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# **Award of the 700 MHz and 3.6-3.8 GHz spectrum bands**

Information Memorandum

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**Publication date:** 13 March 2020

## Important Notice

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This Information Memorandum (Memorandum) has been prepared by Ofcom in connection with the proposed award of licences in the 700 MHz and 3.6-3.8 GHz spectrum bands by auction. Terms and expressions used in this Memorandum are as defined in annex 7 of this Memorandum, or in the text of the Memorandum itself.

The award process will be conducted in accordance with regulations to be made by Ofcom pursuant to powers under Section 14 of the Wireless Telegraphy Act 2006, pursuant to which the grant of the licences may be made following a procedure set out in regulations issued by Ofcom.

The regulations to be made in respect of this award are referred to in this Memorandum as the Regulations. A copy of the Statement on the final draft of the regulations for the award of spectrum in the 700 MHz and 3.6-3.8 GHz frequency bands has been published alongside this Memorandum and can be found on Ofcom's website at [www.ofcom.org.uk](http://www.ofcom.org.uk). Recipients of this Memorandum should note that only the Regulations will have statutory effect. Accordingly, in the event of any difference between this Memorandum and the provisions of the Regulations, the Regulations are definitive and will prevail.

This Memorandum has been prepared solely in connection with the proposed award of licences in the 700 MHz and 3.6-3.8 GHz spectrum bands, and has been made available for information purposes only. This Memorandum does not constitute an offer or invitation to participate in the award process, nor does it constitute the basis for any part of any contract which may be concluded in relation to the award process or in respect of any award of licences. This Memorandum shall not (nor any part of it) nor the fact of its distribution form the basis of, or be relied upon in connection with, or act as any inducement to enter into, any decision or commitment in respect of any award of licences. The whole of this Memorandum should be read. This Memorandum is not intended to form any part of the basis of any investment decision or other evaluation or any decision to participate in the award process, and should not be considered as a recommendation by Ofcom or its advisers to any recipient of this Memorandum to participate in the award process. Each recipient of this Memorandum is recommended to seek its own advice from independent advisors and must make its own independent assessment of the potential value of a licence after making such investigation as it may deem necessary in order to determine whether to participate in the award process.

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<http://www.ofcom.org.uk/email-updates>. Shortly before the commencement of the award process, the Ofcom website will carry more detailed information about the award process.

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# 1. Introduction

- 1.1 This Memorandum provides information for those parties considering bidding in this award process for one or more Wireless Telegraphy Act 2006 (WT Act) licences to establish or use stations for wireless telegraphy or to install or use apparatus for wireless telegraphy in one or both of the 700 MHz or 3.6-3.8 GHz bands.
- 1.2 The frequencies being auctioned in the 700 MHz band are 703-733 MHz, 738-758 MHz and 758-788 MHz. The frequencies being auctioned in the 3.6-3.8 GHz band are 3680-3800 MHz.
- 1.3 In particular, this Memorandum:
- describes the characteristics of the bands for which the licences are to be awarded;
  - explains some factors that may affect licensees' use of the bands;
  - summarises some of the principal terms of the licences that will be issued following completion of the award process, and provides in annexes 1 to 2 template examples of the licences that will be issued for the 700 MHz and 3.6-3.8 GHz bands;
  - sets out the spectrum lots that will be available in the award process and the reserve price for each lot;
  - provides certain information in relation to the award process; and
  - provides information on a range of other associated issues.
- 1.4 Certain terms used in this Memorandum are explained in the glossary in Annex 7.
- 1.5 This Memorandum may be further updated following its publication, and parties considering bidding in this award process should check the latest available information on the spectrum awards website<sup>1</sup>.

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<sup>1</sup> <https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards>

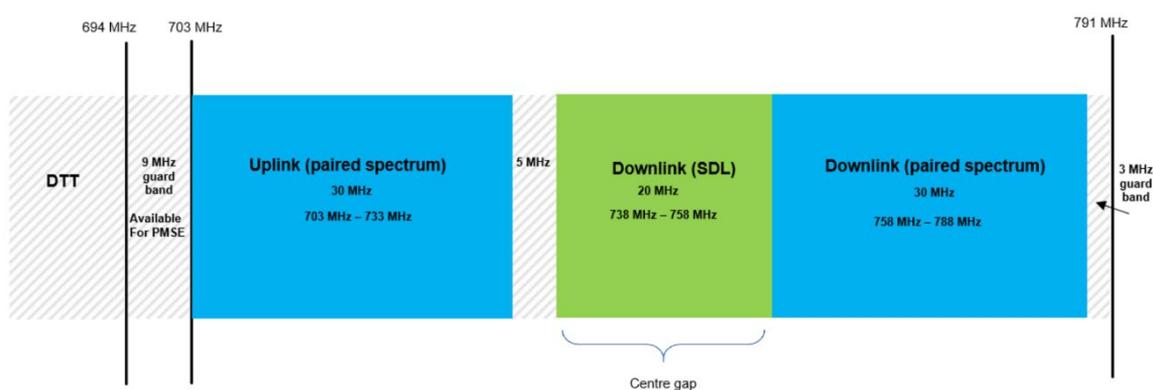
## 2. Spectrum bands to be awarded

### 700 MHz

#### Details of 700 MHz frequencies

- 2.1 We are awarding 80 MHz of spectrum in the 700 MHz band within the 694-790 MHz frequency range. The arrangement of this spectrum is illustrated in Figure 2.1 below. It consists of two x 30 MHz blocks of paired spectrum (703-733 MHz and 758-788 MHz), and a 'centre gap' of 20 MHz at 738-758 MHz.
- 2.2 The paired spectrum in the 700 MHz band is configured under a mobile band plan based on a Frequency Division Duplex (FDD) arrangement, with the uplink delivered in the 703-733 MHz frequencies and the down link in the 758-788 MHz frequencies. The centre gap is suitable for delivering supplementary downlink (SDL) signals for mobile services.

Figure 2.1: The 700 MHz spectrum band



Source: Ofcom

- 2.3 Within the broader 694-791 MHz range, there is a 9 MHz frequency separation at 694-703 MHz between mobile and DTT services; a 5 MHz frequency separation at 733-738 MHz between the FDD uplink and the centre gap (738-758 MHz); and a 3 MHz frequency separation at 788-791 MHz between the FDD downlink and mobile services in the neighbouring 800 MHz band. There is no frequency separation between the FDD downlink and the centre gap. These frequency separations do not form part of the spectrum to be auctioned.

#### Details of particular EU legislation affecting the band

- 2.4 Although the United Kingdom is no longer a member state of the European Union, EU law continues to apply in the UK for a transitional period. The Commission Implementing Decision (EU) 2016/687<sup>2</sup> of 28 April 2016 harmonised the technical conditions for the

<sup>2</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L..2016.118.01.0004.01.ENG>

availability and efficient use of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services. It also aimed to facilitate flexible national use in response to specific needs in accordance with radio spectrum policy programme (RSPP) priorities.

2.5 On 17 May 2017, the European Parliament and Council adopted Decision 2017/899<sup>3</sup> (the “2017 UHF Decision”), which requires Member States to repurpose the 700 MHz frequency band from its current TV broadcasting and PMSE use to new mobile broadband use by 30 June 2020. In doing so, Member States must apply the technical conditions laid down in the Commission implementing decision adopted on 28 April 2016<sup>4</sup> to harmonise the technical conditions of use and band plan for the 700 MHz band.

2.6 Art. 3(1) of the 2017 UHF Decision provides that:

When Member States authorise the use of or amend existing rights to use the 700 MHz frequency band, they shall take due account of the need to achieve the target speed and quality objectives set out in Article 6(1) of Decision No 243/12/EU, including coverage in predetermined national priority areas where necessary, such as along major terrestrial transport paths, for the purpose of allowing wireless applications and European leadership in new digital services to contribute effectively to Union economic growth. Such measures may include conditions to facilitate or encourage the sharing of network infrastructure or spectrum in accordance with Union law<sup>5</sup>.

2.7 The target speed and quality objectives set out in art. 6(1) of Decision No. 243/12/EU<sup>6</sup>, which Art.3(1) of the 2017 UHF Decision refers to, include “achieving the target for all citizens to have access to broadband speeds of not less than 30 Mbps by 2020”. Recital 9 to the 2017 UHF Decision specifies that such target includes both indoor and outdoor coverage.

2.8 In complying with Art. 3(2) of the 2017 UHF Decision, Member States are required to “assess the need to attach conditions to the rights of use for frequencies within the 700 MHz frequency band and, where appropriate, shall consult relevant stakeholders”<sup>7</sup>.

## UK allocations within and adjacent to the 700 MHz band

2.9 Figure 2.2 below illustrates the current spectrum allocations within and adjacent to the 700 MHz band. The illustration is based on the UK frequency Allocation Table (UKFAT), the current issue of which was last updated on 8 January 2020.

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<sup>3</sup> Decision (EU) 2017/899 of the European Parliament and of the Council of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32017D0899>

<sup>4</sup> Commission Implementing Decision (EU) 2016/687 of 28 April 2016 on the harmonisation of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the Union: [http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L\\_.2016.118.01.0004.01.ENG](http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.118.01.0004.01.ENG)

<sup>5</sup> See also Recital 9 of the 2017 UHF Decision.

<sup>6</sup> Decision 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme: <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32012D0243>

<sup>7</sup> Art. 3(2) of the 2017 UHF Decision.

- 2.10 The UKFAT is published by Ofcom<sup>8</sup>. It identifies how various frequency bands are currently used in the UK (referred to as ‘allocations’). The UKFAT covers both civilian and non-civilian uses of spectrum in the UK. It is updated from time to time in the light of spectrum policy decisions nationally and internationally.
- 2.11 The allocations in Figure 2.2 are identified in terms of primary and secondary services, the distinction defined in the Radio Regulations of the ITU being that stations of a secondary service shall not cause harmful interference to stations of primary services nor claim protection from harmful interference from stations of a primary service. However, stations of a secondary service can claim protection from harmful interference of the same or other secondary service(s) that are assigned at a later date. The Radio Regulations apply in interference disputes between countries, but not ordinarily between users within the UK.
- 2.12 Ofcom also publishes an Interactive Spectrum Map<sup>9</sup> which can be used to browse and search how different spectrum bands are used in the United Kingdom by sector and by product/application. This map covers spectrum from 8.3 kHz to 275 GHz. The Interactive Spectrum Map is currently in the process of being updated in respect of use at 3925-4009 MHz and also shared access licensing in the 3.8-4.2 GHz band.

**Figure 2.2: UK allocations within and adjacent to the 700 MHz band**

Frequency	Allocation
460 – 470 MHz	Fixed (Primary) Mobile (Primary)
470 – 694 MHz	Broadcasting (Primary) Land Mobile (Secondary)
694 – 790 MHz	Broadcasting (Primary) Mobile except aeronautical mobile (Primary)
790 – 862 MHz	Broadcasting (Primary) Fixed (Primary) Mobile except aeronautical mobile (Primary)
862 – 870 MHz	Mobile (Primary)
870 – 876 MHz	Mobile (Primary)
876 – 880 MHz	Mobile (Primary)

<sup>8</sup> <http://static.ofcom.org.uk/static/spectrum/fat.html>

<sup>9</sup> <http://static.ofcom.org.uk/static/spectrum/map.html>

### Use between 694-790 MHz

- 2.13 The 694-790 MHz band is allocated to broadcasting and mobile (except aeronautical mobile) services on a primary basis. The band is currently used for Digital Terrestrial Broadcasting services and also for Programme Making and Special Events (PMSE) use. Additionally, the band 470-790 MHz is used for White Space Devices both licence exempt and licensed.

### Use above 470 MHz and below 694 MHz

- 2.14 The band 470-694 MHz is allocated to broadcasting on a primary basis and to land mobile on a secondary basis. It is used for PMSE (470-694 MHz) and Broadcasting (470-606 MHz and 614-694 MHz). Additionally, the band 470-790 MHz is used for White Space Devices both licence exempt and licensed.

### Use above 790 MHz and below 862 MHz

- 2.15 The band 790-862 MHz is allocated to broadcasting, fixed services and mobile (except aeronautical mobile) on a primary basis. It is used for mobile (791-821 MHz and 832-862 MHz) and for PMSE (823-832 MHz).

## International allocations and uses within and adjacent to the 700 MHz band

- 2.16 Figure 2.3 below outlines the designated allocations across the world in the 470 to 890 MHz band as set out in the ITU Radio Regulations based on the outcome of World Radiocommunication Conference 2015 (WRC-15). Copies of the ITU Radio Regulations, edition of 2016, are available at the link below<sup>10</sup>. Following the World Radio Conference in 2019 (WRC-19) a new version of the ITU Radio Regulations is in preparation.

Figure 2.3: ITU Radio regulations allocations in the 470-890 MHz band

Allocation to services		
Region 1	Region 2	Region 3
<b>460-470</b>	FIXED MOBILE 5.286AA Meteorological -satellite (space-to-Earth) 5.287 5.288 5.289 5.290	
<b>470-694</b> BROADCASTING	<b>470-512</b> BROADCASTING	<b>470-585</b> FIXED

<sup>10</sup> <https://www.itu.int/pub/R-REG-RR-2016>

	Fixed Mobile 5.292 5.293 5.295	MOBILE 5.296A BROADCASTING
	<b>512-608</b> BROADCASTING 5.295 5.297	5.291 5.298
	<b>608-614</b> RADIO ASTRONOMY Mobile-satellite except aeronautical mobile-satellite (Earth-to-space)	<b>585-610</b> FIXED MOBILE 5.296A BROADCASTING RADIONAVIGATION 5.149 5.305 5.306 5.307
5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312	<b>614-698</b> BROADCASTING Fixed Mobile	<b>610-890</b> FIXED MOBILE 5.296A 5.313A 5.317A BROADCASTING
<b>694-790</b> MOBILE except aeronautical mobile 5.312A 5.317A BROADCASTING 5.300 5.311A 5.312	5.293 5.308 5.308A 5.309 5.311A	
<b>790-862</b> FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.312 5.319	<b>698-806</b> MOBILE 5.317A BROADCASTING	
<b>862-890</b> FIXED Mobile except aeronautical mobile 5.317A BROADCASTING 5.322 5.319 5.323	Fixed 5.293 5.309 5.311A <b>806-890</b> FIXED MOBILE 5.317A BROADCASTING	
	5.317 5.318	5.149 5.305 5.306 5.307 5.311A 5.320

- 2.17 The Radio Regulations specify the following allocations in the band 694-790 MHz:
- Primary allocations to broadcasting in all three ITU Regions;
  - Primary allocations to mobile (except aeronautical mobile) in Region 1 and mobile in Region 3. In Region 2 mobile has a secondary allocation between 614-698 MHz and a primary allocation between 698-806 MHz;
  - Primary allocations to fixed services in Region 3 and secondary allocation to fixed services in Region 2.
- 2.18 The Radio Regulations contain a footnote 5.312A. This advises that in Region 1 the use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, service is subject to the provisions of Resolution 760 (Rev.WRC-19) and to also see Resolution 224 (Rev. WRC-19). Resolution 760 (Rev. WRC-19) is titled 'Provisions relating to the use of the frequency band 694-790 MHz in Region 1 by the mobile, except aeronautical mobile, service and by other services' and relates to, amongst other things the implementation of IMT services. Resolution 224 (Rev. WRC-19) is titled 'Frequency bands for the terrestrial component of International Mobile Telecommunications below 1 GHz' and relates to, amongst other things, the implementation of IMT services.
- 2.19 Footnote 5.317A advises that the parts of the frequency band 698-960 MHz in Region 2 and the frequency band 694-790 MHz in Region 1 and 790-960 MHz in Regions 1 and 3 which are allocated to the mobile service on a primary basis are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) - see Resolutions 224 (Rev. WRC-19), 760 (Rev. WRC-19) and 749 (Rev. WRC-19) where applicable. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations.

## France

- 2.20 There is currently a Memorandum of Understanding (MoU) with France for spectrum coordination relating to land mobile radiocommunication networks covering use of the frequencies 703 MHz-2690 MHz in the area of the Channel Islands and France<sup>11</sup>.
- 2.21 Additionally, there is currently a MoU with France for spectrum coordination relating to land mobile radiocommunication networks covering use of the frequency range 703-2690 MHz in the main land area<sup>12</sup>.

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<sup>11</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0032/108968/MoU-CI-France-703-2690-LTE-01-01-18.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0032/108968/MoU-CI-France-703-2690-LTE-01-01-18.pdf)

<sup>12</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0033/108969/MoU-UK-France-703-2690-LTE-01-01-18.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0033/108969/MoU-UK-France-703-2690-LTE-01-01-18.pdf)

## Ireland

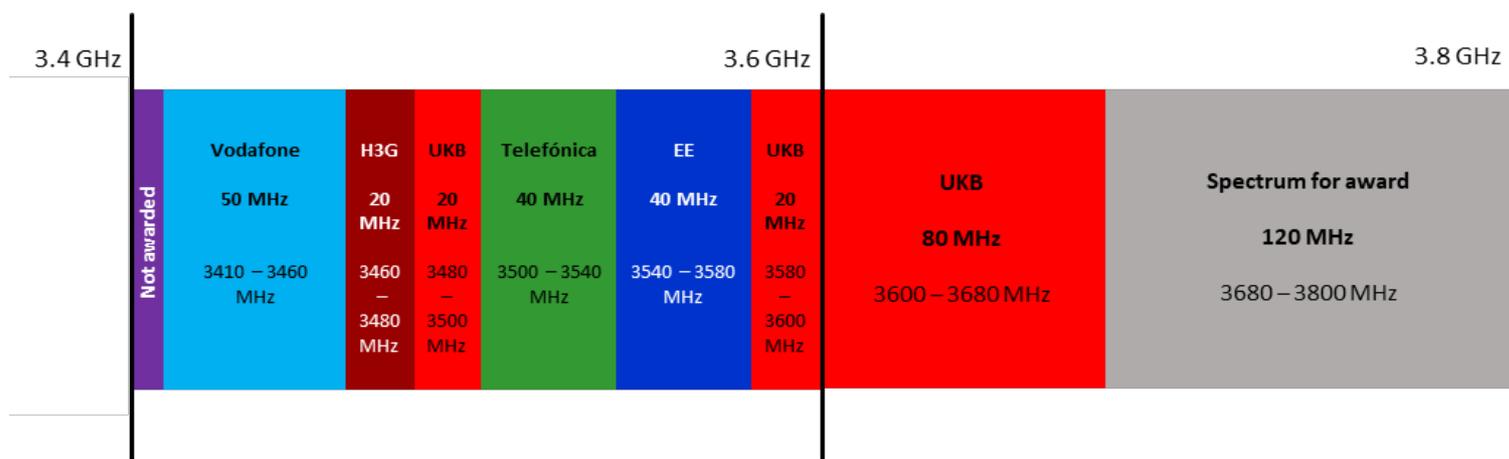
2.22 There is currently an MoU with the Republic of Ireland regarding spectrum coordination of land mobile networks in the frequency range 703-2690 MHz<sup>13</sup>.

### 3.6-3.8 GHz

#### Details of 3.6-3.8 GHz frequencies

2.23 We are awarding 120 MHz of contiguous spectrum in the 3.6-3.8 GHz band between 3680 and 3800 MHz. As shown in Figure 2.4 below (which also covers the frequencies in the 3410-3480 MHz band that we awarded in April 2018), the 3.6-3.8 GHz band sits immediately above the spectrum holdings of UK Broadband Limited (UKB) a wholly owned subsidiary of Hutchison 3G UK Limited (H3G).

Figure 2.4: The 3.6-3.8 GHz award band, alongside the already awarded 3.4 GHz band



Source: Ofcom

#### Details of particular EU legislation affecting the band

2.24 Although the the United Kingdom is no longer a member state of the European Union, EU law continues to apply in the UK for a transitional period. On 21 May 2008, the European Commission adopted Decision 2008/411/EC<sup>14</sup> which harmonises the conditions for the availability and efficient use of the 3.4 GHz-3.8 GHz frequency band for terrestrial systems capable of providing electronic communications services in the EU. The Decision provided that Member States should designate, by 1 January 2012, the 3.6-3.8 GHz band on a non-

<sup>13</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0017/85211/mou-uk-ireland-703-2690-MHz-combined-land-mobile.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0017/85211/mou-uk-ireland-703-2690-MHz-combined-land-mobile.pdf)

<sup>14</sup> <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008D0411>

exclusive basis for terrestrial communications networks in compliance with the technical parameters set out in the annex to the Decision.

- 2.25 On 2 May 2014, the European Commission adopted Decision 2014/276/EU<sup>15</sup>, which amended Commission Decision 2008/411/EC, primarily in relation to the technical conditions in compliance with which the band should be made available<sup>16</sup>.
- 2.26 On 24 January 2019, the Commission updated the relevant technical conditions applicable to the 3.4 GHz-3.8 GHz frequency band by introducing further amendments to Decision 2008/411/EC through its Decision 2019/235<sup>17</sup>. Recital 10 of this decision, which concerns the defragmentation of the 3.4 GHz-3.8 GHz frequency band, reads as follows:

“Taking into account Article 54 of the European Electronic Communications Code, Member States should aim at ensuring a defragmentation of the 3 400-3 800 MHz frequency band so as to provide opportunities to access large portions of contiguous spectrum line with the goal of gigabit connectivity. This includes facilitating trading and/or leasing of existing rights of use. Large contiguous spectrum portions of preferably 80-100 MHz facilitate the efficient deployment of 5G wireless broadband services, for example using Active Antenna Systems (AAS), with high throughput, high reliability and low latency in line with the policy objective of gigabit connectivity. This objective is of particular importance for a defragmentation”.

- 2.27 Article 54 of the Code, which is referred to above, includes the following provision on the 3.4-3.8 GHz frequency band:

“(1) By 31 December 2020, for terrestrial systems capable of providing wireless broadband services, Member States shall, where necessary in order to facilitate the roll-out of 5G take all appropriate measures to:

(a) reorganise and allow the use of sufficiently large blocks of the 3.4-3.8 GHz band”.

## UK allocations within and adjacent to the 3.6-3.8 GHz band

- 2.28 Figure 2.5 below illustrates the current UK spectrum allocations within and adjacent to the 3.6-3.8 GHz band.

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<sup>15</sup> [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L\\_.2014.139.01.0018.01.ENG](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.139.01.0018.01.ENG)

<sup>16</sup> The EC Decision (as amended) has been implemented into law by way of Statutory Instrument 2016 No. 495 which is available at the following link: <https://www.legislation.gov.uk/ukSI/2016/495/contents/made>

<sup>17</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0235&from=EN>

**Figure 2.5: UK allocations within and adjacent to the 3.6-3.8 GHz band**

Frequency	Allocation
3.3 – 3.41 GHz	Amateur (Secondary) Mobile (Secondary) Radiolocation (Primary)
3.41 – 3.6 GHz	Mobile (Primary)
3.6 – 3.8 GHz	Mobile (Primary)
3.6 – 4.2 GHz	Fixed Satellite (space-to-Earth) (Primary) Fixed (Primary)
3.8 – 4.2 GHz	Mobile (Secondary)
4.2 – 4.4 GHz	Aeronautical Mobile (R) (Primary) Aeronautical Radionavigation (Primary)

**Use above 3.6 GHz and below 4.2 GHz**

2.29 The band 3.6-3.8 GHz is allocated to mobile on a primary basis and on a secondary basis for 3.8-4.2 GHz. The band 3.6-4.2 GHz is used by permanent satellite earth stations and receive only earth stations (ROES). Point to point fixed links are used between 3689-3925 MHz and between 4009-4200 MHz. The frequencies 3600-3680 MHz and 3925-4009 MHz are licensed to UK Broadband Limited. The band 3.8-4.2 GHz is also available for Shared Access use (please see paragraph 7.2).

**Use above 3.41 GHz and below 3.6 GHz**

2.30 The band 3.41-3.6 GHz is allocated to mobile on as primary basis. It is used for mobile and for public sector (military use).

**Use above 4.2 GHz and below 4.4 GHz**

2.31 The band 4.2-4.4 GHz is allocated to aeronautical mobile (R) and to aeronautical radionavigation on a primary basis. It is used by aeronautical services and for both civil and public sector use.

**International allocations and uses within and adjacent to the 3.6-3.8 GHz band**

2.32 Figure 2.8 below outlines the designated allocations across the world in the 3400-4400 MHz band as set out in the ITU Radio Regulations as agreed at WRC-15. Following the World Radio Conference in 2019 (WRC-19) a new version of the ITU Radio Regulations is in preparation.

**Figure 2.8: ITU Radio Regulations allocations in the 3400-4200 MHz band**

Allocation to services		
Region 1	Region 2	Region 3
3400- 3600	3400-3500	3400-3500
FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.430A Radiolocation         5.431	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.431A 5.431B Amateur Radiolocation 5.433 5.282	FIXED FIXED-SATELLITE (space-to-Earth) Amateur Mobile 5.432 5.432B Radiolocation 5.433 5.282 5.432A
	<b>3500-3600</b> FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.431B Radiolocation 5.433	<b>3500-3600</b> FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.433A Radiolocation 5.433
<b>3600-4200</b> FIXED FIXED-SATELLITE (space-to-Earth) Mobile	<b>3600-3700</b> FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.434 Radiolocation 5.433	<b>3600-3700</b> FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile Radiolocation 5.435
	<b>3700-4200</b> FIXED FIXED-SATELLITE (space -to-Earth) MOBILE except aeronautical mobile	
<b>4200- 4400</b>	AERONAUTICAL MOBILE (R) 5.436 AERONAUTICAL RADIONAVIGATION 5.438 5.437 5.439 5.440	

The Radio Regulations specify the following allocations in the band 3600-4200 MHz:

- Primary allocations to fixed service and fixed-satellite (space-to-earth) in all three Regions;
- Primary allocations to mobile, except aeronautical mobile, in Regions 2 and 3. In Region 1 there is an allocation to mobile on a secondary basis;
- Secondary allocations to radiolocation in Regions 2 and 3 between 3600-3700 MHz.

## France

2.33 There is currently a MoU with France for spectrum coordination relating to land mobile radiocommunication networks covering use of the frequencies 3400-3800 MHz in the area including France, the UK and the Channel Isles.<sup>18</sup>

## Ireland

2.34 The UK has an MoU with the Republic of Ireland relating to wireless access services in respect of the frequencies 3400-3800 MHz.<sup>19</sup>

## Isle of Man

2.35 The UK has an MoU with the Isle of Man for spectrum coordination relating to land mobile radiocommunication networks covering use of the frequencies 3400-3800 MHz.<sup>20</sup>

## Other emissions in the 700 MHz and 3.6-3.8 GHz band

2.36 UWB devices use very large bandwidth but transmit at very low power levels. Commission Implementing Decision (EU) 2017/1438<sup>21</sup> of 4 August 2017 amended Decision 2007/131/EC<sup>22</sup> on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the EU. The Wireless Telegraphy (Ultra-Wideband Equipment) (Exemption) Regulations 2015 (SI 2015 No. 591)<sup>23</sup> exempted the establishment, installation or use of equipment using ultra-wideband technology from the requirement to be licensed under section 8(1) of the Wireless Telegraphy Act 2006.

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<sup>18</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0015/85011/mou\\_uk-ci-france\\_2300-2400\\_3400-3800\\_mhz\\_19-11-14.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0015/85011/mou_uk-ci-france_2300-2400_3400-3800_mhz_19-11-14.pdf)

<sup>19</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0032/84596/mou\\_uk-ireland\\_3400-3800\\_mhz\\_01-04-08.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0032/84596/mou_uk-ireland_3400-3800_mhz_01-04-08.pdf)

<sup>20</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0014/85100/mou\\_uk-iom\\_2300\\_2400\\_mhz\\_and\\_3400-3800\\_mhz\\_-\\_09-12-15.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0014/85100/mou_uk-iom_2300_2400_mhz_and_3400-3800_mhz_-_09-12-15.pdf)

<sup>21</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D1438&from=EN>

<sup>22</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:055:0033:0036:EN:PDF>

<sup>23</sup> <http://www.legislation.gov.uk/uksi/2015/591/made/data.pdf>

## 3. Factors affecting use of the award bands

### 700 MHz

#### Existing Systems

- 3.1 The 700 MHz band is currently used by DTT, PMSE and White Space Devices. In our statement of November 2014, ‘Decision to make the 700 MHz band available for mobile data – statement’, on clearing the 700 MHz band (“the November 2014 statement”) we set out our decision to make the paired spectrum in the 700 MHz band available for mobile data use.<sup>24</sup>

#### DTT

- 3.2 In our statement of October 2016, ‘Maximising the benefits of 700 MHz clearance: Enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap’, (“the October 2016 statement”), we set out our decision to accelerate the timeline for clearance, so that the band would be cleared by Q2 2020. In the October 2016 statement, we also said that we would make the centre gap spectrum available for mobile downlink.<sup>25</sup> Until the DTT users of the paired spectrum in the 700 MHz band have been reallocated to alternative spectrum, that spectrum in the 700 MHz band will not be available for use by mobile services. Our position is that DTT may continue using the centre gap (738-758 MHz) once mobile services have started using the 700 MHz paired spectrum should mobile services not be ready to begin using the centre gap spectrum. However, DTT will be removed from the centre gap once the mobile services indicate that they are ready to begin using it (further details of the licence condition relating to this is set out in paragraph 5.9).
- 3.3 Clearance of the 700 MHz band of its existing DTT users began in late 2017 in the north of Scotland and continues across the UK. The physical transmitter changes are being coordinated by Digital UK and implemented by Arqiva, the supplier of the UK’s DTT infrastructure.<sup>26</sup> Support for DTT viewers affected by transmitter changes is being provided by Freeview.<sup>27</sup> The diagram below shows a timeline of the dates for 700 MHz clearance events at the main affected transmitter groups across the UK.

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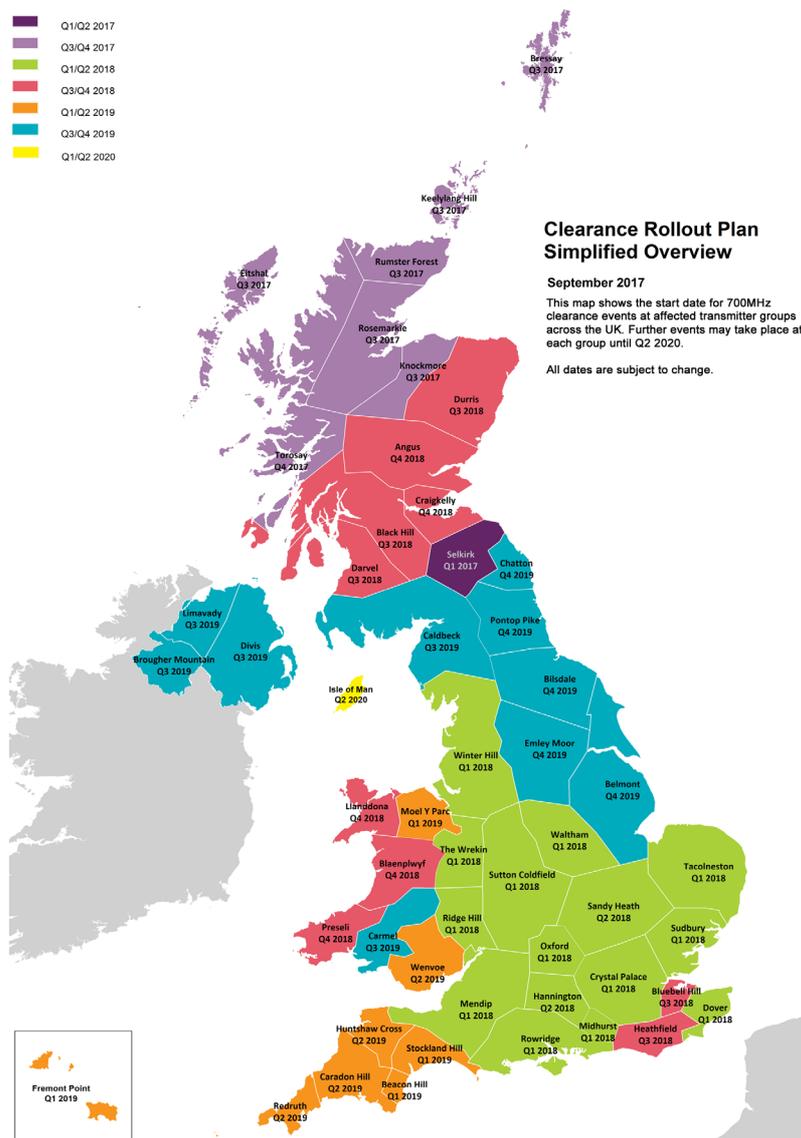
<sup>24</sup> Decision to make the 700 MHz band available for mobile data – statement, [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0024/46923/700-mhz-statement.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0024/46923/700-mhz-statement.pdf), 19 November 2014.

<sup>25</sup> Maximising the benefits of 700 MHz clearance: Enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap, [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-statement.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-statement.pdf), 17 October 2016.

<sup>26</sup> [http://www.digitaluk.co.uk/operations/700mhz\\_clearance](http://www.digitaluk.co.uk/operations/700mhz_clearance)

<sup>27</sup> <https://www.freeview.co.uk/tvchanges>

Figure 3.1: Timeline of 700 MHz clearance events for main transmitter groups



3.4 In December 2018 we published our second 700 MHz clearance programme timescale review, summarising our review of the programme’s progress. This review confirmed that the 700 MHz clearance programme is delivering to schedule and that we expect the process to complete in Q2 2020 as planned.<sup>28</sup> As of 13 January 2020, 89% of the programme’s clearance events had been completed.

3.5 It is possible that Arqiva will still be transmitting some DTT channels using the centre gap (738-758 MHz) when the roll out of mobile services in other parts of the 700 MHz band begins. Transmission of these channels has been permitted by the issue of an interim multiplex licence.

<sup>28</sup> 700 MHz clearance programme timescale review: review of progress, risks and readiness, [https://www.ofcom.org.uk/data/assets/pdf\\_file/0027/129933/Statement-700-MHz-clearance.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0027/129933/Statement-700-MHz-clearance.pdf), 13 December 2018.

- 3.6 The responsibility to manage the impact of any incoming interference received by viewers watching services transmitted from the centre gap would sit with Arqiva. We will therefore not require any viewer support scheme run by the mobile operators to provide assistance to viewers who lose services carried by the interim multiplexes.<sup>29</sup>

## PMSE

- 3.7 The 700 MHz band is currently used for PMSE. On 17 October 2016 we published a statement<sup>30</sup> titled 'Maximising the benefits of 700 MHz clearance: Enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap'. In the statement we gave formal notice to PMSE users that from 1 May 2020 they will no longer have access to the 700 MHz band to deliver their services. However in November 2017 we published our statement<sup>31</sup> titled 'Spectrum for audio PMSE: Use of the 694-703 MHz band' where we set out our decision to allow PMSE users to continue to access the 700 MHz guard band (694-703 MHz) beyond 2020. Consequently, PMSE will cease to have access to the 703-790 MHz band beyond 1 May 2020 but will remain in spectrum below 703 MHz which is adjacent to the award mobile uplink band.

## White Space Devices

- 3.8 White Space Devices (WSD) both licence exempt and licensed use the 700 MHz band. Our decision to clear the 700 MHz band means that WSD use of the 694-790 MHz band must cease by 1 May 2020.

## Other factors to consider

### SDL mobile systems

- 3.9 We would expect FDD operators to consider SDL use in their base station design before deploying their network. The differing ways the spectrum is integrated into networks could dictate differing filtering requirements.

### PPDR

- 3.10 We note that the Commission Decision (EU) 2016/687<sup>32</sup> also includes the potential for Public Protection and Disaster Relief (PPDR) services to use the frequencies 733-736 MHz and 788-791 MHz. This is not part of the award and we are not aware of any concrete plans for this spectrum to be used for PPDR in the UK. However, an option remains for PPDR uses in the future.

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<sup>29</sup> We set out this position in 'Maximising the benefits of 700 MHz clearance: Enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap' [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-Statement.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-Statement.pdf), p. 32

<sup>30</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-Statement.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-Statement.pdf)

<sup>31</sup> <https://www.ofcom.org.uk/consultations-and-statements/category-1/700-mhz-guard-band-pmse>

<sup>32</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L.2016.118.01.0004.01.ENG>

## 3.6-3.8 GHz

### Existing Systems

#### Permanent earth stations and receive only earth stations

- 3.11 In October 2017, we published a statement<sup>33</sup> proposing that, in order to facilitate deploying future mobile services in the band across the UK, we would vary existing Permanent Earth Station (PES) licences and grants of Recognised Spectrum Access (RSA) such that we would no longer take satellite earth stations with a receiver component in the band into account for frequency management purposes from 1 June 2020.
- 3.12 In February 2018, we published an update<sup>34</sup> setting out the decisions we had taken on relevant licences and grants.
- 3.13 In our July 2017 statement and consultation<sup>35</sup> we said that satellite earth stations (SES) could continue to receive signals in the band on a licence exempt basis following the end of notice periods (while noting that their ability to continue to receive without suffering interference that might adversely affect their service could vary between sites). We said we would explore the possibility of applying localised restrictions in future licences to facilitate continuing operation of satellite services in the 3.6-3.8 GHz band, where these would not have a material impact on mobile deployment (please see paragraphs 3.29-3.31 for further details).

#### Fixed links

- 3.14 In October 2017, we published a statement confirming that, we would revoke fixed links licences with a notice period of five years, but aiming for fixed links operations to migrate out of the band by June 2020 where possible.
- 3.15 In February 2018, we published an update<sup>36</sup> setting out the decisions we had taken on individual licences. We issued notices to revoke all fixed links licences, effective on 23 December 2022.

### Interim co-ordination of receive only earth stations and fixed links that will apply during the interim period only

- 3.16 Given the notice periods for the revocation of fixed link licences and variation of grants of RSA, there may be some constraints on new use of this spectrum in some areas of high population, such as the south-east of England and parts of the Midlands in the intervening

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<sup>33</sup> <https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-at-3.6-3.8-ghz>

<sup>34</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0018/110718/3.6GHz-3.8GHz-update-timing-spectrum-availability.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0018/110718/3.6GHz-3.8GHz-update-timing-spectrum-availability.pdf)

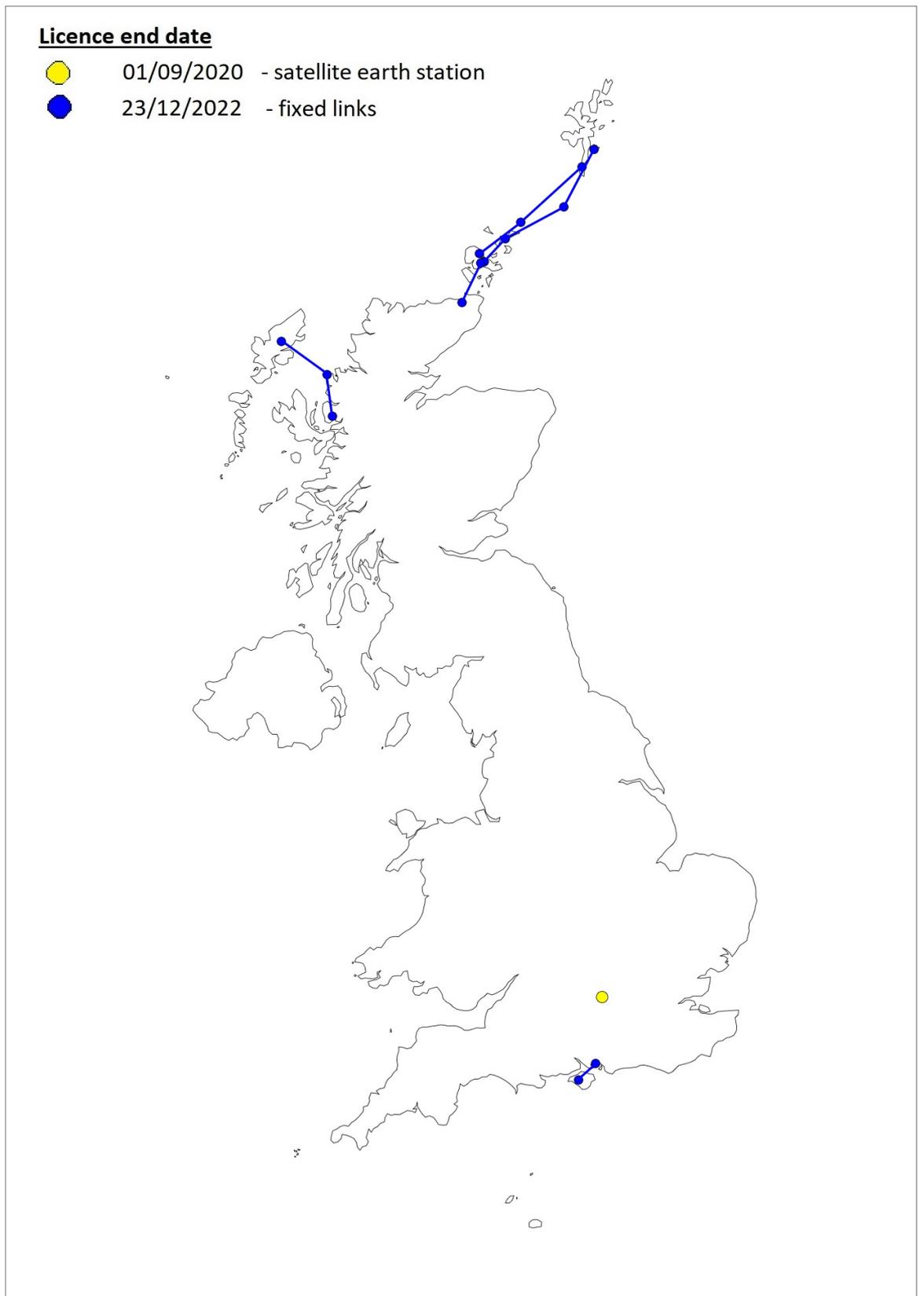
<sup>35</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0017/103355/3-6-3-8ghz-statement.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0017/103355/3-6-3-8ghz-statement.pdf)

<sup>36</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0018/110718/3.6GHz-3.8GHz-update-timing-spectrum-availability.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0018/110718/3.6GHz-3.8GHz-update-timing-spectrum-availability.pdf)

period following the award. However, we note that the spectrum is not being used for fixed links and/or satellite services in large parts of the UK.

3.17 Figure 3.2 below shows the revocation date and location of the earth station and fixed links.

Figure 3.2: Revocation date and location of the earth station and fixed links



- 3.18 In our October 2017 statement we said that we would continue to maintain appropriate protections for registered band users whose licence(s), or grant(s) of RSA, are revoked or varied (as applicable) until the relevant notice period had lapsed.
- 3.19 This means that, during the interim period prior to the end of 2022, new licensees in the 3.6-3.8 GHz band will need to submit to Ofcom technical information about each base station they intend to deploy which is located within the co-ordination areas defined in the Notice: Interim coordination procedure for 3.6-3.8 GHz spectrum access licences. Ofcom will use that information to assess the potential impact of the new base station against existing registered satellite earth stations and fixed links within the dates that their protection is provided.
- 3.20 New licensees will not be permitted to transmit from base stations unless the planned deployment passes the coordination process. It should be noted that Ofcom will not be able to enter into detailed discussion or offer additional services in relation to base station coordination. We will provide a pass/fail for each base station processed through the coordination tool and the margin in relation to the coordination threshold.
- 3.21 New licensees are required to submit technical details in batches of at least 100, unless agreed beforehand, as it will not be practical for Ofcom to process individual base stations or multiple small batches.
- 3.22 The coordination notice for new licensees is set out at annex 4.<sup>37</sup> The annex presents the current list of registered band user locations which shall be protected.
- 3.23 In general, we note that base station deployments within 50 km of the registered band user locations are particularly at risk of failing the coordination process.
- 3.24 There are currently seven PES licences and four grants of RSA that provide recognition of the use of frequencies in the 3.6–3.8 GHz frequency range. The seven PES licences and three of the four grants of RSA recognition will end on 1 June 2020. The remaining grant of RSA will end on 1 September 2020. The interim protections for fixed links will remain until 23 December 2022. We looked in more detail at the potential constraints that these interim protections may place on early base station deployments in our March 2020 Statement.<sup>38</sup>
- 3.25 There are 16 fixed links which are expected to remain in the band during the interim period and, of these, all but one are in remote areas away from major population centres and are thus unlikely to significantly impact mobile roll-out during this period. There are many areas of the UK, where future use by licensees would not be expected to be significantly affected by the existing authorisations.
- 3.26 Prospective bidders should note that there is one link operating between the Isle of Wight and Portsmouth which could potentially constrain early mobile deployments. This link operates a 30 MHz carrier centred at 3740 MHz. Further information about this fixed link

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<sup>37</sup> This co ordination notice will also apply to the existing licensee within the 3600 – 3800 MHz band.

<sup>38</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0020/192413/statement-award-700mhz-3.6-3.8ghz-spectrum.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0020/192413/statement-award-700mhz-3.6-3.8ghz-spectrum.pdf)

can be found on our Spectrum Information Portal.<sup>39</sup> The technical assignment coordination criteria for fixed links is set out in OfW 446.<sup>40</sup>

- 3.27 We concluded that roll-out of base stations is likely to be difficult within a radius of 50 km of the Isle of Wight to Portsmouth link, with about 80% of the sectors we analysed failing to meet the protection criteria for this fixed link. For base stations further away, roll-out is likely to be minimally affected with about 4% of sectors analysed that lie within a few kilometres either side of the extended corridor of the fixed link (out to 200 km) failing to meet the protection criteria for the link. For this small number of sectors which failed coordination the failure margin is relatively small (median margin ~3 dB) implying that with reasonable mitigation (e.g. reducing powers or careful pointing) most of the sectors that failed could be deployed with minimal impact on network performance.
- 3.28 The Table below shows the number of sectors that failed to meet the interference criteria and the failure margin for both of the areas in our analysis.

**Figure 3.3: Summary of results for areas A and B**

<b>Location<sup>[a]</sup></b>	<b>Total sectors analysed</b>	<b>Number of sectors failing</b>	<b>% failed sectors</b>	<b>failure margin, median value</b>
Area A	224	179	80 %	~ 30 dB
Area B	1492	54	4 %	~ 3 dB

[a] Area A is within 50 km of the fixed link receiver  
 Area B is within about 20 km either side of the extended boresight of the link (which cuts across parts of the South East of England including parts of London).

<sup>39</sup> <https://www.ofcom.org.uk/spectrum/information/spectrum-information-system-sis/spectrum-information-portal>

<sup>40</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0017/92204/ofw446.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0017/92204/ofw446.pdf)

Figure 3.4: Isle of Wight to Portsmouth fixed link and Area A<sup>41</sup>



## Restrictions which apply on an enduring basis

### Permanent earth stations and receive only earth stations

- 3.29 In the March 2020 Statement<sup>42</sup> we decided on a restriction zone with a radius of 1 km would provide some degree of reassurance for these operators that mobile base stations using the 3.6 GHz band will not be situated directly next to their earth stations, while meeting our objective to ensure that any constraints to mobile deployment should be kept to a minimum and should not prevent MNOs from offering mobile services in the area affected.
- 3.30 There is a 1 km restriction zone from the locations in the map below. The National Grid details of the locations can be found in annex 5.

<sup>41</sup> This map is reproduced from Ordnance Survey material with permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationary Office.

<sup>42</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0020/192413/statement-award-700mhz-3.6-3.8ghz-spectrum.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0020/192413/statement-award-700mhz-3.6-3.8ghz-spectrum.pdf)

**Figure 3.5: In band restrictions around earth station sites**



- 3.31 For any base station within a restriction zone, the 3.6 GHz spectrum access licensee must ensure that the calculated signal power at the centre point of restriction zone within any 5 MHz portion of the 3.6 - 3.8 GHz band is no greater than -43 dBm/5 MHz. For more information please see the Notice of in-band restriction zones in annex 5.

#### **MOD sites**

- 3.32 MOD has a small amount of ongoing use within the band at one location in Bude, Cornwall which must be protected.
- 3.33 The Notice in annex 6 specifies the protection thresholds and coordination procedure necessary to ensure the protection of existing and continuing MOD usage in the 3.6-3.8 GHz band from potential harmful interference from the networks in the band.
- 3.34 When planning its network deployment, the 3.6-3.8 GHz licensee must check whether the protection thresholds would be exceeded as a result of any proposed 3.6-3.8 GHz deployment.
- 3.35 The Notice requires that the assessment is made for all deployments up to 25 km from Bude assuming base stations are up to 30m high. Licensees are advised that sites which are higher than this but located outside of the coordination area may still cause interference to MOD systems in certain circumstances. The 3.6-3.8 GHz licensee must therefore consider whether any of its deployments which are greater than 30m above ground level are likely to cause any impact to the Protected Site and coordinate if it is necessary.
- 3.36 If it is not possible to adjust the deployment so that the threshold is not exceeded, the 3.6-3.8 GHz licensee may only deploy if agreement is reached with the operator of Bude. In the first instance, contact should be made via Ofcom who will facilitate a discussion between the licensee's appropriately security cleared personnel and the operator of the Protected Site.

## Services above 3.8 GHz

### Fixed links

- 3.37 Our fixed links analysis considered the existing fixed links in channel 8 (centre frequency 3830 MHz, bandwidth 30 MHz), which, following the closure of channels 4 to 7 and the removal of existing fixed links in these channels, will be the fixed link channel closest to the 3.8 GHz boundary. Currently there are nine fixed link frequency assignments in channel 8.

### Locally licensed services

- 3.38 The 3.8-4.2 GHz band has been made available<sup>43</sup> for further shared access which could facilitate deployment of private networks and fixed wireless access uses. We are not authorising new use in the 5 MHz block in 3800-3805 MHz.
- 3.39 Those local licences may be using a number of different radio technologies, including 4G or 5G and therefore may not be following the same frame structure as networks in 3.6-3.8 GHz. Given the higher transmit power allowed below 3.8 GHz, the risk profile is such that new users above 3.8 GHz could suffer interference from networks below 3.8 GHz which is greater than the risk in the other direction when users above 3.8 GHz are not synchronised with the networks below. To mitigate the potential risk of interference across the 3.8 GHz boundary, we said that new users operating close to the 3.8 GHz boundary may wish to adopt the same synchronisation requirements as those we have defined for spectrum below 3.8 GHz.
- 3.40 Ofcom's Shared Access Licence Guidance document<sup>44</sup> sets out the standard technical conditions and the approach Ofcom generally expects to take issuing Shared Access licences. We retain the discretion to amend our approach to make exceptions or disapply the guidance if it is appropriate to do so in particular circumstances.

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<sup>43</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf)

<sup>44</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0035/157886/shared-access-licence-guidance.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0035/157886/shared-access-licence-guidance.pdf)

## 4. The licences

### Introduction and summary

- 4.1 In this section we summarise some of the licence conditions we will include in the WT Act licences to be awarded to the winning bidders. There are two types of licences available in the Auction:
- a licence for use of frequencies in the 700 MHz band (an example template for the Spectrum Access 700 MHz licence is set out at annex 1).
  - a licence for use of frequencies in the 3.6-3.8 GHz band (an example template for the Spectrum Access 3.6-3.8 GHz licence is set out at annex 2).
- 4.2 For the avoidance of doubt the licences will not guarantee exclusive use of the spectrum awarded. In the future, we may grant additional authorisations to allow the use of all, or part, of the spectrum, including the spectrum that is the subject of this award process. Such authorisation may occur, for example, by way of the grant of new licences, decisions as to the variation of existing licences, or decisions as to exemptions from licensing. We would develop and consult on the conditions of use under any such additional authorisations in order to manage the risk of harmful interference. Please also see paragraph 7.2.
- 4.3 We have not imposed any non-technical restrictions on the use to which the spectrum could be put in the licences (such as specifying the type of service that should be offered, the technology that should be deployed or the equipment that should be used).
- 4.4 The licences contain only those technology and usage restrictions that are in our view proportionate and necessary for spectrum management reasons to manage the risk of harmful interference and to ensure compliance with our statutory duties and international obligations. It should be noted, however, that the services that a licensee intends to offer may be constrained by regulation of downstream services (at retail or wholesale level) such as the General Conditions of Entitlement under the Communications Act 2003 and other legislation. Potential bidders should seek their own advice in this regard.
- 4.5 The licences will be awarded under the WT Act. Each licence grants the licensee the right to establish, install and use radio equipment in accordance with specific technical parameters set out in the licence for an indefinite term (see paragraph 4.9). The licence also sets out the conditions that apply to the licensee in respect of:
- Date of commencement of licences (see paragraph 4.7 to 4.8);
  - The circumstances in which we may revoke the licence (see paragraphs 4.10 to 4.11);
  - Licence variation (see paragraphs 4.12 to 4.13);
  - Changes to licensee's details (see paragraph 4.14);
  - Fees (see paragraphs 4.15 to 4.16);
  - Access and inspection (see paragraph 4.17);
  - Modification, restriction and closedown (see paragraphs 4.18 to 4.19);
  - Geographical boundaries (see paragraphs 4.20 to 4.21);

- Spectrum trading (see paragraphs 4.22 to 4.24);
  - Coordination procedures (see paragraphs 4.25 to 4.26);
  - Cooperation clause in the 3.6-3.8 GHz licences (see paragraph 4.27);
  - Provision of information to facilitate optimum spectrum use (see paragraph 4.28);
  - Notice for 738-758 MHz frequencies (see paragraph 4.29);
  - Use it or lose it conditions (see paragraph 4.30); and
  - Roaming conditions (see paragraph 4.31).
- 4.6 We have not summarised all of the licence terms in this section, and in particular have not summarised the technical parameters to be included in the schedule to the licences. However, example template licences are annexed to this Memorandum as set out at 4.1 above.

## **Date of commencement of licences**

- 4.7 WT Act licences will be granted to winning bidders soon after the conclusion of the award and once any outstanding payments to cover their licence fees have been paid (the licence fee for the initial period will be determined through the award process).
- 4.8 Potential licensees for 700 MHz individual frequency lots should note the requirement detailed in paragraph 5.9 of this Information Memorandum.

## **Term, revocation and variation**

- 4.9 Each licence will have an indefinite term and will continue in force from the date of grant until revoked by Ofcom or surrendered by the licensee.
- 4.10 There will be limited rights of revocation during an initial term (the Initial Term) of 20 years. After the Initial Term, Ofcom will be able to revoke the licence for spectrum management reasons, provided we have given the licensee at least five years' notice. Please see paragraph 3f) of the example licences in annexes 1 and 2.
- 4.11 The licence can also be revoked, including during the Initial Term, in the following circumstances:
- at the request or with the consent of the licensee;
  - if there has been a breach of any of the terms of the licence;
  - if it appears to be necessary or expedient to do so in the interests of national security or for the purpose of complying with an international obligation of the UK;
  - if it appears to be necessary or expedient to do so for the purposes of complying with a direction by the Secretary of State to us under Section 5 of the Communications Act 2003 or Section 5 of the WT Act;
  - if the licensee has not complied with any requirement of any relevant trading regulations; or
  - if the licensee has not complied with certain requirements of the Wireless Telegraphy (Licence Award) Regulations 2020 (the "Regulations").

4.12 Where we propose to vary or revoke a licence, we must follow the procedure in paragraphs 6, 6(a) and 7 of schedule 1 to the WT Act. The notice under the WT Act must state the reasons for the proposed variation or revocation and specify a period during which the licensee may make representations, or where the notice relates to a failure to observe licence conditions, meet those licence conditions.

4.13 Any variation of the licence will be in accordance with the requirements of the WT Act.

## **Changes to licensee's details**

4.14 The licensee must give prior notice to us in writing of any proposed changes to the licensee's name and address.

## **Sum payable for the licence**

4.15 The sum payable in respect of each licence will be determined through the award process in accordance with the Regulations.

## **Licence fee after the Initial Term**

4.16 Licensees will be liable to pay additional licence fees in respect of the licences if they continue to hold them after the end of the initial 20 year period. The level of these fees will depend on our general approach to fees for the use of spectrum at the relevant time, and how that general approach relates to these licences and to our statutory duties at that time. The level of the fees cannot therefore be determined now. Note that we would expect to give prior notice of our specific proposals to charge fees, and to consult as appropriate, before fees are introduced.

## **Access and inspection**

4.17 Licensees will be required to permit any person authorised by Ofcom to have access to and to inspect the radio equipment specified in the licence at all reasonable times (or, when an urgent situation arises, at any time) to ensure that the licensee is using the radio equipment in accordance with the conditions of the licence.

## **Modification restriction and closedown**

4.18 We may require the radio equipment or any part of it to be modified, restricted in use or temporarily or permanently closed down if:

- A licensee has breached the terms of its licence; and/or
- Use of the radio equipment is or may be causing or contributing to undue interference to the operation of other authorised radio equipment.

4.19 We may also require the radio equipment to be modified, restricted in use or temporarily or permanently closed down if it appears to be requisite or expedient to do so in the event of a national or local state of emergency. We 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

### 700 MHz

- 4.20 Subject to the requirements of any coordination procedures notified under schedule 1 of the licence, the licences permit use within the United Kingdom. For the avoidance of doubt, the United Kingdom includes the United Kingdom territorial sea (measured in accordance with section 1 of the Territorial Sea Act 1987) but does not include the Channel Islands or the Isle of Man.

### 3.6-3.8 GHz

- 4.21 Subject to the requirements of any coordination procedures notified under schedule 1 of the licence, the licence permits use within the United Kingdom but excludes the areas set out in paragraph 17 of the licence. For the avoidance of doubt the United Kingdom does not include the Channel Islands or the Isle of Man. The excluded areas set out in paragraph 17 of the 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.

## Spectrum trading

- 4.22 A licensee cannot assign its licence to another party, but it may transfer the rights and obligations to another person under the spectrum trading regime. We expect the 700 MHz and 3.6-3.8 GHz bands to be used for mobile access in the future and we have therefore included them in the Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011<sup>45</sup>. The effect of including these bands in the Mobile Trading Regulations is to enable us to conduct an assessment of the impact of competition on any trade before deciding on whether to approve that trade. We have also made the Wireless Telegraphy (Spectrum Trading)(Amendment) Regulations 2019<sup>46</sup> to remove the 742-750 MHz, 758-766 MHz and 3605-3689 MHz frequencies from the Schedule to the Wireless Telegraphy (Spectrum Trading) Regulations 2012.
- 4.23 We have not included spectrum leasing provisions in the new licences for the 700 MHz and 3.6-3.8 GHz bands, but we will keep this position under review and may extend leasing to these bands if we consider it appropriate in the future.
- 4.24 We provide guidance on our website on the spectrum trading process.<sup>47</sup>

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<sup>45</sup> <http://www.legislation.gov.uk/uksi/2011/1507/contents>

<sup>46</sup> <https://www.legislation.gov.uk/uksi/2019/950/made/data.pdf>

<sup>47</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0029/88337/Trading-guidance-doc-jul15v0-1-2.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0029/88337/Trading-guidance-doc-jul15v0-1-2.pdf)

## Coordination procedures

- 4.25 Licensees will be required to ensure that the Radio Equipment is operated in compliance with such coordination procedures as may be notified to them by Ofcom from time to time in accordance with Schedule 1 of the licence.
- 4.26 Please see section 5 of this document for further details of the licence conditions relating to coexistence.

## Cooperation clause in the 3.6-3.8 GHz licences

- 4.27 The licence(s) for the 3.6-3.8 GHz band include a clause which requires cooperation between licensees to prevent harmful interference between mobile networks. This clause is not included in the licences for the 700 MHz band as there will be no TDD operation in this band and hence the particular risk of inter-operator interference when operating TDD networks which are adjacent in frequency does not exist in this case.

## Provision of information to facilitate optimum spectrum use

- 4.28 A condition in the licence will require licensees to provide us, on request, with certain information regarding their use of the radio equipment.

## Notice for 738-758 MHz frequencies

- 4.29 The 700 MHz licences include a requirement for licensees to give us three months' notice of when, how and where they intend to start using the spectrum, and give Arqiva three months' notice of when they intend to start using the spectrum.

## Use it or lose it conditions

- 4.30 The WT Act licences do not include a 'use it or lose it' condition. However, on 16 July 2019, DCMS published a consultation document 'Implementing the European Electronic Communications Code'<sup>48</sup>. The consultation included, amongst other things, proposals relating to the inclusion of 'use it or lose it' conditions in WT Act licences. We will keep the position under review and will publish any updates that may be necessary relating to the inclusion of these conditions. Please also see paragraph 7.17 for information on the European Electronic Communications Code.

## Roaming conditions

- 4.31 It should be noted that Ofcom may impose roaming conditions, as appropriate, in the licences relating to the 700 MHz award frequencies in the future. Any future proposals to

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<sup>48</sup> <https://www.gov.uk/government/consultations/implementing-the-european-electronic-communications-code>

impose roaming obligations would be subject to detailed analysis and consultation at that time.

# 5. The licences – conditions relating to coexistence

## Introduction

5.1 In this section we provide details of the conditions relating to coexistence which will be included in the WT Act licences awarded to the winning bidders.

## 700 MHz

### DTT coexistence

5.2 Once mobile networks start using the 700 MHz band they will need to coexist with television services in nearby frequencies (below 694 MHz). This means that there is a risk of interference between the two services, including that mobile base station and handset transmissions could interfere with television reception. We conducted studies and a consultation to assess this risk and set out our conclusions in our update of December 2017.<sup>49</sup>

5.3 Under a condition in their licences, the 700 MHz licensees authorised to use the frequencies in the two 30 MHz blocks of paired spectrum and the ‘centre gap’ of 20 MHz at 738-758 MHz will be required collectively to set up and operate a scheme to provide advice and assistance to viewers suffering undue interference from mobile services and resolve it. The licence condition does not prescribe in detail how the licensees should set up and run a scheme (or schemes).

5.4 Licensees are also required to submit to Ofcom for its approval a joint plan setting out the approach they will take. An indication of what we expect to see in the joint plan is provided in the form of guidance, set out in annex 3 of this Information Memorandum. The plan must make provisions in at least the following areas.

- Engaging with consumers – Licensees need to make appropriate provision for informing consumers at risk of being affected by interference. We expect licensees to provide an advice line and to advertise that help is available.
- Assisting consumers who experience problems – Licensees need to assist consumers who experience interference resulting from mobile in the 700 MHz band.
- Helping vulnerable consumers – Licensees need to take account of the needs of vulnerable consumers.
- Operational functions – Licensees have to take account of the operational side of supporting DTT viewers. This includes how the costs of viewer support is funded and how performance is tracked.

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<sup>49</sup> Coexistence of new services in the 700 MHz band with digital terrestrial television, [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0025/108655/update-coexistence-700-mhz.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0025/108655/update-coexistence-700-mhz.pdf), 13 December 2017.

- 5.5 Ofcom retains the power to impose a fall-back plan should licensees submit no satisfactory joint plan. We have the power to take enforcement action, including imposing financial penalties assessed in light of Ofcom’s penalty guidelines,<sup>50</sup> against licensees who do not comply with their licence conditions.
- 5.6 The licensees will have a 10-week window following the award of licences for the 700 MHz band to submit their joint plan to Ofcom for consideration. We will evaluate the plan in accordance with the objective that 700 MHz mobile services do not cause undue interference to DTT viewers – and, if they do, that new mobile licensees take appropriate and proportionate measures to address any undue interference. We will respond to the licensees within six weeks with our approval or otherwise.
- 5.7 We retain fall-back powers to allow us to impose our own plan if the licensees propose no acceptable version. In this case, we will require licensees to provide a viewer support scheme where we set detailed requirements. The costs for the scheme will be borne by the licensees, with costs shared out in proportion to the licensees’ holdings in the 700 MHz band. The fall-back option will include the components given in our guidance.
- 5.8 The responsibility to manage the impact of any incoming interference received by viewers watching services transmitted in the centre gap will sit with Arqiva. We will not therefore require any viewer support scheme run by 700 MHz licensees to provide assistance to viewers who may lose services carried by the interim multiplexes.

### **Notice for use of the centre gap frequencies**

- 5.9 The licence for the 700 MHz frequencies includes a requirement for licensees, with centre gap frequencies (738-758 MHz) to give us three months’ notice of when, how and where they intend to start using the spectrum. At the same time, the licensee(s) must notify Arqiva of when they intend to start using the spectrum and we will extend the end date of Arqiva’s interim multiplex licence to conclude on this date. This will provide Arqiva with three months’ notice of removal of DTT from the centre gap.

### **3.6-3.8 GHz**

- 5.10 The licence for the 3.6-3.8 GHz frequencies includes a requirement for licensees to ensure compliance with such coordination procedures as may be notified to the licensee by Ofcom from time to time. Ofcom intends to notify all relevant licensees of the following coordination procedures at the time of initial grant of the licences:
- Notice: Interim coordination procedure for 3.6-3.8 GHz spectrum access licences;
  - Notice: In-band restriction zones around satellite earth stations in the 3.6-3.8 GHz band;
  - Notice of coordination procedure for MOD sites related to the 3.6-3.8 GHz band.

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<sup>50</sup> The current version of these guidelines is available at [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0022/106267/Penalty-Guidelines-September-2017.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0022/106267/Penalty-Guidelines-September-2017.pdf)

5.11 In addition, 3.6-3.8 GHz licensees will be required to comply with a synchronisation requirement as specified in Schedule 1 of the relevant licence. Figure 5.1 gives a high level overview of the requirements.

**Figure 5.1: High level summary of the synchronisation requirements**

Synchronisation option	
Full synchronisation with frame Structure A	The fully synchronised frame structure is a 10 ms frame with a 1:3 uplink/downlink ratio and TD-LTE frame configuration 2 using special sub-frame configuration 6 is compatible with this frame structure. A licensee operating radio equipment which uses this frame structure must comply with the Permissive emissions mask.
Semi-synchronisation with frame Structure B	The semi-synchronised frame structure is a 10 ms frame which contains three synchronised sub-frames and seven flexible sub-frames which can be used for either downlink or uplink. This is compatible with all TD-LTE frame configurations. A licensee operating radio equipment which uses this frame structure must comply with the Restrictive mask which is required to reduce the risk of interference to adjacent mobile networks in the absence of full synchronisation.

## 6. The award process

### Introduction

- 6.1 The award process will be conducted in accordance with the Auction Regulations, which set out the award process in detail. We have published a Statement on the final draft of the auction regulations for the award of the 700 MHz and 3.6-3.8 GHz frequency bands alongside this document.<sup>51</sup>
- 6.2 Anyone making or considering making an application for a spectrum licence by bidding in the auction should read and understand the rules of the award process as set out in the Regulations. The information in this section should be read in conjunction with the Regulations. If there is any discrepancy between this Information Memorandum and the Regulations, the Regulations are definitive and will prevail.
- 6.3 The purpose of the following paragraphs is to provide a short description of the award process, particularly in relation to the steps involved and certain other practical matters.

### Available spectrum

- 6.4 The frequencies being awarded comprise 80 MHz of spectrum in the 700 MHz band between 703-733 MHz, 758-788 MHz and a centre gap of 20 MHz at 738-758 MHz. Additionally, 120 MHz of spectrum in the 3.6-3.8 GHz band between 3680-3800 MHz is being awarded.

### Auction format

- 6.5 The auction will consist of two parts: a principal stage and an assignment stage. The principal stage will be a Simultaneous Multiple Round Ascending (SMRA) format and the assignment stage will be a single round sealed bid format. In the principal stage bids are submitted for individual frequency-generic lots, in multiple lot categories, at the same time. The principal stage proceeds through successive rounds with increasing prices until there are no new bids. At the end of the principal stage, the auction bidding moves into the assignment stage.

### Summary of the award process

- 6.6 In summary, the award process will be as follows:
- Interested parties are required to apply for the grant of a licence;
  - Applicants need to qualify to participate in the award process. An applicant may be disqualified where Ofcom determines that it is not fit to hold a licence. An applicant

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<sup>51</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0018/192411/auction-regulations-award-700mhz-3.6-3.8ghz-spectrum.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0018/192411/auction-regulations-award-700mhz-3.6-3.8ghz-spectrum.pdf)

will also be unable to qualify if a member of its bidder group (i.e. a related company) is also a member of the bidder group of another applicant;

- The first stage of the auction is the principal stage, consisting of successive rounds. The principal stage determines the amount of spectrum won by bidders bidding for frequency-generic lots, and the base price for each winning principal stage bid;
- The second stage of the auction is the assignment stage, whereby specific frequencies are assigned to principal stage winning bidders. The assignment stage results in the determination of the winning assignment stage bids and the additional price for each winning assignment stage winner to be paid in addition to their base price;
- For winning bidders of 3.6-3.8 GHz spectrum, there will be an optional negotiation period during which they will have the opportunity to agree unanimously their frequency assignments, or alternatively, a subset of winning bidders of 3.6 GHz lots could agree to be assigned adjacent frequencies;
- The final stage is the grant stage, whereby Ofcom grants licences to winning bidders.

## Lot categories

6.7 The available spectrum will be offered in the following lot categories:

- 3.6 GHz lots, containing 24 lots, each consisting of 5 MHz of spectrum in the 3.6 GHz-3.8 GHz band. The minimum number of 3.6 GHz lots that a bidder can bid for is two;
- 700 MHz individual frequency lots, containing four lots, each consisting of 5 MHz of spectrum in the 700 MHz band; and
- 700 MHz, paired frequency lots, containing six lots, each consisting of 2x5 MHz of spectrum in the 700 MHz band.

## Reserve prices

6.8 The reserve price for each lot is as follows:

- 3.6 GHz - £20 million per 5 MHz lot;
- 700 MHz individual frequency lots - £1 million per 5 MHz lot; and
- 700 MHz paired frequency lots - £100 million per 2x5 MHz lot.

## Spectrum cap

6.9 There will be a spectrum cap limiting the total bandwidth that any operator may hold after the auction equal to 416 MHz. For some operators this may set a limit on the maximum amount of spectrum they can acquire in the auction.

## Activity rules

### Eligibility points

6.10 Bidders will be subject to activity rules in relation to their bidding in the principal stage. Each lot will be assigned the following eligibility points:

- Each 3.6 GHz frequency lot is assigned one eligibility point;
  - Each 700 MHz individual frequency lot is assigned one eligibility point; and
  - Each 700 MHz paired frequency lot is assigned four eligibility points.
- 6.11 A bidder's activity in a principal stage round is measured by the sum of eligibility points associated with bids made in the round and/or with standing high bids.
- 6.12 Each bidder will have a given number of eligibility points at the start of the auction. These will be determined by its financial deposit. The eligibility of a bidder in the first principal stage round is set to the bidder's initial eligibility and in subsequent rounds may be adjusted down by reference to its eligibility and activity in the preceding round. Therefore, if a bidder's activity is less than its eligibility, then the bidder's eligibility for the following round would be reduced (and set equal to the activity level of the round just ended).
- 6.13 Bidders will be allowed up to three 'waivers' (eligibility events) where they may abstain from bidding without affecting their eligibility for the next round.

## Expected timings

- 6.14 The Regulations do not impose a timetable for the award process. We provide indicative timings for the award process in the 'Process guidance for potential applicants and bidders in the auction' which has been published on the Ofcom website<sup>52</sup>.

## Start of the award process

- 6.15 The award process may only begin after the Regulations have come into force. The Regulations will state the date when they come into force.
- 6.16 We will publish a notice of the deadline for receipt of applications on the Ofcom website.

## Questions and answers before the deadline for applications

- 6.17 Any party interested in participating in the award process may submit questions in writing to Ofcom in relation to any aspect of the award process. Questions should be submitted at least five business days before the provisional deadline for applications. We will aim to respond to all questions at least two business days before the deadline for applications. Questions should be sent by email to [radiospectrum.award@ofcom.org.uk](mailto:radiospectrum.award@ofcom.org.uk).
- 6.18 Our normal manner of responding to a question will be by email. We will then consider whether to publish a copy of the question and of any response, in whole or in part, on the Ofcom website. In doing so, we will not normally identify the person who has asked the question without their consent. Any person not wishing any part of their question to be published, should clearly mark the relevant part(s) "Confidential" and we will take this into account in deciding whether and what to publish.

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<sup>52</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0027/192474/process-guidance-700mhz-3.6-3.8ghz-auction.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0027/192474/process-guidance-700mhz-3.6-3.8ghz-auction.pdf)

## Application stage

- 6.19 We will publish on the spectrum awards section of the Ofcom website the details of the application procedures, including the time period for delivery of application forms as well as the deadline for and guidance on the payment arrangements for the initial deposit of £100,000.
- 6.20 In exceptional circumstances, we may be required to change the day, time or place for delivery of application forms or the payment of the initial deposit. We will take reasonable steps to inform interested parties of a change.
- 6.21 We will grant applicants access to some features of the bidder and auctioneer interface through a version of the software that will be used in the auction. We expect login details and a user manual for the electronic auction system to be sent by email to applicants the day after they submit their application. Applicants will need digital certificates to be able to login to the software at this stage, although these will be different from those used in the actual auction. Details will be provided in the email. Unless they are disqualified, or withdraw their applications within the period allowed for such withdrawals, applicants will be able to use the software to run internal mock auctions and training throughout the auction. Training may also be organised by Ofcom.

## Qualification stage

- 6.22 We expect to notify each applicant of the names and associates of each other applicant shortly after the application day. This notification will also set a deadline by which applicants must notify us of whether or not any members of their applicant group are also associates of another applicant or are also an applicant. In such cases, applicants must also notify the other applicant(s) concerned.
- 6.23 In parallel with this exercise, we will also consider whether any members of one applicant group are also members of another applicant group.
- 6.24 If it appears to us that a member of one applicant group is also a member of another applicant group, we will notify the applicants and ask them to resolve any common memberships.
- 6.25 In determining whether applicants are qualified to bid in the award process we will take into account whether the applicant or any member of its applicant group is receiving or attempting to receive services in relation to the award process from anyone who has provided or is providing services to Ofcom in relation to the award process. For these purposes the advisers to Ofcom in connection with certain aspects of the award process hitherto appointed (others may be added to this list nearer to the auction) are DotEcon Ltd, Auctionomics, NIIT Technologies, NCC Group, Smith Institute for Industrial Mathematics and System Engineering, KPMG and Pen Test Partners Ltd.

## Preparations for the Principal Stage

- 6.26 Once we have qualified applicants as bidders, and after the time allowed for withdrawals, we will:
- Publish the names of bidders on the Ofcom website;
  - Notify each bidder of passwords and make available to each bidder digital certificates required to access and use the electronic auction system and verify its identity (these will be changed for the actual auction);
  - Notify each bidder of the bidder training arrangements; and
  - Notify each bidder of the deadline by when bidders may pay additional deposits, and details of the relevant bank account.

## Principal stage

- 6.27 In the principal stage bidders place bids for individual lots in multiple lot categories at the same time. The bidder's financial exposure is determined by the bidder's demand and by the prices for each lot category set by Ofcom at the start of each round. In the first round prices for each lot category are set at the pre-announced reserve prices. Where there is excess demand in a lot category, we will randomly rank the bidders that placed bids in a given round and allocate lots as 'standing high bids' to these bidders until there are no more lots available. This rule means that, at most, only one bidder in each band could be standing high bidder on fewer lots than it bid for. If all lots have been allocated as standing high bids at the current round price in a category, the price will increase in that category for the next round. The principal stage rounds end when there are no new bids or waivers in a round.
- 6.28 At the end of each day of the principal stage we will publish on our website the round prices for each lot category and limited information on the level of excess demand reached in the last round of the day.
- 6.29 There is no limit on the number of principal stage rounds that may be held on a business day. We may decide not to hold any principal stage rounds on a business day. We have provided further guidance on the scheduling of rounds in the 'Process guidance for potential applicants and bidders in the auction'.

## Assignment stage

- 6.30 Upon completion of the principal stage of the auction, which determines the amount of spectrum that each bidder wins in each lot category, an assignment stage will be held which will determine the precise frequencies awarded providing that there is at least one winning bidder in a lot category. The assignment stage will have a sealed-bid single-round format with a second price rule. For the 3.6-3.8 GHz band, there will also be an opportunity for winning bidders to negotiate their assignments.
- 6.31 The assignment stage bid options will only allow for outcomes in which a bidder is assigned a contiguous frequency block corresponding to the bandwidth acquired in the principal

stage. And in which any lots not assigned to a bidder also form a contiguous frequency block.

## **Negotiation period for winners of 3.6-3.8 GHz spectrum**

- 6.32 For the 3.6-3.8 GHz band, bidders that have won spectrum in the 3.6-3.8 GHz band will have an opportunity to negotiate an alternative outcome to the assignment stage. If at least two winning principal stage winners of 3.6-3.8 GHz spectrum consent to a negotiation period, Ofcom will pause the auction after assignment stage bidding for a period of up to four weeks. Ofcom will not process or reveal the assignment stage bids during this period.
- 6.33 If all bidders unanimously agree the assignments in the 3.6-3.8 GHz band during this period, they must notify Ofcom of this agreement by submitting a ‘full adjacency agreement form’. Ofcom will then proceed to assign the 3.6-3.8 GHz spectrum in accordance with this agreement. Under these circumstances, bidders will not pay any ‘additional prices’ for their 3.6-3.8 GHz assignments. We refer to this as a ‘unanimous agreement’.
- 6.34 If all bidders are unable to come to a unanimous agreement, but a subset of bidders successfully agree to be assigned adjacent frequency locations in the 3.6-3.8 GHz band, they must notify Ofcom of this agreement by submitting a ‘partial adjacency agreement form’. Ofcom will reflect this agreement in the outcome as set out below. We refer to this as a ‘partial agreement’.
- 6.35 This subset of bidders must notify Ofcom by the specified deadline of:
- which bidders have agreed to be part of the subset; and
  - the order of the bidders’ assignments in the subset.
- 6.36 There will be two phases of the negotiation period. Ofcom will accept notifications of a unanimous agreement in both the first and second phases of the negotiation period. However, Ofcom will only accept notifications of any partial agreement between subsets of bidders in the second phase of this period, which is expected to be the last week of the four-week negotiation period.

## **Determination of winning assignments and additional prices**

- 6.37 Ofcom will determine the winning assignment stage bids for: 700 MHz individual frequencies, 700 MHz paired frequencies and, where there is no valid adjacency agreements, 3.6 GHz lots. The winning assignment plan for each band will be the combination of bids for assignment stage options that is compatible with a valid assignment band plan and yields the greatest value. For the 3.6-3.8 GHz band, valid assignment band plans are also subject to the criteria that winners of 20 MHz or less that are not party to an adjacency agreement must be placed at the top or bottom of the band (with the exception that leftover lots may be placed anywhere in the band, including between winners of 20 MHz or less).
- 6.38 Where there is one or more valid partial adjacency agreement between winning 3.6 GHz bidders, Ofcom will similarly determine the winning assignment 3.6 GHz band plan but, for

parties to a partial adjacency agreement, Ofcom will treat the spectrum won by these bidders as a single contiguous block with a bid value for zero. Valid 3.6 GHz assignment band plans are restricted to those in which parties to a partial adjacency agreement are assigned adjacent frequencies.

- 6.39 If there are multiple assignment plans that yield the greatest value, Ofcom will employ a method of random selection from amongst those valid combinations of assignment stage bids to select the winning assignment plan.
- 6.40 Where there is a valid full adjacency agreement in 3.6 GHz, Ofcom will assign the 3.6 GHz frequencies in accordance with the band plan agreed by all winning 3.6 GHz bidders, and specified in their full adjacency agreement forms.
- 6.41 Winning bidders may have to pay 'additional prices', which will be based on the opportunity cost of their assignment stage bids. However, any bidder that is party to an adjacency agreement will not have to pay an additional price for its 3.6 GHz assignment.

## Grant stage

- 6.42 We will determine the outcome of the assignment stage in accordance with the Regulations and notify bidders. The total sum payable by each winning bidder is the sum of the base prices across each of the lot categories for which they have won licences and the respective additional prices. Licences will only be granted after receipt of any sums owing.

## Electronic auction system

- 6.43 Both the principal stage and the assignment stage will be conducted using an electronic auction system ("EAS"). Bidders will be able to access the system over the public internet using a standard web-browser. The minimum requirements in terms of hardware and software are described in a user manual distributed to bidders after their application is submitted.
- 6.44 Bidders will each have their own electronic security details to connect to the EAS and will need to ensure that these details are not disclosed to third parties. In the event of any actual or suspected breach of security, bidders should contact us at the earliest opportunity.
- 6.45 The EAS only allows a bidder to be logged in from one computer at any one time.
- 6.46 The EAS allows bidders to make submissions and observe the progress of the auction, including the number of completed rounds; whether a round is currently running; and a countdown timer for making submissions when deadlines are in force. It also displays a clock synchronised with the auction server. Deadlines apply according to the time submissions are received at the server, not the time they are sent from the bidder's computer. Therefore, it is prudent for bidders to make submissions in good time prior to the end of each round to allow for network delays. Submissions are not processed by the EAS and results are not released until after the end of each round, so there is no strategic advantage to bidders in delaying submissions.

- 6.47 Making submissions during the principal stage using the EAS involves a two-step checking and confirmation process. The EAS will indicate whether a prospective bid submission is compliant with the auction rules and where this is not the case, will indicate to the bidder that the prospective bid is ineligible.
- 6.48 The EAS will provide summaries of each bidder's own submissions and also a history of round prices and any information to be disclosed about aggregate demand (in accordance with the Information Policy set out in the Regulations). Downloadable files of a bidder's own bids and of the auction history will be provided for transferring data to other software applications. These will be available in native comma separated value (.CSV) format.
- 6.49 The EAS provides a one-way messaging system that allows us to send notices to bidders. This will be our primary means of communicating with bidders about round schedules, deposit increase deadlines and other aspects of the award process. If bidders need to contact us, they will need to do so in accordance with the Regulations. We will provide specific contact details before the start of the principal stage.

## **Ofcom events related to the award process**

- 6.50 We will undertake remote training for bidders on the use of the electronic auction system, if this is required. This is in addition to applicants having access to a version of the software to run internal mock auctions and training.

## **Payment of Deposits and Ofcom's Bank Account**

- 6.51 Any sum payable by an applicant or bidder must be paid into the bank account specified by Ofcom, with accompanying information which identifies that applicant or bidder the value and date paid. We will publish on the spectrum awards section of the Ofcom website <https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards> details of the bank account into which deposits must be paid.
- 6.52 The Regulations set out when we may or will require deposit payments. We expect to give bidders at least one full business day to pay a deposit into Ofcom's bank account. After the auction has concluded, any excess funds placed on deposit in Ofcom's auction account, i.e. funds not subsequently required for payment in connection with the auction, will be returned to bidders. Any interest earned on deposits will be paid to HM Treasury.

## 7. Additional matters

### Future mobile spectrum

- 7.1 Ofcom's programme of spectrum awards is subject to change from time to time, as are other aspects of spectrum policy and regulations. The latest information on Ofcom's programme of spectrum awards is given on our spectrum awards website.<sup>53</sup>

### Shared access

- 7.2 We published a statement 'Enabling wireless innovation through local licensing: Shared access to spectrum supporting mobile technology' on 25 July 2019<sup>54</sup>. This statement set out our decision to make spectrum in the 3.8-4.2 GHz, 1800 MHz and 2300 MHz spectrum bands available through local licences; to introduce a new way to access spectrum that is already licensed to mobile operators (but which is not being used or planned for use in a particular area within the next three years) and adding the 24.25-26.5 GHz band to our spectrum sharing framework for indoor-only deployments. For the avoidance of doubt the 700 MHz and 3-6-3.8 GHz spectrum being auctioned would fall within the scope of the above shared access provisions.

### Limiting exposure to electromagnetic fields (EMF)

- 7.3 We published a consultation titled 'Proposed measures to require compliance with international guidelines for limiting exposure to electromagnetic fields (EMF)' on 21 February 2020<sup>55</sup>.
- We are proposing to include a specific condition in Wireless Telegraphy Act licences requiring licensees to comply with the relevant levels from the ICNIRP Guidelines. This condition would apply to all equipment which can transmit at powers above 10 Watts (including, for example, the licences of mobile phone companies, TV and radio broadcasters and most point-to-point microwave links).
  - We also propose to apply a similar approach for equipment that is exempt from the requirement to have a licence and that can transmit at powers above 10 Watts, such as certain types of satellite terminals.
  - In addition, we are proposing that spectrum licensees keep records (including the results of any measurements, tests and calculations) that demonstrate how they have complied with the ICNIRP Guidelines.
- 7.4 The consultation closes on 15 May 2020. We will publish a statement in 2020. If we proceed with the proposals and do so prior to the grant of the licences, we will revise the

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<sup>53</sup> <https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards>

<sup>54</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf)

<sup>55</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0013/190003/5g-condoc.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0013/190003/5g-condoc.pdf)

licences accordingly before grant. If we decide to proceed with the proposals after grant of the licences, then we will vary the licences to include the new conditions.

## Ofcom's work on mobile coverage

### Consumer information

7.5 Ofcom publishes reports on the UK's communications infrastructure, focusing on coverage and performance of fixed broadband and mobile networks. Our annual Connected Nations reports<sup>56</sup> (previously called Infrastructure Report) chart the UK's evolving communications infrastructure, and our progress towards becoming genuinely connected nations. In addition, we publish two smaller updates a year, which focus on the key changes in coverage since our last report.

### Ofcom consultations

7.6 Details of Ofcom consultations, those that are currently open and those that are closed, can be found on our website at <https://www.ofcom.org.uk/consultations-and-statements>.

### Competition from other services

7.7 Any party considering participating in the award process must make its own independent assessment of the competition that its services using the 700 MHz or 3.6-3.8 GHz bands will face from existing and future services, and the implications of this competition for the potential value of a licence.

7.8 As noted, Ofcom may authorise others to use spectrum to offer such services. Such authorisation may occur, for example, by way of the grant of new licences, decisions as to the variation of existing licences, or decisions as to exemptions from licensing.

7.9 As set out in the Spectrum Management Strategy and elsewhere, Ofcom's general policy is to move towards authorising the use of spectrum on a basis that provides much greater flexibility for the use of spectrum to respond to demand and to be economically efficient.

### Innovation and trial licences

7.10 We currently issue two classes of short-term non-operational wireless telegraphy licences<sup>57</sup>:

- Innovation and research – licensed for up to twelve months; and
- Demonstration and trial – licensed for up to twelve months.

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<sup>56</sup> <https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research>

<sup>57</sup> <https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/non-operational-licences>

- 7.11 These licences enable the use of spectrum on a non-commercial, non-permanent basis for activities such as the building or developing of apparatus, undertaking research and for trials and demonstrations of radio apparatus. Ofcom assesses the risk of potential interference to existing services and may contact existing authorised users in the course of that work. Any licences issued are on a non-interference and non-protected basis and can be withdrawn in the unlikely event of an issue arising.
- 7.12 At the time of this award, there may be non-operational licences in the spectrum bands being awarded which may continue, subject to not impacting the incoming operational services. Ofcom may issue further non-operational licences in future, again subject to non-interference to operational users.

### **Other non-commercial usage**

- 7.13 Ofcom may from time to time give advice to Crown bodies, such as the Foreign and Commonwealth Office regarding proposals for short-term use of frequencies by visiting diplomats and dignitaries.

### **UK Electronic Communications Code**

- 7.14 In December 2017, a new Electronic Communications Code took effect under the Communications Act 2003 to make it easier for network operators to install and maintain apparatus such as phone masts, exchanges and cabinets on public and private land. Further information on the UK Electronic Communications Code is available on the Ofcom website<sup>58</sup>.

### **Other regulation of the provision of electronic communication services and networks**

- 7.15 It is the responsibility of interested parties who are considering using the spectrum bands being awarded to provide electronic communication services or electronic communications networks to familiarise themselves with any relevant regulation. It should be noted that all aspects of regulation are subject to change from time to time, including without limitation the relevant legislative framework and the nature of regulation within any given legislative framework. In addition, decisions taken pursuant to existing regulation or decisions to establish or vary existing regulation may be subject to an appeal to the Competition Appeal Tribunal or (where relevant) the subject of judicial review proceedings and as a result of any decision, or subsequent appeal, the underlying regulation, provision or decision may need to be re-considered.
- 7.16 In general and by way of example, interested parties should note:

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<sup>58</sup> <https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/policy/electronic-comm-code>

- That there are General Conditions with which they may need to comply. Further information on the General Conditions is available on the Ofcom website<sup>59</sup>;
- That a number of operators may be subject to conditions imposed as a result of a finding of significant market power (SMP), which conditions may enable another operator to rely upon e.g. a right to obtain network access (which may be of a specified type) and other obligations, such as regulated prices;
- That if licensees wish to purchase access and interconnection from operators of existing networks for services in markets where those operators do not have SMP, our expectation is that these services should be negotiated commercially.

## European Electronic Communications Code

7.17 EU Directive 2018/1972<sup>60</sup> of 11 December 2018 established the European Electronic Communications Code. This Directive entered into force on 20 December 2018 and replaces the current EU communications framework. EU Member States are required to transpose the Directive into national legislation by 21 December 2020.

## International frequency allocation and harmonisation

7.18 All aspects of international arrangements are subject to change from time to time. Licensees will be required to ensure that their use of spectrum is consistent with the UK's international obligations. Interested parties should note that we cannot offer any protection to a licensee from spectrum users in neighbouring countries operating in accordance with international agreements.

## Tax

7.19 Any party considering participation in the award process must take its own advice on the tax consequences of being awarded a licence. Payment for WT Act licence fees are not subject to VAT.

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<sup>59</sup> <https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/telecoms-competition-regulation/general-conditions-of-entitlement>

<sup>60</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN>

## 8. Application instructions

### Application procedure

- 8.1 The procedure for making an application for a licence is set out in the Regulations. As explained in section 6, Ofcom will announce details of the relevant time and date for an application to be made on the Ofcom website.

### Contacts for enquiries

- 8.2 Any further enquiries relating to this Memorandum and the award process should be addressed in writing and sent directly to Ofcom at [radiospectrum.award@Ofcom.org.uk](mailto:radiospectrum.award@Ofcom.org.uk). Please ensure that the subject identifies the email as relating to the 700 MHz and 3.6-3.8 GHz award.

### Disclosure of further information

- 8.3 Following the issue of this Memorandum, Ofcom has the discretion to publish further information and to publish questions and answers provided. Ofcom may, however, exercise its discretion not to publish a particular question and answer, in whole or part. Ofcom also reserves the right to publish relevant guidance arising from an answer to such a question. The identity of questioners will not normally be published without their permission.

# A1. Example 700 MHz licence

[Company] – Spectrum Access 700 MHz Licence  
Company Reg No: xxxxxxxx  
First Issued: xx/xx/20 – Licence Number: xxxxxxxx – xx/xx/20

Office of Communications (Ofcom)  
Wireless Telegraphy Act 2006



## SPECTRUM ACCESS 700 MHz

Licence no: **xxxxxxx**  
Date of issue: **xx xxxx 2020**  
Date of commencement: **[Q2] 2020**  
Fee payment date: **xx xxxx** (annually from xx xxxx 2040)

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

**Company**  
(Company registration number **XXXX**)  
("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 from the date of commencement 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<sup>1</sup>;
  - f) for reasons related to the management of the radio spectrum, provided that in such a 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 xx xxxx 2040); or
  - 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 2020 ("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<sup>2</sup>.

#### **Changes to 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 xx xxxx 2040, the Licensee shall each year pay to Ofcom the relevant fee(s) as provided in section 12 of the Act and the regulations made thereunder on or before the fee payment date shown above, or on or before such dates as are 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.

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<sup>1</sup> These are regulations on spectrum trading.

<sup>2</sup> See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

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.

### **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 paragraph 4 of Schedule 1 to this Licence, the Licensee is authorised to establish, install and use the Radio Equipment in the United Kingdom. For the avoidance of

doubt, the United Kingdom includes the United Kingdom territorial sea (measured in accordance with section 1 of the Territorial Sea Act 1987) and does not include the Channel Islands or the Isle of Man.

## Interpretation

17. 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 “DTT Viewers” means viewers of digital terrestrial television services operating at frequencies below 694 MHz who suffer or may be likely to suffer undue interference from mobile services.
- (c) the expressions “interference” and “undue interference” shall have the meanings given by section 115 of the Act;
- (e) the expression “Scheme” means a scheme for the purpose of providing information and advice to DTT Viewers and assisting DTT Viewers to resolve undue interference suffered by them as a result of the Licensee’s use of the Radio Equipment, which meets the requirements in the Scheme Notice;
- (f) the expression “Scheme Notice” means the notice notified by Ofcom to each licensee of the 694-790 MHz frequency range which either:
  - (i) confirms the provisional scheme submitted jointly by all such licensees by [DATE];
  - (ii) confirms the provisional scheme submitted jointly by all such licensees by [DATE] but with such changes as Ofcom considers necessary to meet the policy objectives in “Award of the 700 MHz and 3.6-3.8 GHz spectrum bands”; or
  - (iii) Ofcom has devised in the absence of any provisional scheme submitted jointly by all such licensees by [DATE] which Ofcom considers appropriate to meet the policy objectives in “Award of the 700 MHz and 3.6-3.8 GHz spectrum bands”,  
and which at the date of this Licence is the notice set out in [THE TITLE OF THE NOTICE WE WILL NOTIFY TO THE LICENSEE] and which may be amended from time to time with the prior written consent of Ofcom or by Ofcom on reasonable notice to all such licensees;
- (g) the expression “territorial sea” shall be determined in accordance with the Territorial Sea Act 1987;
- (h) the expressions “wireless telegraphy station” and “wireless telegraphy apparatus” shall have the meanings given by section 117 of the Act;
- (i) 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
- (j) 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: xxxxxxxx**

**Schedule Date: xx xxxx 2020**

**Licence category: Spectrum Access 700 MHz**

## **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 20xx: Terrestrial systems capable of providing electronic communications services in the 700 MHz band

## **Special conditions relating to the Radio Equipment**

3.
  - (a) Subject to paragraphs 3(b) and (c) 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,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.
- (f) During the period this Licence remains in force, unless consent has otherwise been given in writing by Ofcom, the Licensee shall operate the Scheme and comply with its obligations in the Scheme Notice. The Licensee shall provide to Ofcom and any entity established as part of the Scheme, in such manner and at such times as they may reasonably require, such documents or other information as they may require for the purposes of the Scheme's operation, monitoring that operation and assessing its appropriateness and effectiveness.
- (g) In relation to any frequency between 738 MHz and 758 MHz within the Permitted Frequency Blocks (see paragraph 6 below) in any area in the United Kingdom, the Licensee shall only be authorised to use the Radio Equipment to transmit where it has:
  - (i) given Ofcom at least three months' (or such other period as Ofcom shall determine) written notice of the following specified matters and that notice period has expired. The specified matters are, in respect of the Radio Equipment the Licensee intends to use:
    - (a) the nature of the equipment and the purpose of its use;
    - (b) the extent of that use and the geographic areas in which it will occur;
    - (c) the date or dates on which the Licensee intends to begin using the Radio Equipment to transmit within the Permitted Frequency Blocks;
    - (d) such other information as Ofcom may specify; and
  - (ii) simultaneously given Arqiva at least three months' written notice of the date on which it intends to begin using the Radio Equipment to transmit within the Permitted Frequency Blocks and that such notice period has expired.

## **Coordination at frequency and geographical boundaries and compliance with other procedures relating to interference**

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. The Licensee shall also ensure that it complies with any other procedures relating to the mitigation of interference as may be notified to the Licensee by Ofcom from time to time.

## 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.

## Permitted Frequency Blocks

6. Subject to the emissions permitted under paragraph 10 of this Schedule, the Radio Equipment may only transmit within the following frequency bands (the “Permitted Frequency Blocks”):

Downlink frequencies	[Uplink frequencies]
xxx – xxx MHz [; and xxx – xxx MHz]	[xxx – xxx MHz]

## Maximum power within the Permitted Frequency Blocks

7. 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:

- (a) Downlink Frequencies

<i>Radio Equipment</i>	<i>Maximum mean power dBm / 5 MHz EIRP per antenna</i>
Base station*	64

- \* For femtocell base stations, power control must be applied to minimise interference to adjacent channels.

(b) Uplink Frequencies<sup>3</sup>

<i>Radio Equipment</i>	<i>Maximum mean power</i>
Fixed or installed Radio Equipment*	23 dBm EIRP
Mobile or nomadic Radio Equipment*	23 dBm TRP

\* The maximum mean power relates to the EIRP or TRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas. This value is subject to a tolerance of up to + 2 dB, to take account of operation under extreme environmental conditions and production spread.

## Maximum power of base stations outside the Permitted Frequency Blocks

8. For transmissions on the downlink frequencies, the EIRP emanating from the Radio Equipment transmissions at any frequency outside the downlink frequencies of the Permitted Frequency Blocks, but within 738 – 788 MHz, shall not exceed:

<i>Frequency Range</i>	<i>Maximum mean EIRP limit dBm / 5 MHz EIRP per antenna</i>
-5 to 0 MHz offset from lower block edge 0 to 5 MHz offset from upper block edge	22
-10 to -5 MHz offset from lower block edge 5 to 10 MHz offset from upper block edge	18
Out of block baseline power limit (BS) < -10 MHz offset from lower block edge > 10 MHz offset from upper block edge	16

<sup>3</sup> Consumer user equipment will be authorised by means of a licence exemption under section 8 of the Wireless Telegraphy Act 2006

9. In addition, the EIRP emanating from the Radio Equipment transmissions at any frequency outside the downlink frequencies of the Permitted Frequency Blocks shall not exceed the higher (least stringent) of (a) the baseline requirements and (b) the transitional requirements for that frequency.

(a) Baseline requirements

<i>Frequency Range</i>	<i>Maximum mean EIRP limit</i>
470 – 694 MHz	-23 dBm / 8 MHz per cell
694 – 703 MHz	-32 dBm / 1 MHz per cell
703 – 733 MHz	-50 dBm / 5 MHz per cell
733 – 738 MHz	16 dBm / 5 MHz per antenna
788 – 791 MHz	14 dBm / 3 MHz per antenna
791 – 821 MHz	16 dBm / 5 MHz per antenna
832 – 862 MHz	-49 dBm / 5 MHz per cell

(b) Transitional requirements

for a block with lower edge at 738 MHz

<i>Frequency Range</i>	<i>Maximum mean EIRP limit</i>
733 – 738 MHz	22 dBm / 5 MHz per antenna

for a block with lower edge at 743 MHz

<i>Frequency Range</i>	<i>Maximum mean EIRP limit</i>
733 – 738 MHz	18 dBm / 5 MHz per antenna

for a block with upper edge at 783 MHz

<i>Frequency Range</i>	<i>Maximum mean EIRP limit</i>
788 – 791 MHz	16 dBm / 3 MHz per antenna
791 – 796 MHz	17 dBm / 5 MHz per antenna

for a block with upper edge at 788 MHz

<i>Frequency Range</i>	<i>Maximum mean EIRP limit</i>
788 – 791 MHz	21 dBm / 3 MHz per antenna
791 – 796 MHz	19 dBm / 5 MHz per antenna
796 – 801 MHz	17 dBm / 5 MHz per antenna

## Maximum power of terminals outside the Permitted Frequency Blocks

10. For transmissions on the uplink frequencies, the EIRP emanating from the Radio Equipment transmissions at any frequency outside the uplink frequencies of the Permitted Frequency Blocks shall not exceed:

<i>Frequency Range</i>	<i>Maximum mean EIRP limit*</i>
470 – 694 MHz	-42 dBm / 8 MHz
694 – 698 MHz	-7 dBm / 4 MHz
698 – 703 MHz	2 dBm / 5 MHz

\* The power limits are specified as equivalent isotropically radiated power (EIRP) for terminal stations designed to be fixed or installed and as total radiated power (TRP) for terminal stations designed to be mobile or nomadic. The maximum mean power relates to the EIRP or TRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas.

## Interpretation of terms in this schedule

11. In this Schedule:
- (a) **dBm** means the power level in decibels (logarithmic scale) referenced against 1 milliwatt (i.e. a value of 0 dBm is 1 milliwatt);
  - (b) **Downlink** means transmissions from a base station or repeater to a terminal station (handset);
  - (c) **EIRP** means the equivalent isotropically radiated power. This is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain), measured during the “on” part of the transmission;
  - (d) **femtocell** means Radio Equipment transmitting on the downlink frequencies, 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) **Fixed or installed** means used or installed at specific fixed points;
  - (f) **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) **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);

- (h) **lower block edge** means, in relation to each Permitted Frequency Block, the lowest frequency in that Permitted Frequency Block;
- (i) **measurement bandwidth** means the size of an individual spectrum segment within the specified frequency range that is used to measure compliance with the specified power limit;
- (j) **mobile or nomadic** means intended to be used while in motion or during halts at unspecified points;
- (k) **per antenna** means per radiating unit/component (irrespective of the number of radiating elements that make up that unit/component);
- (l) **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;
- (m) **Permitted Frequency Blocks** has the meaning given to it in paragraph 6 of this Schedule;
- (n) **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 frequencies when actively carrying a call (voice, video or data) or signalling from serviced handsets;
- (o) **TRP** means the total radiated power. This is the integral of the power transmitted in different directions over the entire radiation sphere;
- (p) **Uplink** means transmissions from a terminal station (handset) to a base station; and
- (q) **upper block edge** means, in relation to each Permitted Frequency Block, the highest frequency in that Permitted Frequency Block.

## A2. Example 3.6-3.8 GHz licence

Company Limited – Spectrum Access 3.6-3.8 GHz Licence  
Company Reg No: xxxxxxxx  
First Issued: xx/xx/20 – Licence Number: xxxxxxxx – xx/xx/20

Office of Communications (Ofcom)  
Wireless Telegraphy Act 2006



### SPECTRUM ACCESS 3.6 – 3.8 GHz

Licence no: xxxxxxxx  
Date of issue: xx xxxx 2020  
Fee payment date xx xxxx (annually from xx xxxx 2040)

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

**Company**  
(Company registration number XXXX)  
("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<sup>1</sup>;
  - (f) for reasons related to the management of the radio spectrum, provided that in such a case the power to revoke may only be exercised after at least five years' notice is given in writing (such notice must not expire before XX XXXX 2040); or
  - (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 2020 ("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<sup>2</sup>.

#### **Changes to 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 XX XXXX XXXX, the Licensee shall each year pay to Ofcom the relevant fee(s) as provided in section 12 of the Act and the regulations made thereunder on or before the fee payment date shown above, or on or before such dates as are 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

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<sup>1</sup> These are regulations on spectrum trading.

<sup>2</sup> See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

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.

### **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 2020**

Licence category: **Spectrum Access 3.6-3.8 GHz**

### 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 (including whether AAS or non-AAS), and boresight bearing east of true north (if applicable);
    - (iv) radio frequencies which the Radio Equipment uses;
    - (v) transmitted power expressed in dBm / 5 MHz EIRP per cell for non-AAS Radio Equipment; and
    - (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 – 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:

<i>Radio Equipment</i> <sup>3</sup>	<i>Maximum mean power</i>
non-AAS base station <sup>[a]</sup>	65 dBm / 5 MHz EIRP per cell
AAS base station <sup>[a]</sup>	44 dBm / 5 MHz TRP per cell
Mobile or nomadic terminal station <sup>[b]</sup>	28 dBm TRP
Fixed or installed terminal station <sup>[b]</sup>	35 dBm / 5 MHz EIRP

<sup>[a]</sup> For femtocell base stations, power control must be applied to minimise interference to adjacent channels.

<sup>[b]</sup> The maximum mean power relates to the EIRP or TRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas.

## 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, the Licensee must also transmit within the limits of transmission Frame Structure B.

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<sup>3</sup> Consumer user equipment will be authorised by means of licence exemption under section 8 of the Wireless Telegraphy Act 2006

10. The Permissive Transmission Mask means that –

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

	Non-AAS <i>dBm / 5 MHz EIRP per antenna</i>	AAS <i>dBm / 5 MHz TRP per cell</i>
-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) < -10 MHz offset from lower block edge > 10 MHz offset from upper block edge	Min(PMax – 43, 13)	Min(PMax' – 43, 1)

11. The Restrictive Transmission Mask means that –

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

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

12. Frame Structure A (also commonly 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;

- e) 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 commonly 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) 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(f);
- f) the Licensee must cooperate with other licensees 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 downlink-only frame structures such as Supplementary Downlink (SDL) are not permitted.
- h) 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
	D	S	U							

14. Irrespective of whether the Restrictive Transmission Mask or the Permissive Transmission Mask is being used, the EIRP or TRP 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 <i>dBm / MHz<sup>[a]</sup> EIRP per antenna</i>	AAS <i>dBm / MHz<sup>[a]</sup> TRP per cell</i>
Below 3390 MHz	-50	-52

<sup>[a]</sup> We note this level is defined in the Commission Decision 2019/235/EU as per MHz rather than per 5 MHz

	Non-AAS <i>dBm / 5 MHz EIRP per antenna</i>	AAS <i>dBm / 5 MHz TRP per cell</i>
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

## Small Cells

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

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;
- c) **dBm** means the power level in decibels (logarithmic scale) referenced against 1 milliwatt (i.e. a value of 0 dBm is 1 milliwatt);
- d) **Downlink** means transmissions from a base station to a terminal station (handset);
- 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;
- f) **femtocell** means 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;
- g) **Fixed or installed** means used or installed at specific fixed points;
- 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;
- i) **Indoor Domestic Small Cell** means a base station with an EIRP of less than or equal to 24 dBm per 20 MHz carrier that is located within a residential property;
- j) **Indoor Non-domestic Small Cell** means a base station with an EIRP of less than or equal to 24 dBm per 20 MHz carrier that is located Indoors but not within a residential property;
- 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);
- 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 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;
- 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 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 if it is using an AAS. This is measured as TRP per carrier and determined on a per cell basis;
- t) **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;
- u) **TDD** means the application of time-division multiplexing to separate uplink and downlink signals;
- v) **TD-LTE** means the TDD variant of LTE (Long Term Evolution or 4G technology);
- w) **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;
- x) **Uplink** means transmissions from a terminal station (handset) to a base station; and
- y) **upper block edge** means, in relation to each Permitted Frequency Block, the highest frequency in that Permitted Frequency Block.

## A3. Guidance on 700 MHz band coexistence

### Summary

- A3.1 Future use of the 700 MHz band by mobile services presents the risk of undue interference to some DTT viewers. That is, interference from mobile signals which degrades, obstructs or repeatedly interrupts the images, sounds and messages in DTT broadcasts.
- A3.2 To ensure viewers can continue to enjoy the benefits DTT services provide, those suffering from such interference need appropriate information about how to seek help and support should be given to them when they need it. Failing to provide it might leave viewers at risk. Vulnerable consumers could be particularly susceptible to harm.
- A3.3 Licences for spectrum in the 700 MHz band (694 - 790 MHz) therefore contain co-existence and viewer support obligations to ensure that they take appropriate and proportionate measures to resolve any undue interference to DTT viewers. These obligations require licensees to operate a scheme, approved by Ofcom,<sup>1</sup> to provide information and advice to DTT viewers who suffer undue interference caused by mobile services using the band and to provide them with assistance to resolve it. Licensees are required to submit a joint plan for a co-existence scheme or schemes to Ofcom for approval.
- A3.4 The purpose of this guidance is to assist mobile licensees by outlining our expectations for the kind of viewer support scheme Ofcom is likely to approve and how we are likely to assess whether licensees are meeting their obligations. There are three aspects of our guidance, to which licensees should refer when developing their plans for their viewer support schemes.
- a) First, we set out which viewers the 700 MHz licensees are required to support under their licence obligation.
  - b) There are then four broad areas of viewer support in which we will usually expect the 700 MHz licensees to make provisions in order that DTT viewers are protected from undue interference. We would normally expect that licensees would need to make provisions in at least these areas to meet their licence obligations.
  - c) In each of the four areas, there are then more specific considerations we might normally expect the 700 MHz licensees to take account of. However, licensees may be able to meet their licence obligations in other ways, provided the scheme they operate gives DTT viewers adequate protection from interference.
- A3.5 This guidance is not legal advice on how licensees should comply with their licence obligations; nor does it prescribe rules in addition to the licence conditions. While Ofcom is likely to take account of it in assessing whether to approve licensees' schemes and whether they are meeting their obligations, licensees may formulate other schemes and

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<sup>1</sup> Or, in default of a scheme being approved by Ofcom, in accordance with a scheme we impose.

seek our approval for them. They may also take other steps to meet their obligations (provided they continue to meet them).

## The viewers we expect the 700 MHz licensees to assist

- A3.6 In general, the guidance here applies to the provision of information, advice and assistance to DTT viewers using rooftop aerials who lack other means of receiving TV services.
- A3.7 The licensees should also ensure that advice is available to viewers with indoor aerials. However, we are unlikely generally to require licensees to offer mitigation assistance and resolve interference to these viewers.
- A3.8 Some DTT viewers may be affected by interference but have other means to receive TV channels via a cable or satellite pay TV subscription (e.g. from Sky or Virgin Media). In these cases, licensees should consider proportionate means of helping these viewers. For example, they could choose to ensure that advice is available and that filters are available via retail, but we would not generally expect them to provide the full set of assistance measures that may be available to DTT-only users.
- A3.9 We will not require any consumer assistance scheme to help recover TV services provided on an interim basis in the 700 MHz band. The provider of these TV services, Arqiva, may separately make its own arrangements to offer support to viewers affected by interference should it wish to do so.
- A3.10 Viewers who experience interference may include vulnerable people. We will expect viewer support schemes to make specific provision to protect these viewers, who may be at increased risk of harm on account of their vulnerability and may consequently require a higher level of support.

## Areas in which we expect licensees to make provisions for viewer support

- A3.11 Below we outline the broad areas where we will usually expect the 700 MHz licensees to make provisions in order to provide support to viewers affected by undue interference.
- a) **Engaging with consumers** – We would normally expect licensees to make reasonable arrangements to inform viewers who are at risk of being affected by undue interference.
  - b) **Assisting viewers who experience problems** – We expect licensees to make arrangements to provide information and advice to viewers who experience undue interference from mobile services in the 700 MHz band and to assist them to resolve it.
  - c) **Helping vulnerable consumers** – We would normally expect licensees to take account of the needs of vulnerable consumers, both in terms of communication and the information, advice and assistance they provide to resolve problems. This may involve delivering a higher level of service to vulnerable viewers than other DTT viewers receive.

- d) **Operational functions** – Licensees are required to make reasonable arrangements for the operational side of supporting DTT viewers. This includes how the costs of viewer support will be funded, how the required scheme will be operated and managed and its performance tracked, and how evidence of these matters will be provided to Ofcom.

## Specific guidance

- A3.12 In the following section we provide further detail on the specific considerations within each of the above we will usually apply, including the kind of measures they could involve. We would usually expect these to be covered in the plans for schemes submitted by licensees.

## Engaging with consumers

### Advice line

- A3.13 Viewers who experience interference may not know how to resolve their problems. We would therefore anticipate that a viewer support scheme would provide a source of information that viewers can turn to. For this reason, we would normally expect licensees to operate an advice line that viewers can contact.
- A3.14 Multiple advice lines (each run by a separate 700 MHz licensee) may create difficulties for viewers, inhibit their seeking help and limit a scheme's effectiveness. For this reason, we would normally expect licensees to provide a single advice line, with one number to call, to serve as a sole point of contact for viewers, even if licensees choose to have more than one entity implementing other parts of the scheme.
- A3.15 Licensees could meet the expectation to provide an advice line in different ways. For instance, they might decide to set up a new call centre to field calls related to 700 MHz interference or enter into a commercial agreement with another party to provide this service.

### Advertising and communications

- A3.16 Consumers will need to know what help is available to them should their DTT service suffer from interference. Failing this, viewers are unlikely to know who to contact to resolve their problems.
- A3.17 Therefore, we would normally expect licensees to make reasonable efforts to advertise the existence of an advice line as well as the availability of assistance to resolve interference issues. There are a number of channels that licensees might consider using to reach consumers, including social media, print advertising and "pop-up" messages on viewers' TV screens.
- A3.18 We would also normally expect licensees to consider how to communicate proactively with viewers who received assistance from at800 in confirmed cases of 4G interference. Viewers who suffered interference to their DTT service caused by mobile in the 800 MHz

band are more likely to be at high risk of interference from mobile services in the 700 MHz band.

## Assisting consumers who experience undue interference to resolve it

### Providing filters

- A3.19 Most reception problems resulting from 700 MHz coexistence issues can be fixed via the installation of a 700 MHz filter to the back of the television. Filters are smaller than a pack of cards and most people should be able to install them themselves without difficulty.<sup>2</sup> However, viewers could be left at risk of wasting time and money on ineffective equipment if required to seek out and purchase the appropriate model of filter on their own.
- A3.20 We would therefore normally expect licensees to take appropriate and proportionate measures to help viewers who experience undue interference from mobile in the 700 MHz band. We would normally expect this to involve sending a filter to viewers who contact the advice line and who are considered to be suffering from interference resulting from mobile in the 700 MHz band.
- A3.21 We would also normally expect additional assistance to be given to consumers if a filter does not resolve their interference problem. Licensees' obligations are to provide viewers with assistance to resolve undue interference they cause. A key consideration, therefore, is that the licensees must take those steps that appear appropriate and proportionate in the circumstances to ensure an effective remedy.

### Helping vulnerable consumers

- A3.22 Some people's ability to participate in society and receive services is affected by factors such as age-related conditions, disability or income. Life events such as bereavement, redundancy or illness can also temporarily affect them.
- A3.23 Some vulnerable consumers may face greater risk of missing advertising messages or be less able to make use of an advice line. For instance, a TV viewer with a visual impairment could miss on-screen messages. Some vulnerable consumers may be less able to install a filter by themselves. Mobility issues, for example, may prevent a vulnerable person from accessing the rear of their television to plug in the filter.
- A3.24 We would normally expect licensees to make specific arrangements to communicate with vulnerable consumers. Consumers may be considered vulnerable due to circumstances such as:
- a) age (particularly those over 75 years);
  - b) physical or learning disability;
  - c) physical or mental illness;

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<sup>2</sup> In research for 800 MHz coexistence, 95% of people said that fitting the filter having seen instructions was "easy".  
[https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0024/45528/dttinterference.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0024/45528/dttinterference.pdf)

- d) low literacy;
- e) communications difficulties; or
- f) changes in circumstances, such as bereavement.

- A3.25 There are a number of ways in which licensees may give special consideration to communicating with vulnerable consumers. For example, they might engage with community organisations with expertise in disseminating information among vulnerable people.
- A3.26 We would also normally expect licensees to make reasonable arrangements to resolve vulnerable consumers' interference issues. This might involve making reasonable adjustments to the measures they offer other viewers. Such adjustments might include, for example, a home visit from an engineer, in lieu of sending a filter in the mail, when callers to the advice line identify themselves as vulnerable consumers.

## **Operational functions**

### **Tracking performance**

- A3.27 Once support for DTT viewers affected by coexistence issues has been set up, it is important that licensees are able to track its performance. This will ensure that viewer support delivers positive outcomes and identifies where changes might improve performance.
- A3.28 We would therefore normally expect licensees to adopt KPIs and / or SLAs and use them to track the performance of viewer support over its lifetime. Examples of areas in which it might be valuable to measure performance might include the timely delivery of filters to consumers with interference problems, the successful restoration of service to viewers, assistance provided to vulnerable consumers and the number of complaints received.
- A3.29 We would normally expect licensees to report quarterly to Ofcom on the performance of the support scheme, though the intervals between reports could be shorter as required. Licensees can therefore expect to need to keep records of performance and to ensure that this information is in a format that can easily be shared and understood.
- A3.30 Should it appear to Ofcom that viewer support is failing to achieve its objectives, then we would review its activities. The KPIs developed by licensees would assist us in reaching this decision. We would also be guided by the performance of the scheme in comparison to past viewer support operations (specifically the 800 MHz viewer support scheme and the viewer support scheme to assist viewers affected by 700 MHz clearance events).

### **Complaints**

- A3.31 In order to have their plan approved by Ofcom, the 700 MHz licensees will have to demonstrate that overall it will deliver an effective and good quality service to viewers and produce positive outcomes for them. However, it is possible that individual DTT viewers

may still find their interactions with the viewer support provider (or providers) unsatisfactory.

- A3.32 Therefore, we would normally expect licensees to demonstrate that they have made appropriate arrangements for managing any consumer complaints that may arise in the operation of the viewer support scheme.

### **Funding and management**

- A3.33 We would expect to see an indication in the plan submitted by licensees that reasonable consideration has been given to the costs involved in delivering the funding scheme.
- A3.34 This would be even more important should licensees choose, as they may, to form a single joint entity to deliver support to viewers along the lines of DMSL. In that case we might expect to see not only that licensees have considered the cost of delivering the support scheme, but also to how they will split this cost between themselves and the arrangements they make for the effective operation, management and oversight of any such body.
- A3.35 We would also expect to see in the plan submitted by licensees an appropriate upper limit for the cost of service restoration to ensure that the support offered to consumers remains proportionate to the scale of the interference problem.

### **Change control**

- A3.36 Once viewer support is in operation, experience may show the need to react to new information or changing circumstances. This may necessitate changes to the initial plan submitted to Ofcom. We consider it appropriate to allow licensees to retain the flexibility to adapt to new information and to amend their approach to supporting viewers accordingly.
- A3.37 However, we would normally expect licensees would need to submit any changes to the plan for consideration and approval by Ofcom.

### **Scheme duration**

- A3.38 Viewer support should only address interference into DTT from mobile services operating in the 700 MHz band and should not continue indefinitely. Therefore, we would expect to see a timeframe for support scheme operation in the plan submitted by licensees.

## A4. Notice: Interim coordination procedure for 3.6-3.8 GHz spectrum access licences

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Notice: Interim coordination procedure for 3.6-3.8 GHz spectrum access licences

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## About this document

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This notice sets out the interim co-ordination procedure that 3.6-3.8 GHz spectrum access licensees must follow before transmitting from base stations in the 3.6-3.8 GHz band.

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# 1. Introduction

- 1.1 The notice sets out the interim co-ordination procedure to be followed by 3.6-3.8 GHz spectrum access licensees prior to transmitting from base stations in the frequency band 3.6-3.8 GHz. Co-ordination will be effected by means of a 'co-ordination tool' administered by Ofcom.
- 1.2 As of the date of issue of the 3.6-3.8 GHz spectrum access licences, there are a number of incumbent Fixed Link (FL) and Permanent Earth Station (PES) licences and grants of Recognised Spectrum Access (RSA) in the frequency band 3.6-3.8 GHz. In December 2017, Ofcom issued notices to revoke all FL licences in the band with an effective date of 23 December 2022. At the same time Ofcom varied PES licences and grants of RSA, such that we will no longer take satellite earth stations with a receiver component in the band into account for frequency management purposes. These variations are currently in effect except for one grant of RSA which will come into effect on 1 September 2020.
- 1.3 During the interim period Ofcom will ensure the protection of the incumbent FL and PES licensees and grant of RSA by means of the procedure set out in this notice.
- 1.4 This notice will remain in place until the 23 December 2022 (or sooner if the remaining FL licensees vacate the band before this date).

## 2. Procedure

- 2.1 When planning its network deployments, a 3.6-3.8 GHz spectrum access licensee must check whether any of its base stations are located within the co-ordination areas defined in Annex A1 of this notice.
- 2.2 For any base station within a co-ordination area, the 3.6-3.8 GHz licensee must submit the technical details, as defined in Annex A2 of this notice, prior to transmitting on any frequency within the 3.6-3.8 GHz band.
- 2.3 For practical reasons, Ofcom is not able to process individual base stations through the co-ordination tool. Therefore, unless agreed with Ofcom beforehand, 3.6-3.8 GHz spectrum access licensees are required to submit technical details in batches of at least 100 sites. As it is more efficient for Ofcom to process larger batch sizes, licensees are encouraged to submit batches that are as large as possible. Submitting multiple small batches will result in slower processing through the co-ordination tool and may lead to delays in Ofcom providing results.
- 2.4 Upon receipt of a batch of technical details Ofcom will determine, using the co-ordination tool, whether any base station in the batch is likely to cause interference to a FL, or to a PES or RSA Earth station.
- 2.5 In the case that interference is predicted, Ofcom will inform the 3.6-3.8 GHz spectrum access licensee of all base stations that have failed co-ordination, we will provide information indicating which PES or RSA Earth station and/or which FL the base stations have failed against and the margin of each failure. Licensees may not transmit from base stations that have failed co-ordination on any frequency within the 3.6-3.8 GHz band prior to a specified date<sup>1</sup>. Licensees may transmit from base stations that have passed co-ordination provided they stay within the submitted technical details.
- 2.6 At their choice, 3.6-3.8 GHz spectrum access licensees may resubmit, with amended technical details, any base stations that have failed co-ordination. If they then pass co-ordination, the 3.6-3.8 GHz spectrum access licensee may transmit from these base stations provided they stay within the re-submitted technical details.
- 2.7 For the avoidance of doubt, Ofcom is not able to provide further information, guidance or advice about base stations that have failed co-ordination; nor is Ofcom able to facilitate further/detailed discussion between 3.6-3.8 GHz spectrum access licensees and FL and PES licensees and RSA grantee.

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<sup>1</sup> For interference into FL, the date will be 23 December 2022 (sooner if FL licensees agree to vacate earlier). For interference into the RSA earth station, the date will be 1 September 2020.

# A1. Co-ordination areas

200 km from the locations specified below.

Earth stations:

Station name	Licence centre point location	Earth station deployment locations (co-ordination points)	End date
Crowsley Park	SU 72781 80385	SU 72781 80385, SU 72830 80387	01/09/2020

Fixed Links locations:

NGR location (Link end 1)	NGR location (Link end 2)	End date
NG 75520 89850	NB 30500 30290	23/12/2022
HY 78450 55800	HU 38740 18780	23/12/2022
HY 62760 37330	HZ 21290 73180	23/12/2022
HY 62760 37330	HY 41270 11600	23/12/2022
HY 78450 55800	HY 36580 21020	23/12/2022
ND 17770 65820	HY 37700 10190	23/12/2022
SU 65650 05400	SZ 44730 86540	23/12/2022
HY 62760 37330	HZ 21290 73180	23/12/2022
HY 78450 55800	HU 38740 18780	23/12/2022
HY 62760 37330	HY 41270 11600	23/12/2022
NG 75520 89850	NB 30500 30290	23/12/2022
NG 75520 89850	NG 78600 42390	23/12/2022
HU 50300 38700	HZ 21290 73180	23/12/2022
NG 75520 89850	NB 30500 30290	23/12/2022
HY 78450 55800	HY 36580 21020	23/12/2022
ND 17770 65820	HY 37700 10190	23/12/2022

## A2. Technical details

Below we define the details and format of the files containing the station information necessary to carry out the coordination.

Files should be submitted in a specific format (a .xlsb Excel binary file), with a set of columns as follows:

Index Column	Name	Comments
1	Assignment ID	
2	Link ID	
3	Type	
4	Name of Station	Alphanumerical, as defined by stakeholder
5	Service	
6	Sub-Service	
7	Class of Station	
8	Co-ordinate Reference	NGR
9	Station Location X	6-digit NGR location
10	Station Location Y	
11	Network ID	
12	Antenna Location	OUTDOOR/INDOOR
13	Antenna Height (m) - AGL	Antenna above ground level value (m)
14	HCM V Code	
15	HCM H Code	
16	Antenna Gain	Antenna boresight gain (dB)
17	Antenna Azimuth (degrees)	Antenna azimuth (degree)
18	Antenna Elevation	Antenna elevation (degree). Negative values refer to down-tilt angles.
19	Tx Frequency (MHz)	Transmission frequency (MHz)
20	Rx Frequency (MHz)	Reception frequency (MHz)
21	Bandwidth (MHz)	Bandwidth (MHz)
22	Channel Spacing (MHz)	Channel Spacing (MHz)
23	Power Reference	
24	Radiated Power (dBW)	E.I.R.P (dBW)
25	Antenna Polarisation	Horizontal, Vertical or Cross-Polar
26	Coverage Radius (km)	
27	Validity Start Date	
28	Validity End Date	
29	MPL (dBm)	
30	T/I (dB)	
31	Result	
32	Result Margin (dB)	
33	Description of Result	

34	Channel Priority	
35	Location (Indoor,Outdoor)	
36	Airborne (for information)	
37	Antenna Type	Reference given by Ofcom
38	Antenna Beamwidth (Degrees)	
39	Tx Station Activity Factor	
40	Tuning Range Start (MHz)	
41	Tuning Range End (MHz)	
42	Tuning Range Step (kHz)	
43	Tuning Range Duplex Space (kHz)	
44	Spec Efficiency Class	Reference given by Ofcom
45	Antenna Ident	Reference given by Ofcom

A5. Notice: In-band restriction zones around satellite earth stations in the 3.6-3.8 GHz band

Notice: In-band restriction zones around satellite earth stations in the 3.6-3.8 GHz band

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## About this document

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This notice sets out the procedure that 3.6-3.8 GHz spectrum access licensees must follow before transmitting from base stations in the 3.6-3.8 GHz band in order to respect the in-band restriction zones around satellite earth stations in 3.6-3.8 GHz.

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# 1. Introduction

- 1.1 The notice sets out the procedure that 3.6-3.8 GHz spectrum access licensees must follow prior to transmitting from base stations in the frequency band 3.6-3.8 GHz in order to respect the in-band restriction zones around specific satellite earth stations in 3.6-3.8 GHz.
- 1.2 As of the date of issue of the 3.6-3.8 GHz spectrum access licences, there is one grant of Recognised Spectrum Access (RSA) which authorises use of frequencies in the 3.6-3.8 GHz band. In December 2017, Ofcom varied PES licences and grants of RSA, such that we will no longer take satellite earth stations with a receiver component in the band into account for frequency management purposes. These variations are currently in effect except for one grant of RSA which will come into effect on 1 September 2020.
- 1.3 In October 2017<sup>1</sup> we told the operators of satellite earth stations that they could continue to operate in the band on a licence exempt basis following the end of the periods indicated above (noting that their ability to continue to receive without suffering interference, that might adversely affect their service, could vary between sites), and that we would explore the possibility of applying localised restrictions in future licences to facilitate continuing operation of satellite services in the 3.6-3.8 GHz band, where these would not have a material impact on mobile deployment.
- 1.4 Four satellite earth station operators have expressed an interest in restriction zones around their sites and we have concluded that a restriction zone with a radius of 1km around each site would be appropriate to ensure new mobile base stations will not be situated directly next to their SES sites, while meeting the objective to ensure that constraints to mobile deployment be kept to a minimum and whilst not preventing MNOs from offering mobile services in the area affected.
- 1.5 This notice applies to 3.6-3.8 GHz spectrum access licences and is effective from 1 June 2020.

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<sup>1</sup> <https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-at-3.6-3.8-ghz>

## 2. Procedure

- 2.1 When planning its network deployments, a 3.6-3.8 GHz spectrum access licensee must check whether any of its base stations are located within the satellite earth station (SES) restriction zones defined in Annex A1 of this notice.
- 2.2 For any base station within a restriction zone, the 3.6-3.8 GHz spectrum access licensee must ensure that the calculated signal power at the centre point of restriction zone within any 5 MHz portion of the 3.6-3.8 GHz band is no greater than -43 dBm/5 MHz.
- 2.3 The 3.6-3.8 GHz spectrum access licensee must calculate the power level at the centre point of restriction zone, assuming free space path loss, according to the following formula:

$$P_{Rx} = P_{Tx} - L_{fs} \quad (\text{dBm/5 MHz})$$

where:

$P_{Rx}$ : Power received at the centre point of restriction zone (dBm/5 MHz)

$P_{Tx}$ : Equivalent isotropically radiated power from the base station in the direction of the centre point of restriction zone (dBm/5 MHz) including accounting for base station antenna downtilt

$L_{fs}$ : Free space path loss between the base station and centre point of restriction zone (dB)

and where:

$$L_{fs} = 32.4 + 20 \log f + 20 \log d \quad (\text{dB})$$

where:

$f$ : frequency of transmission (MHz)

$d$ : distance between the base station and the centre point of restriction zone (km).

- 2.4 The 3.6-3.8 GHz spectrum access licensee must maintain records demonstrating that the requirements of this notice have been met for all base stations deployed within each satellite earth station restriction zone and must make these records available to Ofcom on request.
- 2.5 For the avoidance of doubt, 3.6-3.8 GHz spectrum access licensees do not need to apply the procedure in this notice to any base station located outside the restriction zones defined in Annex A1 of the notice.

# A1. Restriction zones

1 km from the locations specified below

Name Station	NGR location
Goonhilly	SW 72270 21070
Madley 1	SO 42106 37742
Madley 2	SO 42730 36967
Whitehill	SP 47862 18634
Woofferton	SO 50964 68171

## A6. Notice of coordination procedure for MOD sites related to the 3.6-3.8 GHz band

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Notice of coordination procedure for  
MOD sites related to the 3.6-3.8 GHz  
band

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# 1. Introduction

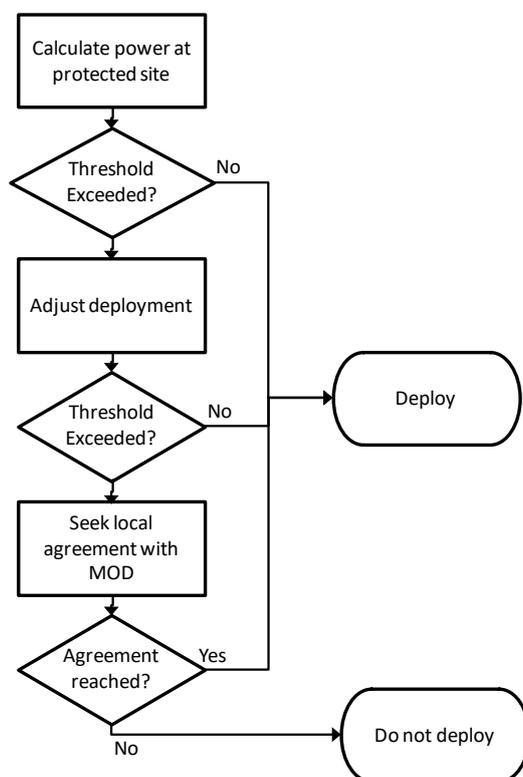
- 1.1 This Notice is notified to each 3.6-3.8 GHz Licensee under their respective 3.6-3.8 GHz licences.
- 1.2 MOD has a small amount of ongoing use within the band at one location in Cornwall which must be protected.
- 1.3 This Notice specifies the protection thresholds and coordination procedure necessary to ensure the protection of existing and continuing MOD usage in the 3.6-3.8 GHz band from potential harmful interference from the networks in the 3.6-3.8 GHz Band.
- 1.4 In this Notice:
  - “3.6-3.8 GHz Band” means the following frequencies: 3600 MHz to 3800 MHz;
  - “3.6-3.8 GHz Base Station” means a Base Station which are licensed to transmit using frequencies in the 3.6-3.8 GHz Band;
  - “3.6-3.8 GHz Deployment” means a 3.6-3.8 GHz Base Station or a 3.6-3.8 GHz Fixed or Installed Terminal Station deployed by a 3.6-3.8 GHz Licensee. For the purposes of this Notice indoor femtocells and indoor smart/intelligent repeaters, as defined in Schedule 1 of the 3.6-3.8 GHz licence, are excluded from a 3.6-3.8 GHz Deployment;
  - “3.6-3.8 GHz Fixed or Installed Terminal Station” means a fixed or installed Terminal Stations which is not exempt from licensing by the Wireless Telegraphy Act (Exemption) Regulations and which is licensed to transmit using frequencies in the 3.6-3.8 GHz Band;
  - “3.6-3.8 GHz Licensee” means the licensee under a licence authorising use in the United Kingdom of frequencies in the 3.6-3.8 GHz Band;
  - “Base Station” means radio equipment that transmits to a Terminal Station(s);
  - “MOD” means the Ministry of Defence;
  - “Protected Site” means the list of sites set out in this Notice;
  - “Signals” means the transmission in the 3600 to 3800 MHz band from the 3.6-3.8 GHz communications equipment;
  - “Site Protection Threshold” means the threshold that the 3.6-3.8 GHz Licensee must comply with as specified in this Notice;
  - “Terminal Station” means radio equipment that receives downlink transmissions from Base Stations.

## 2. The procedure

### Overview of coordination procedure

- 2.1 When planning its network deployment, the 3.6-3.8 GHz Licensee must check whether the protection thresholds set out in this document would be exceeded as a result of any proposed 3.6-3.8 GHz Deployment. To do so, the 3.6-3.8 GHz Licensee will need to calculate the communications signal at the relevant Protected Site location(s) (see protection thresholds section below).
- 2.2 If these calculations show that the relevant threshold will not be exceeded as a result of the planned deployment, then the deployment can go ahead. If the calculations show that the relevant threshold(s) would be exceeded as a result of the planned deployment, the 3.6-3.8 GHz Licensee may consider adjusting the deployment.
- 2.3 If it is not possible to adjust the deployment so that the threshold(s) are not exceeded, the 3.6-3.8 GHz Licensee may only deploy if agreement is reached with the operator(s) of the relevant site(s).
- 2.4 In the first instance, contact should be made via Ofcom who will facilitate a discussion between the licensee's appropriately security cleared personnel and the operator of the Protected Site.

**Figure 2:1: Flowchart illustrating coordination procedures for deployments within the coordination zone**



## List of sites to be protected

2.5 The sites to which these coordination procedures apply are listed in Figure 2.2 below.

**Figure 2.2: 3.6-3.8 GHz Band Protected Site Locations**

Site	Location
Bude	SS 208 126

## Protection thresholds

2.6 The 3.6-3.8 GHz Licensee must use the methodology in this Notice to ensure that emissions from each proposed 3.6-3.8 GHz deployment (or combination of deployments) in its licensed 3.6-3.8 GHz Band do not exceed the threshold for the in-band communications signal given in Figure 2.3.

**Figure 2.3: Site Protection Thresholds**

In-band communication signal		
Bude		
Site protection thresholds	Threshold for Signals in the 3410 to 3600 MHz band [1]	-69 dBm /5 MHz
	Height	18m above ground level
	Area where calculation is to be performed	Up to 25km from Bude
Note [1]: The protection thresholds are defined during the 'on' period of the transmit signal and referenced to a 0 dBi receive antenna		

## Compliance with the thresholds

2.7 Prior to deployment, the 3.6-3.8 GHz Licensee must use the methodology in this Notice to assess whether the protection thresholds specified in Figure 2.3 will be exceeded as a result of its planned 3.6-3.8 GHz deployment for any Protected Site. There is no requirement to undertake an assessment outside of the calculation areas given in Figure 2.3 except as described in paragraph 2.8 below.

2.8 The calculation areas in Figure 2.3 have been developed on the basis of Base Stations at 30m above ground level in order to constrain the area over which coordination must be undertaken. However, Licensees are advised that sites which are higher than this but located outside of the coordination area may still cause interference to MOD systems in certain circumstances. The 3.6-3.8 GHz Licensee must therefore consider whether any of its deployments which are greater than 30m above ground level are likely to cause any impact to the Protected Site and coordinate if it deems necessary.

- 2.9 In carrying out this assessment for deployments within the calculation areas described in Figure 2.3 the 3.6-3.8 GHz Licensee must use propagation models described below with the parameters given in Figure 2.4.
- 2.10 The 3.6-3.8 GHz Licensee must maintain records of its calculations and assessments and make these available to Ofcom if required.

### Exceeding the threshold

- 2.11 The thresholds may only be exceeded in relation to a specific Protected Site if the 3.6-3.8 GHz Licensee has reached an agreement with the operator of that Protected Site (Ofcom will facilitate the necessary introductions). Any such agreement must be recorded in writing in a form agreed by both the 3.6-3.8 GHz Licensee and the site operator. The 3.6-3.8 GHz Licensee must maintain a record of all such agreements, and make them available to Ofcom on request.

### Propagation Model

- 2.12 A basic transmission loss (path loss) will be calculated using ITU-R Recommendation P.1812-4 “A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands”<sup>1</sup>. It predicts signal levels exceeded for a given percentage of time. The assessment will use a time percentage of 10% as included in Figure 2.4 below.
- 2.13 This recommendation predicts signal levels exceeded for a given percentage of locations and a given percentage of time. The assessment will use locations percentage of 50% for all cases. Time percentage of 10% for Base Stations and Fixed or Installed Terminal will be used, as included in Figure 2.4 below.
- 2.14 Predictions are based on the terrain profile and clutter along the path.
- 2.15 Additional losses due to terminal surroundings (terminal clutter losses) shall be applied at both the transmitter and receiver where they are on land. This is based on a representative clutter height assigned to each clutter category. The representative clutter height depends not only on the typical physical height of clutter objects but also on the horizontal spacing of objects and the gaps between them. The required values are given in Figure 2.5.

**Figure 2.4: ITU-R P.1812 parameters**

Time percentage	10%
Nominal path centre latitude $\varphi$ (°)	Bude: 51 The path centre latitude $\varphi$ may be selected on a case by case basis
Sea level surface refractivity, $N_0$ (N-units)	obtained from digital maps provided in Recommendation P.1812-4 as described in §3.5
The average radio-refractive index lapse-rate through the lowest 1km of the atmosphere, $\Delta N$ (N-units/km)	obtained from digital maps provided in Recommendation P.1812-4 as described in §3.5

<sup>1</sup> [www.itu.int/rec/R-REC-P.1812-4-201507-I/en](http://www.itu.int/rec/R-REC-P.1812-4-201507-I/en)

Figure 2.5: Representative clutter heights

ITU-R P.1812-4 Clutter Type	Representative Clutter Height (m)	
	Use in profile equation <sup>2</sup> For i=2 to n-1	Use in Terminal clutter losses <sup>3</sup> and add to profile equation for i=1 and n
Water/Sea	0	10
Open/Rural	0	10
Suburban	10	10
Urban/Trees/Forest	15	15
Dense Urban	20	20
In all cases the default parameter value for $w_s$ of 27 should be used		

### Terrain database

- 2.16 Digital terrain map data with 50m resolution shall be used. Examples include Ordnance Survey “Landform Panorama<sup>®</sup>” or “OS Terrain<sup>®</sup> 50” datasets<sup>4</sup>.

### Clutter database

- 2.17 A digital land classification (“clutter”) dataset with 50m or better resolution such as Infoterra 50m clutter<sup>5</sup>, Siradel 20m clutter<sup>6</sup> or other equivalent shall be used.
- 2.18 The Infoterra and Siradel datasets identify 10 and 17 different clutter categories respectively. Mapping of these clutter categories to the required P.1812 clutter designations in Figure 2.5 is given in Figure 2.6.

<sup>2</sup> Equation 1c in P.1812-2: <http://www.itu.int/rec/R-REC-P.1812-2-201202-l/en>

<sup>3</sup> Section 4.7 in P.1812-2 applicable to Equation 64b for water/sea/open and rural categories and Equation 64a for the other categories and profile equation 1c

<sup>4</sup> <http://www.ordnancesurvey.co.uk/business-and-government/products/opendata-products-grid.html>

<sup>5</sup> <http://www.space-airbusds.com>

<sup>6</sup> <https://www.siradel.com/>

Figure 2.6: P-1812-4 clutter code mapping

ITU-R P 1812-4 Clutter Categories	Infoterra		Siradel	
	Category	Code	Category	Code
Water/Sea	Water	10	Sea	1
			River	2
			Lake	3
Open/Rural	Parks/Recreation	6	Open	4
	Open	7	Low density vegetation	5
	Open in urban	8	Park	7
Suburban	Industry	3	Village	8
	Suburban	4	Residential	9
	Village	5	Dense residential	10
Urban	Urban	2	Urban	11
			Mean dense urban	12
Trees/Forest	Forest	9	High density vegetation	6
Dense urban	Dense urban	1	Dense urban	13
			High dense urban	14
			Industrial	15
			Building blocks	16
			Airport	17

## A7. Glossary of terms

<b>Business day</b>	A day (other than a Saturday or Sunday) on which banks are generally open in London for normal business.
<b>dB</b>	Decibel. A logarithmic unit used to measure sound level.
<b>dB<sub>i</sub></b>	Decibels relative to isotropic. The gain of an antenna system relative to an isotropic radiator at radio frequencies.
<b>dBm</b>	The power level in decibels (logarithmic scale) referenced against 1 milliwatt (i.e. a value of 0 dBm is 1 milliwatt).
<b>DCMS</b>	Department for Digital, Culture, Media and Sport.
<b>DTT</b>	Digital Terrestrial Television – Broadcasting delivered by digital means. In the UK and Europe, DTT transmissions use the DVB-T and DVB-T2 technical standards.
<b>EAS</b>	Electronic auction system.
<b>EIRP</b>	Equivalent isotropically radiated power.
<b>FDD</b>	Frequency Division Duplex – a technology where separate frequency bands are used for send and receive operations.
<b>GHz</b>	Gigahertz. A unit of frequency of one billion cycles per second.
<b>H3G</b>	Hutchison 3G UK Limited
<b>ICNIRP</b>	International Commission on Non-Ionizing Radiation Protection
<b>IMT</b>	International mobile telecommunications.
<b>ITU</b>	International Telecommunications Union - Part of the United Nations with a membership of 193 countries and over 900 private-sector entities and academic institutions. The ITU's headquarters are in Switzerland.
<b>kHz</b>	Kilohertz. A unit of frequency of one thousand cycles per second.
<b>Mbps</b>	Megabits per second.
<b>MHz</b>	Megahertz. A unit of frequency of one million cycles per second.
<b>MOD</b>	Ministry of Defence.
<b>MoU</b>	Memorandum of understanding.
<b>Ofcom</b>	The Office of Communications.
<b>PES</b>	Permanent earth station
<b>PMSE</b>	Programme-making and special events. A class of radio application that supports a wide range of activities in entertainment, broadcasting, news

	gathering and community events.
<b>PPDR</b>	Public Protection and Disaster Relief
<b>ROES</b>	Receive-only earth stations.
<b>RSA</b>	Recognised Spectrum Access.
<b>RSPP</b>	Radio Spectrum Policy Programme.
<b>SDL</b>	Supplemental downlink. – where unpaired spectrum is used for downlink transmission only.
<b>SES</b>	Satellite earth station.
<b>SMRA</b>	Simultaneous Multiple Round Ascending.
<b>TDD</b>	Time Division Duplex – a technology where the uplink is separated from the downlink by the allocation of different time slots in the same frequency band.
<b>UHF</b>	Ultra high frequency.
<b>UKB</b>	UK Broadband Limited
<b>UKFAT</b>	UK Frequency Allocation Table.
<b>UWB</b>	Ultra wideband.
<b>WRC 15</b>	World Radio Conference (WRC-15 refers to the World Radio Conference which was held in 2015).
<b>WSD</b>	White Space Devices
<b>WT Act</b>	Wireless Telegraphy Act 2006.