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# Variation of UK Broadband's Spectrum Access Licence for 3.6 GHz spectrum

Ofcom's consideration of a request to vary the  
permitted lower frequency block

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**CONSULTATION:**

Publication Date: 27 June 2018

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# About this document

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UK Broadband holds a spectrum licence which authorises it to use 168 MHz of radio spectrum in two separate 84 MHz blocks at 3605 – 3689 MHz ('lower frequency block') and at 3925 – 4009 MHz ('upper frequency block'). UK Broadband has requested a number of changes to this licence concerning the lower frequency block, including: shifting it down by 5 MHz, surrendering its rights to use 4 MHz of spectrum in that block, and changing the applicable technical conditions.

This consultation sets out Ofcom's provisional view that it is minded to agree to the requested variation.

We invite the views of interested parties by **8 August 2018** and will consider responses before reaching a final decision.

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The following Annexes are published as separate documents:

- A6. Requested variation to the UKB Licence
- A7. UKB Licence showing proposed changes in mark-up

# 1. Executive Summary

- 1.1 UK Broadband, which was acquired by Hutchison 3G UK Limited (“**H3G**”) in 2017, holds a Spectrum Access licence (the “**UKB Licence**”) authorising it to use two non-adjacent blocks of 84 MHz at 3605 – 3689 MHz (the “**lower frequency block**”) and 3925 – 4009 MHz (the “**upper frequency block**”).<sup>1</sup>
- 1.2 On 29 May 2018, UK Broadband requested the following changes to the UKB Licence:
- to shift its lower frequency block down by 5 MHz to make it adjacent to the 20 MHz spectrum block licensed to UK Broadband at 3580 – 3600 MHz;
  - to reduce its frequency holding in the lower frequency block by 4 MHz, so that it would hold 80 MHz from 3600 – 3680 MHz (rather than 84 MHz from 3605 – 3689 MHz);
  - to align the technical requirements that would apply to the frequencies 3600 – 3680 MHz with the technical requirements that currently apply to the UK Broadband licence in the 3.4 – 3.6 GHz band; and
  - to allow a transitional period during which UK Broadband would continue to be authorised to use 3605 – 3689 MHz under the current technical requirements, whilst also being authorised to deploy 3600 – 3680 MHz under the new technical requirements. This transitional period would end from the later of 1 September 2019 or nine months from the date of the licence being varied.
- 1.3 UK Broadband notes in its request that each of the elements is complementary and that it reserves the right to refuse its consent to a variation that includes only some and not all elements requested. This document assesses UK Broadband's variation request and consults stakeholders on our provisional conclusion that it is appropriate to grant the requested variation. For ease of reference, where we refer to H3G in this document, we are also referring to its subsidiary, UK Broadband.

## Ofcom's provisional view

- 1.4 We have considered the requested licence variation in light of our relevant licensing functions and statutory duties. Our provisional conclusion, which is subject to this consultation, is that it is appropriate to grant the requested variation and we are minded to do so.
- 1.5 The proposed variation would defragment and simplify the holdings in the 3.6 – 3.8 GHz band. It would also increase the amount of usable spectrum that can be made available in our planned award of spectrum in the 3.6 – 3.8 GHz band. Consumers should benefit from the requested variation, as it is likely to lead to higher quality enhanced mobile broadband services being available, such as due to an increased likelihood of spectrum being held by the optimal user of that spectrum. Consumers may also benefit from these services being available earlier, although this is less certain. We consider that these outcomes would be

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<sup>1</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0019/83800/SA-3.6-LICENCE-UK-Broadband-0823615-11-01-18w.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0019/83800/SA-3.6-LICENCE-UK-Broadband-0823615-11-01-18w.pdf)

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.

- 1.6 We recognise that as a result of the variation UK Broadband would hold 100 MHz of contiguous spectrum, compared with the 84 MHz of contiguous spectrum and the separate 20 MHz which it currently holds from 3580 – 3600 MHz. We expect that the variation would be likely to provide a benefit to H3G (and its customers), in that it may allow H3G to be able to offer increased peak speeds by using a larger carrier and potentially better coverage by having higher in-block power levels. Absent this variation, H3G would likely have to win at auction the 5 MHz of spectrum which currently split the UK Broadband spectrum holdings, in order to gain access to 100 MHz of contiguous spectrum.<sup>2</sup> We have therefore considered whether any benefit accruing to H3G from the variation could have an adverse impact on competition, to the ultimate detriment of consumers more broadly.
- 1.7 In summary, we do not consider it likely that any benefit to H3G of gaining access to 100 MHz of contiguous spectrum, as opposed to separate 84 MHz and 20 MHz blocks, would be so significant as to provide H3G with an unmatched competitive advantage over its competitors. Further, even if H3G were to gain a substantial advantage, we consider it would be unlikely to be enduring as other providers will have opportunities to win spectrum in the future award. We therefore do not consider the proposed variation would be likely to have an adverse impact on competition such that we should not consent to the variation.
- 1.8 Finally, we have considered whether the variation would have an adverse impact on other spectrum users, and have provisionally concluded that it would not. The requested changes to technical conditions would not impact the benchmark spectrum quality currently received by 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 – 3.8 GHz band,<sup>3</sup> due to continued coordination of UK Broadband deployments. Specifically, the more permissive out of band emissions mask in the new technical requirements would be included in the existing coordination tool, and UK Broadband would continue to be required to abide by the existing coordination procedure for all of its new sites and for changes to its existing sites.

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<sup>2</sup> Assuming we include this 5 MHz in our forthcoming spectrum award. It would also be possible to H3G to seek to win spectrum in that auction which sits immediately above its 84 MHz block, to gain access to a greater amount of contiguous spectrum in the band.

<sup>3</sup> We have issued notices to revoke all fixed links licences in the band with an effective date of 23 December 2022, although we are aiming for fixed links operations to migrate to alternative frequencies or technologies by June 2020 where possible. We have also varied Permanent Earth Station licences and grants of Recognised Spectrum Access such that we will no longer take registered satellite earth stations with a receive component in the 3.6 – 3.8 GHz band into account for frequency management purposes from 1 June 2020, or 1 September 2020 in the case of one grant of RSA.

## Next steps

- 1.9 We invite comments from stakeholders on the proposal in this consultation by **8 August 2018**. Subject to the outcome of this consultation, we intend to publish a statement and to vary UK Broadband's licence as soon as practicable.

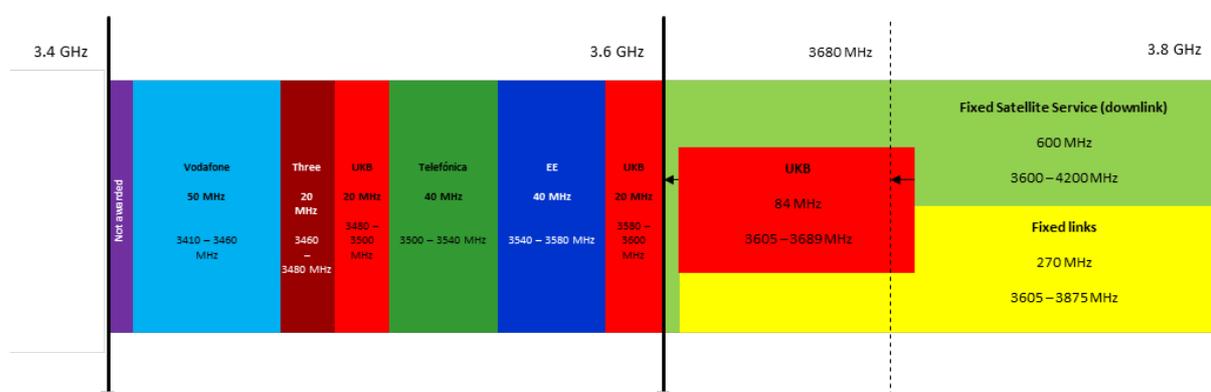
## 2. The requested variation

- 2.1 UK Broadband Limited (“**UK Broadband**”), which was acquired by Hutchison 3G UK Limited (“**H3G**”)<sup>4</sup> in 2017, holds a Spectrum Access licence<sup>5</sup> (the “**UKB Licence**”) authorising it to use two non-adjacent blocks of 84 MHz at 3605 – 3689 MHz (the “**lower frequency block**”) and 3925 – 4009 MHz (the “**upper frequency block**”). These frequencies may be used to provide mobile services, including mobile broadband services.
- 2.2 On 29 May 2018 we received an application from UK Broadband for variation of the lower frequency block of the UKB Licence, followed by some clarifications on the changes to the technical requirements requested.<sup>6</sup>

### Current spectrum authorisations in the 3.4 – 3.8 GHz band

- 2.3 Figure 1 below shows current spectrum authorisations in the 3.4 – 3.8 GHz band. The arrows show the effects of the requested variation on the frequencies of the lower frequency block. We have previously announced plans to award the 116 MHz in the 3.6 – 3.8 GHz band that is not already licensed to UK Broadband in the second half of 2019.<sup>7</sup> The lower frequency block currently fragments the spectrum available for a future award into 5 MHz from 3600 – 3605 MHz, located between two spectrum blocks licensed to UK Broadband, and 111 MHz from 3689 – 3800 MHz.

Figure 1: Current spectrum authorisations at 3.4 – 3.8 GHz<sup>8</sup>



### UK Broadband’s licence variation request

- 2.4 UK Broadband has requested the following changes to the UKB Licence:

<sup>4</sup> Trading as Three.

<sup>5</sup> See [https://www.ofcom.org.uk/data/assets/pdf\\_file/0019/83800/SA-3.6-LICENCE-UK-Broadband-0823615-11-01-18w.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0019/83800/SA-3.6-LICENCE-UK-Broadband-0823615-11-01-18w.pdf)

<sup>6</sup> See paragraph 2.9.

<sup>7</sup> Ofcom, July 2017. Improving consumer access to mobile services at 3.6 GHz – 3.8 GHz, Statement and Consultation. [https://www.ofcom.org.uk/data/assets/pdf\\_file/0017/103355/3-6-3-8ghz-statement.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0017/103355/3-6-3-8ghz-statement.pdf)

<sup>8</sup> Note: there are no fixed links in channels 1 to 3 (3605 – 3695 MHz paired with 3925 – 4015 MHz)

- to shift its lower frequency block down by 5 MHz;
- to reduce its frequency holding in the lower frequency block by 4 MHz, so that it would hold 80 MHz from 3600 – 3680 MHz;
- to align the technical requirements that apply to the frequencies 3600 – 3680 MHz with the technical requirements that apply to the Spectrum Access Licence authorising UK Broadband to use two non-adjacent blocks of 20 MHz in the 3.4 – 3.6 GHz spectrum band, at 3480 – 3500 MHz and 3580 – 3600 MHz (the “UKB 3.4 – 3.6 GHz Licence”); and
- to allow a transitional period during which UK Broadband would continue to be authorised to use 3605 – 3689 MHz under the current technical requirements, whilst also being authorised to deploy 3600 – 3680 MHz under the new technical requirements.

2.5 UK Broadband is making a single request for all these changes and notes in its variation request that it reserves the right to refuse its consent to a variation that includes only some and not of all elements requested.

2.6 Below, we describe in more detail the elements of UK Broadband's requested variation.

### Shifting down and reducing the lower frequency block

2.7 UK Broadband is seeking to move its lower frequency block down by 5 MHz so that it would be immediately adjacent to UK Broadband's existing spectrum holdings under the UKB 3.4 – 3.6 GHz Licence.

2.8 As the lower frequency block has a bandwidth of 84 MHz, a move down by 5 MHz would result in the lower frequency block moving to 3600 – 3684 MHz. In addition to this move, UK Broadband has proposed to surrender 4 MHz of spectrum from the lower frequency block, to result in a final licensed allocation of 80 MHz at 3600 – 3680 MHz.

### Transitional arrangements

2.9 In order to manage the transition from the current use of 3605 – 3689 MHz to future use of 3600 – 3680 MHz, UK Broadband has requested a transitional period during which equipment on some sites could continue to operate temporarily in the 3605 – 3689 MHz range to avoid adversely affecting existing customers. Equipment on upgraded sites would operate in the new 3600 – 3680 MHz range during this period. Subsequent to the submission of the variation request, UK Broadband has requested that:<sup>9</sup>

- access to the 3600 – 3680 MHz range be granted under technical requirements consistent with those in the UKB 3.4 – 3.6 GHz Licence (as shown in the new Schedule 1 of the draft licence at Annex A7); and

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<sup>9</sup> UK Broadband initially requested that “For the Lower Frequency Block only, UKB requests that Ofcom delete paragraphs 2, 6 and 7 of Schedule 1 to the existing 3.6 GHz Licence and replace them with paragraphs 2 and 8 to 15 inclusive of the 3.4 – 3.6 GHz Licence (with the frequency offsets referenced in paragraph 14 of the 3.4 – 3.6 GHz Licence amended appropriately for the 3.6 GHz Licence variation).” However, UK Broadband subsequently requested the changes described in paragraph 2.9.

- access to the 3605 – 3689 MHz range continue under the existing technical requirements of the UKB Licence, with this access to be withdrawn from the later of 1 September 2019 or nine months from the date of the licence being varied.
- 2.10 The requested variation would therefore result in a 5 MHz increase in the total amount of spectrum available to UK Broadband during the transitional period between the date of Ofcom's variation statement and the date of withdrawal of the frequencies from 3680 – 3689 MHz. However, UK Broadband said that "UKB is not seeking to increase the frequencies it will use for any particular customer at any one time" and specified that any "particular customer will use either 3605 – 3689 MHz or 3600 – 3680 MHz".<sup>10</sup>
- 2.11 The enduring result of the requested variation to the frequencies in the UKB Licence would be:
- UK Broadband would have a lower frequency block of 80 MHz that is subject to new technical requirements, and would be able to use 3580 – 3680 MHz as a single 100 MHz contiguous block of spectrum (instead of two non-contiguous blocks of 80 MHz and 20 MHz without the variation); and
  - an increase in the total amount of spectrum available for the future award from 116 MHz to 120 MHz, and that all the spectrum available for award would be contiguous (instead of two non-contiguous blocks of 111 MHz and 5 MHz without the variation).

### **Aligning the technical requirements for 3600 – 3680 MHz with the UKB 3.4 – 3.6 GHz Licence**

- 2.12 The effect of aligning the technical requirements that apply to the frequencies 3600 – 3680 MHz with the technical requirements that apply to the UKB 3.4 – 3.6 GHz Licence, and which also apply to the Spectrum Access licences awarded in the 3.4 – 3.6 GHz band, would be:
- updating the applicable "Interface Requirement", from IR2015 to IR2097;<sup>11</sup>
  - increasing the maximum power for base stations; and
  - introducing specific transmission masks, frame structures and inter-operator synchronisation requirements.
- 2.13 The differences between the current technical requirements of the UKB Licence and the UKB 3.4 – 3.6 GHz Licence are summarised in Table 1 below.

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<sup>10</sup> UK Broadband's licence variation request, pages 22 and 25.

<sup>11</sup> IR 2097: [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0017/85031/ir\\_2097\\_2015\\_final.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0017/85031/ir_2097_2015_final.pdf)

**Table 1: Summary of differences between existing technical requirements in the UKB Licence and those in the UKB 3.4 – 3.6 GHz licence**

	Existing technical requirements in the UKB Licence	Technical requirements in the UKB 3.4 – 3.6 GHz Licence
Synchronised Operation	No synchronised frame structure No Permissive mask Must comply with the UKB mask	Synchronised operation must: <ul style="list-style-type: none"> <li>• Use Frame Structure A; and</li> <li>• Time align with neighbours; and</li> <li>• Comply with the Permissive mask</li> </ul>
Unsynchronised Operation	Unsynchronised use permitted with the UKB mask	Unsynchronised operation not permitted, however partial synchronisation is permitted and must: <ul style="list-style-type: none"> <li>• Use Frame Structure B; and</li> <li>• Time align with neighbours; and</li> <li>• Comply with the Restrictive mask</li> </ul>
Base station in-block power limits	60 dBm / 5 MHz EIRP per Equipment	65 dBm / 5 MHz EIRP per Equipment
Fixed terminal in-block power limits	60 dBm / 5 MHz EIRP per Equipment	35 dBm / 5 MHz EIRP per Equipment

2.14 As set out in the table, UK Broadband must currently comply with a specific out-of-band emissions mask in 3605 – 3689 MHz and is not required to synchronise with its neighbours. The regulations that apply to the UKB 3.4 – 3.6 GHz Licence and the other licences in the 3.4 – 3.6 GHz band (i.e. the regulations which UK Broadband has requested we incorporate into the UKB Licence) encourage users to synchronise uplink and downlink time slots by allowing any users who synchronise to use the Permissive Mask, which is more relaxed than the mask in the UK Broadband Licence. Details of the relevant Frame Structures and Masks are contained in the draft licence at Annex A7.

2.15 The technical requirements that UK Broadband is requesting are in line with EC Decision 2014/276/EU.<sup>12</sup> We note that CEPT has produced a draft report which recommends updating the existing harmonised technical conditions to add additional technical conditions relevant to the use of Active Antenna Systems.<sup>13</sup> It is expected that the amendment to this EC Decision will be approved later in 2018 or early 2019.

<sup>12</sup> Commission Implementing Decision of 2 May 2014 on amending Decision 2008/411/EC on the harmonisation of the 3400 – 3800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community

<sup>13</sup> European Conference of Postal and Telecommunications Administrations, CEPT, draft Report 67.

- 2.16 We note that UK Broadband has committed to maintaining protection of co-channel and adjacent services above 3689 MHz at the same interference thresholds as currently apply. This is addressed in paragraphs 4.63 – 4.64.
- 2.17 UK Broadband has not suggested an out-of-band limit at the 3680 MHz boundary (in addition to the out-of-block limits implicit in the Permissive and Restrictive emissions masks). We consider that the Permissive and Restrictive emissions masks and the coordination requirement are, together, sufficient to ensure coexistence with adjacent users above 3680 MHz without need for an additional out-of-band requirement.

## 3. Legal framework

- 3.1 This section provides an overview of the main UK and European legislative provisions relevant to spectrum licensing and to the requested licence variation.
- 3.2 The applicable legal framework derives from our duties and powers 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 Framework<sup>14</sup> 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.

### Licence variation

#### Ofcom's powers to vary a spectrum licence

- 3.3 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.
- 3.4 Ofcom has a duty set out in section 9(7) of the 2006 Act, reflecting Article 6 of the EU Authorisation Directive 2002/20/EC, 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.
- 3.5 Ofcom has a broad discretion under paragraph 6 of Schedule 1 of the 2006 Act to vary licences, subject to certain limitations:
- 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;

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<sup>14</sup> 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.

- 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 Authorisation Directive (2002/20/EC); 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

- 3.6 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 the licensee, we are under no obligation (under the 2006 Act) to consult on the proposal.
- 3.7 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.
- 3.8 These provisions implement Article 14 of the Authorisation Directive which requires Member States to 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).
- 3.9 We consider that the variation requested by UK Broadband is 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, which are summarised below.
- 3.10 Following consideration of stakeholders' responses, we will publish our final decision, which we are currently aiming to make as soon as possible.

## Impact assessment

- 3.11 This consultation as a whole, including its annexes, comprises an impact assessment as defined in Section 7 of the 2003 Act.
- 3.12 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.
- 3.13 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

- 3.14 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".
- 3.15 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.
- 3.16 We do not consider that the requested licence variation 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

- 3.17 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.
- 3.18 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.
- 3.19 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)).
- 3.20 The management of the UK radio spectrum is carried out within a framework set out by the European Common Regulatory Framework, which aims to harmonise the regulation of electronic communications networks and services throughout the European Union. Related to that, 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. These requirements, which give effect to the requirements of Article 8 of the Framework Directive and are to be read accordingly, include:
- 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**

- 3.21 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.
- 3.22 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.
- 3.23 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 the requested variation

4.1 In this section we set out our assessment of UK Broadband's variation request and our provisional conclusion that it is appropriate to grant the requested variation.

### 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 UKB Licence as requested by UK Broadband, in light of the relevant factors and evidence, in order to reach an outcome that most appropriately meets our relevant statutory duties.

### Assessment of the requested variation

#### Securing optimal use of spectrum

4.5 The requested licence variation would:

- address the existing fragmentation of the 3.6 – 3.8 GHz band; and
- increase the total amount of spectrum available for the future award.

4.6 The UK Broadband lower frequency block currently fragments the spectrum available for a future award into 5 MHz from 3600 – 3605 MHz, located between two spectrum blocks licensed to UK Broadband; and 111 MHz from 3689 – 3800 MHz.

4.7 In its current position, the 5 MHz block at 3600 – 3605 MHz is likely to be of limited use to MNOs other than H3G for future mobile services including 5G, because the minimum channel size defined by 3GPP for 5G New Radio (NR) is 10 MHz and it is recognised that 5G services require larger contiguous bandwidths. This 5 MHz block would be of greater use if it could be used as part of a larger 5G NR channel. Shifting the lower frequency block down, as requested by UK Broadband, would result in a contiguous block of spectrum for award. As a result, bids for the 5 MHz would be based on the underlying intrinsic valuation for blocks of 3.6 GHz spectrum, without the risk of its value being reduced by its current specific location.

4.8 The requested variation also includes the proposed surrender of 4 MHz of spectrum. This would directly increase the total amount of spectrum available in the future award by

4 MHz, to 120 MHz. In doing so, it would also increase the usability of the single 1 MHz that currently sits within the 111 MHz spectrum block.<sup>15</sup>

- 4.9 UK Broadband's requested variation would result in it having temporary access to 5 MHz more spectrum than is currently authorised in its licence. We are of the view that allowing this would be proportionate to achieve the benefits set out above. As this spectrum is not available to be licensed to other users ahead of the future award, temporary use by UK Broadband is not limiting on others.<sup>16</sup> As set out in paragraph 2.10 above, UK Broadband would also not be using the full 89 MHz to serve any particular customer at any one time. This would be ensured by the terms of the amended licence, which would stipulate that any piece of radio equipment could use either 3605 – 3689 MHz or 3600 – 3680 MHz (see paragraph 5 of Schedule 2 to the draft licence at Annex A7).

### Provisional conclusion on securing optimal use of spectrum

- 4.10 Overall, the requested variation would have the combined effect of increasing the amount of contiguous spectrum in the 3.6 – 3.8 GHz band award which is usable by all by 10 MHz, from 110 MHz to 120 MHz. We note that 10 MHz of spectrum is roughly a 9% increase in the spectrum usable by all for the future 3.6 – 3.8 GHz award.
- 4.11 Our view is that the requested variation is likely to have a positive impact on the efficient use of spectrum, by allowing this spectrum to be acquired by the user with the highest value for it.
- 4.12 We note that it might be possible for the more efficient use of 10 MHz to be achieved by alternative means (such as trading of spectrum rights or regulatory action). Indeed, in planning for the future spectrum award, we had been considering the issue of spectrum fragmentation in the 3.6 – 3.8 GHz band which arises from the current location of UK Broadband's respective spectrum holdings. However, some of these potential alternative means would not be within our control, or would have associated lead times, with potential uncertainties or other impacts (e.g. if we considered it appropriate to revoke the licence for the 4 MHz which UK Broadband has proposed to surrender, under the terms of its licence this would require a minimum of five years' notice absent UK Broadband's consent).
- 4.13 In light of the above we consider that granting the variation would be consistent with our duty to secure the optimal use of the spectrum.

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<sup>15</sup> 5G NR channel sizes in this frequency range vary in size from a minimum of 10 MHz to a maximum of 100 MHz. As it is not usable within these block sizes, 1 MHz of a 111 MHz/116 MHz block is likely to be of no, or limited, use in the award. Options defined by 3GPP for 5G NR channel bandwidth in the 3400-3800 MHz range: 10, 15, 20, 40, 50, 60, 80, 90, 100 MHz.

<sup>16</sup> We note that Innovation and Trials licences allow access to any frequency band, including those already licensed, subject to coordination and availability. <https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/non-operational-licences>

## Impact on H3G and on other mobile providers

- 4.14 In order to assess the impact of the requested variation on citizens and consumers, and its potential effects on competition, we discuss the effect of the variation on the services offered by mobile providers from which these impacts flow.
- 4.15 We note that:
- shifting down the lower frequency block (moving into the frequencies at 3600 – 3605 MHz) is likely to benefit H3G as it will result in H3G having access to 100 MHz of contiguous spectrum and we consider the effect of this below;
  - shifting down the lower frequency block will also benefit bidders in the future award since it would result in a larger contiguous block of spectrum in the award;
  - the changes to technical regulations are likely to benefit H3G;<sup>17</sup> and
  - the surrender of 4 MHz by UK Broadband is likely to benefit others in the future award since they would have the opportunity to bid for these frequencies.
- 4.16 We recognise that as a result of the variation UK Broadband would hold 100 MHz of contiguous spectrum, compared with the 84 MHz of contiguous spectrum and the separate 20 MHz which it currently holds from 3580 – 3600 MHz. We expect that the variation would be likely to provide a benefit to H3G (and its customers), in that it may allow H3G to be able to offer increased peak speeds by using a larger carrier and potentially better coverage by having higher in-block power levels.

### Impact on H3G

- 4.17 Given that UK Broadband requested the variation, we consider that it is likely to provide a net benefit to H3G. That is, the expected economic value to H3G from the variation is likely to outweigh the costs to H3G, in terms of replacing its existing equipment in 3605 – 3689 MHz with new equipment in 3600 – 3680 MHz and surrendering 4 MHz of spectrum. We therefore do not assess the scale of costs to H3G involved in relocating its frequencies.
- 4.18 In its variation request, UK Broadband argues certain benefits for H3G.<sup>18</sup> First, H3G's customers would benefit from "fast 5G fixed wireless access services" from [X] and from "fast 5G mobile services" [Y]. Second, H3G estimates that these new services could offer average download speeds of as much as 475Mbit/s. Third, H3G would be able to use 3580 – 3680 MHz as a single 100 MHz contiguous block and not have to use carrier aggregation. H3G also highlights that in the absence of a modification to the technical requirements, any deployment by UK Broadband of the 3.6 – 3.8 GHz spectrum on the same sites as those used for the 3.4 – 3.6 GHz spectrum would potentially leave large gaps in coverage because of the lower power levels in the UKB Licence. Fourth, allowing phased implementation of the variation will ensure that H3G will be able to maintain its service levels to existing customers.

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<sup>17</sup> In the short term. We expect that the technical regulations for the 3.6 – 3.8 GHz award will afford other operators in the band the same flexibility.

<sup>18</sup> UK Broadband's licence variation request, pages 19, 24, 29 and 30.

4.19 We acknowledge that there is considerable uncertainty with regards to the capabilities and performance of future mobile technologies and the improvement customers will experience from future mobile networks. Given this uncertainty, it is possible that the changes requested in the licence variation may not deliver a material increase in the quality of H3G's network. However, as listed above, UK Broadband considers this licence variation to have benefits to their network, and so we assume that some benefits would be likely to accrue to H3G as a result. For the purpose of assessing the impact of the variation on H3G, we discuss potential benefits to H3G below:<sup>19</sup>

- technological benefits from changes to technical regulations being made earlier than would otherwise be the case; and
- technological benefits of contiguous spectrum.

#### **Benefits to H3G of changes to technical requirements**

4.20 As set out above (see paragraphs 2.12 – 2.14), the requested changes to technical requirements would increase the maximum power for base stations, and relaxation of the out of band emissions limit when fully synchronised and using the Permissive mask.

4.21 These changes would likely impact the network that UK Broadband could deploy in this spectrum. For example, the current mask in the UKB Licence would be difficult to achieve for active antenna systems.<sup>20</sup> We understand that active antennas are likely to be an important part of future mobile networks, where they are expected to improve spectral efficiency and provide consumers with increased peak and average throughputs and greater capacity. Increased power would also provide H3G with increased coverage.

4.22 The requested technical requirements are in line with the technical requirements for licensees in the 3.4 – 3.6 GHz band. Unlike these licensees, UK Broadband is constrained in 3.6 – 3.8 GHz by the need to coordinate with registered satellite and fixed links users, which will remain even after the variation.<sup>21</sup>

4.23 We also anticipate that, even had a variation not been requested, we would have proposed to change the technical requirements for UK Broadband's 3.6 – 3.8 GHz spectrum at the same time as those to be awarded in the 3.6 – 3.8 GHz band. As such, any possible benefit to H3G arising from these technical requirement changes is likely to be limited to the

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<sup>19</sup> We have also considered the possibility that the frequencies that H3G would acquire might be intrinsically more valuable than those it is surrendering, for reasons other than aligning two of its spectrum blocks into one contiguous block. Although the lower block is less likely to be affected by the presence of fixed links in frequencies 3695 – 3800 MHz, which may not be fully removed from the band until December 2022, in many areas fixed links are expected to be relocated earlier. Further, we note that both blocks are likely to be constrained by the presence of incumbent satellite earth stations. Therefore, we do not have clear evidence to suggest that the location 3600 – 3605 MHz is intrinsically more valuable than 3684 – 3689 MHz.

<sup>20</sup> Active Antenna Systems (AAS) are radio equipment units where the active radio frequency front-end is integrated into the structure of the antenna itself. In current mobile networks the radio frequency front-end is typically housed in a separate unit (typically a "remote radio unit" or "RRU") which is connected to passive antennas through cables. AAS enable the full benefits of Massive MIMO to be realised, principally greater cell throughput through use of high-order beamforming and/or spatial multiplexing.

<sup>21</sup> See paragraph 4.62.

period between granting of the variation and the upcoming award, which we expect to take place in the second half of 2019.

### Technological benefit of contiguous spectrum

- 4.24 The requested variation would lead to H3G holding a contiguous block of 100 MHz of spectrum across the 3.6 GHz boundary, at 3580 – 3680 MHz. UK Broadband has indicated<sup>22</sup> that this variation would allow them to use this spectrum to offer a “100 MHz 5G service”, rather than using two separate 80 MHz and 20 MHz carriers.
- 4.25 We are not aware of plans for *intra-band carrier aggregation* in 3.4 – 3.8 GHz for early 5G devices, at least for now, so in the short-term a 100 MHz carrier could provide a faster peak throughput than a service using separate 20 MHz and 80 MHz 5G NR carriers in the 3.4 – 3.8 GHz band.
- 4.26 A 100 MHz contiguous carrier would only offer marginally higher average speeds and total network capacity than separate 20 MHz and 80 MHz carriers when multiple devices are accessing the network at the same time (e.g. at particularly busy times of day). This marginal increase in total network capacity is because it is slightly easier to dynamically load-balance between users; and fewer boundaries between carriers can allow for slightly higher spectrum utilisation rates because fewer guard bands or reduced power blocks are required for coexistence between adjacent carriers.
- 4.27 In the longer term, 100 MHz of contiguous spectrum might give an operator more flexibility than an operator with separate 20 MHz and 80 MHz blocks. For example, an operator choosing to operate an unsynchronised network<sup>23</sup> would need to build in guard bands to meet the restrictive band-edge mask, and it would need to do this at each band edge. This implies that for a given total amount of spectrum held, an operator with one block of spectrum would be able to use more spectrum for carriers than an operator with two blocks of spectrum.
- 4.28 While there is currently considerable uncertainty about 5G services and use cases, aligning two non-contiguous blocks into one larger contiguous block might allow H3G to offer higher peak speed and greater future flexibility relative to its current holding.
- 4.29 We are unaware of any specific examples of services that are critically dependent on contiguous 100 MHz carriers that would not also work for an 80 MHz carrier. Therefore, the requested variation is unlikely to allow H3G to offer new services which it would not otherwise be able to offer.<sup>24</sup>

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<sup>22</sup> UK Broadband's licence variation request, page 1.

<sup>23</sup> An operator may choose to operate an unsynchronised network for a number of reasons, for example, to adopt a new frame structure to allow it to serve new ultra-reliable low-latency communications (URLLC) use cases; or to vary its uplink / downlink ratio in response to changing user demand.

<sup>24</sup> The variation would provide H3G with the flexibility to exploit any such use cases which may arise in the future.

### **Benefits to potential users of the 3.6 – 3.8 GHz band from an increased amount of available spectrum**

- 4.30 UK Broadband's requested variation would make a further 4 MHz directly available to users in the upcoming 3.6 – 3.8 GHz award, as well as making a further 6 MHz more useful to other users than H3G. This means that there will be additional (and more usable) spectrum for other providers to use to deliver competing services, including 5G.

### **Promotion of competition**

- 4.31 In deciding whether it would be appropriate to agree to the licence variation as requested, we have considered how the variation might affect competition.
- 4.32 We note that the 10 MHz effective increase in the amount of usable spectrum in the upcoming award is likely to have a beneficial impact on competition. This increases the ability of providers with smaller shares of spectrum, both in the 3.6 – 3.8 GHz band (i.e. all companies other than H3G), and in total, to increase their spectrum holdings, and so reduce any asymmetries in spectrum shares. It therefore increases the opportunity for at least one other provider to improve its competing service offering.
- 4.33 We have also considered the potential for the requested variation to lead to a distortion of competition to the detriment of consumers, against which we would need to balance the benefits to consumers. Such a distortion could arise if the licence variation were to result in H3G acquiring an unmatched competitive advantage over its competitors, which endured over time. For example, a significant quality advantage could induce consumers to switch from other providers to H3G, or the competitive constraint imposed upon H3G by other providers could be lessened, allowing it profitably to raise its prices or reduce the quality of its offering, to the detriment of consumers.
- 4.34 The potential source of any relevant competitive advantage for H3G would be the gains it obtains from the licence variation. If H3G would gain no material increase in the quality of its network, there would be no basis for a material distortion of competition. Therefore, for the purpose of assessing the potential for distortion of competition, we assume the case in which H3G would gain some benefit from the variation. First, we consider the magnitude of any advantage H3G might be able to obtain from the requested variation. We then consider whether any such advantage is likely to persist over time.

### **Magnitude of any potential advantage to H3G**

- 4.35 Below, we set out our reasons for considering that, even if H3G were to benefit from the requested variation, any such benefit is unlikely to lead to a material distortion of competition.
- 4.36 H3G (through UK Broadband) currently has the largest block of contiguous spectrum in the 3.4 – 3.8 GHz band (84 MHz), and could offer enhanced mobile broadband services irrespective of whether the requested variation is granted. The incremental impact of the requested variation is the potential for H3G to be able to offer increased peak speeds by

using a larger carrier and potentially better coverage by having higher in-block power levels, earlier than might otherwise be the case.

- 4.37 We note that even a limited incremental improvement could be concerning if it is building on a pre-existing quality advantage, for example, if this makes the quality advantage to H3G large enough to influence a significant number of consumers to switch to it.
- 4.38 Network quality (or network performance) is a broad concept, which includes several aspects valued by consumers such as network reliability, network coverage, download and upload speeds, latency, jitter, webpage browsing times, call quality and call success rate, etc. These metrics are not just related to the performance of the radio access network but also depend on the performance of the core and backhaul networks as well as other aspects. Some of these parameters are also interrelated.<sup>25</sup>
- 4.39 Therefore, while the requested variation may give UK Broadband improvements in some aspects of network quality, we consider that there are a number of factors which might limit the extent to which they are likely to drive consumer switching to the extent sufficient to materially distort competition:
- There are a number of dimensions to retail competition. Some consumers may value other aspects of their service, such as price, customer service, handset choice, contract terms and other aspects of network performance (including coverage).<sup>26</sup>
  - Speeds matter primarily to the extent they affect the consumer's experience. Peak speeds will rarely be experienced by consumers and may not provide any obvious benefit for most consumers most of the time. For this reason, we do not consider that peak speeds are particularly relevant to competition, though high peak speeds may provide some marketing advantage.<sup>27</sup> The speeds individual users receive will depend on factors other than the amount of spectrum deployed, such as how many other users are demanding data in the cell and whether that user is close to the base station or is at the edge of the cell.
  - The impact of the requested variation on average speeds and total network capacity (which is often the greater constraint on the user experience in practice, and so is more relevant for competition) is likely to be marginal.
  - Consumer devices do not currently support 5G services in 3.4 – 3.8 GHz, and it is uncertain when they will be available. Even when devices become available, take-up is likely to develop over time, and so it is likely that only a fraction of consumers would take advantage of 5G ahead of the future award by switching to or not churning away from H3G, which limits the extent to which the variation could lead to a distortion of competition.<sup>28</sup>

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<sup>25</sup> Ofcom, July 2017. *Award of the 2.3 and 3.4 GHz spectrum: Annexes to the statement*, [https://www.ofcom.org.uk/data/assets/pdf\\_file/0013/104305/Statement-annexes-Award-of-the-2.3-and-3.4-GHz-spectrum-bands.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0013/104305/Statement-annexes-Award-of-the-2.3-and-3.4-GHz-spectrum-bands.pdf), paragraph A2.5.

<sup>26</sup> Ofcom, July 2017. *Award of the 2.3 and 3.4 GHz spectrum: Annexes to the statement*, paragraph A2.26.

<sup>27</sup> Ofcom, July 2017, *Award of the 2.3 and 3.4 GHz spectrum: Annexes to the statement*, paragraph A2.34.

<sup>28</sup> [3<].

- All the other MNOs have at least 40 MHz of spectrum in the 3.4 – 3.6 GHz band, which is likely to allow them to deploy the new 5G radio interface and latest antenna techniques to offer improved customer experience.<sup>29</sup> We also note the public statements made by EE, O2 and Vodafone:
  - EE has announced that it will launch a live 5G trial in East London later this year at ten sites<sup>30</sup> and has indicated that they may launch a 5G commercial network before the end of 2019.<sup>31</sup>
  - In April 2018 O2 published a document on the benefits 5G deployment will bring to the UK<sup>32</sup>, the operator has also announced plans to launch a 5G test bed at the O2 venue in London later this year.<sup>33</sup>
  - Vodafone recently used the spectrum it won in the 3.4 GHz award to trial 5G technology<sup>34</sup> and has begun deploying Massive MIMO technologies in order to boost capacity in some high demand areas.<sup>35</sup>

4.40 We also note that, irrespective of the requested variation, there are likely to be some short-term constraints on the services H3G can deploy in the 3.4 – 3.8 GHz band:

- As explained above, it is uncertain when consumer devices that support 5G will be available; and
- Any deployments in the 3.6 – 3.8 GHz band will be constrained to some degree by the need for coordination with permanent earth stations and receive-only earth stations until mid-2020, and fixed links potentially until the end of 2022. Deployments using 3.4 – 3.6 GHz spectrum are not subject to this constraint.

4.41 Therefore, we consider that, even if H3G were to gain an advantage as a result of the requested variation, it is unlikely to lead to a material distortion of competition.

4.42 We also note that the scale of any advantage H3G might acquire (and therefore the size of any potential distortion to competition) is likely to be correlated to the benefits to H3G's customers. As such, our assessment here implies that the advantages to H3G's customers in aggregate are likely to be similarly modest.

### Would any competitive advantage to H3G persist over time?

4.43 We now consider whether, even if a competitive advantage from higher quality enhanced mobile broadband services were to arise, such an advantage would persist over time. This will depend on the extent to which other providers will have opportunities in the future to improve their competing services to reduce any incremental quality advantage that H3G

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<sup>29</sup> Ofcom, July 2017. *Award of the 2.3 and 3.4 GHz spectrum: Annexes to the statement*, paragraph A11.159.

<sup>30</sup> <http://newsroom.ee.co.uk/ee-set-to-switch-on-uks-first-5g-trial-network-in-londons-tech-city-east-london/>

<sup>31</sup> Gavin Pattison, outgoing CEO of BT, told analysts in a strategy and earnings presentation in May 2018 that the company would launch a live 5G network "within 18 months" indicating that a network would be live by late 2019.

<sup>32</sup> <https://d10wc7q7re41fz.cloudfront.net/wp-content/uploads/2018/03/Smart-Cities-Report.pdf>

<sup>33</sup> <https://news.o2.co.uk/press-release/o2-launch-5g-test-bed-o2/>

<sup>34</sup> <https://mediacentre.vodafone.co.uk/pressrelease/first-test-new-5g-spectrum-across-live-network/>

<sup>35</sup> <https://mediacentre.vodafone.co.uk/blog/modernising-network-soaring-4g-data/>

might obtain from the licence variation, and the ease with which other providers would be able to regain any customers they had lost as a result of any quality advantage H3G had.

- 4.44 We consider that other providers will have opportunities to improve the quality of their services in time through spectrum acquisitions in the 3.6 – 3.8 GHz award and through carrier aggregation.
- 4.45 The award offers other providers the opportunity to acquire spectrum in the 3.6 – 3.8 GHz band, which could reduce the difference between the total amount of spectrum held by H3G and by other providers in the 3.4 – 3.8 GHz band.<sup>36</sup> Indeed, the requested variation would effectively make an extra 10 MHz of spectrum usable by all available in the award. The persistence of any advantage to H3G beyond the award would depend on the timing of the usability of the 3.6 – 3.8 GHz band, and the extent to which dual connectivity<sup>37</sup> and carrier aggregation<sup>38</sup> is supported by consumer devices. As we explained above:
- The award is likely to occur before significant numbers of consumers have taken up devices capable of 5G services.
  - Although the 3.6 – 3.8 GHz band will not necessarily be available nationwide before the end of 2022, it will be available in many areas before this.
  - Our current understanding is that dual connectivity will allow inter-band carrier aggregation (i.e. the aggregation of multiple carriers across different spectrum bands) between 4G and 5G carriers that could allow for higher peak speeds.<sup>39</sup>
  - We do not expect intra-band carrier aggregation (i.e. the aggregation of multiple 5G NR carriers in non-contiguous spectrum blocks within a single spectrum band, such as 3.4 – 3.8 GHz) to be supported by early 5G devices, but it may be supported in the long-term.
- 4.46 In addition, other mobile operators could choose other ways to improve the quality of their networks, which we expect would allow them to reduce the magnitude of any advantage H3G holds to a sufficient extent for any competition concern to be diminished. These include (but are not limited to):
- building more sites to improve coverage and capacity in their networks;
  - refarming their existing spectrum holdings to 5G NR and accessing future mobile bands; and

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<sup>36</sup> The amount of spectrum in the 3.6 – 3.8 GHz award means that it is only possible for one company to obtain the same amount of total spectrum in the 3.4 – 3.8 GHz band, or to obtain the same amount of contiguous spectrum in the 3.6 – 3.8 GHz award as H3G holds. However, we do not consider it necessary for providers to hold identical spectrum holdings in order to be effective competitors.

<sup>37</sup> Dual Connectivity is a technique that allows a user device to be simultaneously connected to multiple base stations of different types (e.g. to a macro cell layer base station and to a small cell) or to a single base station using carriers of different types (e.g. LTE and 5G NR carriers). In 5G, dual connectivity might typically be used to allow a 5G NR data carrier to be combined with a LTE carrier which carries control plane traffic (and possibly other LTE carriers which also carry data).

<sup>38</sup> Carrier Aggregation is a technique that allows a user device to simultaneously transmit or receive data from multiple carriers of the same type, e.g. multiple LTE carriers or multiple 5G NR carriers) from the same base station.

<sup>39</sup> As an example, dual connectivity will allow for control information to be sent over a 4G channel and for user data to be sent over up to 3x 4G carriers (e.g. 20 MHz each) aggregated with a single 5G channel (e.g. 80 MHz). This could provide a similar throughput to that available from a single 100 MHz 5G NR channel.

- investing in new technologies such as Massive MIMO.

4.47 Therefore, there may be some short-term limits on the ability of other providers to use the spectrum acquired in the future award, but these are expected to reduce over time. Over time other providers will be able to improve the quality of their competing offerings, and so reduce any quality advantage H3G holds.

#### **Provisional conclusion on the competition impact of the requested variation**

4.48 The requested variation is likely to provide a benefit to competition by making 10 MHz of spectrum usable by all available in the award.

4.49 We have also considered the potential for the requested variation to lead to a distortion of competition to the detriment of consumers if the variation were to allow H3G to offer higher peak speeds and increased coverage earlier than it otherwise would. However, we do not consider it likely that this would be significant enough to provide H3G with an unmatched competitive advantage, as many consumers would not be aware of, and/or not sufficiently value the increase in peak speeds of H3G's services, relative to the many other aspects of providers' services, to drive switching.

4.50 Further, were such an advantage to arise, we do not believe it would endure over time. The opportunity to acquire spectrum in the upcoming award (which will likely occur before significant take-up of consumer devices which support 5G), and aggregation with LTE and 5G NR carriers (using dual connectivity) will allow all providers to provide enhanced mobile broadband services.

4.51 Therefore, we consider that the proposed variation is consistent with our duty to promote competition where appropriate, and that it is unlikely that it would have a material adverse impact on competition to the detriment of consumers.

#### **Benefits for citizens and consumers**

4.52 Making spectrum in the 3.6 – 3.8 GHz band available for mobile services through the future award will support meeting increasing consumer demand for mobile data, as well as delivering new and improved mobile services, including 5G.

4.53 We also note that, in general, consumers benefit where services are available earlier, or at a higher quality, than they would otherwise be.

4.54 The requested variation is likely to mean that mobile consumers will benefit from higher quality mobile broadband services:

- H3G customers might benefit from a slightly higher quality mobile broadband service for the reasons set out above. We note that the scale of benefit to H3G is correlated with the scale of benefits to its customers.
- The customers of other MNOs would benefit from the increased amount of usable spectrum available in the award which would allow at least one other user to acquire more spectrum than it would absent the requested variation, and therefore offer a

larger volume, lower cost or better quality of mobile broadband service than it otherwise would.

- 4.55 There may also be some timing benefits related to consumers getting enhanced mobile broadband services, although this is more uncertain:
- Although the timing at which H3G customers are able to benefit from enhanced mobile broadband services is unlikely to be affected by the requested variation, the timing at which H3G customers are able to benefit from enhanced mobile broadband services using a 100 MHz carrier would be brought forward.<sup>40</sup>
  - Customers of other MNOs may benefit from earlier enhanced mobile broadband services, to the extent that the requested variation, and any improvement in the services H3G is able to provide because of that variation, stimulates other MNOs to bring forward investment and rollout of enhanced mobile broadband services.
- 4.56 More generally, an increase in the quality of enhanced mobile broadband services that H3G could be able to provide could stimulate a competitive response from other providers in terms of other aspects of their offering, to the benefit of consumers. There is likely to be a correlation between the scale of any quality gain to H3G and the likelihood of a competitive response from other MNOs.

#### **Provisional conclusion on the benefits for citizens and consumers**

- 4.57 We consider it likely that there will be benefits to citizens and consumers from some increase in the quality of mobile broadband services provided.

#### **Impact on other spectrum users**

- 4.58 We have considered the impact of the requested variation on other spectrum users (in band and in adjacent bands). We assess below how the requested variation could impact existing fixed links and fixed satellite users of the 3600 – 3800 MHz band.
- 4.59 At the 3600 MHz boundary, the adjacent user to the varied UKB Licence would be UK Broadband itself, under the UKB 3.4 – 3.6 GHz Licence. Therefore we have not considered the impact on this licensee.
- 4.60 In future, the adjacent user above 3680 MHz would be the winner of that spectrum in the 3.6 – 3.8 GHz award. We will consult on the technical conditions for the new 3600 – 3800 MHz licences to be awarded in due course, and therefore do not discuss these future licensees here.

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<sup>40</sup> Compared to the potential counterfactual situation where H3G holds 100 MHz contiguous spectrum following the future award, having acquired either the 5 MHz from 3600-3605 MHz or additional spectrum above its existing holding. We recognise that achieving contiguity through the variation removes the risk of H3G not achieving this via the award.

### Fixed links and fixed satellite users

- 4.61 The 3.6 – 3.8 GHz band is currently authorised for fixed links and fixed satellite services (to receive space-to-Earth transmissions) as well as to UK Broadband under the UKB Licence. UK Broadband shares the band on a first-come-first-served basis with existing registered users coordinated through Ofcom.<sup>41</sup> When UK Broadband seeks a new deployment it must submit technical information about that base station to Ofcom. We use that information to assess whether the new base station is likely to undermine benchmark spectrum quality for existing registered satellite earth stations and fixed links. UK Broadband is not permitted to deploy new base stations unless the application is passed by the coordination process.<sup>42</sup>
- 4.62 In 2017 we issued notices to revoke all fixed links licences in the band with an effective date of 23 December 2022, although we are aiming for fixed links operations to migrate to alternative frequencies or technologies by June 2020 where possible. We also varied Permanent Earth Station licences and grants of Recognised Spectrum Access (RSA) such that we will no longer take registered satellite earth stations with a receive component in the 3.6 – 3.8 GHz band into account for frequency management purposes from 1 June 2020, or 1 September 2020 in the case of one grant of RSA. We therefore need to consider the impact of UK Broadband's requested variation on existing registered users of the 3.6 – 3.8 GHz band until these variations and revocations for incumbents become effective.<sup>43</sup>
- 4.63 As set out in paragraphs 2.12 – 2.14, the requested changes to the technical requirements of the UKB Licence would permit an increase in power and a relaxation of the out of band emissions limit when using the Permissive mask. This would have the potential to increase the level of interference received by existing users. However, in its variation request, UK Broadband states that existing licensees and holders of grants of RSA in the 3.6 – 3.8 GHz band will not be affected by the requested changes to technical requirements, because UK Broadband “will undertake not to increase existing interference levels experienced by them without their consent and to continue to comply with existing coordination obligations.”
- 4.64 Were we to grant the variation, we would continue to coordinate new UK Broadband deployments with registered users and would add the new emission mask to the existing coordination tool.<sup>44</sup> In addition, any request to change the technical characteristics of existing deployments would need to be coordinated again, and there is no guarantee that

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<sup>41</sup> In this document we use the term “registered users” to denote satellite earth station receiver components which appear in Schedule 2 of a Permanent Earth Station licence or Schedule 1 of a grant of Recognised Spectrum Access for Receive Only Earth Stations registered with frequencies in the range 3.6 – 3.8 GHz; and, where relevant, authorised licensed fixed links in this range.

<sup>42</sup> As set out in the coordination notice: UK Spectrum Co-Ordination: Co-ordination of licensed services in the band 3605 – 3689 MHz paired with 3925 – 4009 MHz, January 2008.

[https://www.ofcom.org.uk/data/assets/pdf\\_file/0027/85086/coordination\\_processes.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0027/85086/coordination_processes.pdf)

<sup>43</sup> Future coordination requirements for the 3.6 – 3.8 GHz band to ensure that Defence capabilities are not unduly affected by other users will be notified separately.

<sup>44</sup> In-band power is part of the information UK Broadband would include in any coordination request.

these will automatically pass coordination. The changes to technical conditions should therefore not unduly impact the benchmark spectrum quality of registered users of the 3.6 – 3.8 GHz band.

- 4.65 The 'receive' components of satellite earth stations are authorised under licence exemption regulation,<sup>45</sup> and we are aware of some cases where users are or may be receiving from satellites using the 3.6 – 3.8 GHz band at sites on a licence exempt basis.<sup>46</sup> Unlike registered users, these users receiving under licence exemption are not coordinated, and therefore do not receive benchmark spectrum quality. There is a risk that such users would experience increased interference.

#### **Provisional conclusion on impact on other spectrum users**

- 4.66 Our provisional view is that, whilst there is a potential risk of increased interference to satellite earth stations operating under licence exemption, the requested variation would not degrade the benchmark spectrum quality that existing users receive in the 3.6 – 3.8 GHz band.

### **Provisional overall conclusion**

- 4.67 In light of all of the above considerations, considered in the round, our provisional conclusion is that it is appropriate to grant the requested variation and we are minded to do so.
- 4.68 The requested variation would increase the total amount of spectrum available in the future award to 120 MHz of contiguous spectrum, and increase the amount of spectrum in the award that is usable by all from 110 to 120 MHz. This is likely to have a positive impact on the efficient use of spectrum, by allowing this spectrum to be acquired by the user with the highest value for it.
- 4.69 Whilst there is a potential risk of increased interference to satellite earth stations operating under licence exemption, the requested changes to technical conditions will not impact the benchmark spectrum quality received by existing registered users of the band, due to continued coordination of UK Broadband deployments. Specifically, the more permissive out of band emissions mask in the new technical requirements will be included in the existing coordination tool, and UK Broadband will continue to be required to abide by the existing coordination procedure for all new sites and changes to existing sites.
- 4.70 The variation is likely to provide a benefit to competition by making 10 MHz of spectrum usable by all available in the award.
- 4.71 We have also considered the potential for the requested variation to lead to a distortion of competition to the detriment of consumers. We recognise that if the licence variation does

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<sup>45</sup> The Wireless Telegraphy Apparatus (Receivers) (Exemption) Regulations 1989 (SI1989/123), January 1989, <http://www.legislation.gov.uk/uksi/1989/123/contents/made>

<sup>46</sup> Ofcom, July 2017. *Improving consumer access to mobile services at 3.6 GHz to 3.8 GHz*, Statement and Consultation. [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0017/103355/3-6-3-8ghz-statement.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0017/103355/3-6-3-8ghz-statement.pdf), paragraph 4.22.

result in a material gain for H3G in the quality of its mobile broadband services, this could distort competition. We have considered whether having access to 100 MHz of contiguous spectrum compared to its current holdings might be capable of giving H3G an unmatched advantage over its competitors. Whilst we acknowledge that an increase in contiguous spectrum may give H3G some competitive advantage, for example by being able to offer higher peak speed and increased coverage earlier than might otherwise be possible, we do not consider it likely that it would provide H3G with an unmatched competitive advantage. Further, any advantage H3G could acquire is unlikely to be enduring, as other providers would have other opportunities such as acquiring spectrum in the future award of 3.6 – 3.8 GHz spectrum.

4.72 Therefore, we consider that the proposed variation is consistent with our duty to promote competition where appropriate, and that it is unlikely that it would have a material adverse impact on competition to the detriment of consumers.

4.73 Overall, consumers are likely to benefit from the requested variation, as it is likely to lead to higher quality enhanced mobile broadband services being available, such as due to an increased likelihood of spectrum being held by the optimal user of that spectrum. Consumers may also benefit from these services being available earlier, although this is less certain.

## Legal tests

4.74 Subject to consultation, we consider that the variation we are minded to make to the UKB Licence is:<sup>47</sup>

- **objectively justifiable** as it would enable us to release 4 MHz of spectrum from 3685 – 3689 MHz, as well as to relocate 5 MHz of spectrum from 3680 – 3685 MHz. This variation would increase the amount of contiguous spectrum available in the future award from 111 MHz to 120 MHz;
- **non-discriminatory** as any participant in the future award would have the opportunity of winning the additional usable spectrum that would be available in the award, subject to any competition measures or other relevant award rules we may decide to put in place;
- **proportionate** since the changes that we are minded to approve are the minimum necessary to achieve a more efficient allocation of spectrum in a timely manner, and do not give rise to disproportionate effects; and
- **transparent** as it is clear on the face of the requested licence variation what it is intended to achieve.

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<sup>47</sup> As set out in paragraph 3.4 – 3.5, Ofcom also has a duty 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.

## Consultation question

4.75 We invite stakeholders to respond to the following question:

**Q1** - *Do you agree with Ofcom's proposal to vary the UKB Licence as requested?  
If not, please explain why you think it would not be appropriate to vary the licence.*

## 5. Implementation and next steps

### Implementation

- 5.1 UK Broadband is only proposing to make changes to the lower frequency block. We note that in its variation request UK Broadband suggested that it is likely to be convenient to establish separate licences for the upper and lower frequency blocks. We do not think this is necessary at this time, and instead we propose to retain a single licence, with the requirements for 3600 – 3680 MHz in one schedule, and the requirements for 3605 – 3689 MHz and the upper frequency block in a separate schedule. Below, we set out how we propose to implement the requested variation, subject to the outcome of this consultation.
- 5.2 We propose to implement the requested variation by amending the UKB Licence so that:
- The main body of the UKB Licence would remain as it is now.
  - Schedule 1 of the UKB Licence would authorise use of the frequencies 3600 – 3680 MHz from the date the variation takes effect. These frequencies would be authorised for use in accordance with the same technical conditions as those in the UKB 3.4 – 3.6 GHz Licence (with a change to paragraph 7 to refer to the relevant frequencies, i.e. “3600 – 3680 MHz”). The only other difference being that in paragraph 14 of Schedule 1 the additional band edge requirements relevant to the upper band edge are no longer relevant and have been removed.
  - Schedule 2 of the UKB Licence would authorise the use of:
    - i) 3605 – 3689 MHz, until 1 September 2019; and
    - ii) the upper frequency block (i.e. 3925 – 4009 MHz).
  - The frequencies set out in Schedule 2 of the amended UKB Licence would be authorised for use in accordance with the current technical conditions of the UKB Licence (i.e. there would be no change to the technical conditions). Equipment currently deployed in 3605 – 3689 MHz would continue to be authorised under the technical conditions contained in this schedule. A new provision under paragraph 5 of Schedule 2 (“Permitted Frequency Bands”) would require the Licensee to ensure that, at any point in time, any Radio Equipment transmitting in the Lower Frequency Block complies with the requirements set out either in Schedule 2 or Schedule 1. We also propose to amend the current reference to the applicable interface requirements (i.e. “IR 2015”) in paragraph 2 of Schedule 2 to reflect a recent update (i.e. “IR 2015.1 to IR 2015.3”).<sup>48</sup>
  - Schedule 3 of the UKB Licence would set out the requirements for spectrum leasing. We wouldn't make any changes to the content of this schedule, although we would re-number it as Schedule 3.

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<sup>48</sup> See Ofcom's document entitled “UK Interface Requirements 2015.1 to IR 2015.3. Spectrum Access in the 3400 MHz to 4009 MHz band”, amended on January 2018; [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0028/84853/ir\\_2015\\_3\\_4ghz.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0028/84853/ir_2015_3_4ghz.pdf)

- 5.3 These changes are shown in the marked-up version of the UKB Licence, set out in Annex A7.

## Licence fees

- 5.4 This variation does not affect the annual licence fee rate which is currently payable by UK Broadband under the Wireless Telegraphy (Licence Charges) Regulations 2011. If we grant the variation, the fees payable by UK Broadband on the next annual payment date (December 2018) will be calculated on the basis of the amount of spectrum that UK Broadband will hold on that date. We have previously said that we would consider reflecting the opportunity cost of mobile use in the licence fee that UK Broadband pays for its spectrum in the 3.6 – 3.8 GHz band.<sup>49</sup> In reviewing this fee, we would expect to take into account the bids and prices in the award of 3.6 – 3.8 GHz spectrum (provided the award is not materially delayed), along with any other relevant evidence. We will consult on our proposals before revising this fee.

## Next steps

- 5.5 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 **8 August 2018** to provide comments.
- 5.6 If we decide to accept the variation, we will also issue the licensee with an amended licence.

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<sup>49</sup> Ofcom, July 2017. *Improving consumer access to mobile services at 3.6 GHz to 3.8 GHz*, Statement and Consultation.

# A1. Responding to this consultation

## How to respond

- A1.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 8 August 2018.
- A1.2 You can download a response form from <https://www.ofcom.org.uk/consultations-and-statements/category-2/variation-uk-broadbands-spectrum-access-licence-3.6-ghz>. You can return this by email or post to the address provided in the response form.
- A1.3 If your response is a large file, or has supporting charts, tables or other data, please email it to [3.6GHz.variation@ofcom.org.uk](mailto:3.6GHz.variation@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>). This email address is for this consultation only, and will not be valid after 8 August 2018.
- A1.4 Responses may alternatively be posted to the address below, marked with the title of the consultation:
- Kirsty Logan  
Ofcom  
Riverside House  
2A Southwark Bridge Road  
London SE1 9HA
- A1.5 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.
- A1.6 We will publish a transcript of any audio or video responses we receive (unless your response is confidential)
- A1.7 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.
- A1.8 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.
- A1.9 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 A4. 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.

- A1.10 If you want to discuss the issues and questions raised in this consultation, please contact Kirsty Logan on 020 7981 3095, or by email to [Kirsty.Logan@ofcom.org.uk](mailto:Kirsty.Logan@ofcom.org.uk).

## Confidentiality

- A1.11 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](http://www.ofcom.org.uk), as soon as we receive them.
- A1.12 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.
- A1.13 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.
- A1.14 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

- A1.15 Following this consultation period, Ofcom plans to publish a statement as soon as practicable.
- A1.16 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

- A1.17 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex x.
- A1.18 If you have any comments or suggestions on how we manage our consultations, please email us at [consult@ofcom.org.uk](mailto: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.
- A1.19 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact Steve Gettings, Ofcom's consultation champion:

Steve Gettings  
Ofcom  
Riverside House  
2a Southwark Bridge Road  
London SE1 9HA  
Email: [corporationsecretary@ofcom.org.uk](mailto:corporationsecretary@ofcom.org.uk)

## A2. Ofcom's consultation principles

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

#### **Before the consultation**

- A2.1 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**

- A2.2 We will be clear about whom we are consulting, why, on what questions and for how long.
- A2.3 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.
- A2.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.
- A2.5 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.
- A2.6 If we are not able to follow any of these seven principles, we will explain why.

#### **After the consultation**

- A2.7 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.

## A3. Consultation coversheet

### BASIC DETAILS

Consultation title: organisation realise

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? \_\_\_\_\_

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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)

## A4. Consultation question

A4.1 We invite stakeholders to respond to the following question:

***Q1:** Do you agree with Ofcom's proposal to vary the UKB Licence as requested?  
If not, please explain why you think it would not be appropriate to vary the licence.*

## A5. Glossary

<b>3GPP</b>	The 3rd Generation Partnership Project (3GPP) is a body that develops standards for mobile technology
<b>5G</b>	5G is the term used to describe the next generation of wireless networks beyond 4G LTE mobile networks. 5G is expected to deliver faster data rates and better user experience. Technical standards are still under development and are likely to include both an evolution of existing and new radio technologies.
<b>5G NR</b>	5G NR refers to the new air interface that has been developed by 3GPP for 5G. This defines how 5G base stations and user devices both transmit and receive radio signals using spectrum
<b>CEPT</b>	The European Conference of Postal and Telecommunications Administrations
<b>Communications Act</b>	The Communications Act 2003
<b>EC</b>	European Commission
<b>ECC</b>	Electronic Communications Committee, one of the three business committees of CEPT.
<b>EU</b>	European Union
<b>GHz</b>	Gigahertz. A unit of frequency of one billion ( $10^9$ ) cycles per second
<b>H3G</b>	Hutchison 3G UK, a mobile network operator which trades as Three (or 3) in the UK
<b>LTE</b>	Long Term Evolution. Part of the development of 4G mobile systems that started with 2G and 3G networks.
<b>Massive MIMO</b>	Massive MIMO is a high-order MIMO technology typically using a large number of antenna elements at the base station and user terminal. This technology uses spatial multiplexing and beamforming to enhance spectral efficiency and deliver higher throughputs in mobile networks.
<b>MHz</b>	Megahertz. A unit of frequency of one million cycles per second.
<b>MNO</b>	Mobile Network Operator
<b>Ofcom</b>	The Office of Communications
<b>PES</b>	A satellite Permanent Earth Station
<b>ROES</b>	Receive Only Earth Station. In satellite services, an earth station which does not transmit, but receives signal from a satellite.

## Variation of UK Broadband's Spectrum Access Licence for 3.6 GHz spectrum

<b>RSA</b>	Recognised Spectrum Access. RSA is a regulatory mechanism that provides formal recognition of receive-only radio stations by allowing Ofcom to take them into account when planning spectrum use and assigning frequencies to other radio users.
<b>UK Broadband</b>	A UK supplier of fixed wireless mobile services, now owned by H3G.
<b>UKB 3.4 – 3.6 GHz Licence</b>	The Spectrum Access Licence authorising UK Broadband to use two non-adjacent blocks of 20 MHz in the 3.4 – 3.6 GHz spectrum band, at 3480 – 3500 MHz and 3580 – 3600 MHz.