofcom’s response

- 3.26 We do not believe that it is necessary to delay the variation until a revised ECoP has been agreed, which we think would introduce unnecessary delay and not provide regulatory certainty to licensees wishing to deploy these systems. We anticipate that as TalkTalk and other licensees will plan their deployments and procure the necessary apparatus this would allow time for the industry to progress in parallel the development of any changes to the ECoP that the industry might wish to consider.
- 3.27 As we outlined in the Consultation, we will offer the same variation to any other Concurrent Spectrum Access licensee.

Future authorisation of the band

- 3.28 Shyam Telecom UK and Ventura Next also expressed a preference to change the current way that the band is authorised. Both respondents highlighted the example in Sweden where a 5 MHz duplex band (1780-1785 MHz and 1875-1880 MHz) was allocated on a licence-exempt basis for a variety of low power technologies. Ventura Next highlighted our comment in the consultation regarding the lack of use of this

band after ten years of licensing arguably demonstrates that it has not been used effectively. They go on to state that it is not a question of technology but incentives and market structure. They said that as innovators they would be free to use LTE or other technologies within appropriate (low) power limits.

Ofcom's response

- 3.29 Although we note these comments, these suggestions are outside the scope of the Consultation. However, we are today publishing a separate consultation on the wider issues associated with the Concurrent Spectrum Access band. This consultation will cover the future of the spectrum and licences, including the number of licences authorised to share the spectrum and the level of fees that may be charged for licences. We invite stakeholders to provide any comment they might have by responding to that consultation.

Impact on Competition

- 3.30 We consider that in general spectrum liberalisation should be highly beneficial to competition, by removing unnecessary constraints on the competitive process. In our view, the requested variation would be likely to strengthen competition in the provision of services and is likely to facilitate wider and more effective use of the spectrum than has been the case to date.
- 3.31 While we have not undertaken a detailed analysis of competition, it is felt that liberalisation of the spectrum to facilitate the use of 4G / LTE technology is therefore likely to result in a wider range of choice for consumers, with the possibility of innovative new services being developed.
- 3.32 Only modest deployments within the spectrum have been made to date. Opening the band to newer technology could encourage licensees now to take forward developments where perhaps they had previously been reluctant to commit investment. However, not granting the variation would be likely to stifle innovation and impede the opportunity for next-generation services to develop in the band.

Potential impact for consumers

- 3.33 A number of other concurrent licensees, including some that have already deployed GSM services within the bands, have indicated in their responses that they would welcome the proposed variation. TalkTalk has requested a variation that will facilitate the deployment of LTE apparatus commonly available in Europe. This could lead to wider product availability for the band and create a wider range of services and an increased number of market players in the telecoms area that generally would intensify the competitive process, which ultimately would benefit consumers. If a current licensee decided against developing services, the opportunity remains for trading which could be facilitated by the increased choice of technology.

Ofcom's decision

- 3.34 Having considered our duties under the 2003 Act and the 2006 Act, as set out in this document, our decision is that it is appropriate for us to grant the variation requested by TalkTalk. Annex 2 contains a copy of the amended licence.

- 3.35 In the interest of fairness, we will offer the same variation to any eligible holder of a licence in this category. To give effect to this decision, all the other licensees will shortly receive a letter from Ofcom proposing this technical variation.

Annex 1

List of respondents

BT PLC

DECT Forum

FMS Solutions Ltd

John Gilliver

Scottish Government

Shyam Telecom UK Ltd

TalkTalk Telecom Group PLC

UK Broadband

Ventura Next

Vodafone

Annex 2

Copy of the amended TalkTalk licence

TalkTalk Communications Limited
Concurrent Spectrum Access Licence for the use of the Spectrum Bands
1781.7 – 1785.0 MHz paired with 1876.7 – 1880.0 MHz
Company Registration no. 03849133
First Issued: 02 May 2006 - Licence Number: 291498 – Issue 2 - 29/09/16

Wireless Telegraphy Acts 1949 and 1998
Office of Communications (Ofcom)

CONCURRENT SPECTRUM ACCESS LICENCE FOR THE USE OF THE SPECTRUM BANDS 1781.7 – 1785.0 MHz PAIRED WITH 1876.7 – 1880.0 MHz

This is a consolidated version of the licence granted by Ofcom to **TalkTalk Communications Limited** (formerly Opal Telecom Limited) on **02 May 2006** as varied on **29 September 2016**.

Licence no. **291498**

Date of issue: **29 September 2016**

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

TalkTalk Communications Limited
Company Registration Number 03849133
("the Licensee")
Stanford House
Garrett Field
Birchwood
Warrington
WA3 7BH

to establish, install and use radio transmitting and receiving stations and/or radio apparatus as described in the schedule(s) (herein after together called "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.

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Licence Revocation and Variation

3. Where Ofcom exercises its power to revoke or vary the Licence in accordance with section 1(4) of the Wireless Telegraphy Act 1949, the Licensee shall be notified in writing.
4. Pursuant to section 4 of the Wireless Telegraphy Act 1998 Ofcom may not revoke this Licence under section 1(4) of the Wireless Telegraphy Act 1949 except:
 - (a) at the request, or with the consent, of the Licensee;
 - (b) in accordance with paragraphs 8 and 9 ;
 - (c) if there has been a material breach of any of the terms 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 168(1) and (3) of the Communications Act 2003¹;
 - (e) if, in relation to the Licensee, any of the events listed in regulation 32 of the Wireless Telegraphy (Licence Award) Regulations 2006 occurred prior to the grant of this Licence where the occurrence of the event materially affected the outcome of the award process under these regulations;
 - (f) in accordance with section 4(5) of the Wireless Telegraphy Act 1998;
 - (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 or section 156 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) years notice is given in writing to the Licensee; and
 - (ii) such notice must expire after ten (10) years from the date of first issue of this Licence.
5. For the avoidance of doubt, and without prejudice to paragraphs 3 and 4 above, Ofcom may only revoke this Licence in accordance with section 1E of the Wireless Telegraphy Act 1949.

Changes

6. This Licence may not be transferred.²

¹ These are regulations on spectrum trading.

² However rights and obligations arising by virtue of this wireless telegraphy licence may be transferred in accordance with regulations made by Ofcom under powers conferred by section 168(1) and (3) of the Communications Act 2003. See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

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7. The Licensee must give immediate notice to Ofcom in writing of any change to the Licensee's name and address from that recorded on the Licence.

Fees

8. The Licensee shall pay to Ofcom the fee(s), in cash and without set-off or counter-claim, described in Schedule 2 of this Licence, on the date(s) also described therein, failing which Ofcom may revoke this Licence. In accordance with section 4A of the Wireless Telegraphy Act 1998 any such fee is recoverable by Ofcom.
9. On or after the expiry of ten years from the date of issue of this Licence the Licensee shall pay to Ofcom such sum(s) as may be provided for in regulations made by Ofcom under section 1 and 2(2) of the Wireless Telegraphy Act 1998, failing which Ofcom may revoke this Licence.
10. 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 section 1 and 2(2) of the Wireless Telegraphy Act 1998 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 4A of the Wireless Telegraphy Act 1998 any such amount and any such interest is recoverable by Ofcom.
11. 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 section 1 and 2(2) of the Wireless Telegraphy Act 1998 will be made, except at the absolute discretion of Ofcom in accordance with regulation 36 of the Wireless Telegraphy (Licence Award) Regulations 2006.

Radio Equipment Use

12. The Licensee must ensure that the Radio Equipment is constructed, established, installed and used only in accordance with the provisions specified in Schedule 1 of this Licence. Any proposal to amend any detail specified in Schedule 1 of this Licence must be agreed with Ofcom in advance and implemented only after this Licence has been varied or reissued accordingly.
13. 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.

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Access and Inspection

14. The Licensee shall permit any 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

15. A person authorised by Ofcom may require the Radio Equipment, or any part thereof, 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 material breach of this 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.
16. Ofcom may require 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

17. This Licence authorises the Licensee to establish, install and use the Radio Equipment only in the United Kingdom.
18. This Licence does not authorise the establishment, installation and use of the Radio Equipment in the Isle of Man or in the Channel Islands.

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Interpretation

19. In this Licence:
- (a) the establishment, installation and use of the Radio Equipment shall be interpreted as establishment and use of stations and installation and use of apparatus for wireless telegraphy as specified in section 1 of the Wireless Telegraphy Act 1949; and
 - (b) the expressions "undue interference", "station for wireless telegraphy" and "apparatus for wireless telegraphy" shall be construed in accordance with section 19 of the Wireless Telegraphy Act 1949;
20. 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.
21. 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

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SCHEDULE 1 TO LICENCE NUMBER: 291498

Licence Category: Licence for the Use of the Spectrum Bands 1781.7 – 1785.0 MHz paired with 1876.7 – 1880.0 MHz

This schedule forms part of licence no **291498**, granted to **TalkTalk Communications Limited** on **2 May 2006** and varied on **29 September 2016**.

1. Description of Radio Equipment Licensed

In this Licence, the Radio Equipment means any station for wireless telegraphy or apparatus for wireless telegraphy.

2. Interface Requirements for the Radio Equipment

That Radio Equipment shall comply with one or other of the following Interface Requirements:

IR 2045	Low Power Concurrent Systems
IR 2014	Public Wireless Networks
IR 2087	(LTE and WiMAX equipment in 900 MHz and 1800 MHz Bands)

These Interface Requirements have been published by Ofcom in accordance with Article 4.1 of Directive 1995/5/EC of the European Parliament and of the Council on radio equipment and telecommunications terminal equipment (RTTE) and the mutual recognition of their conformity.

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

(a) During the period that this Licence remains in force and for 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);

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- c) antenna height (AGL) and type;
 - d) radio frequencies used by the Radio Equipment;
- (ii) a statement of the number of subscribing customers.
- (b) The Licensee shall inform Ofcom of the address of the premises at which this Licence and the information detailed at sub-paragraph (a) above shall be kept.
- (c) The Licensee must submit to Ofcom copies of the records detailed in sub-paragraph (a) above at such intervals as Ofcom shall notify to the Licensee.
- (d) The Licensee must also submit to Ofcom in such a manner and at such times, all information relating to the establishment, installation or use of the station for wireless telegraphy or apparatus for wireless telegraphy, whether stored in hard copy or electronic form, as reasonably requested for the purposes of verifying compliance with this Licence or for statistical purposes.

4. Site Clearance Requirements

- (a) A site clearance certificate is not required for any transmitter (whether indoor or outdoor) which:
- (i) only uses a transmitter radiating not more than 17dBW ERP; and
 - (ii) only uses a transmitter with the highest point of the antenna being less than thirty (30) metres above ground level.
- (b) Further, a site clearance certificate is not required for a transmitter which uses an antenna which is placed at an existing site, which has received site clearance by Ofcom, where the height of that antenna does not exceed the antenna height permitted under the existing site clearance certificate by five (5) metres.
- (c) Subject to sub-paragraphs (a) and (b), the Radio Equipment must not be established, installed or used without Ofcom first issuing a site clearance certificate for each transmitter.

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5. 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 stations for wireless telegraphy and apparatus for wireless telegraphy shall be established or installed, sited, used and transmit in a manner that will allow services in the Permitted Frequency Bands, whether similar, competing or otherwise, (including those offered by the Notified Licensees) to be employed in neighbouring premises (including premises on different floors on the same building).
- (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 use of radio frequency channels, by not using more channels than are necessary to service customers;
 - (ii) Avoidance of interference by limiting transmission power to that which is no greater than necessary for service of customers;
 - (iii) Selection of sites in a manner that will minimise the probability of interference arising;
 - (iv) Siting of equipment within customer premises and at other sites in a manner that will minimise the probability of interference arising; and
 - (v) Arrangements for communicating information between companies to facilitate engineering coordination.

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

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- (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-paragraphs (e) above or (g) below 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 immediately be provided to Ofcom. 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.

6. **Cross-border Coordination**

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

7. **Permitted Frequency Bands**

Subject to the Out-of-Block Emissions permitted under paragraph 8, the Radio Equipment must only transmit and/or receive on the following two frequency bands (the "Permitted Frequency Bands"):

- (i) 1781.7 – 1785.0 MHz – Mobile Transmit; and
- (ii) 1876.7 – 1880.0 MHz – Base Transmit.

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8. Permissible Out-of-Block Emissions

For Out-of-Block Emissions, the Maximum mean EIRP density within the frequency ranges set out below as measured from the upper or lower frequencies of either of the Permitted Frequency Bands of Operation shall not exceed the following:

Permitted frequency band 1781.7 – 1785.0 MHz

Frequency range as measured from the lower frequency of the frequency band	Maximum mean EIRP density dBm/kHz
0.0 to -0.1 MHz	$-33 + 140 \times \Delta_{FL}^*$
-0.1 to -0.3 MHz	$-47 + 30 \times (\Delta_{FL}^* + 0.1)$
-0.3 to -1.5 MHz	-53
-1.5 to -5.7 MHz	-63

* Note: Δ_{FL} is the offset from the lower edge of the relevant Permitted Frequency Band in MHz (it has values between 0 and -0.3 MHz).

Permitted frequency band 1781.7 – 1785.0 MHz

Frequency range as measured from the higher frequency of the frequency band	Maximum mean EIRP density dBm/kHz
0.0 to 0.05 MHz	$-23 - 60 \times \Delta_{FH}^*$
0.05 to 0.2 MHz	$-26 - 140 \times (\Delta_{FH}^* - 0.05)$
0.2 to 0.4 MHz	$-47 - 30 \times (\Delta_{FH}^* - 0.2)$
0.4 to 1.6 MHz	-53
1.6 to 5.8 MHz	-63

* Note: Δ_{FH} is the offset from the upper edge of the relevant Permitted Frequency Band in MHz (it has values between 0 and +0.4 MHz).

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Permitted frequency band 1876.7 – 1880.0 MHz

Frequency range as measured from the lower frequency of the frequency band	Maximum mean EIRP density dBm/kHz
-6.2 to -3.2 MHz	-55
-3.2 to 0.0 MHz	$-45 + 10 \times (\Delta FL^* - 0.2)/3$

* Note: Δ_{FL} is the offset from the lower edge of the relevant Permitted Frequency Band in MHz (it has values between 0 and - 0.3 MHz).

Permitted frequency band 1876.7 – 1880.0 MHz

Frequency range as measured from the higher frequency of the frequency band	Maximum mean EIRP density dBm/kHz
0.0 to 0.05 MHz	$-23 - 60 \times \Delta FH^*$
0.05 to 0.1 MHz	$-26 - 153.3 \times (\Delta FH^* - 0.05)$
0.1 to 2.8 MHz	$-45 - 10 \times (\Delta FH^* - 0.2)/3$
2.8 to 5.8 MHz	-55

* Note: Δ_{FH} is the offset from the upper edge of the relevant Permitted Frequency Band in MHz (it has values between 0 and + 0.4 MHz).

9. Maximum Mean EIRP Density

(a) Except where Ofcom consents in accordance with sub-paragraphs (b) and (c) to the higher maximum mean EIRP density mentioned therein, the Maximum mean EIRP density in the Permitted Frequency Bands shall not be greater than the figures indicated in the second column of the following tables.

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For the frequency band 1781.7 to 1785.0 MHz

Frequency range as measured from the lower frequency of the frequency band	Maximum mean EIRP density dBm/kHz	
	where paragraph 9(a) above applies	where paragraph 9(b) below applies
0 to 0.05 MHz	$-33 + 140 \times \Delta_{FL}^*$	$-33 + 140 \times \Delta_{FL}^*$
0.05 to 0.1 MHz	$-26 + 60 \times (\Delta_{FL}^* - 0.05)$	$-26 + 60 \times (\Delta_{FL}^* - 0.05)$
0.1 to 0.2 MHz	$-23 + 230 \times (\Delta_{FL}^* - 0.1)$	$-23 + 300 \times (\Delta_{FL}^* - 0.1)$
0.2 to 3.2 MHz	0 [†]	7 [†]
3.2 to 3.3 MHz	$-23 + 230 \times (3.3 - \Delta_{FL}^*)$	$-23 + 300 \times (3.3 - \Delta_{FL}^*)$

For the frequency band 1876.7 to 1880.0 MHz

Frequency range as measured from the lower frequency of the frequency band	Maximum mean EIRP density dBm/kHz	
	where paragraph 9(a) above applies	where paragraph 9(b) below applies
0 to 0.05 MHz	$-33.6 + 153.3 \times \Delta_{FL}^*$	$-33.6 + 153.3 \times \Delta_{FL}^*$
0.05 to 0.1 MHz	$-26 + 60 \times (\Delta_{FL}^* - 0.05)$	$-26 + 60 \times (\Delta_{FL}^* - 0.05)$
0.1 to 0.2 MHz	$-23 + 230 \times (\Delta_{FL}^* - 0.1)$	$-23 + 300 \times (\Delta_{FL}^* - 0.1)$
0.2 to 3.2 MHz	0 [†]	7 [†]
3.2 to 3.3 MHz	$-23 + 230 \times (3.3 - \Delta_{FL}^*)$	$-23 + 300 \times (3.3 - \Delta_{FL}^*)$

* Note: Δ_{FL} is the offset from the lower edge of the relevant Permitted Frequency Band in MHz (it has values between 0 and +0.2 MHz and between +3.2 and +3.3 MHz).

† within the occupied bandwidth of the transmission.

(b) Where the Licensee wishes to operate with a higher maximum mean EIRP density indicated in the third column in the tables above in any particular location or in any particular circumstances the Licensee must first procure the notification to Ofcom of letters of consent from each of the Notified Licensees in which each Notified Licensee agrees to the use by the Licensee in a particular location or particular circumstances of that higher density.

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10. Antenna Height

Irrespective of any site clearance provided by Ofcom, the highest point of outdoor antenna systems shall be no more than 10 metres above ground level.

11. Interpretation of terms in this Schedule

In this Schedule:

- a) "Mobile Transmit" means transmission from any mobile or user station;
- b) "Base Transmit" mean transmission from any base station;
- c) "EIRP" 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);
- d) "ERP" means the effective radiated power. This is the product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction;
- e) "dBm" means the power level in decibels (logarithmic scale) referenced against 1 milliwatt (i.e. a value of 0 dBm is 1 mW);
- f) "dBW" means the power level in decibels (logarithmic scale) referenced against 1 Watt (i.e. a value of 0 dBW is 1 W);
- g) "Occupied bandwidth" means the width of the frequency band occupied such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5% of the total mean power of the emission;
- h) "Maximum mean EIRP density" means the average EIRP transmitted during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions;
- i) "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 Frequency Bands;
- j) "Permitted Frequency Bands" means the two frequency bands set out in paragraph 7; and
- k) "Notified Licensees" means the holders of wireless telegraphy licences (which relate to the Permitted Frequency Bands) which are notified to the Licensee by Ofcom.

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SCHEDULE 2 TO LICENCE NUMBER: **291498**

Licence Category: **Licence for use of the Spectrum Bands 1781.7 – 1785 MHz paired with 1876.7-1880 MHz**

Licence fee: £155,555.