making communications work
for everyone

Variation of Spectrum Access licences in the 3400 to 3680 MHz band

Ofcom's consideration of the requests to align the technical conditions of certain 3.4GHz, 3.5GHz and 3.6GHz Spectrum Access licences with European Commission Decision 2019/235

CONSULTATION:

Publication Date: 18 April 2019
Closing Date for Responses: 19 May 2019

Contents

Section

Annex

1. Overview

Spectrum provides the airways that support wireless services, including mobile phones, used by people and businesses every day. Ofcom manages the use of spectrum in the UK. It does this by issuing a licence to use radio frequencies or making regulations to exempt the use from licensing. From time to time Ofcom or licensees will make proposals to change a licence. We have received a request from EE, Hutchison, Telefonica and Vodafone asking that Ofcom vary a number of Spectrum Access 3.4 GHz, 3.5 GHz and 3.6 GHz licences. These variations would facilitate the deployment of Active Antenna Systems (AAS).

This document consults on the proposals made by the four licensees to amend the technical conditions of four Spectrum Access 3.4 GHz licences, one Spectrum Access 3.5 GHz licence and one Spectrum Access 3.6 GHz licence. It also sets out our provisional view that we are minded to grant these variation requests.

Making these changes to the licence is consistent with the European Union (EU) Harmonisation Decision[1] which Ofcom is legally obliged to implement. However, irrespective of the EU Decision, Ofcom is also currently minded to make these changes for the reasons set out in this consultation document. This takes into account Ofcom's statutory duties and functions and the analysis of the impact and benefits of the changes.

Ofcom is now inviting interested parties to submit comments by 19 May 2019 detailing any comments they might have about the proposed licence variations, particularly on the technical changes.

What we are consulting on - in brief

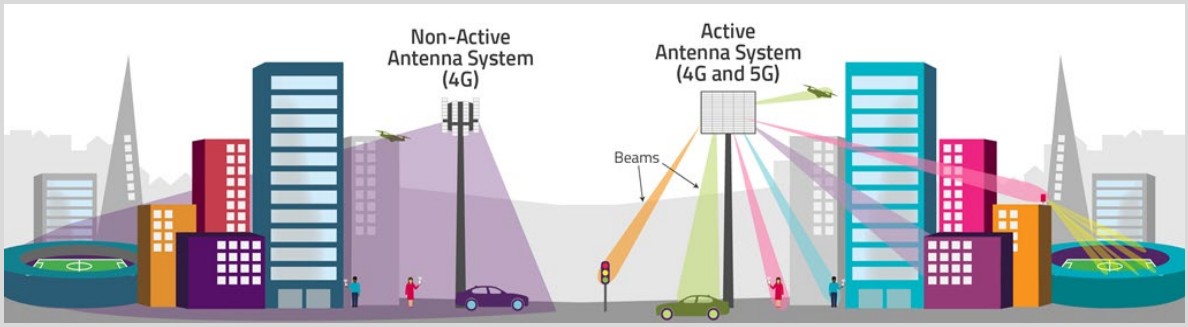
Four licence holders have requested that Ofcom vary the technical conditions in their Spectrum Access 3.4 GHz, 3.5 GHz and 3.6 GHz licences. EE, Telefonica and Vodafone each hold a Spectrum Access 3.4 GHz licence. Hutchison (and its wholly owned subsidiary UK Broadband) has three licences, a Spectrum Access 3.4 GHz licence, a Spectrum Access 3.5 GHz licence and a Spectrum Access 3.6 GHz licence.

The four mobile network operators (MNOs) have requested that the technical conditions in these licences be amended. The requests seek to align the Spectrum Access 3.4 GHz, 3.5 GHz and 3.6 GHz licences with the recent European Union (EU) Harmonisation Decision (the "EU Decision") on the 3.4 to 3.8 GHz band.[2] The EU Decision of 24 January 2019 amends Decision 2008/411/EC to update the relevant technical conditions applicable to the 3400-3800 MHz frequency band and adds new emissions limits for AAS.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0235&from=EN

[2] "3.4 GHz" = 3410 – 3600 MHz, "3.6-3.8 GHz" = 3600 – 3800 MHz and "3.4-3.8 GHz" = 3410 – 3800 MHz or 3400 – 3800 MHz (usually clear from the context).

The licence variations requested would facilitate the deployment of AAS as part of each licensee's mobile network.



In detail, the licence variations would:

1) Add to the special conditions relating to Radio Equipment to accommodate new total radiated power (TRP) in-block and out-of-block power limits for active antenna base stations (AAS).
2) Raise the terminal power limits from 25 dBm to 28 dBm.
3) Remove the additional band edge requirement above 3605 MHz and insert a new requirement at 3800 MHz and above.

The removal of the additional band edge requirement above 3605 MHz has been requested for five out of the six licences. The change is not relevant to Hutchison/UK Broadband's 3.6 GHz licence. The variation would remove an obligation on the licensees which is effectively redundant given recent changes to Hutchison/UK Broadband's 3.6 GHz licence (in December 2018).

Ofcom is currently minded to grant the all of the licence variations.

This overview is a simplified high-level summary only. The proposals we are consulting on and our reasoning are set out in the full document.

2. Background

2.1 Four licence holders (EE, Hutchison, Telefonica, and Vodafone) have requested that Ofcom vary the technical conditions of four Spectrum Access 3.4 GHz licences acquired by auction in 2018. Hutchison has also requested that Ofcom vary its UK Broadband 3.5 GHz and 3.6 GHz Spectrum Access licences[3] that UK Broadband hold (UK Broadband was acquired by Hutchison in 2017).

2.2 The licensees have requested technical conditions in each licence be varied so that they align with the EU Decision, noting that what is proposed is also in accordance with the draft proposed licences set out in our consultation document *"Award of the 700 MHz and 3.6-3.8 GHz spectrum bands"* (the "Award Consultation").[4]

2.3 The timing of the requests and the licences involved are provided in **Table 1** below.

Table 1: Variation Requests

Licence holder	Licence No	Frequency	Date of request
EE Limited	1151563/1 issued 12 April 2018 (Spectrum Access 3.4 GHz)[5]	3540 - 3580 MHz	3 April 2019
Hutchison	1151568/1 issued 12 April 2018 (Spectrum Access 3.4 GHz)[6]	3460 - 3480 MHz	12 February 2019
UK Broadband	1111442 issued 11 January 2018 (Spectrum Access 3.5 GHz)[7]	3480 - 3500 MHz 3580 - 3600 MHz	12 February 2019
	0823615, issued 14 December 2018 (Spectrum Access 3.6 GHz)[8]	3600 - 3680 MHz	
Telefonica	1151572/1 issued 12 April 2018 (Spectrum Access 3.4 GHz) [9]	3500 - 3540 MHz	12 February 2019
Vodafone	1151573/1 issued 12 April 2018 (Spectrum Access 3.4 GHz)[10]	3410 - 3460 MHz	17 January 2019

2.4 All licensees must adhere to the technical conditions set out in the licence and IR 2097.[11]

[3] The UK Broadband licences were acquired by auction in June 2003 and by company acquisition in March 2007.
[4] https://www.ofcom.org.uk/consultations-and-statements/category-1/award-700mhz-3.6-3.8ghz-spectrum
[5] https://www.ofcom.org.uk/__data/assets/pdf_file/0022/114268/SA-3.4-GHz-LICENCE-EE-1151563-1-12-04-18w.pdf
[6] https://www.ofcom.org.uk/__data/assets/pdf_file/0023/114269/SA-3.4-GHz-LICENCE-H3G-1151568-1-12-04-18w.pdf
[7] https://www.ofcom.org.uk/__data/assets/pdf_file/0033/97944/SA-3.5-LICENCE-UK-Broadband-Licence-1111442-11-01-18w.pdf
[8] https://www.ofcom.org.uk/__data/assets/pdf_file/0019/83800/SA-3.6-LICENCE-UK-Broadband-0823615-14-12-18w.pdf
[9] https://www.ofcom.org.uk/__data/assets/pdf_file/0015/114270/SA-3.4-GHz-LICENCE-Telefonica-1151572-1-12-04-18w.pdf
[10] https://www.ofcom.org.uk/__data/assets/pdf_file/0016/114271/SA-3.4-GHz-LICENCE-Vodafone-1151573-1-12-04-18w.pdf
[11] https://www.ofcom.org.uk/__data/assets/pdf_file/0017/85031/ir_2097_2015_final.pdf

European harmonisation decision

2.5 The EU Decision of 29 January of 2019 (2019/235/EC) amends Decision 2008/411/EC to update of relevant technical conditions applicable to the 3.4 to 3.8 GHz frequency band including the addition of new emissions limits for AAS.

2.6 The EU Decision requires new harmonised conditions to be introduced which are relevant to 4G and 5G systems in the 3.4 to 3.8 GHz frequency band for both non-AAS and AAS.

2.7 The EU Decision requires that when Member States designate and make available, on a nonexclusive basis, the band for electronic communications networks, they shall do so in compliance with the parameters set out in the Annex to the Decision. It also provides for the co-existence of wireless broadband electronic communications services in 3.4 to 3.8 GHz with services in adjacent bands (below 3400 MHz and above 3800 MHz).[12]

Ofcom Award Consultation on the proposed 3.6-3.8 GHz licences

2.8 In December 2018, Ofcom published its proposals for the award of the 700 MHz and the 3.6 to 3.8 GHz spectrum bands in the Award Consultation document.[13] That consultation document includes proposals for the upcoming award of spectrum in the 3680 to 3800 MHz band and a draft set of technical conditions that are aligned with the recent EU Decision on harmonisation of the 3.4 to 3.8 GHz band.[14]

2.9 Ofcom's Award Consultation closed on 12 March 2019. Nothing in these proposed licence variations should impact on the technical requirements for those award licences. As discussed below, the key reason for the present licence variation requests is to align with the EU Decision which will assist existing mobile operators with the deployment of improved 4G and 5G infrastructure involving AAS in the 3410 to 3680 MHz band.

Requested licence variations

2.10 The licensees have requested that Ofcom:

a) Add to the special conditions relating to Radio Equipment to accommodate a new TRP in-block and out-of-block power limits for AAS.

b) Raise the terminal power limits from 25 dBm to 28 dBm TRP.

c) Remove the band edge requirement above 3605 MHz and replace it with a requirement at 3800 MHz and above.

[12] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.037.01.0135.01.ENG&toc=OJ:L:2019:037:TOC
[13] https://www.ofcom.org.uk/consultations-and-statements/category-1/award-700mhz-3.6-3.8ghz-spectrum
[14] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.037.01.0135.01.ENG&toc=OJ:L:2019:037:TOC

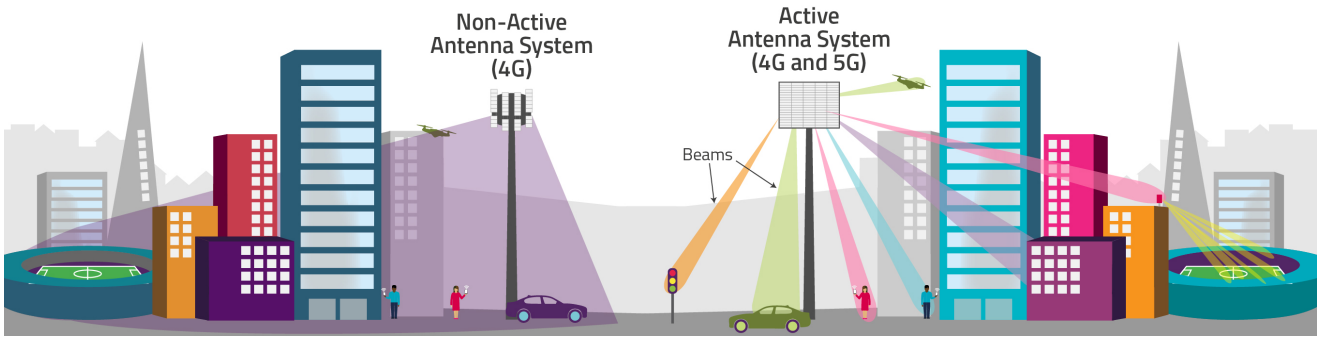
New TRP in-block and out-of-block power limits for AAS

2.11 The four licensees have requested that their licences are varied to enable them to deploy AAS. As noted above, the requests would update certain technical conditions in each licence to align them with the EU Decision.

2.12 The practical effect of AAS for consumers could be a higher quality of service in busy areas once a significant number of users have devices which support the 3.4-3.8 GHz band. This is because AAS enable massive multiple-input multiple-output (MIMO) [15] which can increase the capacity of the radio access network in busy areas. As 3.4 to 3.8 GHz is a key frequency band for 5G services in the UK, the licence variations help to facilitate high capacity 5G services.

2.13 This technology has the potential to significantly increase the spectral efficiency and network capacity through the use of beamforming (focusing radio energy in a specific direction), spatial multiplexing (re-using frequencies to send data to different users) and other techniques which take advantage of the location of people and their phones.

Figure 1: AAS and beamforming



2.14 The block edge masks (BEMs) for AAS are defined in terms of TRP, which is different from the current emissions masks which are defined in terms of effective isotropically radiated power (EIRP). In the current 3.4 GHz, 3.5 GHz and 3.6 GHz licences, only non-AAS in-block, out-of-block and out-of-band power limits are specified.

2.15 The power limits for both non-AAS and AAS requested by licensees are expressed in paragraphs (a) – (c) and Table 2 - Table 6 below:

a) the power transmitted in the Permitted Frequency Blocks (in-block) shall not exceed the limits set out in Table 2.

[15] Massive MIMO is a high-order MIMO technology typically using a large number of antenna elements at the base station and user terminal.

Table 2: Maximum power within the Permitted Frequency Blocks

Radio Equipment	*Maximum mean power*
non-AAS base station	65 dBm / 5 MHz EIRP per cell
AAS base station	44 dBm / 5 MHz TRP per cell
Mobile or nomadic terminal station	28 dBm TRP
Fixed or installed terminal station	35 dBm / 5 MHz EIRP

b) the maximum mean EIRP or TRP emanating from the Radio Equipment transmissions at any frequency outside the Permitted Frequency Blocks (out-of-block)[16], but within 3410 to 3800 MHz, shall not exceed the requirements in Table 3 for synchronised base stations (those using Frame Structure A) and shall not exceed the requirements in Table 4 for semi-synchronised base stations (those using Frame Structure B). :

Table 3: Maximum power of base stations outside the Permitted Frequency Blocks - Frame Structure A

	Non-AAS	AAS
	dBm / 5 MHz EIRP per antenna	*dBm / 5 MHz TRP per cell*
-5 to 0 MHz offset from lower block edge 0 to 5 MHz offset from upper block edge	Min (PMax – 40, 21)	Min (PMax' – 40, 16)
-10 to -5 MHz offset from lower block edge 5 to 10 MHz offset from upper block edge	Min (PMax – 43, 15)	Min (PMax' – 43, 12)
Out of block baseline power limit (BS) Below -10 MHz offset from lower block edge Above 10 MHz offset from upper block edge Within 3400-3800 MHz	Min (PMax – 43, 13)	Min (PMax' – 43, 1)

Table 4: Maximum power of base stations outside the Permitted Frequency Blocks -Frame Structure B (baseline)

	Non-AAS	AAS
	dBm / 5 MHz EIRP per cell	*dBm / 5 MHz TRP per cell*
Out of block baseline power limit (BS)	-34	-43

c) the EIRP or TRP emanating from the Radio Equipment transmissions at any frequency outside the Permitted Frequency Blocks (out-of-band) shall not exceed the following additional band edge requirements in Table 5 and Table 6:

[16] Out-of-block means the spectrum which is within 3.4 to 3.8 GHz but outside of an individual licensee's spectrum in the band.

Tables 5 & 6: Maximum power of base stations outside the Permitted Frequency - additional band edge requirements

	Non-AAS	AAS
	dBm / MHz EIRP per antenna	*dBm / MHz[17] TRP per cell*
Below 3390 MHz	-50	-52

	Non-AAS	AAS
	dBm / 5 MHz EIRP per antenna	*dBm / 5 MHz TRP per cell*
3390 – 3400 MHz	Min (PMax – 43, 13)	Min (PMax' – 43, 1)
3400 – 3405 MHz	Min (PMax – 43, 15)	Min (PMax' – 43, 12)
3405 – 3410 MHz	Min (PMax – 40, 21)	Min (PMax' – 40, 16)
3800 – 3805 MHz	Min (PMax – 40, 21)	Min (PMax' – 40, 16)
3805 – 3810 MHz	Min (PMax – 43, 15)	Min (PMax' – 43, 12)
3810 – 3840 MHz	Min (PMax – 43, 13)	Min (PMax' – 43, 1)
Above 3840 MHz	-2	-14

2.16 The out-of-block and out-of-band emissions limits sought by licensees are in line with the harmonised technical conditions in EU Decision.

2.17 The current 3.4 GHz, 3.5 GHz and 3.6 GHz licenses do not define an out-of-band power limit above 3800 MHz. Following the request of licensees, we propose to provide out-of-band emissions limits for both non-AAS and AAS above 3800 MHz consistent with the harmonised technical conditions in the EU Decision.

2.18 The EU decision clarifies that the radar protection baseline below 3390 MHz for non-AAS should be applied on a 'per antenna' basis. Following the request of licensees, we propose to use this definition in the proposed licence variations.

Alignment of power limits for mobile or nomadic terminal stations

2.19 The four licensees have requested that the power limits in their Spectrum Access 3.4 GHz, 3.5 GHz and 3.6 GHz licences are aligned with those in the EU Decision. These allow the mobile and nomadic terminal station power limit in the 3.4 to 3.8 GHz band to be 28 dBm TRP. This limit is higher than the 25 dBm TRP limit permitted in the existing licences.

Remove the additional band edge requirement above 3605 MHz

2.20 All licensees have asked for a variation to the current licence to remove the additional band edge requirement above 3605 MHz from their 3.4 GHz and 3.5 GHz Spectrum

[17] We note this level is defined in the Commission Decision 2019/235/EU as per MHz rather than per 5 MHz.

Access licences. This condition is now obsolete as a result of changes to the UK Broadband 3.6 GHz licence in December 2018.

2.21 The requested variations relating to the band edge requirement above 3605 MHz are not part of the alignment of the technical conditions arising from the EU decision.

2.22 In Ofcom's April 2018 award of the Spectrum Access 3.4 GHz licences, 150 MHz was allocated in the band 3410 to 3600 MHz. The licences awarded contained an emission limit to protect UK Broadband's existing services outside of the award band above 3605 MHz.

2.23 In setting out the technical licence conditions for the 3.4 GHz licences in May 2015, Ofcom stated that should the spectrum holder use a Time-Division Duplex[18] (TDD) frame structure compatible with the 3410 to 3600 MHz licensees, then the protective restrictive emission above 3605 MHz would no longer be needed.

2.24 In December 2018, Ofcom agreed to make changes to the UK Broadband Spectrum Access 3.6 GHz licence. This was to align the technical requirements that would apply to the frequencies 3600 to 3680 MHz with the technical requirements that currently apply to UK Broadband's spectrum access licence in the 3.4 GHz band and to move the lower frequency of the licence from 3605 MHz to 3600 MHz. The variation also reduced its frequency holding so that it would hold 80 MHz from 3600 to 3680 MHz (rather than 84 MHz from 3605 to 3689 MHz).

2.25 Prior to that licence variation, all licensees were required to comply with a specific out-of-band emissions mask in 3605 to 3689 MHz and UK Broadband was not required to synchronise with its neighbours. However, requirements applying to the UK Broadband licence and the other spectrum access licences in the 3.4 to 3.6 GHz band encouraged licensees to synchronise uplink and downlink time slots by allowing users who synchronised to use a more permissive mask.

2.26 The December 2018 licence variation consequentially meant that UK Broadband now uses the same synchronisation framework as in the 3410 to 3600 MHz licences and as such, the additional protection above 3605 MHz is now no longer needed.

2.27 The removal of the restriction above 3605 MHz potentially avoids additional filtering costs to the licensees of the 3410 to 3600 MHz band in cases where they could not synchronise with the spectrum licensee above 3605 MHz, reducing the costs to MNOs of rolling out their networks.

Document Structure

2.28 This document is structured as follows:

i) This section, Section 2, contains the background to the requested variations.

[18] Time-division duplexing is the application of time-division multiplexing to separate outward and return signals.

ii) Section 3 sets out the Legal Framework and Preliminary Assessment of requested variations.

iii) Section 4 advises of the process for implementing the requested variations following this consultation.

iv) Annex A1 contains a draft varied licence template applicable to the six licences.

3. Legal framework

3.1 This section provides an overview of the main European and UK legislative provisions relevant to wireless telegraphy licensing and the requested variations. It is not a full statement of all the legal provisions which may be relevant to Ofcom's functions and to wireless telegraphy licensing.

3.2 The applicable legal framework derives from our duties and powers under both domestic and European legislation. Specifically, from:

a) the Communications Act 2003 (the 2003 Act) and the Wireless Telegraphy Act 2006 (the 2006 Act); and

b) the European Common Regulatory Framework (the CRF) for electronic communications networks and services and when implemented into UK law, the European Electronic Communications Code (EECC) which introduces spectrum harmonisation measures and procedures.[19]

3.3 We note that the CRF is currently being revised, and that the European Electronic Communications Code (the "Code") which will replace it, will come into effect with an implementation deadline of December 2020.

3.4 The UK Government intends to implement the Code, notwithstanding the UK's exit from the EU. As such, we have had the new provisions of the Code in mind in considering the licence variation requests and as appropriate, we make reference to the Code in that context in this consultation document.

Licence variation

Ofcom's powers to vary a spectrum licence

3.5 Ofcom's powers to carry out its spectrum functions are set out in the 2006 Act. Such powers include, under sections 9 and 10, the general power to revoke or vary any wireless telegraphy licences. Schedule 1 of the 2006 Act sets out a process for the variation of wireless telegraphy licences.

3.6 Ofcom has a duty set out in section 9(7) of the 2006 Act to ensure that wireless telegraphy licence conditions are objectively justified in relation to networks and services to which they relate, non-discriminatory, proportionate and transparent. Ofcom considers that this obligation is ongoing and must be assessed against market circumstances and the state of technology development at the time.

3.7 Ofcom has a broad discretion under paragraph 6 of Schedule 1 of the 2006 Act to vary licences, subject to certain limitations:

[19] European Electronic Communications Code (EECC) entered into force on 20 December 2018.

- pursuant to paragraph 6A of Schedule 1 of the 2006 Act, any variation of a wireless telegraphy licence must be objectively justifiable;
- UK obligations under European 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;
- section 5 of the 2003 Act and section 5 of the 2006 Act enable the Secretary of State to give directions to Ofcom in respect of the carrying out of our spectrum functions;
- Ofcom must act in accordance with its statutory duties, including the duty to secure optimal use of the spectrum, our duties under section 3 of the 2006 Act and obligations under the CRF and the Code; and
- general legal principles, which include the duties to act reasonably and rationally when making decisions and to take account of any legitimate expectations.

The licence variation process

3.8 Schedule 1 of the 2006 Act sets out a process for the variation of wireless telegraphy licences. In cases where a variation is proposed by licensees, we are under no obligation (under the 2006 Act) to consult on the proposal.

3.9 Section 7 of the 2003 Act provides that where we are proposing to do anything for the purposes of, or in connection with, the carrying out of our functions, and it appears to us that the proposal is important, then we are required to carry out and publish an assessment of the likely impact of implementing the proposal, or a statement setting out our reasons for thinking that it is unnecessary to carry out such an assessment. Where we publish such an assessment, stakeholders must have an opportunity to make representations to us about the proposal to which the assessment relates.

3.10 We consider that the variations requested by the five licensees are important for the purposes of section 7 of the 2003 Act. On that basis, we are publishing for consultation our proposal to vary this licence and our assessment of the likely impact of doing so, to give interested third parties an opportunity to make representations. We have made this assessment in light of our statutory duties.

3.11 Following consideration of stakeholders' responses, we will publish our final decision on the licence variations, which we are currently aiming to make as soon as possible.

Impact assessment

3.12 This consultation as a whole, including its annexes, comprises an impact assessment as defined in Section 7 of the 2003 Act.

3.13 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.

3.14 Ofcom is an evidence-based organisation and welcomes responses to this consultation. Any comments about our assessment of the impact of our proposals should be sent to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals. For further information about our approach to impact assessments, see the guidelines, Better policy-making: Ofcom's approach to impact assessment, which are on our website: http://stakeholders.ofcom.org.uk/consultations/better-policy-making/-policy-making/

Equality Impact Assessment

3.15 Ofcom is required by statute to assess the potential impact of all our functions, policies, projects and practices on the following equality groups: age, disability, gender, gender reassignment, pregnancy and maternity, race, religion or belief and sexual orientation. We refer to groups of people with these protected characteristics as "equality groups".

3.16 We fulfil these obligations by carrying out an Equality Impact Assessment ("EIA"), which examines the potential impact our proposed policy is likely to have on people, depending on their personal circumstances. EIAs also assist us in making sure that we are meeting our principal duty of furthering the interests of citizens and consumers, regardless of their background and identity.

3.17 We do not consider that the requested licence variations would have any negative impacts on any equality group. We have not considered it necessary to carry out separate EIAs in relation to our additional equality duties in Northern Ireland, regarding religious belief and political opinion. This is because we anticipate that our proposals would not have a differential impact on any equality group in Northern Ireland compared to consumers in general.

Ofcom's general duties

3.18 Section 3 of the 2003 Act 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.

3.19 In doing so, Ofcom is required to secure, amongst other things (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 services.

3.20 In performing its duties, 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 broadband 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).

3.21 Section 4 of the 2003 Act requires Ofcom, when carrying out its spectrum functions, to act in accordance with "six community requirements" when managing the UK spectrum, including:

- the requirement to promote competition (section 4(3));
- the requirement to secure that Ofcom's activities contribute to the development of the European internal market (section 4(4)); and
- the requirement to promote the interests of all persons who are citizens of the European Union (section 4(5)).

Ofcom's duties when carrying out spectrum functions

3.22 In carrying out its spectrum functions it is the duty of Ofcom (under section 3 of the 2006 Act) 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.

3.23 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.

3.24 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.

4. Assessment of requested variation

4.1 In this section we set out our assessment of the licence variation requests and our provisional conclusion that it is appropriate to grant the requested variations.

Ofcom's analytical framework

4.2 The radio spectrum is a finite national resource of considerable economic and social value.

4.3 In considering the variation of individual licences and taking account of our duties and in light of those duties, the factors that we take into account include:

- securing optimal spectrum use;
- promoting competition;
- benefits for consumers and citizens;
- the impact on spectrum users in the same and adjacent bands; and
- ensuring that the licence variation is objectively justifiable.

4.4 In reaching our provisional conclusions, we have had to balance the advantages and disadvantages of varying the licenses, in light of the relevant factors and evidence, in order to reach an outcome that most appropriately meets our relevant statutory duties.

4.5 We have considered both the likely impact on competition of granting the variations and the likely impact on spectrum management, in particular the impact on existing licensed or exempted use of adjacent spectrum.

4.6 In deciding whether to vary the licences as requested, we have considered the extent to which varying the licence would:

a) 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

b) 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.

Assessment of the requested variation

The policy objective and the public benefit

4.7 We have a principal duty 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. In securing these principal duties we are further required to secure the optimal use for wireless telegraphy of the electro-magnetic spectrum.

4.8 Spectrum is a scarce and valuable resource. These licences are of direct public benefit because they ensure that citizens, consumers and businesses can all realise the greatest available value from use of the frequencies. Our overall policy objectives for the Spectrum Access 3.4 GHz, 3.5 GHz and 3.6 GHz licences are to:

a) maximise the likelihood of securing their optimal use, and

b) promote competition in relevant markets.

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

4.9 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.

4.10 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.

4.11 Following on from this, we have considered whether granting the variations would be consistent with the minimum necessary to provide adequate protection against harmful interference.

4.12 With regard to our assessment of harmful interference, we have considered this separately for in-band and out-of-band interference.

4.13 Licensees have requested an in-block power limit for AAS of 44 dBm/(5 MHz) TRP per cell. We observe that this limit is the same as we have proposed for the draft 3.6 to 3.8 GHz licences in the current Award Consultation. The limit has been determined by converting the non-AAS limit (65 dBm/(5 MHz) EIRP per cell) considering a typical sector antenna with 21 dBi gain.[20] This in-block limit for AAS is understood to be appropriate for protecting other spectrum users because it is derived from the existing non-AAS power limits and so will have a similar impact on other users.

4.14 We believe that the in-block power limit of 44 dBm/(5 MHz) TRP per cell will not be a material constraint on the ability of operators to deploy 5G. This is based on our review of the market which found that most 3.4 to 3.8 GHz AAS currently in development have a target power of 200 W.[21]

4.15 The amendments to the out-of-band power limits requested by licensees are the same as in the EU Decision and we consider these appropriate for coexistence with users in adjacent bands.

[20] 44 dBm/(5 MHz) per cell TRP = (65 dBm /(5 MHz) EIRP per cell) minus (a single 21 dBi antenna)

[21] For example, a 200 W TRP base station operating in a 40 MHz channel has a power spectral density of 44 dBm/(5 MHz) TRP per cell.

Promoting competition and benefits for consumers and citizens

4.16 In accordance with our duties to promote competition, we want to ensure that consumers and businesses continue to benefit from strong competition in the provision of mobile services. We believe the UK market is generally operating well with continuing innovation and relatively low prices compared to other markets internationally.[22]

4.17 Consumers should benefit from the requested variations, as they are likely to lead to higher quality enhanced mobile broadband services being available, due to licensees being able to more optimally use the spectrum they have.

4.18 Consumers may also benefit from improved 4G and new 5G services being available earlier, although this is less certain. We consider that these outcomes would be consistent with our duties to secure optimal use of the spectrum, to promote competition, and to promote the efficient management and use of the spectrum.

4.19 The requested variations apply to licences held by all four MNOs. As noted in section 2, we have proposed in the Award Consultation that aligned technical conditions would apply to the 3.6 to 3.8 GHz licences to be awarded. Therefore, we do not consider the proposed variations would be likely to have an adverse impact on competition between MNOs or any other licensees in the 3.4 to 3.8 GHz band.

4.20 Finally, we have considered whether the variations would have an adverse competitive impact on other spectrum users, and have provisionally concluded that they would not. The requested changes to technical conditions would not impact the spectrum quality of existing Permanent Earth Station and Fixed Links licensees or holders of grants of Recognised Spectrum Access for Receive Only Earth Stations in the 3.6 to 3.8 GHz band. This is primarily due to continued coordination of MNO deployments. Specifically, the more permissive out of band emissions mask in the new technical requirements would be included in the existing coordination tool, and licensees would continue to be required to abide by the existing coordination procedure for new sites and for changes to existing sites.

4.21 The amendments requested by licensees to facilitate the deployment of AAS are the same as in the EU Decision and we consider these appropriate for coexistence with other users of the spectrum, including Earth Station and Fixed Link licensees.

Provisional view

4.22 We have considered the requested licence variations in light of our relevant licensing functions and statutory duties. Our provisional view, which is subject to this

[22] See for example, the comprehensive competition assessment for the 3.4GHz award https://www.ofcom.org.uk/__data/assets/pdf_file/0022/103819/Statement-Award-of-the-2.3-and-3.4-GHz-spectrum-bands-Competition-issues-and-auction-regulations.pdf

consultation, is that it is appropriate to grant the requested variations to the six licences and we are minded to do so.

4.23 However, we note that the requested changes align with the recent EU Decision on the 3.4 to 3.8 GHz band.[23] This is our view irrespective of the EU legal obligations under the EU Decision.

4.24 In addition, the removal of the protective restrictive emission above 3605 MHz has been flagged in previous Ofcom consultations.[24]

4.25 Ofcom's intention is to ensure that regulation does not prove an impediment to innovation in 5G. As set out in our discussion document "*Enabling 5G in the UK*"[25], we are working with our partners to ensure that the regulatory framework does not create a barrier to innovative uses for 5G.

4.26 Without these licence variations, the licensees would be limited in the way they could deploy improvements to their mobile networks and could slow or impede 5G innovation.

4.27 Overall, consumers are likely to benefit from the proposed licence variations from higher quality of innovative mobile services being available and through the optimal spectrum use on the part of licensees. Consumers may also benefit from these services being available earlier.

Consultation question

4.28 We invite stakeholders to respond to the following question:

Q1 *- Do you agree with Ofcom's proposal to vary the licences as requested?*

If not, please explain why you think it would not be appropriate to vary the licences.

Q2 *- Do you have any other comments on the assessment or the factors considered as part of the assessment?*

Q3 *- Do you have any comments on the technical changes?*

[23] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1549615962331&uri=CELEX:32019D0235

[24] See the Ofcom Statement *Variation of UK Broadband's spectrum access licence for 3.6 GHz spectrum* at page 52 of the https://www.ofcom.org.uk/__data/assets/pdf_file/0014/130253/Statement-UK-Broadbands-spectrum-access-licence-3.6-GHz.pdf

[25] https://www.ofcom.org.uk/__data/assets/pdf_file/0022/111883/enabling-5g-uk.pdf

5. Implementation and next steps

Implementation

5.1 EE, Hutchison, Telefonica, and Vodafone are proposing to make changes to the following licences.

Licence holder	Licence No	Frequency	Date of request
EE Limited	1151563/1 issued 12 April 2018 (Spectrum Access 3.4 GHz)[26]	3540 - 3580 MHz	3 April 2019
Hutchison/ UK Broadband	1151568/1 issued 12 April 2018 (Spectrum Access 3.4 GHz)[27]	3460 - 3480 MHz	12 February 2019
	1111442 issued 11 January 2018 (Spectrum Access 3.5 GHz)[28]	3480 - 3500 MHz 3580 - 3600 MHz	
	0823615, issued 14 December 2018 (Spectrum Access 3.6 GHz)[29]	3600 - 3680 MHz	
Telefonica	1151572/1 issued 12 April 2018 (Spectrum Access 3.4 GHz) [30]	3500 - 3540 MHz	12 February 2019
Vodafone	1151573/1 issued 12 April 2018 (Spectrum Access 3.4 GHz) [31]	3410 - 3460 MHz	17 January 2019

5.2 Below, we set out how we propose to implement the requested variations, subject to the outcome of this consultation.

5.3 We propose to implement the requested variations by amending the existing licences in accordance with the Annex A1. Accordingly:

- The main body of each licence would remain as it is now, along with any other schedules, expect Schedule 1.
- Schedule 1 of the licences would continue to authorise use of the frequencies in each licence (noted in the table above).
- The frequencies set out in Schedule 1 of each licence are authorised for use in accordance with the current technical conditions of the Licence. Equipment deployed by licensees would continue to be authorised under the technical conditions contained in this schedule.

[26] https://www.ofcom.org.uk/__data/assets/pdf_file/0022/114268/SA-3.4-GHz-LICENCE-EE-1151563-1-12-04-18w.pdf
[27] https://www.ofcom.org.uk/__data/assets/pdf_file/0023/114269/SA-3.4-GHz-LICENCE-H3G-1151568-1-12-04-18w.pdf
[28] https://www.ofcom.org.uk/__data/assets/pdf_file/0033/97944/SA-3.5-LICENCE-UK-Broadband-Licence-1111442-11-01-18w.pdf
[29] https://www.ofcom.org.uk/__data/assets/pdf_file/0019/83800/SA-3.6-LICENCE-UK-Broadband-0823615-14-12-18w.pdf
[30] https://www.ofcom.org.uk/__data/assets/pdf_file/0015/114270/SA-3.4-GHz-LICENCE-Telefonica-1151572-1-12-04-18w.pdf
[31] https://www.ofcom.org.uk/__data/assets/pdf_file/0016/114271/SA-3.4-GHz-LICENCE-Vodafone-1151573-1-12-04-18w.pdf

- Paragraph 8 of Schedule 2 of Annex A1 raises the mobile terminal power limits from 25dBm to 28 dBm.
- Paragraphs 9-14 of Schedule 2 of Annex A1 add to the special conditions relating to Radio Equipment to accommodate new TRP in-block and out-of-block power limits for active AAS.
- Paragraph 14 of schedule 2 of Annex A1 removes the obsolete band edge requirement above 3605 MHz and inserts a new requirement at 3800 MHz and above..
- Paragraph 16 of Schedule 2 of Annex A1 introduces a number of new and amended terms to the interpretation section of the licence. The new and amended terms are consistent with those in EU decision. These are outlined below:
  - The new terms in the draft licence are 5G NR, AAS, Non-AAS, per antenna, per cell, and PMax'.
  - The amended terms in the draft licence are femtocell, PMax[32] and TDD.

5.4 These changes are shown in a draft marked-up version of the licence, set out in Annex A1.

Licence fees

5.5 Licence fees for Spectrum Access licences are generally calculated with reference to the amount of spectrum held and the geographic extent of the spectrum authorisation. The licence variation requests do not involve changes to these parameters and would therefore have no impact on licence fees.

5.6 We note that Spectrum Access 3.4 GHz licences were awarded via auction in April 2018. As such, licensees paid the licence fee for the initial 20-year period as part of the award process.

5.7 Ofcom has recently consulted on the level of annual licence fees that should be set for UK Broadband's Spectrum Access 3.5 GHz and Spectrum Access 3.6 GHz licences, and on draft regulations to give effect to the proposed fees.[33] The consultation sets out the proposed approach and timelines for implementing the new fees. Ofcom is currently reviewing consultation responses and will publish its decision in due course.

Next steps

5.8 We intend to make a final decision and publish a statement as soon as possible. In making our final decision, we will carefully consider any comments that stakeholders make. We are giving stakeholders until **19 May 2019** to provide comments.

[32] EE Limited has indicated in preliminary advice to Ofcom that it is not seeking to amend the term PMax from the definition in its current licence.

[33] https://www.ofcom.org.uk/consultations-and-statements/category-2/annual-licence-fees-3.4-ghz-3.6-ghz-spectrum

5.9 If we decide to accept the variation, we will also issue the licensees with amended licences.

A1. Draft Licence Variations (3.4GHz, 3.5GHz and 3.6GHz Spectrum Access Licences)

First Issued: xx/xx/18 – Licence Number: xxxxxxx – xx/xx/18

Office of Communications (Ofcom)
Wireless Telegraphy Act 2006

Ofcom
making communications work for everyone

SPECTRUM ACCESS [3.4 GHz], [3.5 GHz] or [3.6GHz]

This licence replaces the version of the licence issued by Ofcom on XXXX [2018]
Licence no.: **xxxxxxx**
Date of issue: **xx xxxx 2019**
Fee Payment Date: **xx xxxx** (annually from xx xxxx [2038] or [relevant due dates])

1. The Office of Communications (Ofcom) grants this wireless telegraphy licence ("the Licence") to

   [Company]
   (Company Registration number: xxxxxxx)
   ("the Licensee")
   Add 1
   Add 2
   Add 3
   Postcode

   to establish, install and use wireless telegraphy stations and/or wireless telegraphy apparatus as described in the schedule to this Licence (together "the Radio Equipment") subject to the terms set out below.

Licence term

2. This Licence shall continue in force until revoked by Ofcom 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, or with the consent, of the Licensee;

   (b) if there has been a breach of any of the terms of this Licence;

   (c) in accordance with schedule 1 paragraph 8(5) of the Act;

   (d) if it appears to Ofcom to be necessary or expedient to revoke the Licence for the purpose 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;

   (e) 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 of the Act[1];

   (f) for reasons related to the management of the radio spectrum, provided that in such case the power to revoke may only be exercised after at least five years' notice is given in writing (such notice period must not expire before XXXX 2038); or

[1] These are regulations on spectrum trading.

(g) 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 breach of the Wireless Telegraphy (Licence Award) Regulations 2018 ("the Regulations").

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

Transfer

5. This Licence may not be transferred. 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 of the Act[2].

Changes to the Licensee Details

6. The Licensee shall give prior notice to Ofcom in writing of any proposed change to the Licensee's name and address as recorded in paragraph 1 of this Licence.

Fees

7. In accordance with the Regulations, the fee in consideration of which this licence is granted is [£**XXXX**].

8. From [Date **XXXX**], the Licensee shall each year pay to Ofcom the relevant fee as provided under section 12 of the Act and regulations made thereunder on or before the fee payment date shown above, or on or before such dates as shall be notified in writing to the Licensee.

9. The Licensee shall also pay interest to Ofcom on any amount which is due to Ofcom under the terms of this Licence or provided for in any regulations made by Ofcom under sections 12 or 13(2) of the Act from the date such amount falls due until the date of payment, at the then applicable Bank of England base rate. 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, revoked or varied, no refund, whether in whole or in part, of any amount which is due under the terms of this Licence, payable in accordance with the Regulations, 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.

Radio equipment use

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

12. The Licensee shall 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.

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

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. Any 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 breach of a term of the Licence has occurred; and/or

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

15. Ofcom may require any of 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 has been served on the Licensee or a general notice applicable to holders of a named class of licence has been published.

Geographical boundaries

16. Subject to the requirements of any coordination procedures notified to the Licensee pursuant to Schedule 1 to this Licence, and excluding the areas set out in paragraph 17 of this Licence, the Licensee is authorised to establish, install and use the Radio Equipment in the United Kingdom. (The Licensee is not authorised to establish, install and use the Radio Equipment in the Channel Islands or the Isle of Man).

17. The areas excluded from this licence are the territorial sea and any inland waters adjacent to the territorial sea, but in the case of streams, rivers or other watercourses which form part of such inland waters they are only excluded where such stream, river or watercourse is more than 2km wide.

Interpretation

18. In this Licence:

(a) the establishment, installation and use of the Radio Equipment shall be interpreted as establishment and use of wireless telegraphy stations and installation and use of wireless telegraphy apparatus as specified in section 8(1) of the Act;

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

(c) the expressions "wireless telegraphy station" and "wireless telegraphy apparatus" shall have the meanings given by section 117 of the Act;

(d) the expression "territorial sea" shall be determined in accordance with the Territorial Sea Act 1987;

(e) the expression "inland waters" shall have the meaning given by section 221(1) of the Water Resources Act 1991;

(f) the schedule forms part of this Licence together with any subsequent schedule(s) which Ofcom may issue as a variation to this Licence at a later date; and

(g) the Interpretation Act 1978 shall apply to this Licence as it applies to an Act of Parliament.

Issued by Ofcom

Office of Communications

SCHEDULE 1 TO LICENCE NUMBER: xxxxxxx

Schedule Date: **xx xxxx 2019**

Licence Category: **Spectrum Access [3.4 GHz], [3.5 GHz] or [3.6GHz]**

Description of Radio Equipment

1. References in this schedule to the Radio Equipment are references to any wireless telegraphy station or wireless telegraphy apparatus that is established, installed and/or used under this schedule.

Interface Requirements for the Radio Equipment

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

   IR 2097: Terrestrial systems capable of providing electronic communications services in the 3.4 to 3.8 GHz band.

Special conditions relating to the Radio Equipment

3.

a) Subject to paragraph 3(b) of this schedule, during the period that this Licence remains in force, unless consent has otherwise been given by Ofcom, the Licensee shall compile and maintain accurate written records of the following details relating to the Radio Equipment:

   i) postal address (including post code);

   ii) National Grid Reference, to at least 10m resolution;

   iii) antenna height (above ground level), type, and boresight bearing east of true north (if applicable);

   iv) radio frequencies which the Radio Equipment uses; and

   v) Transmitted power expressed in dBm / 5 MHz EIRP per cell for non-AAS Radio Equipment; and

   ~~v)~~vi) Transmitted power expressed in dBm / 5 MHz TRP per cell for AAS Radio Equipment.

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

b) The conditions relating to the keeping of records contained in sub-paragraphs 3(a)(i), (ii) and (iii) of this schedule shall not apply in respect of femtocell equipment and smart/intelligent low power repeater equipment.

c) The conditions relating to the keeping of records contained in paragraph 3(a) of this schedule shall not apply in respect of licence exempt radio equipment.

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

e) The Licensee shall submit to Ofcom in such manner and within such period as specified by Ofcom, such other information in relation to the Radio Equipment, or any wireless telegraphy station or wireless telegraphy apparatus which the Licensee is planning to use, as Ofcom may from time to time request. Such information may include, but is not limited to, information in relation to the radio frequency, transmitted power and date of first use for wireless telegraphy stations or wireless telegraphy apparatus to be established, installed or used within such timeframe and in such areas as Ofcom may reasonably request.

Coordination at frequency and geographical boundaries

4. The Licensee shall ensure that the Radio Equipment is operated in compliance with such coordination procedures as may be notified to the Licensee by Ofcom from time to time.

International cross-border coordination

5. The Licensee shall 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 from time to time.

Cooperation between Licensees

6. In addition to complying with the specific transmission terms, conditions and limitations set out in this Licence, the Licensee must liaise and co-operate with other holders of licences in the 3410 MHz – ~~3600~~ 3800 MHz band (if necessary adjusting transmission power and other technical parameters of transmission) in such a way that harmful interference is not caused by one network deployment to that of another Licensee within the band.

Permitted Frequency Blocks

7. The Radio Equipment may only transmit within the following frequency bands (the "Permitted Frequency Blocks"):

xxxx – xxxx MHz

Maximum power within the Permitted Frequency Blocks

8. Subject to any more restrictive limitations imposed by the coordination requirements notified by Ofcom in accordance with paragraphs 4 and 5 of this schedule, the power transmitted in the Permitted Frequency Blocks shall not exceed:

Radio Equipment	Maximum mean power
non-AAS base station[a]	65 dBm / 5 MHz EIRP per cell
AAS base station[a] ~~Base station (see Note 1)~~	44 dBm / 5 MHz TRP per cell ~~65 dBm / 5 MHz EIRP*~~
Mobile or nomadic terminal station[b]	2~~5~~ dBm TRP*
Fixed or installed terminal station[b]	35 dBm / 5 MHz EIRP*

[a] For femtocell base stations, power control must be applied to minimise interference to adjacent channels.
[b] The maximum mean power relates to the EIRP or TRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas.

~~* The maximum mean power relates to the EIRP or TRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas.~~

~~Note 1: For femtocell base stations, power control must be applied to minimise interference to adjacent channels.~~

Maximum power of base stations outside the Permitted Frequency Blocks

9. When transmitting, the Licensee must either transmit in accordance with the condition in paragraph (a) or in accordance with the condition in paragraph (b) –

   a) The condition referred to is that the Licensee must transmit within the limits of the Permissive Transmission Mask and, if doing so, the Licensee must also transmit within the limits of transmission Frame Structure A.

   b) The condition referred to is that the Licensee must transmit within the limits of the Restrictive Transmission Mask, and, if doing so, it must also transmit and within the limits of transmission Frame Structure B.

10. The Permissive Transmission Mask means that –

    for transmissions on the downlink frequencies, the ~~-~~ maximum mean EIRP or TRP ~~EIRP~~ emanating from the Radio Equipment transmissions at any frequency outside the Permitted Frequency Blocks, but within 3410 – 3800 MHz, shall not exceed the following transitional and baseline requirements:

	Non-AAS dBm / 5 MHz EIRP per antenna[3]	AAS dBm / 5 MHz TRP per cell	
-5 to 0 MHz offset from lower block edge 0 to 5 MHz offset from upper block edge	Min(PMax – 40, 21)	Min(PMax' – 40, 16)	~~Min(PMax – 40, 21) dBm / 5 MHz EIRP per antenna~~
-10 to -5 MHz offset from lower block edge 5 to 10 MHz offset from upper block edge	Min(PMax – 43, 15)	Min(PMax' – 43, 12)	~~Min(PMax – 43, 15) dBm / 5 MHz EIRP per antenna~~
Out of block baseline power limit (BS) < -10 MHz offset from lower block edge > 10 MHz offset from upper block edge	Min(PMax – 43, 13)	Min(PMax' – 43, 1)	~~Min(PMax – 43, 13) dBm / 5 MHz EIRP per antenna~~

11. The Restrictive Transmission Mask means that –

[3] For the purposes of this clause as it would appear in the draft EE Limited Spectrum Access 3.4 GHz licence, EE Limited has given preliminary advice that it would retain the existing definition of PMax rather than the one proposed by 2019/235/EC. This means that for EE Limited, PMax° would be used instead of PMax. **PMax°** is the maximum mean power for the base station in question, measured as EIRP per carrier and determined irrespective of the number of antennas.

for transmissions on the downlink frequencies, the EIRP emanating from the Radio Equipment transmissions at any frequency outside the Permitted Frequency Blocks, but within 3410 – 3800 MHz, shall not exceed the following baseline:

~~non-AAS dBm / 5 MHz EIRP*~~	non-AAS dBm / 5 MHz EIRP per cell*~~AAS dBm / 5 MHz EIRP~~*	AAS dBm / 5 MHz TRP per cell
Out of block baseline power limit (BS)	- 34 ~~dBm / 5 MHz EIRP*~~	-43

~~* The maximum mean power relates to the EIRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas.~~

12. Frame Structure A (also known as the "Preferred Frame Structure") means that:

    a) transmissions from the Licensee's base stations have a frame structure as shown in Figure 1. Timeslots (or subframes) 0, 2 to 5 and 7 to 9 must be allocated to Downlink (D) or Uplink (U) transmissions as indicated or may be left with no transmissions;

    b) the Licensee must ensure that the special subframe (S) in timeslots 1 and 6 have a structure that is compatible with TD-LTE special subframe configuration 6, also known as 9:3:2 (DwPTS: GP: UpPTS). For the avoidance of doubt, a special subframe structure is compatible where there are no uplink transmissions within the downlink pilot timeslot (DwPTS) or guard period (GP) and no downlink transmissions within the uplink pilot timeslot (UpPTS) or guard period (GP);

    c) timeslots must have a duration of 1 millisecond;

    d) the Licensee shall ensure that frames start at a common reference time so that all licensees' frames are aligned and transmissions synchronised;

    Note: TD-LTE frame configuration 2 (3:1) is compatible with this frame structure, as are some 5G NR frame configurations. Other technologies are permitted provided that the requirements of 12(a) to 12(d) are met.

13. Frame Structure B (also known as the "Compatible Frame Structure") means that:

    a) transmissions from the Licensee's base stations must have a frame structure as shown in Figure 2. Timeslots (or subframes) 0 and 2 must be allocated to Downlink (D), or Uplink (U) transmissions as indicated;

    b) the Licensee must ensure that the special subframe (S) in timeslot 1 has a structure that is compatible with TD-LTE special subframe configuration 6, also known as 9:3:2 (DwPTS: GP: UpPTS). For the avoidance of doubt, a special subframe structure is compatible where there are no uplink transmissions within the downlink pilot timeslot (DwPTS) or guard period (GP) and no downlink transmissions within the uplink pilot timeslot (UpPTS) or guard period (GP);

    c) timeslots must have a duration of 1 millisecond;

    d) the Licensee shall ensure that frames start at a common reference time so that all licensees' frames are aligned and transmissions synchronised;

    ~~e)~~a) ~~all current TD-LTE frame configurations are compatible with this frame structure, as are some 5G NR frame configurations. Other technologies are permitted provided that the requirements of 13(a) to 13(d) are met;~~

f)e) timeslots with no transmission indicated may have no transmission or must be determined as a Downlink, Uplink or Special subframe as necessary in order to ensure compliance with paragraph 13(c) and 13(fg);

g)f) the Licensee must cooperate to minimise harmful sub-frame overlaps if different technologies are used. On rare occasions this may require the frame alignment or guard period to be slightly offset;

g) for the avoidance of doubt all-downlink frame structures such as Supplementary Downlink (SDL) are not permitted.

Note: all current TD-LTE frame configurations are compatible with this frame structure, as are some 5G NR frame configurations. Other technologies are permitted provided that the requirements of 13(a) to 13(d) are met.;

Figure 1: Frame Structure A

DL/UL ratio	Subframe number									
	0	1	2	3	4	5	6	7	8	9
3:1	D	S	U	D	D	D	S	U	D	D

Figure 2: Frame Structure B

DL/UL ratio	Subframe number									
	0	1	2	3	4	5	6	7	8	9
Any	D	S	U							

14. Irrespective of whether the Restrictive Transmission Mask or the Permissive Transmission Mask is being used, the EIRP or TRP ~~EIRP~~ emanating from the Radio Equipment transmissions at any frequency outside the Permitted Frequency Blocks shall not exceed the following additional band edge requirements:

	Non-AAS *dBm / MHz[a] EIRP per antenna*	AAS *dBm / MHz[a] TRP per cell*
Below 3390 MHz	-50	-52

[a] We note this level is defined in the Commission Decision 2019/235/EC~~U2014/276/EU~~ as per MHz rather than per 5 MHz

	Non-AAS *dBm / 5 MHz EIRP per antenna*[4]	AAS *dBm / 5 MHz TRP per cell*
3390 – 3400 MHz	Min(PMax – 43, 13)	Min(PMax' – 43, 1)
3400 – 3405 MHz	Min(PMax – 43, 15)	Min(PMax' – 43, 12)
3405 – 3410 MHz	Min(PMax – 40, 21)	Min(PMax' – 40, 16)
3800 – 3805 MHz[5]	Min(PMax – 40, 21)	Min(PMax' – 40, 16)

[4] The non-AAS limits in this clause for 3800 MHz through to 3840 MHz are determined according to the definition of PMax in 2019/235/EC. That definition of PMax *is the maximum mean power for the base station in question if it is using a non-AAS. This is measured as EIRP per carrier and determined on a per antenna basis.*

[5] For the purposes of the non-AAS limits in this clause below 3410 MHz, EE Limited has given preliminary advice that it would retain the existing definition of PMax rather than the one proposed by 2019/235/EC. This means that for EE Limited's licence, PMax° would be used instead of PMax.

3805 – 3810 MHz	Min(PMax – 43, 15)	Min(PMax' – 43, 12)
3810 – 3840 MHz	Min(PMax – 43, 13)	Min(PMax' – 43, 1)
Above 3840 MHz	-2	-14

~~3405 MHz – 3410 MHz 3600 MHz – 3605 MHz~~	~~Min(PMax – 40, 21) dBm / 5 MHz EIRP per antenna~~
~~3400 MHz – 3405 MHz~~	~~Min(PMax – 43, 15) dBm / 5 MHz EIRP per antenna~~
~~3390 MHz – 3400 MHz~~	~~Min(PMax – 43, 13) dBm / 5 MHz EIRP per antenna~~
~~Below 3390 MHz~~	~~- 50 dBm / MHz[6] EIRP*~~
~~Above 3605 MHz (see Note 2)~~	~~- 34 dBm / 5 MHz EIRP*~~

~~* The maximum mean power relates to the EIRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas.~~

~~Note 2: This limit shall not apply if the licensee of the Spectrum Access 3.6 GHz licence (above 3605 MHz), uses a TDD frame structure identical to Frame Structure A.~~

Small Cells

~~16.~~15. The Licensee is required to comply with the Permissive Transmission Mask as set out in paragraph 10 of this schedule but is not required to comply with the frame structure requirements set out in paragraphs 12 or 13 above, for:

a) Indoor Domestic Small Cells; or

b) Indoor Non-domestic Small Cells, except where another licensee demonstrates that they are suffering harmful interference as a result.

If another licensee demonstrates that they are suffering harmful interference as a result of an Indoor Non-domestic Small Cell, the Indoor Non-domestic Small Cell must comply with the requirements set out in paragraphs 9 and 12 above, where Frame Structure A is used or those requirements set out in both paragraphs 9 and 13 above where Frame Structure B is used.

Interpretation of terms in this schedule

~~17.~~16. In this schedule:

a) "5G NR" means 5G New Radio and refers to the air interface that has been developed by 3GPP for fifth generation (5G) mobile radio networks. This air interface defines how 5G base stations and user devices both transmit and receive radio signals using spectrum;

b) "AAS" means active antenna system. An AAS is a base station and antenna system where the amplitude and / or phase between antenna elements is continually adjusted resulting in an antenna pattern that varies in response to short term changes in the radio environment. This is not intended to include long term beam

shaping such as fixed electrical down tilt. In AAS base stations the antenna system is integrated as part of the base station system or product;

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

~~b)~~d) "Downlink" means transmissions from a base station to a terminal station (handset);

~~c)~~e) "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), measured during the "on" part of the transmission;

~~d)~~f) "femtocell" means ~~Radio Equipment transmitting on the downlink frequencies,~~a base station which operates at a power not exceeding 24 dBm EIRP per carrier, and which is or will be used only by and under the control of the Licensee, following the establishment of a telecommunications link between the femtocell and a network of the Licensee;

~~e)~~g) "Fixed or installed" means used or installed at specific fixed points;

~~f)~~h) Indoor" means a location inside a building or place in which the shielding will typically provide the necessary attenuation to protect wireless telegraphy against harmful interference;

~~g)~~i) "Indoor Domestic Small Cell" means a base station with an EIRP of less than or equal to 24dBm per 20 MHz carrier that is located within a residential property;

~~h)~~j) "Indoor Non-domestic Small Cell" means a base station with an EIRP of less than or equal to 24dBm per 20 MHz carrier that is located indoors but not within a residential property;

~~i)~~k) "IR" means a United Kingdom Radio Interface Requirement notified by Ofcom in accordance with Article 8 of Directive 2014/53/EU of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment (known as the Radio Equipment Directive);

~~j)~~l) "lower block edge" means, in relation to each Permitted Frequency Block, the lowest frequency in that Permitted Frequency Block;

m) "mobile or nomadic" means intended to be used while in motion or during halts at unspecified points;

n) "non-AAS" means a piece of Radio Equipment which is not an AAS;

o) "per antenna" means per radiating ~~component~~unit/component (irrespective of the number of radiating elements that make up that unit/component);

p) "per cell" means per specific piece of Radio Equipment. For a multi-sector base station, per cell refers to each one of the individual sectors irrespective of the number of transmit antennas;

~~l)~~q) "Permitted Frequency Blocks" has the meaning given to it in paragraph 7 of this Schedule;

r) "PMax" ~~is the maximum mean power for the base station in question, measured as EIRP per carrier and determined irrespective of the number of antennas~~ is the maximum mean power for the base station in question if it is using a non-AAS. This is measured as EIRP per carrier and determined on a per antenna basis;

s) "PMax°" is the maximum mean power for the base station in question, measured as EIRP per carrier and determined irrespective of the number of antennas; [Proposed for EE Limited's licence only]

~~m)~~t) "PMax'" is the maximum mean power for the base station in question if it is using an AAS. This is measured as TRP per carrier and determined on a per cell basis;

~~n)~~u) "smart/intelligent low power repeater" means a repeater which operates with power not exceeding 24 dBm EIRP per carrier, which may be established by customers of the Licensee who have written agreements with the Licensee and:

- The Licensee has ultimate control of the repeater, i.e. each individual repeater can be disabled remotely by the Licensee;
- The repeater operates only on the Licensee's frequencies and with their valid Public Land Mobile Network Identifier;
- Must not cause undue interference to other spectrum users; and
- The repeater only transmits on the uplink timeslot when actively carrying a call (voice, video or data) or signalling from serviced handsets.

~~o)~~v) "TDD" means the application of time-division multiplexing to separate ~~outward~~uplink and downlink ~~and return~~ signals;

~~p)~~w) "TD-LTE" means the TDD variant of LTE (Long Term Evolution or 4G technology);

~~q)~~x) "TRP" means the total radiated power. This is the integral of the power transmitted in different directions over the entire radiation sphere, measured during the on part of the transmission;

~~r)~~y) "Uplink" means transmissions from a terminal station (handset) to a base station; and

~~s)~~z) "upper block edge" means, in relation to each Permitted Frequency Block, the highest frequency in that Permitted Frequency Block.

Ofcom

A2. Responding to this consultation

Delete these annexes if your document is not a consultation

How to respond

A2.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 19 May 2019.

A2.2 You can download a response form from https://www.ofcom.org.uk/consultations-and-statements/category-3/consultation-proposal-vary-3.4ghz-radio-spectrum-licences. You can return this by email or post to the address provided in the response form.

A2.3 If your response is a large file, or has supporting charts, tables or other data, please email it to Elizabeth.Press@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet (https://www.ofcom.org.uk/consultations-and-statements/consultation-response-coversheet).

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

Elizabeth Press
Spectrum Policy Advisor
Spectrum Management and Authorisation
Spectrum Group
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A2.5 We welcome responses in formats other than print, for example an audio recording or a British Sign Language video. To respond in BSL:

- Send us a recording of you signing your response. This should be no longer than 5 minutes. Suitable file formats are DVDs, wmv or QuickTime files. Or
- Upload a video of you signing your response directly to YouTube (or another hosting site) and send us the link.

A2.6 We will publish a transcript of any audio or video responses we receive (unless your response is confidential).

A2.7 We do not need a paper copy of your response as well as an electronic version. We will acknowledge receipt if your response is submitted via the online web form, but not otherwise.

A2.8 You do not have to answer all the questions in the consultation if you do not have a view; a short response on just one point is fine. We also welcome joint responses.

A2.9 It would be helpful if your response could include direct answers to the questions asked in the consultation document. The questions are listed at Annex A5. It would also help if you could explain why you hold your views, and what you think the effect of Ofcom's proposals would be.

A2.10 If you want to discuss the issues and questions raised in this consultation, please contact Elizabeth Press on 020 76206814, or by email to Elizabeth.Press@ofcom.org.uk.

Confidentiality

A2.11 Consultations are more effective if we publish the responses before the consultation period closes. In particular, this can help people and organisations with limited resources or familiarity with the issues to respond in a more informed way. So, in the interests of transparency and good regulatory practice, and because we believe it is important that everyone who is interested in an issue can see other respondents' views, we usually publish all responses on our website, www.ofcom.org.uk, as soon as we receive them.

A2.12 If you think your response should be kept confidential, please specify which part(s) this applies to, and explain why. Please send any confidential sections as a separate annex. If you want your name, address, other contact details or job title to remain confidential, please provide them only in the cover sheet, so that we don't have to edit your response.

A2.13 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and try to respect it. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A2.14 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's intellectual property rights are explained further at https://www.ofcom.org.uk/about-ofcom/website/terms-of-use.

Next steps

A2.15 Following this consultation period, Ofcom plans to publish a statement in May 2019.

A2.16 If you wish, you can register to receive mail updates alerting you to new Ofcom publications; for more details please see https://www.ofcom.org.uk/about-ofcom/latest/email-updates

Ofcom's consultation processes

A2.17 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex A3.

A2.18 If you have any comments or suggestions on how we manage our consultations, please email us at consult@ofcom.org.uk. We particularly welcome ideas on how Ofcom could more effectively seek the views of groups or individuals, such as small businesses and residential consumers, who are less likely to give their opinions through a formal consultation.

A2.19 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact the corporation secretary:

Corporation Secretary
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA
Email: corporationsecretary@ofcom.org.uk

A3. Ofcom's consultation principles

Ofcom has seven principles that it follows for every public written consultation:

Before the consultation

A3.1 Wherever possible, we will hold informal talks with people and organisations before announcing a big consultation, to find out whether we are thinking along the right lines. If we do not have enough time to do this, we will hold an open meeting to explain our proposals, shortly after announcing the consultation.

During the consultation

A3.2 We will be clear about whom we are consulting, why, on what questions and for how long.

A3.3 We will make the consultation document as short and simple as possible, with a summary of no more than two pages. We will try to make it as easy as possible for people to give us a written response. If the consultation is complicated, we may provide a short Plain English / Cymraeg Clir guide, to help smaller organisations or individuals who would not otherwise be able to spare the time to share their views.

A3.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.

A3.5 A person within Ofcom will be in charge of making sure we follow our own guidelines and aim to reach the largest possible number of people and organisations who may be interested in the outcome of our decisions. Ofcom's Consultation Champion is the main person to contact if you have views on the way we run our consultations.

A3.6 If we are not able to follow any of these seven principles, we will explain why.

After the consultation

A3.7 We think it is important that everyone who is interested in an issue can see other people's views, so we usually publish all the responses on our website as soon as we receive them. After the consultation we will make our decisions and publish a statement explaining what we are going to do, and why, showing how respondents' views helped to shape these decisions.

A4. Consultation coversheet

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

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

Nothing ☐

Name/contact details/job title ☐

Whole response ☐

Organisation ☐

Part of the response ☐

If there is no separate annex, which parts? _____

_____

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

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

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

Name Signed (if hard copy)

A5. Consultation questions

A5.1 Ofcom is inviting interested parties to submit comments by 19 May 2019 on its proposals to amend the technical conditions for five 3.4 GHz, 3.5 GHz and 3.6 GHz Spectrum Access Licences.

Question 1: Do you agree with Ofcom's proposal to vary the licences as requested?

If not, please explain why you think it would not be appropriate to vary the licences.

Q2 *- Do you have any other comments on the assessment or the factors considered as part of the assessment?*

Q3 *- Do you have any comments on the technical changes?*