



Update on 5G spectrum in the UK

Statement

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About this document

This document provides an overview of the diverse services and applications the next generation of mobile technology, 5G, is being designed to enable. These services will have different characteristics and different requirements in terms of speed, capacity, reliability and latency. In order for these services to be delivered effectively, Ofcom must manage the limited supply of spectrum – the raw material necessary for all wireless communications – and balance the needs of different users.

It also provides an overview of the international process that has led to the identification of appropriate bands to meet the 5G requirements and provides an update on our programme of work with regards to these bands.

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Section 1

Executive summary

What is 5G?

- 1.1 For an increasing number of UK consumers and businesses, mobile connectivity is now an everyday necessity. Our desire to get online wherever we are – and at ever faster speeds – has also helped fuel an explosion in mobile data.
- 1.2 5G is the next generation of mobile technologies and is being designed to provide greater capacity for wireless networks, offer greater reliability, and deliver extremely fast data speeds, enabling innovative new services across different industry sectors.
- 1.3 The first wave of commercial products is expected to be available in 2020. However, initial pre-commercial deployments are already expected to start from 2018.

What services and applications will 5G support?

- 1.4 5G technologies are under development, and are likely to include both an evolution of existing and new radio technologies. Potential 5G services and applications can be grouped into three different classes:
 - Enhanced Mobile Broadband. Together with an evolution of the services already provided by 4G, 5G is expected to provide faster and more reliable mobile broadband, offering a richer experience to consumers;
 - Massive Machine Type Communications. The Internet-of-Things (IoT) – where gadgets and devices wirelessly connect to the internet and each other – is happening on existing networks. Its technology is being used in everything from smart homes to wearables. 5G should help the evolution of IoT services and applications and improve interaction between different platforms. Possible future applications could include real-time health monitoring of patients; optimisation of street lighting to suit the weather or traffic; environmental monitoring and smart agriculture. Data security and privacy issues will need to be considered given huge amounts of data could be transferred over a public network; and
 - Ultra-Reliable and Low Latency Communications. 5G networks are being designed to be more reliable and have very low latencies (network delays). This could make them suitable for applications such as connected and driverless cars (cars would use the technology to communicate with each other, other road users and even the road infrastructure), and smart manufacturing (potentially connecting all the various machines involved in the different phases of a production chain).
- 1.5 These different services have different requirements in terms of speed, coverage and reliability, which will demand different network solutions (the evolution of existing network and potentially new networks) and different deployment models (including many small cells), an appropriate network infrastructure (which will include both fibre and wireless connectivity to the core network) and access to different spectrum bands.

The role of spectrum in enabling 5G rollout

- 1.6 Spectrum is a critical component of wireless networks. It makes up the ‘airwaves’ that underpin the communication services we use every day; such as mobile, Wi-Fi and TV.
- 1.7 The diverse set of services and applications enabled by 5G will require access to different spectrum bands with different characteristics:
 - Spectrum at lower frequencies, to enable 5G coverage to wider areas;
 - Spectrum at higher frequencies with large bandwidths, to provide the necessary capacity to support a very high number of connected devices and to enable higher speeds to concurrently connected devices; and
 - Spectrum at very high frequencies above 24 GHz (e.g. millimetre wave) with very large bandwidths, providing ultra-high capacity and very low latency. Cells at these frequencies will have very small coverage. It is likely that build-out of 5G networks in millimetre wave bands will be focused on areas of high traffic demand, or to specific locations or premises requiring services with very high capacity.

Ofcom’s activities to ensure early availability of 5G spectrum

- 1.8 One of our key objectives is to ensure that spectrum is made available in the most appropriate and timely way to enable investments, innovation and competition in the development of 5G services to benefit consumers and businesses.
- 1.9 We also consider that achieving early global harmonisation, of at least one 5G band, is critical to the development of a global 5G ecosystem.
- 1.10 Ofcom is playing a leading role internationally in the identification of spectrum bands for 5G having acknowledged the need for different spectrum bands with different characteristics to meet the requirements of future 5G services and networks. We have worked closely with other European spectrum regulators to identify bands that have the potential to be globally harmonised through our work in both the Radio Spectrum Policy Group (RSPG)¹ and the European Conference of Postal and Telecommunications Administrations (CEPT).² This has resulted in the identification of three bands to enable 5G in Europe:
 - Low bandwidth spectrum at **700 MHz**;

¹ The Radio Spectrum Policy Group is a high level advisory group that assists the European Commission in the development of radio spectrum policy and is chaired by one of the Member States. The RSPG ‘Work Programme for 2016 and Beyond’ was adopted in February 2016 and included a work item for spectrum related aspects for Next Generation Wireless systems (5G) http://rspg-spectrum.eu/wp-content/uploads/2013/05/RSPG16-007_rev_sept_2016.pdf

² The European Conference of Postal and Telecommunications Administrations, CEPT, includes all 48 European countries including Russia, CEPT is where technical work for spectrum is carried out. See the CEPT Roadmap for 5G (http://cept.org/Documents/ecc/33486/ecc-16-110-annex-17_cept-roadmap-for-5g)

- **3.4-3.8 GHz**, which has the potential to allow wider bandwidths; and
 - **24.25-27.5 GHz** (the 26 GHz band), for ultra-dense very high capacity networks.
- 1.11 Following on from the RSPG's opinion identifying these bands, the Radio Spectrum Committee (RSC) agreed a Commission mandate to CEPT to develop harmonised technical conditions for spectrum in 3.4 to 3.8 GHz and 26 GHz in support of the introduction of 5G in the European Union.³
- 1.12 We already have plans in place to make the 700 MHz band available for mobile services including 5G, and are currently undertaking work with regard to the 3.4 to 3.6 GHz and the 3.6 to 3.8 GHz bands. We fully support the RSPG's identification of 26 GHz as a "pioneer band" for 5G in Europe, and as a result believe that international studies on the band should be expedited as a matter of priority. We also fully support and are actively promoting 26 GHz as the priority band for global harmonisation.
- 1.13 We have started a programme of work to look at how the 26 GHz band can be made available for 5G in the UK, taking into account existing users and their requirements, and intend to publish a consultation on this shortly.
- 1.14 As part of this work, we are considering the most appropriate authorisation approach for this band to support innovation and competition. Different approaches may be appropriate for different parts of the band and for different applications and services.
- 1.15 We already have a licensing process available to facilitate testing, development research or demonstration of radio equipment to support innovation in the UK. These licences are available for 5G testing.
- 1.16 We will continue to play a leading international role in securing availability of spectrum for 5G. Together with other spectrum regulators we have already started working on studies to identify or confirm, as necessary, the appropriate harmonised technical conditions that will allow 5G services to be rolled out.
- 1.17 In the International Telecommunication Union (ITU)⁴ we will contribute to the preparatory work to identify spectrum for 5G at the World Radio Conference in 2019 (WRC-19) and to the development of 5G standardisation via the IMT-2020 process. We will also seek opportunities to accelerate global harmonisation of these bands, particularly the 26 GHz "pioneer" band, in advance of WRC-19.
- 1.18 We recognise that a number of other bodies are also considering approaches to facilitate the early deployment of 5G. The National Infrastructure Commission

³ The Radio Spectrum Committee is an EU legislative committee. It debates and votes upon both Mandates for technical work to CEPT and European Commission harmonisation decisions.

⁴ The International Telecommunication Union is a UN agency for information and telecommunication technologies.

published their report on 5G in December 2016.⁵ Government, industry and research institutions are also conducting further work in this area.

⁵National Infrastructure Commission, '*Connected Future*'

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/577906/CONNECTED_FUTURE_ACCESSIBLE.pdf

standardised (like the recent ‘Narrow Band IoT’ and other solutions) and will be further evolved into 5G.

- 2.13 Wi-Fi evolutions will also play an important role for consumers, in particular to provide 5G services within homes or offices.

5G will need different frequency bands

- 2.14 The diverse set of 5G services and applications, described in paragraph 2.6, will require a diverse set of spectrum bands, with different characteristics, addressing different requirements, and combining both low and high frequencies:

- Spectrum at lower frequencies, to enable 5G coverage to wide areas;
- Spectrum at higher frequencies with large bandwidths, to provide the necessary capacity to support a very high number of connected devices and to enable higher speeds to concurrently connected devices; and
- Spectrum at very high frequencies above 24 GHz (e.g. millimetre wave) with very large bandwidths, providing ultra-high capacity and very low latency. Cells at these frequencies will have very small coverage. It is likely that build-out of 5G networks in millimetre wave bands will be focused on areas of high traffic demand, or to specific locations or premises requiring services with very high capacity.

- 2.15 Different authorisation approaches may be appropriate for different bands and to enable different type of services; for example, some 5G use cases might require spectrum access to be authorised at a local level directly to businesses. Different aspects of spectrum sharing will also be considered when identifying the most appropriate authorisation regime.

Ofcom's role is to ensure that spectrum is not an inhibitor to enable mobile data growth and early 5G roll out.

- 2.16 One of our key objectives is to ensure that spectrum is made available in the most appropriate and timely way to enable investments, innovation and competition in the development of 5G services to benefit consumers and businesses. We also

consider that achieving early global harmonisation of at least one 5G band is critical to facilitate a rapid development of a global ecosystem.

- 2.17 We have played a leading role globally to identify and focus work on spectrum bands that meet the requirements of the new services and applications 5G will deliver. In Section 3 we provide an overview of the process that has led to the identification of 700 MHz, 3.4 to 3.8 GHz and 26 GHz as spectrum bands for 5G in Europe, and we outline our approach with regards to these bands.

Section 3

Establishing spectrum bands to enable 5G roll out in the UK

Establishing and promoting 5G spectrum bands

- 3.1 Ofcom's responsibilities under the Communications Act 2003 include optimising spectrum use and encouraging investment and innovation. In making spectrum decisions in the UK we balance these responsibilities based on assessments of the benefits provided to citizens and consumers, and stakeholder needs, to make the most efficient use of radio spectrum.
- 3.2 Ofcom is directed by Government to represent the UK on matters of international spectrum policy. This includes participation in international fora such as the Radio Spectrum Policy Group (RSPG), the European Conference of Postal and Telecommunications Administrations (CEPT), the Radio Spectrum Committee (RSC) and in the three sectors of the International Telecommunications Union (ITU).
- 3.3 RSPG and RSC are made up of representatives of member states. Ofcom is currently chairing the RSPG, a high-level advisory group that assists the European Commission in the development of radio spectrum policy. The RSC is chaired by the Commission and debates and votes upon both Mandates for technical work to CEPT, and EC technical harmonisation decisions. CEPT is a regional European body of 48 countries that carries out technical studies to promote harmonisation of spectrum use and enable economies of scale in spectrum technology including mobile.
- 3.4 Ofcom worked closely with national spectrum regulators across Europe, through the Radio Spectrum Policy Group (RSPG) to develop an opinion on spectrum bands for next generation wireless systems (5G) as agreed in the RSPG Work Programme for 2016. The opinion which was consulted upon and formalised in 2016, identified a strategic roadmap for 5G in Europe.⁹ In particular, the roadmap identified the following building blocks for 5G:
 - Low bandwidth spectrum at **700 MHz**;
 - Medium bandwidth spectrum at **3.4 – 3.8 GHz** as a “primary” band, which will provide capacity for new 5G services; and
 - High bandwidth spectrum at **24.25 – 27.5 GHz** as the “pioneer” millimetre wave band to give ultra-high capacity for innovative new services, enabling new business models and sectors of the economy to benefit from 5G.

⁹ Opinion on spectrum related aspects for next-generation wireless systems (5G) http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf

- 3.5 In addition, the RSPG identified the potential for existing mobile bands to be used for 5G.
- 3.6 A Commission Mandate to CEPT was approved by Member States in the RSC with regards to the development of harmonised technical conditions in two “pioneer” bands: 3.4 to 3.8 GHz and the 26 GHz band.¹⁰
- 3.7 The conditions for harmonisation of the 24.25-27.5 GHz band are currently under study in CEPT project team ECC PT1, which sits under the Electronic Communications Committee (ECC). The project team will develop a band plan for 5G and study coexistence with the other radio uses in the band, as well as passive services in the 23.6-24 GHz band. The technical conditions and band plan will be published in an ECC Decision and the results of the studies will be presented in a CEPT Report. The target for publication of these documents is June 2018.
- 3.8 We have, and will continue to engage globally to ensure spectrum is identified and harmonised for 5G.

Ofcom’s position on 5G bands

- 3.9 The choice of 700 MHz, 3.4 to 3.8 GHz and 26 GHz will create the best opportunity for the UK to benefit from the first wave of 5G equipment.
- 3.10 The 26 GHz band, which has been identified as the “pioneer” band in the millimetre wave frequency range¹¹ offers the most credible possibility to establish, ahead of WRC-2019, a global band for 5G. Global availability is a primary objective: we see this as essential to provide the environment for a vibrant market in affordable consumer 5G devices.
- 3.11 We remain committed to exploring further bands for 5G in addition to 700 MHz, 3.4 to 3.8 GHz and 26 GHz, as part of the preparations for the WRC-19.
- 3.12 In line with our broader requirement to encourage innovation, we have a licensing process available to facilitate testing, development, research and demonstration of radio equipment. These licences can be used for 5G testing.
- 3.13 Two licence products are available: the Non Operational Development licence (largely used for research purposes) and the Non Operational Temporary Use licence (largely used in trials); these licences can both support the use of radio equipment that is under development.

700 MHz

- 3.14 Our work to clear the 700 MHz band to make it available for mobile data is well underway. In November 2014 we published a statement setting out our decision to

¹⁰Mandate to CEPT to develop harmonised technical conditions for spectrum use in support of the introduction of next-generation (5G) terrestrial wireless systems in the Union http://cept.org/Documents/ecc-pt1/34326/ecc-pt1-17-055_5g-mandate

¹¹ Strictly speaking, mmWave is the band of spectrum between 30 GHz and 300 GHz – wavelengths at these frequencies are between 1mm and 1cm long. The term is commonly used refer to frequencies above 24 GHz and this is how we use it here

re-plan the frequencies which Digital Terrestrial Television (DTT) and PMSE¹² services use, to make this spectrum available for mobile data.¹³

- 3.15 One objective of our clearance programme is to ensure that clearance does not cause undue disruption to DTT viewers, and we have also made additional spectrum at 960-1164 MHz available for PMSE users. We will continue our clearance work with the intention of ensuring that the band is available nationally for mobile data by Q2 2020.
- 3.16 We expect to conduct an award for this band in 2018/19, and have said that we will seek to include a coverage obligation as one of the conditions of using this spectrum. We will consult on this new obligation, and on the conditions for the award.

3.4 GHz – 3.8 GHz

- 3.17 With regards to 3.4 to 3.6 GHz, 150 MHz of spectrum in this range (3410-3480 MHz and 3500-3580 MHz) has been cleared and released by the public sector and is due to be auctioned later this year. Our consultation on the competition measures and specific detail of the auction design closed on 30 January.¹⁴ We are currently assessing responses.
- 3.18 With regards to 3.6 to 3.8 GHz, the 3605 to 3689 MHz band is already assigned to electronic communication services, including mobile, where the band is shared with other existing users coordinated through Ofcom.
- 3.19 On 6 October we issued a consultation proposing to make the remaining 116 MHz within the 3.6 to 3.8 GHz band available for mobile services.¹⁵ The consultation set out proposed policies concerning current users of the band, these are: satellite earth stations and fixed links, as well as UK Broadband's licence for the 3605 to 3689 MHz band.
- 3.20 Our consultation on extending mobile use in the 3.6 to 3.8 GHz closed on the 15 December 2016. We are currently reviewing responses and intend to issue a further publication in the first half of 2017.

26 GHz

- 3.21 We are supportive and are actively promoting this band as the priority millimetre wave band for global harmonisation; and we are contributing to the international work in the relevant ECC working group and with the ITU (for WRC-19) including taking a leading role in the studies on coexistence.
- 3.22 This band presents significant advantages compared to other millimetre wave bands. It already has a mobile allocation in the ITU Radio Regulations across

¹² Programme Making and Special Events, e.g. wireless cameras and microphones particularly used to support the TV, film and theatre, music and sports events.

¹³ https://www.ofcom.org.uk/_data/assets/pdf_file/0024/46923/700-mhz-statement.pdf

¹⁴ *Award of the 2.3 and 3.4 GHz spectrum bands, November 2016*
https://www.ofcom.org.uk/_data/assets/pdf_file/0026/93545/award-of-the-spectrum-bands-consultation.pdf

¹⁵ *Improving consumer access to mobile services at 3.6 to 3.8 GHz, October 2016,*
<https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-at-3.6-3.8-ghz>

most of the band, this makes it feasible for other countries to start using it for 5G ahead of WRC-19.

- 3.23 On the domestic side, we have initiated a program of work to develop proposals on how to make all or part of the 26 GHz band available for early 5G deployment in the UK. We intend to publish a consultation on this in the first half of 2017. As part of this work, we are considering the most appropriate authorisation approach for this band to support innovation and competition. Different approaches may be appropriate for different parts of the band and for different applications and services.
- 3.24 Our programme of work will identify options to make this band available for 5G in the UK, taking into consideration current users and their requirements; these are:
- Fixed links. These are point to point wireless links used to convey voice or data traffic between specified geographic locations and are used for a variety of applications, including backhaul provision for mobile network base stations; distributing TV signals from studios to broadcast transmitter sites; and connecting nodes within private or corporate communication networks.
 - Earth stations of Earth exploration satellite systems (EESS). These are used for receiving earth observation data, for example satellite imagery or climate data, from Earth exploration satellite systems.
 - Data relay satellite systems in the Inter satellite service. Data Relay Satellites (DRS), operating in the band 25.25-27.5 GHz, are used in relaying environmental, weather and disaster monitoring data collected by low Earth orbiting satellites to an earth station (see above).
- 3.25 In the UK and Europe, fixed links are the most widely deployed existing users in the 26 GHz band; and in the UK there are around 3,000 fixed links in the sub-band 24.25-26.5 GHz.
- 3.26 Responsibility for granting permission to use frequencies in the sub-band 26.5-27.5 GHz rests with Defence. The MOD believes there is scope for 5G to be deployed in this band in the UK.
- 3.27 In the UK, there is one Earth-exploration satellite service Earth Station receiver in the 26 GHz band with a grant of Recognised Spectrum Access (RSA), at Harwell. It is located reasonably far from major urban/built up areas of the country.
- 3.28 We are contributing to international coexistence studies aimed at identifying the appropriate technical conditions to enable shared access to the band by EESS earth stations and proportionate protection of the on-board receivers of DRS.
- 3.29 These coexistence studies will also look at the feasibility of further Earth Stations being established. Nonetheless we expect that only a small number of Earth stations are likely to be needed in the UK in order to realise the benefits from the data downlinked in this band from Earth exploration satellites. It is also likely to be possible to locate any future earth stations well away from built up areas of the country where demand for 5G in this band will be the greatest.

Identifying further bands for 5G

- 3.30 WRC-19, under Agenda Item 1.13, will consider a range of frequency bands for potential 5G use. The full list of bands being studied, as specified in Resolution 238 (WRC-15), being:
- 24.25-27.5 GHz, 31.8-33.4 GHz, 37-40.5 GHz, 40.5-42.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47-47.2 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz.
- 3.31 As part of our overall strategy, we will define a UK roadmap for all of the bands being considered for 5G. We intend to establish our priorities for the different bands, based primarily on UK utilisation, the direction of travel and requirements for other services (other than 5G mobile access) and the chances for global harmonisation. This may lead to us deprioritising and/or opposing consideration of certain bands for 5G where this use is clearly not in the UK interests. We expect to publish the roadmap by the middle of 2017 and will provide regular updates on this as the international work progresses towards WRC-19.
- 3.32 In the following sections we highlight a few of the bands under consideration.

Further work on 32 GHz and 40 GHz

- 3.33 The RSPG opinion also highlighted 32 GHz and 40 GHz as promising bands for 5G and CEPT confirmed these as priorities for study for WRC-19. Ofcom recognises the potential of these bands for 5G but considers them as longer term potential priorities. We will therefore, as appropriate, contribute to the international study work on these bands in preparation for WRC-19 and take a view on their suitability for 5G deployment in the UK at a later stage.

66 – 71 GHz

- 3.34 The 66-71 GHz band is another of the bands being studied for potential 5G use in preparation for WRC-19. This band has no reported usage in the recent CEPT questionnaire.¹⁶ The band is adjacent to the 57- 66 GHz band, which is being made available in many countries for licence-exempt use by multi gigabit applications.

International programme of work

- 3.35 We plan to play an active role in international study work on the 5G bands.
- 3.36 We are leading the work in ECC PT1 on the 26 GHz band, and working with other spectrum regulators we will follow up with more comprehensive studies in the coming months.
- 3.37 We will also actively contribute to studies, on other bands being considered for 5G as part of the preparations for WRC-19 under Agenda item 1.13, being guided by the priorities we will establish in the UK roadmap. Our objective is, as far as

¹⁶ Summary of responses to questionnaire on bands for AI1.13
[http://www.cept.org/files/4549/ECC%20PT1\(16\)133%20Annex%2031rev1%20Results%20of%20A1_13%20questionnaire.docx](http://www.cept.org/files/4549/ECC%20PT1(16)133%20Annex%2031rev1%20Results%20of%20A1_13%20questionnaire.docx)

possible, to develop an international consensus on bands well in advance of WRC-19.

Section 4

Next steps

4.1 Ofcom will focus on the following activities:

- 700MHz: We will continue our work on 700MHz clearance to ensure that the band is nationally available for mobile data to a target of no later than Q2 2020.¹⁷
- 3.4 to 3.6 GHz: The consultation closed on 30 January 2017. We are currently considering the responses we have received and will publish a statement setting out our decisions.
- 3.6 to 3.8 GHz: We will develop our approach, taking into account the outcome of the consultation to extend mobile use in this band, which closed on the 15 December.
- 26 GHz: We have initiated a programme of work focusing on options to make all or part of the band available for 5G in the UK. We plan to publish a consultation on our proposals with regards to 26 GHz in H1 2017.
- Preparation work for WRC-19: We will continue to actively contribute to international studies on other bands for 5G. We will also seek to build a consensus on globally harmonised bands ahead of WRC-19.

¹⁷ https://www.ofcom.org.uk/data/assets/pdf_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-Statement.pdf