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Maximising the benefits of 700 MHz clearance

Enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap

Statement

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About this document

In November 2014 we decided to make valuable spectrum in the 700MHz band available for mobile data as soon as practicably possible. Initial plans indicated that it would be possible to make the band available by the end of 2021. Our more recent analysis suggests that benefits to citizens and consumers would be greater if it was available sooner.

In this document we set out two decisions in relation to the 700 MHz clearance programme. First, we have taken a spectrum management decision that we will work to accelerate the programme by 18 months and release the 700 MHz band in Q2 2020.

Second, we have decided that 20 MHz of spectrum in the part of the 700 MHz band known as the centre gap, should be allocated for use by mobile data (specifically mobile downlink). Linked to this, we have also decided to allow the interim multiplexes to continue operating in this spectrum until at least 1 May 2020, or until mobile downlink services in this spectrum are deployed. As a result of these decisions we are serving notice on PMSE users that operate in the 700 MHz band that from 1 May 2020 they will no longer have access to spectrum in this band to deliver their services.

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Section 1

Executive summary

In this document we consider when to change of use of the 700 MHz band and future use of the 700 MHz centre gap

1.1 In November 2014, we published a Statement (the '2014 Statement')[1] setting out our decision to re-plan the frequencies which Digital Terrestrial Television (DTT) and wireless microphones (also referred to as 'audio PMSE devices') use and make valuable spectrum between 694 and 790 MHz (the '700 MHz band') available for mobile data. This is a key part of our broader strategy for ensuring that sufficient spectrum is available to meet projected increases in demand for mobile data.

1.2 Supported by Government and working with the DTT multiplex operators, we have set up a major programme of work (the '700 MHz clearance programme') to implement this decision. The objectives of this programme are to: make the 700 MHz band available for mobile data as soon as practicably possible; safeguard the ongoing delivery of the benefits DTT and PMSE provide; avoid undue disruption to viewers and secure value for money. In order to achieve our objectives in relation to DTT we are developing a plan which will allow for the continuation of all the main national DTT services and local TV services after clearance. Government confirmed in August 2015, that it will fund the 700 MHz Spectrum Clearance programme, which is now part of the Government's portfolio of Major Projects.

1.3 On 11 March 2016 we published a consultation (the '2016 consultation') on two key aspects of the 700 MHz clearance programme:

- The timescales on which we aim to clear and release the 700 MHz band; and
- The future use of part of the band, called the centre gap.

1.4 This document follows on from that consultation. It sets out the decisions we have reached on these issues, having taken into account consultation responses.

We will aim to bring forward release of the 700 MHz band to Q2 2020

1.5 In our 2014 Statement we decided to make the 700 MHz band available for mobile data as soon as practicably possible. Initial plans showed that it would be possible to complete the programme by no later than the end of 2021. We have been looking for ways to complete the programme sooner than this.

1.6 Earlier this year the DTT multiplex operators proposed a plan which would enable completion of clearance to be brought forward to Q2 2020. We estimate that accelerating completion of the programme by 18 months will increase the benefits of clearance by between £19m and £60m.[2] We took a cautious approach to the analysis which underpins this estimate. Consequently, we believe that the benefits

[1] https://www.ofcom.org.uk/__data/assets/pdf_file/0024/46923/700-mhz-statement.pdf

[2] Unless stated otherwise all costs and benefits referenced in this document are 2016 NPV.

are likely to lie towards the top of the range we have identified and may even exceed it.

1.7 Set against these benefits, we estimate the economic cost of bringing clearance forward to be £14m-15m.

1.8 Accelerating clearance will mean that Arqiva Services Limited has to change the frequencies used by some temporary DTT services, known as 'interim multiplexes', which currently operate in the 600 MHz band (550 MHz –606MHz). This is because we will move the main national DTT services into the 600 MHz band in order to clear the 700 MHz band. We awarded Arqiva Services Limited a licence for the interim multiplexes in 2013 on the basis that we would likely need to revoke it if we cleared the 700 MHz band. We have the power to revoke the licence for spectrum management reasons by giving 2 years' notice, although revocation cannot take effect until the end of 2018, which is the minimum term of the licence.

1.9 Moving the interim multiplexes to alternative frequencies before then will allow us to access the 600 MHz band before the minimum term of the licence ends, thereby speeding up the clearance programme.

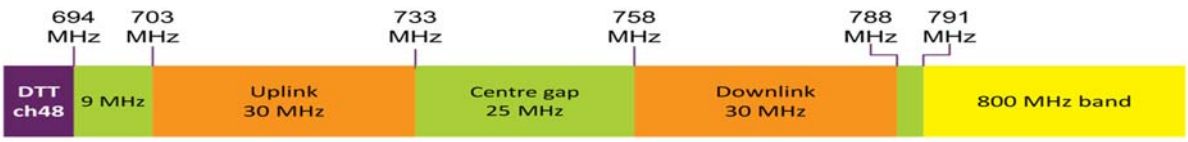
1.10 As we explained in our 2014 Statement, a small proportion of viewers will need to replace their aerials due to clearance and a number of PMSE users will need to replace their equipment. Acceleration will mean both viewers and PMSE users have to make these changes up to 18 months earlier than they would previously have had to. In this document we explain that we do not consider that bringing these changes forward will have a material adverse effect on viewers. Nor do we believe that it will compromise our ability to safeguard the benefits PMSE provides.

1.11 Our assessment is that the benefits of accelerating the programme by 18 months outweigh the costs of doing so, and acceleration can be achieved whilst minimising disruption to viewers and without compromising our objective of safeguarding the benefits that PMSE provides. On balance, we therefore consider that adopting the accelerated plan will best secure optimal use of spectrum. Consequently, we have taken a spectrum management decision that we will work to bring forward release of the 700 MHz band to Q2 2020. Given that it is funding the programme, we have discussed this decision with Government. Ministers have agreed that the proposal to clear the band by no later than Q2 2020 should be adopted.

We have decided to allocate the centre gap to mobile data

1.12 When the 700MHz band becomes available for mobile data, it will be divided into the components set out in the diagram below. The 2014 Statement focussed mainly on the 'paired spectrum' (the uplink and downlink) and did not make a decision about use of the centre gap.

Configuration of 700 MHz band after clearance



1.13 We have considered a range of options for use of the centre gap: mobile data services; use for emergency services communications networks; use by PMSE; and use by DTT.

1.14 As noted above, a key element of our strategy is to ensure sufficient spectrum is available to meet growing demand for mobile data. Consumer use of mobile data, via smartphones, tablets and other devices is growing fast. Total data traffic across networks in recent years has been growing at around 60% a year. We believe that strong growth will continue for some time. For example, in our recent update to our mobile data strategy we forecast that by 2025 mobile data traffic could be between 12 and 47 times greater than 2014 levels.[3] In view of these projections, there is likely to be demand for additional mobile spectrum. The centre gap could play a particularly useful role in fulfilling that demand, because it is low frequency spectrum with good propagation characteristics and is therefore well suited to providing wide area coverage.

1.15 Conversely, demand for spectrum for the other candidate use cases can be fulfilled elsewhere:

1.15.1 The UK Government plans to use commercial mobile networks to provide communications facilities to the emergency services. Therefore, we do not consider that there is likely to be demand for us to ring fence spectrum in the centre gap for emergency services.

1.15.2 We have recently made the band 960 to 1164 MHz available for low power audio PMSE sharing with aeronautical services. This provides a significant amount of spectrum which we consider sufficient to meet future demand for audio PMSE spectrum.[4]

1.15.3 We consider that after change of use of the 700MHz band DTT will have access to sufficient spectrum between 470 and 694MHz to continue delivering its important benefits.

1.16 We have therefore decided to allocate the centre gap to mobile data.

We are minded to let the interim multiplexes operate in the centre gap until licensees deploy mobile data services there

1.17 A number of broadcast stakeholders including Arqiva and Digital UK have asked that we defer the point at which the centre gap is allocated for mobile data. They have argued that, rather than making the centre gap available for mobile data in 2020 alongside the paired spectrum, we should release it at the end of 2022 and allow the interim multiplexes to operate in the centre gap until then. They have expressed the view that licensees are not likely to want to use the centre gap for mobile data until after 2022. Moreover, they say that switching off the interim multiplexes in 2020 could cause detriment to viewers and undermine the competitiveness of the DTT platform.

1.18 We do not agree with these arguments. The centre gap is already incorporated into the latest version of the 3 GPP mobile equipment standard and we therefore do not envisage that developing equipment that works in this spectrum should pose a major technical challenge. Given the rate of growth in mobile data traffic, we consider that it is more likely than not that there will be demand to use the centre gap for mobile data by Q2 2020. This accords with the view expressed by mobile industry stakeholders such as Hutchison 3G UK and Huawei. Moreover, currently the interim multiplexes

[3] https://www.ofcom.org.uk/consultations-and-statements/category-1/mobile-data-strategy

[4] https://www.ofcom.org.uk/consultations-and-statements/category-2/new-spectrum-audio-pmse

account for a relatively low proportion (ca. 0.7%) of DTT viewing. Whilst we recognise this could change over time, we do not believe that the evidence available at the moment supports the view that discontinuing these multiplexes at the time of clearance would seriously undermine the DTT platform.

1.19 All this considered, we have decided to make the centre gap available for mobile data in Q2 2020, at the same time we release the paired spectrum. On balance, we consider that this decision will best give effect to our duties to secure optimal use of the spectrum and to further the interests of citizens and consumers.

1.20 Whilst the evidence available at the moment does not support the view that the loss of the interim multiplexes would seriously undermine the attractiveness of the DTT platform, we recognise that they provide value to viewers that watch the services they carry. We therefore consider that it is likely to be in citizens' and consumers' best interests for the interim multiplexes to continue operating in the centre gap until such time as mobile data services are deployed there.

1.21 Consequently, we consider that there is scope for the interim multiplexes to continue operating in the centre gap until at least 1 May 2020. If demand for mobile data to use the centre gap develops more slowly than we anticipate, we are minded to allow the interim multiplexes to remain in the centre gap until the mobile licensees deploy services there (even if this is after 1 May 2020). We will consider the detail of how this will be implemented, including any licensing implications in due course.

1.22 After 1 May 2020 we will need to consider the risk of interference both from and to mobile services in the paired spectrum. We would not generally expect other users of the band to be required to manage the risk of interference from or to the interim multiplexes.

1.23 We consider that there is a significant risk DTT services in the centre gap could be vulnerable to interference from mobile services in the paired spectrum. Allowing the interim multiplexes to operate until mobile data services in the centre gap switch on would be subject to Arqiva satisfying us that it will take appropriate steps (at its own cost) to manage the impact of such interference.

1.24 Allowing the interim multiplexes to continue operating after 1 May 2020 would also be contingent upon Arqiva demonstrating to us and the mobile licensees that they could operate in the centre gap without causing harmful interference to mobile services in the paired spectrum. To date Arqiva has made a number of arguments as to why such interference would not occur. However, they are predicated on a range of assumptions which Arqiva has not yet validated. Arqiva would need to present further evidence to substantiate its position before we were satisfied that there is no risk of harmful interference.

1.25 If new and contrasting evidence emerges over the coming years, we will consider whether there is a case for revising the position we have set out here. For example, if it were to become evident that mobile data services were not going to be ready to launch in the centre gap until later in the 2020s, we would consider whether allocating the centre gap to them from then remained appropriate.

Notice to PMSE users and funding for PMSE equipment changes

1.26 This document constitutes formal notice that access to the band 694 to 790 MHz will cease to be available for use by PMSE from 1 May 2020 and we will not authorise use beyond this date. As part of its funding for the 700 MHz clearance programme,

Government has agreed to fund a grant scheme to support PMSE users who will have to vacate the 700 MHz band earlier than expected. It has asked us to set up and oversee this scheme and we will consult on the details later this year. This consultation will include proposals as to the type of equipment and users that will be eligible for funding. We currently anticipate the grant scheme launching in 2019.

Section 2

Introduction

We are in the process of clearing the 700 MHz band for mobile data use

2.1 Digital Terrestrial Television (DTT) and audio Programme Making and Special Events (PMSE) services[5] currently use the spectrum between 470 and 790MHz. In November 2014, we published a statement (the '2014 Statement')[6] setting out our decision to change the way part of this spectrum is used and re-allocate the frequencies between 694MHz and 790MHz (the '700MHz band') for mobile data use.

2.2 Since then, supported by Government and working with DTT multiplex operators, we have commenced a major programme of work (the '700 MHz clearance programme') to implement this change. The objectives of this programme are as follows:

2.2.1 To clear and release the 700MHz band as soon as practicably possible;

2.2.2 To achieve value for money in the use of public funds;

2.2.3 To safeguard the ongoing delivery of the benefits DTT provides;

2.2.4 To avoid undue disruption to DTT viewers; and

2.2.5 To safeguard the ongoing delivery of the benefits PMSE provides.

This statement sets out our decisions on two aspects of this programme –timing of clearance and use of the centre gap

2.3 On 11 March 2016 we published a consultation (the '2016 consultation') which set out our proposals in relation to two key aspects of the clearance programme:

2.3.1 **The timescales on which we aim to clear and release the band:** The consultation proposed to take steps to enable us to accelerate the clearance programme to complete in Q2 2020 as opposed to the end of 2021 as proposed in our 2014 Statement. We explained that this would involve moving the interim multiplexes to alternative frequencies (likely the 700 MHz centre gap).

2.3.2 **The future of part of the band called the centre gap**: The 2014 Statement focussed mainly on the paired spectrum and did not make a decision on the future use of the centre gap (see diagram in Executive Summary). Our 2016 consultation considered a range of options and proposed to make the centre gap available for supplemental downlink

[5] The term PMSE refers to radio devices (e.g. wireless microphones, in-ear monitors and talk back intercoms) which are used for activities such as broadcasting, newsgathering, community events, theatre productions and concerts.

[6] https://www.ofcom.org.uk/__data/assets/pdf_file/0024/46923/700-mhz-statement.pdf

(SDL) - a type of mobile data technology used to provide networks with additional downlink capacity. It proposed this allocation start in Q2 2020.

2.4 The consultation closed on 20 May 2016. We received a total of 36 responses, of which six were confidential and four were partly confidential. We have published the 26 non-confidential responses on our website. We discuss the key points from consultation responses in the body of this statement, and give an overview of the responses in annex 1.

2.5 Having taken the consultation responses into account, we have decided to work to bring forward release of the 700 MHz band to Q2 2020 and allocate the centre gap to mobile downlink (which includes SDL) from Q2 2020 onwards. As a result of our decisions, there is scope for the interim multiplexes to operate in the centre gap until at least 1 May 2020. If licensees do not deploy downlink services immediately, we are minded to allow the interim multiplexes to remain in the centre gap until roll-out of such services starts. This is subject to Arqiva being able to demonstrate that doing so would not cause any interference to adjacent mobile data services in the paired part of the 700 MHz band and that it will take appropriate steps (at its own cost) to manage the impact of any interference from mobile services in the paired spectrum into DTT in the centre gap.

2.6 This Statement explains the rationale behind our decisions. The document is structured as follows:

2.6.1 the remainder of this introduction gives an overview of the context and background to the project and describes the analytical and legal framework we have considered in reaching our decision;

2.6.2 **Section 3** discusses our decision to accelerate the clearance programme;

2.6.3 **Section 4** discusses our decision on the future use of the centre gap

2.6.4 **Section 5** discusses a proposal from Arqiva Services Limited that the interim multiplexes should be able to use the centre gap until the end of 2022

2.6.5 **Section 6** discusses our next steps

2.6.6 **Annex 1** summarises the consultation responses we received

2.6.7 **Annex 2** discusses the technical evidence provided by Arqiva in relation to coexistence

2.6.8 **Annex 3** provides an update on the costs and benefits previously included in the 2016 consultation; and

2.6.9 **Annex 4** is an illustration of the current roll out plan to deliver the clearance programme, based on the accelerated timetable

Context and analytical framework

The 700 MHz Clearance programme is an important part of our mobile data strategy

2.7 The widespread uptake of smartphones and tablets has led to a very large growth in demand for mobile data services. Total data traffic across networks in recent years

has been growing at around 60% per year. There is a general consensus that this rapid growth will continue for the foreseeable future. In our recent update to our mobile data strategy we forecast that by 2025 mobile data traffic could be between 12 and 47 times greater than 2014 levels.[7]

2.8 MNOs will be able to meet some of this increase in demand by deploying more base stations and using more efficient technology on their networks. However, if they are to meet the increase in demand efficiently they will also need access to more spectrum.

2.9 Given the benefits mobile data delivers to citizens and consumers, we wish to ensure that an appropriate amount of mobile spectrum is available. The 700MHz clearance programme is a key part of our efforts to do this. However, there are a number of other strands to our work in response to the challenges posed by the growth in demand for mobile data. These include:

2.9.1 Award of the 2.3 GHz and 3.4 GHz bands for mobile data use; and
2.9.2 Current proposal to expand mobile access in the 3.6 to 3.8GHz band noting that access to the spectrum may be constrained by existing services.[8]

The 2014 Statement said we would safeguard DTT by broadly matching current coverage of the main national DTT services

2.10 The DTT platform carries a wide range of TV channels. DTT transmitters broadcast a number of signals, called multiplexes, each of which contains multiple TV channels or radio services. Currently, the following multiplexes hold licences to broadcast on the DTT platform:

2.10.1 Three PSB multiplexes – BBC and D3&4[9] provide these multiplexes. They broadcast from all of the transmitters in the DTT network and are available to around 98.5% of households. These multiplexes carry a range of PSB services, including the BBC's channels, ITV, ITV2, 3 and 4, Channel 4 and Channel 5. Two of the multiplexes carry Standard Definition ('SD') channels only. One of the multiplexes carries the High Definition ('HD') variants of some of the PSB channels.

2.10.2 Three commercial multiplexes – these are licensed to Arqiva Services Limited and SDN. They broadcast from the largest 80 transmitters achieving coverage of around 90% of households. These carry a wide range of channels including ITV 2+1, ITV 3+1 and ITV 4+1

2.10.3 Northern Ireland multiplex – one multiplex that broadcasts RTÉ and TG4 services from three transmitters and covers approximately 78% of households in Northern Ireland.

2.10.4 Local Television Multiplex – this broadcasts local TV services in 20 locations across the country. We expect further local services to launch in up to 14 additional locations.

[7] https://www.ofcom.org.uk/__data/assets/pdf_file/0033/79584/update-strategy-mobile-spectrum.pdf
[8] Improving consumer access to mobile services at 3.6 to 3.8 GHz: https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-at-3.6-3.8-ghz
[9] D3&4 is a joint venture between ITV and Channel 4

2.10.5 Geographic Interleaved spectrum multiplexes - two portions of spectrum that can be used to provide a DTT multiplex in Manchester and Cardiff. The service in Cardiff has not been launched.

2.10.6 Interim multiplexes – In 2013 Ofcom awarded interleaved spectrum in the 600MHz spectrum band (550MHz – 606MHz) to Arqiva on an interim basis by granting a single licence for the establishment of two temporary DTT multiplexes using DVB-T2/MPEG4 technology. These multiplexes have now both launched. They carry a range of HD and SD services and cover around 76% of households.[10] The services they carry include BBC Four HD, RT HD, QVC +1 HD and 5Star+1.

2.11 Most of the multiplexes listed above use a transmission technology called DVB-T and a compression standard called MPEG 2. However, one of the PSB multiplexes, the Northern Ireland multiplex and the interim multiplexes use the more advanced transmission technology DVB-T2 and more advanced compression standard MPEG 4. DVB-T2 and MPEG 4 increase the capacity[11] of a multiplex, thereby enabling the delivery of more TV services and/or of HD services (or an increase in coverage for the same number of services carried).

2.12 In our 2014 Statement we explained that in order to achieve our objective of safeguarding the ongoing delivery of the benefits provided by DTT, we would seek to ensure that the platform remains able to deliver:

2.12.1 Near-universal coverage for PSB services;

2.12.2 Six national multiplexes with coverage broadly matching today;

2.12.3 A similar quantity of local TV services to those that the platform is capable of delivering today (including the Manchester and Cardiff GI services); and

2.12.4 The services carried on the Northern Ireland multiplex.

2.13 Furthermore, we explained that we would not seek to ensure continued delivery of the interim multiplexes following clearance of the band. We set out the view that discontinuation of the interim multiplexes would not jeopardise the DTT platform's ability to provide the citizen and consumer benefits that it does today. The basis for this was that:

2.13.1 There were only a limited number of services on the interim multiplexes, and some of them could be accommodated on other multiplexes; and

2.13.2 In the medium term the platform has a number of options for responding to the loss of capacity on the interim multiplexes – for example upgrading some or all of the DVB-T multiplexes to DVB-T2 or offering additional channels - including HD services - through a broadband connection, using a hybrid of DTT and IPTV.

[10] See Fig. 42: https://www.ofcom.org.uk/research-and-data/infrastructure-research/connected-nations-2015

[11] Capacity is a measure of the maximum throughput at which data or information can be transmitted within a transmission channel in a digital communication system. The capacity of a multiplex is a measure of the maximum net bit rate at which data can be carried on the multiplex (typically quoted in Mbps).

There is an important European dimension to the 700 MHz clearance programme and the decisions set out in this document

2.14 Following the publication of the 2016 consultation, the European Commission published its final Decision (EU) 2016/687 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 (the 'Commission Decision') on 28 April 2016. The Commission Decision sets out the technical conditions that EU Member States must apply if they make the 700 MHz band available for mobile use. The main requirement is the paired band plan and block edge masks for the use of 703-733 MHz paired with 758-788 MHz. For the remainder of the 700 MHz frequency band (including the centre gap), Member states may choose from the following options:

2.14.1 Audio PMSE in all or part of 694-703 MHz and 733-758 MHz

2.14.2 Emergency services communications in 698-703 MHz, 733-736 MHz, 753-758 MHz and 788-791 MHz, or parts of these ranges, noting that emergency services communications can also be provided within the 703-733 MHz and 758-788 MHz paired band.

2.14.3 Machine-to-machine communications with uplink in 733-736 MHz and downlink in 788-791 MHz

2.14.4 Downlink-only transmission in all or part of 738-758 MHz. In practice this is likely to mean SDL in band 67. However, in theory it could refer to other technologies, for example TDD downlink only services or MBMS.

2.15 These options are not mutually exclusive. For example, audio PMSE can be used in some parts of the band while machine-to-machine and downlink-only communications are used in other parts of the band.

2.16 CEPT has also published its own harmonisation measures for this frequency band in ECC Decision (15)01. This harmonised the paired band plan and technical conditions for 703-733 MHz and 758-788 MHz and the band plan and technical conditions for supplemental downlink in 738-758 MHz. Other options are not specified but emergency services communications, machine-to-machine communications and PMSE are given as examples.

2.17 The next step in the European process will be the final "European Parliament and Council Decision on UHF" which will confirm the final date by which Member States must allow the use of the band 690 – 790MHz for electronic communications services. This process is due to complete in late 2016 / early 2017.

Ofcom's specific duties and powers related to spectrum management

2.18 Ofcom's responsibilities for spectrum management are set out primarily in two Acts of Parliament which confer on Ofcom specific duties and powers in respect of spectrum

(and the other sectors we regulate): the Communications Act 2003 (the '2003 Act') and the Wireless Telegraphy Act 2006 (the 'WT Act').[12]

2.19 Our principal duties under the 2003 Act are to further the interests of citizens and consumers, where appropriate by promoting competition. In doing so, we are also required (among other things) to secure the optimal use of spectrum.

2.20 In carrying out our spectrum functions, we have a duty under section 3 of the WT Act to have regard in particular to: (i) the extent to which the spectrum is available for use or further use for wireless telegraphy, (ii) the demand for use of that spectrum for wireless telegraphy and (iii) the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy. We also have a duty to have regard, in particular, to the desirability of promoting: (i) the efficient management and use of the spectrum for wireless telegraphy, (ii) the economic and other benefits that may arise from the use of wireless telegraphy, (iii) the development of innovative services and (iv) competition in the provision of electronic communications services.

2.21 This document sets out the decisions we have taken in accordance with these statutory duties.

Impact Assessment

2.22 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making. As a matter of policy Ofcom is committed to carrying out impact assessments in relation to the great majority of our policy decisions. For further information about our approach to impact assessments, see the guidelines, "Better policy-making: Ofcom's approach to impact assessment", which are on our website.

2.23 We set out our impact assessment in our 2016 consultation document. In this document we take into account relevant responses and set out our conclusions on the impact of our decisions in relation to the centre gap and the timing of clearance.

Equality Impact Assessment

2.24 The decisions set out in this document are derived from an earlier decision to clear the 700MHz band. In reaching that decision we have previously conducted an Equality Impact Assessment to understand if change of use at 700MHz could disproportionately affect any particular group of consumers or raise specific issues for groups that are protected under equality laws. In order to do so we looked at the composition of the DTT audience and found that the DTT audience is likely to include a comparatively higher share of viewers from older age groups. We also found that the practical steps involved in some of the changes that viewers may need to carry out to address interference issues (e.g. change rooftop aerials) are likely to raise challenges for disabled people.

[12] The European Common Regulatory Framework for electronic communications (in particular, the Framework Directive and the Authorisation Directive) sets the broad legal framework for how spectrum use should be authorised and managed in the UK and aims to harmonise the regulation of electronic communications networks and services throughout the European Union.

2.25 In relation to the decisions set out in this document, we have not identified any further differential impact of our decisions (in addition to the ones noted above) in relation to the identified equality groups. We continue to give particular consideration to the needs of older and disabled viewers as part of the ongoing clearance programme.

2.26 Ofcom is required by statute to assess the potential impact of all its functions, policies, projects and practices on a range of equality groups. Ofcom is also subject to similar but distinct equality duties under Northern Ireland legislation. The additional equality groups in Northern Ireland are religious belief, political opinion and dependants.

2.27 One of the objectives of the 700MHz clearance programme is to ensure the DTT platform remains able to deliver the Republic of Ireland TV services (RTÉ and TG4) carried by the Northern Ireland multiplex. Ofcom is also working with our regulatory counterparts in the Republic of Ireland – ComReg – to ensure the continued availability of 'overspill' from the Republic's DTT service – Saorview – to viewers in Northern Ireland. This work is undertaken as part of broadcasting commitments made by the UK and Irish governments in the 1998 Belfast Agreement and their 2010 Memorandum of Understanding.

2.28 Ofcom's research shows that the Republic of Ireland's TV channels are popular with viewers in Northern Ireland. Just under a third of households watch RTÉ One and RTÉ2 on at least a monthly basis.

2.29 We consider that the decisions set out in this document and our 2014 decision to clear and release the 700 MHz band would affect all groups in Northern Ireland equally and are likely to have no, or minor, differential impact in Northern Ireland compared to consumers in general.

2.30 Nonetheless, there are two ways we can minimise any potential impact on the audience in Northern Ireland. First, we anticipate that the frequency band planning we are undertaking with ComReg will result in the post-clearance coverage of the Northern Ireland multiplex, and Saorview overspill from the Republic of Ireland, matching current availability as closely as possible.

2.31 Second, Ofcom will work with ComReg and the relevant UK and Irish government departments to co-ordinate the clearance programme in Northern Ireland and the Republic of Ireland, and to help manage the effect on DTT viewers in both jurisdictions. In this regard we have the benefit of the experience of the successful all-island co-ordination of Digital Switchover in 2012.

2.32 As the clearance programme progresses, we will continue to give particular consideration to the needs of Northern Ireland DTT viewers who watch services from the Republic of Ireland, either via the Northern Ireland multiplex or via overspill.

Section 3

Acceleration of 700 MHz clearance

Summary

3.1 In our 2014 Statement we decided to change use of the 700 MHz band from DTT to mobile data services as soon as practicably possible. Initial plans indicated that it would be possible to complete the change by no later than the end of 2021. We have since been working with the multiplex licensees and Arqiva Transco to identify ways to accelerate those plans in the light of the potential benefits to citizens and consumers.

3.2 In our 2016 consultation we set out proposals to accelerate the clearance process by varying the frequencies used by the interim multiplexes. This would bring forward the date of release of the 700 MHz by 18 months, to Q2 2020 instead of end 2021.

3.3 We received 36 responses to the consultation. 22 respondents agreed with our proposal to accelerate and our provisional view that acceleration would deliver benefits to citizens and consumers, which would outweigh the costs. A minority, however, disagreed and considered that acceleration would cause challenges for them that would outweigh the benefits. A number of respondents raised concerns about the proposal, including that it was uncertain whether acceleration could be achieved in practice, the impact on the PMSE community and the potential disruption to viewers.

3.4 Having considered the consultation responses and having regard to our statutory duties, we have decided to proceed with our proposal. This section explains the rationale for this decision and addresses the key points on which respondents to the consultation provided submissions. A consideration of stakeholder responses to the 2016 consultation is included at annex 1.

The 700 MHz clearance programme will involve a number of changes to DTT and PMSE equipment

3.5 In our 2014 Statement, we explained that change of use of the 700 MHz band will involve:

- **Changes to the frequencies DTT uses:** We wish to ensure that the DTT platform remains able to deliver a wide range of channels with broadly the same coverage as today following the change. In order to do this, we are working with the broadcasters to re-plan the frequencies the DTT network uses.
- **A major programme of DTT infrastructure modifications:** Arqiva Transco, the company that owns and operates the physical infrastructure on which DTT is broadcast, will need to modify a substantial proportion of the DTT transmission infrastructure to enable it to operate at the revised frequencies.
- **Viewers retuning their televisions:** A large number of households will need to retune their televisions as a result of the change.
- **Aerial replacements and repoints:** A small number of viewers will need to replace or possibly repoint their aerials.

- **A small number of viewers may need to install filters to protect their televisions from interference once mobile networks are deployed in the 700 MHz band:** There is a risk that mobile signals in the 700 MHz band could cause interference to DTT viewing in a small proportion of households.

- **PMSE equipment replacements:** Following the change, PMSE users will no longer be able to access spectrum in the 700 MHz band. This will mean that they need to replace all PMSE equipment which operates exclusively in that band. Users with equipment that operates both in and below the 700 MHz band may also need to replace equipment depending on the extent of reduction in utility of that equipment. Some users who operate in fixed locations may also need to replace a proportion of equipment that operates in a subset of the 470-694 MHz tuning range. This is because revisions to the DTT frequency plan will mean that the frequencies below 694 MHz which are available for PMSE users will change in some locations.

In our 2014 Statement we indicated that it would be possible to clear the 700 MHz band by no later than the end of 2021

3.6 The 2014 Statement outlined our decision to make the 700 MHz band available for mobile data as soon as practicably possible. The initial plan which we discussed in the 2014 Statement showed that we would be able to clear the 700 MHz band of DTT and PMSE services by no later than the end of 2021.

3.7 This plan (the “end 2021 plan”) assumed that the interim multiplexes would be switched off at the end of 2018 to make room for national DTT services to move into the 600 MHz band, with viewers needing to retune their televisions between 2019 and 2021.

Varying the frequencies in the interim multiplexes’ licence would enable us to bring completion of the programme forward to Q2 2020

3.8 Following the 2014 Statement and at Ofcom’s request, the multiplex operators examined ways to make it possible to accelerate the clearance process.

3.9 The multiplex operators have developed a new plan (the “accelerated plan”) which would clear the 700 MHz band and make it available for release for mobile data use in Q2 2020, instead of end 2021 under the original plan. More specifically, the accelerated plan indicates that it will be possible to release the band by 1 May 2020.

3.10 The accelerated plan requires the interim multiplexes, which currently operate in the 600 MHz band, to be moved into alternative frequencies above 694 MHz from 2017 onwards. The current expectation is that under this plan, the interim multiplexes would predominantly be rehoused in the spectrum between 742 MHz and 758 MHz, which is part of what will become the 700 MHz centre gap. However, in principle the interim multiplexes could be rehoused in other vacant frequencies in the 700 MHz band until those frequencies are required for the other multiplexes as part of the revised DTT frequency plan.

3.11 Rehousing the interim multiplexes is an important part of the accelerated clearance plan because the 600 MHz band needs to be cleared of its existing users so that the national multiplexes and local TV services in the 700 MHz band can be relocated there.

3.12 The spectrum licence for the interim multiplexes runs until 2026. We have the power to revoke the licence for spectrum management reasons by giving 2 years' notice, although revocation cannot take effect until the end of 2018, which is the minimum term of the licence.

3.13 We had originally said in our 2014 Statement that we would revoke the interim multiplexes' licence effective from the end of 2018 once the minimum term expires. We said that the national DTT multiplexes would start to move into the 600 MHz band once the interim multiplexes had been switched off. The end 2021 plan was based on this assumption and this would have meant DTT frequency changes could begin to be made in 2019.

3.14 Under the accelerated plan frequency changes for the DTT multiplexes will need to start from July 2017 onwards. In order to implement this plan, the interim multiplexes would need to start moving out of the 600 MHz band in August 2017.

3.15 Given that the interim multiplexes have a minimum term until the end of 2018, in order to allow the accelerated plan to happen, we would need to move them to alternative frequencies. To do this, we would need to go through a statutory licensing process to vary their licence.

Our view is that this would deliver net benefits to citizens and consumers

3.16 Below we set out the costs and benefits of accelerating the programme in the manner described above, assessed against the original end 2021 plan (i.e. we consider the costs and benefits of accelerating clearance by 18 months). As described above, under the original plan we would have revoked the interim multiplexes' licence at the end of 2018.

Accelerating the programme by moving the interim multiplexes will increase the benefits of change of use of the 700 MHz band

3.17 The table below summarises the main benefits of change of use of the 700 MHz band which we identified in our 2014 Statement. They fall into the following categories: network cost savings, performance benefits, benefits deriving from the earlier availability of the centre gap, coverage benefits and benefits arising from access to new services.

Table 1: Benefits of releasing the 700 MHz at the end of 2021 – expressed in 2016 NPV[13]

Benefit	Magnitude
Network cost savings: Access to the 700 MHz band will enable MNOs to meet increases in demand for mobile data at a lower cost than would otherwise have been the case. We expect a significant proportion of these savings to be passed to consumers as a result of competition in the market.	£572m-912m

[13] In our consultation document we quoted figures using 2015 NPV when we should have used 2016 NPV. We have corrected this and the table above presents the figures in 2016 NPV.

Performance benefits: Improvement in the performance (e.g. download speeds) that mobile users will experience	£450m-£556m
Use of centre gap: Our analysis focused on the benefits of change of use of the paired spectrum (703-733 MHz and 758-788 MHz). Additionally, there would be some benefits from use of the centre gap. We discuss these below.	Unquantified
Coverage benefits: Broader economic and social benefits if a 700 MHz award included a coverage obligation.	Unquantified
Access to new services: Change of use of the 700 MHz band could facilitate the launch of new services.	Unquantified; could be significant, but could be 0.

3.18 This assessment of the benefits of change of use of the 700 MHz band was based on the end 2021 plan. Our analysis suggests that bringing clearance forward by 18 months would increase these benefits in the following ways:

- **Network cost savings / performance benefits:** We estimate these would increase by £19m-£55m if the 700 MHz band was available 18 months earlier.
- **Earlier availability of centre gap:** Benefits quantified at ca. £5m. As we explain in the 2016 consultation, recent market benchmarks suggest that use of the centre gap for SDL could deliver benefits in excess of £100m over 20 years. This would imply that accelerating use of the centre gap for mobile data by 18 months has the potential to deliver benefits of £5m or more
- **Coverage benefits:** Accelerating clearance would bring forward the point at which any coverage obligation attached to the 700 MHz award was delivered.
- **Access to new services**: Equally, it is also possible that bringing forward availability of the 700 MHz band could increase any benefits associated with the launch of new services in the band. For the purposes of this analysis, we are not putting significant weight on this benefit since we consider it to be too speculative.
- **Continued access to services carried on interim multiplexes:** Varying the frequencies of the interim multiplexes would allow them to continue to operate beyond the end of their minimum term in 2018, rather than discontinuing the service in 2018 as we had originally anticipated under the end 2021 plan. Allowing the interim multiplexes to continue for longer would deliver benefits to viewers that value the services they carry.

3.19 We presented these benefits in the consultation. A number of respondents from the mobile sector agreed with this assessment of the benefits of acceleration. Broadcast stakeholders such as Digital UK and Arqiva endorsed our proposal to accelerate the programme, without explicitly commenting on our estimate of the scale of the benefits associated with acceleration.

3.20 A number of respondents to our 2016 consultation, including Viacom,[14] Digital UK and Arqiva, said that whilst completing clearance in Q2 2020 should be achievable, there is some risk of missing this target date (and therefore failing to realise all of the benefits we have identified). This is principally because the accelerated plan relies on a substantial amount of DTT infrastructure work taking place in summer 2017 and provides for limited contingency. A lot of this work involves changing the antennas at the top of DTT transmission masts. This entails engineers working at the top of the masts and helicopters airlifting the antennas. It is only possible to do this during periods of good weather. If there is a prolonged period of bad weather in 2017 this could cause delays to the infrastructure works and potentially compromise Arqiva's ability to complete DTT clearance in Q2 2020.

3.21 We agree that this is a risk. However, we believe that the chance of clearance being pushed back is relatively small. As discussed below, in light of the potential risk of delay, we have agreed with Government that we will review this target date in August 2017.

3.22 Whilst it was supportive of accelerating the programme, Arqiva raised a number of concerns about the process for varying the interim multiplexes' licence. It noted that in the 600 MHz Award Statement[15] we said that if we needed to access the 600 MHz band before the end of 2018 we would seek to conduct any transition in line with the following principles:

3.22.1 If retuning activity becomes necessary, we would aim to commence this in areas of the country where there are no 600MHz interim multiplexes being broadcast;

3.22.2 If access to 600MHz frequencies was required where interim multiplexes are being broadcast, we would seek to avoid the most populous areas (i.e. those areas of most significance for the licensee) until after 2018; and

3.22.3 Where it was unavoidable for us to have access to frequencies in the 600MHz band we would, where possible, seek to make alternative frequencies available for the DTT services provided under the 600 MHz licence.

3.23 Arqiva expressed the view that we have not followed these principles. The accelerated plan was developed by Arqiva Transco and the DTT multiplex operators in discussion with Ofcom. Because radio waves travel across borders, we needed to coordinate the frequency changes we are undertaking with our international neighbours (who are also in the process of clearing the 700 MHz band). This coordination imposed constraints on the order in which frequency changes at individual sites happened and therefore meant there was limited scope to avoid retuning in populous areas before the end of 2018 or to start in areas of the country where no 600 MHz interim multiplexes are being broadcast. Consistent with what we said in the 600 MHz Award Statement, we are, however, making alternative frequencies available to the interim multiplexes.

14 https://www.ofcom.org.uk/consultations-and-statements/category-1/maximising-benefits-700mhz-clearance

15 https://www.ofcom.org.uk/__data/assets/pdf_file/0022/54652/600_mhz_statement.pdf

It would also increase the impact on DTT viewers and PMSE users

3.24 Accelerating the 700 MHz clearance programme in the manner described above would also increase the costs in a number of ways.

DTT infrastructure costs

3.25 Acceleration will increase the cost of the DTT infrastructure modifications needed for clearance. In our consultation document we originally estimated that acceleration would increase the cost of the DTT infrastructure modifications needed for the programme by up to £5m-10m (the cost of changing the interim multiplexes' frequencies accounted for £3m-5m of this increase).

3.26 The estimates we provided in our consultation document were our own, as we had not yet received detailed information on costs from the broadcasters and multiplex operators at the time. Since we published the consultation, the multiplex operators have provided us with a detailed costed plan for delivering the programme (the "Clearance Delivery Plan" or "CDP"). We have thus refined our cost estimate in light of the information in the CDP. We did not receive any additional substantive information on costs from the responses provide to our consultation. Based on information in the CDP, we now estimate that acceleration will increase the overall economic cost of DTT infrastructure changes by around £8m. This takes into account both increases in the cash cost of the changes and discounting effects as we discuss in annex 3.

Viewer support

3.27 A number of respondents raised concerns that acceleration could raise disruption to viewers and called for Ofcom to ensure that they were protected. They noted that one of Ofcom's objectives for 700 MHz clearance include avoiding undue disruption to viewers and said they would be concerned if the accelerated plan were to put this at risk. We agree that it is important that we do not compromise our objectives in relation to viewers. We have therefore considered carefully the impact acceleration would have on viewers.

3.28 Accelerating clearance will have three main DTT viewer-related impacts: earlier retunes; earlier aerial replacements or repoints; and economic costs of bringing forward spending on any communications or support provided to viewers.

- **Earlier and additional retunes:** The main impact of acceleration will be that most viewers will need to retune their televisions earlier than they would have otherwise. We have not revised our original estimate of the cost of retunes, which we estimated in our 2016 Consultation to be ca. £200k[16]. In its response to our consultation Digital UK said that in addition to causing people to retune earlier, the accelerated plan would mean that around 20% of viewers need to carry out more retunes than they would have had to under the end 2021 plan. Work on developing the end 2021 plan stopped at a relatively early stage. Therefore we do not know have a good sense of how many retunes there would have been under this plan. By extension we cannot robustly quantify the extent of additional retuning under the accelerated plan. We are therefore recognising additional retunes as an unquantified cost of acceleration. As discussed in our 2014

[16] In our 2016 consultation we referred to this figure as less than £1m.

Statement, the available evidence suggests that most households find retunes easy. Consequently, we do not believe additional retunes are likely to have a material impact on the costs of the plan.

- **Earlier aerial replacements / repoints:** A small number of viewers will also have to replace their aerials earlier than under the end 2021 plan.[17] We estimate the cost of bringing aerial replacement forward in this way to be £1m-£1.5m.

- **Earlier launch of the consumer information program:** By having to launch the consumer support program earlier there is an increased time-value effect which leads to higher economic costs. Since our March 2016 consultation we have revised the total cost of the consumer information program. As a result, the new estimated incremental cost of early release on the consumer information program is ca. £200k.

3.29 On balance we do not consider that these incremental effects of acceleration will pose a significant challenge for viewers. We therefore consider that accelerating the programme in the manner discussed is compatible with our objective of avoiding undue disruption to viewers.

Interim multiplex coverage

3.30 The interim multiplexes' coverage will decrease by between 1% and 5%. However, 95-99% of viewers who currently receive the interim multiplexes will retain access to their services for at least 18 months longer than they would have done under the original end 2021 plan, in which the interim multiplexes would have been switched off at the end of 2018.

PMSE equipment replacement

3.31 Some PMSE users will need to replace their equipment up to 18 months earlier than they would have had to under the end 2021 plan. We estimate this will increase the economic costs of PMSE equipment changes by ca. £5m.

3.32 In their responses to our consultation, some stakeholders expressed concern that acceleration would increase the risks posed by clearance to the PMSE community. We discuss these concerns below.

3.33 As we set out in our 2014 Statement, PMSE users will no longer be able to use the 700 MHz band once we release it for mobile data use. The 700 MHz band constitutes approximately 1/3 of the total spectrum available for audio PMSE and plays an important role in the delivery of the events the PMSE community provides. In order to mitigate the effects of loss of access to the 700 MHz band and safeguard the benefits the PMSE community provides we recently allocated alternative spectrum in the 960-1164 MHz band to PMSE.[18] We anticipate that some PMSE users are likely to use

[17] The number of viewers who will need to replace their aerial at the time of clearance is slightly higher under the accelerated plan than under the end 2021 plan. This is because around 10,000 households (around a 0.5% increase), who would have had to replace their aerials between Q2 2020 and end 2021 due to the lifespan of their equipment coming to an end, will now need to replace these aerials as clearance reaches their area. The effect for these households will be that they need to replace their aerials up to 18 months earlier than they would have otherwise had to.

[18] https://www.ofcom.org.uk/consultations-and-statements/category-2/new-spectrum-audio-pmse

spectrum in this band once the 700 MHz clearance programme is complete. There is currently no PMSE equipment on the market operating in the 960-1164 MHz band. As such, PMSE equipment manufacturers will need to develop and bring to market equipment in this band before it can be used by the PMSE community.

3.34 Respondents including BEIRG[19] and Copsey Communications argued that bringing clearance forward by 18 months would increase the risk that new PMSE equipment operating in the 960-1164 MHz band will not be on the market in time for clearance. BEIRG said that the consequence of this would be that PMSE users were 'forced to replace their 700 MHz equipment before any new equipment operating in the 960-1164 MHz band arrives on the market'. It expressed the view that this would mean that after clearance PMSE users would not have access to enough usable spectrum to be able to 'continue to deliver the quantity and quality of services that event producers and consumers have come to expect'.

3.35 In addition, BEIRG argued that, even if equipment in the 960-1164 MHz band was available in time for clearance, acceleration would significantly reduce the time PMSE users had to test or assess this equipment extensively before they use it. BEIRG expressed concern that this would increase the risk of problems with the sound system occurring at live events.

3.36 We do not agree with these points. We are aware that a major wireless microphone manufacturer and a major PMSE stakeholder are currently testing prototype equipment in the 960-1164 MHz band. We understand that these tests are progressing well to date and suggest that there are no major technical hurdles which would prevent equipment operating in this band from being on the market in advance of an accelerated clearance.

3.37 We recognise that acceleration will mean there is less time for users to test equipment before they need to bring it into regular use. However, we consider that even under this accelerated timeline there should be time for users to test their new equipment sufficiently. We note that to date the tests have not provided any evidence that equipment in the 960-1164 MHz band will operate in a fundamentally different way from equipment in the 700 MHz band. For example, the tests show that the 960-1164 MHz band has broadly similar propagation characteristics to the 700 MHz band. We therefore do not agree that there is a major risk of additional disruption when theatres and other PMSE users start to bring this equipment into use.

3.38 As part of its funding for the 700 MHz clearance programme, Government has agreed to fund a grant scheme to support PMSE users who will have to vacate the 700 MHz band earlier than expected. It has asked us to set up and oversee this scheme and we will consult on the details later this year. This consultation will include proposals as to the type of equipment and users that will be eligible for funding. We currently anticipate the grant scheme launching in 2019.

On balance, our view is that the increase to the benefits will exceed the increase to the costs

3.39 Table 2 below summarises the benefits and costs of accelerating clearance by varying the frequencies used by the interim multiplexes.

[19] https://www.ofcom.org.uk/__data/assets/pdf_file/0030/74757/beirg.pdf

3.40 We took a cautious approach to the analysis which underpins the estimates in the table and tended to make conservative assumptions about the size of both benefits and costs. We have identified a number of unquantified benefits, some of which could be significant. Consequently, we believe that the benefits are likely to lie towards the top of the range we have identified and may even exceed it, whereas we do not anticipate that the costs will exceed our estimates. Based on our analysis, we therefore believe that the benefits of accelerating clearance are likely to outweigh the costs, potentially by a significant margin.

Table 2: Summary of economic costs and benefits of bringing forward the release of the 700 MHz band to Q2 2020 in 1st January 2016

Benefits	Quantified Benefits	Total Benefits
18 months' extra national availability of paired spectrum	£19m – 55m quantified benefits.[20] Some unquantified benefits on top of this.	£19m – 60m of quantified benefits
18 months' extra availability of centre gap	Scale of benefits uncertain but estimated at up to £5m	
95-99% of households retain access to interim multiplexes for 15 months longer than under end 2021 plan	Scale of benefits not quantified	Some unquantified benefits which could be small but could also prove significant
Costs	**Quantified Costs**	**Total Costs**
Incremental costs of increase to PMSE costs	£5m	£14m-15m of quantified costs
Consumer related costs[21]	£1m-£2m	
Incremental infrastructure economic cost	£8m	Unquantified cost resulting from reduction in coverage of interim multiplexes. Likely to be outweighed by unquantified benefits of interim multiplexes running beyond the end of 2018.
1-5% households lose access to interim multiplexes early	Unquantified – not likely to be material to our analysis. Outweighed by viewer benefits.	

We have therefore decided to work to to bring forward release of the 700 MHz band to Q2 2020

3.41 As set out above, we consider that accelerating clearance will deliver net benefits, a significant proportion of which we would expect to flow to citizens and consumers. As we have explained, we consider that accelerating the programme will not have a material effect on viewers and that it should not compromise our ability to achieve our

[20] This estimate of the benefits of acceleration is derived from the CBA we undertook for 700 MHz clearance.

[21] Includes incremental costs of aerial replacements, retuning and consumer information program.

objective of safeguarding the benefits PMSE provides. On balance, we therefore consider that accelerating the 700 MHz clearance programme is likely to represent an efficient use of spectrum. Consequently, we have taken a spectrum management decision to work to bring forward release of the 700 MHz band to Q2 2020.

3.42 As discussed above, there is a (relatively small) risk of us missing the Q2 2020 target date for clearance. Since the risk mostly relates to potential delays to work on transmitter sites which need to be modified in the summer of 2017, we should know if this risk is going to materialise by August 2017. We have therefore agreed with Government that we will review this target date in August 2017.

Section 4

Use of the 700 MHz centre gap

4.1 In our 2016 consultation we proposed to make 20 MHz of the centre gap available for SDL in Q2 2020. Furthermore, we proposed to enable the interim multiplexes to continue operating in the centre gap until the end of Q1 2020, rather than discontinuing them at the end of 2018.

4.2 Stakeholder responses to these proposals were mixed. Mobile stakeholders generally agreed with our proposal to make the centre gap available for SDL from Q2 2020 onwards. However, some mobile stakeholders argued that we should take a more technology neutral approach and allocate the centre gap to mobile data, without specifying which mobile data technology licensees should use.

4.3 In general, broadcast stakeholders did not disagree with our proposal that we should make the centre gap available for SDL in the long term. However, a number of them, notably Arqiva Services Limited and Digital UK argued that we should defer the point at which this allocation came into effect and allow the interim multiplexes to use the centre gap until 2023.

4.4 Most PMSE stakeholders disagreed with our proposals and argued that we should allocate the centre gap to PMSE.

4.5 Having considered the consultation responses and having regard to our statutory duties, we have decided to make 20 MHz of the centre gap available for mobile downlink transmission. In practice this is likely to mean SDL band 67. However, in theory it could refer to other technologies, for example TDD downlink only services or MBMS. This section explains the rationale for this decision and addresses the key points on which respondents to the consultation provided submissions. A consideration of stakeholder responses to the 2016 consultation is included at annex 1. We discuss Arqiva Services Limited and Digital UK's suggestion that we delay the point at which the centre gap becomes available for SDL in section 5.

We have assessed a range of options for use of the centre gap

4.6 We have considered five potential uses for the centre gap: mobile downlink (most likely to be SDL); Emergency services; Audio PMSE; Machine to Machine communication; and DTT. Below we discuss these options and the position we have taken in relation to each one, with reference to stakeholder responses to our consultation. We have assessed each in turn to determine the option which would, overall, represent the optimal use of the spectrum, in order to give best effect to our statutory duties. In making this assessment, we have also considered the Commission Decision dealing with the technically harmonised conditions of the use of the 700 MHz band and the draft join European Council and European Parliament Decision dealing in particular with the timing of release of the band.

4.7 In our 2016 consultation, we focussed our analysis of the case for making the centre gap available for mobile data on SDL. For the reasons discussed below, in this document we have slightly broadened our focus. We now focus on mobile downlink services more generally, whilst noting that (as explained in section 2) SDL is the most likely mobile downlink service to use the centre gap.

We consider there is likely to be significant demand to use the centre gap for mobile downlink

4.8 Demand for mobile data is growing rapidly. Total data traffic across networks in recent years has been growing at around 60% per year. There is a general consensus that this rapid growth will continue for the foreseeable future. For example, in our recent update to our mobile data strategy we forecast that by 2025 mobile data traffic could be between 12 and 47 times greater than 2014 levels.22. As discussed in our Mobile Data Strategy[23] we expect that sub 3GHz spectrum release will increase the available spectrum by 28% in the next 5 - 10 years. Even allowing for improvements in spectrum efficiency, we therefore consider that it is likely there will be demand for additional mobile spectrum. Because it is low frequency spectrum with good propagation characteristics, we consider that the centre gap could be particularly attractive in this context.

4.9 The vast majority of mobile data traffic is downlink (e.g. video traffic). The UK Spectrum Policy Forum recently noted that the downlink to uplink ratio in a data driven network is now about 7:1.[24] This asymmetry in data traffic means that demand for downlink spectrum is likely to be particularly high. Making the centre gap available for mobile downlink could play a useful role in addressing this asymmetry.

4.10 Mobile industry responses to our 2016 consultation provide further evidence in support of the view that there will be demand for additional mobile spectrum in the centre gap. For example, Huawei stated that it considered the allocation of the centre gap to mobile data to be 'essential to efficiently support the growing consumer demand for mobile data'.[25] Similarly, Hutchison 3G UK said that it expected the centre gap to play a key role in helping meet increases in demand for mobile data.[26]

4.11 Consumers value mobile data highly. Therefore, we consider that ensuring that sufficient spectrum is available to meet increases in demand for mobile data will result in significant benefits for consumers.

4.12 Amongst other things, making the centre gap available for mobile downlink could help support competition in the mobile market.

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[22] https://www.ofcom.org.uk/__data/assets/pdf_file/0033/79584/update-strategy-mobile-spectrum.pdf

[23] See figure 7 of http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-data-strategy/statement/update-strategy-mobile-spectrum.pdf

[24] Spectrum Policy Forum (December 2015), *UK Spectrum Usage & Demand, Second Edition*, prepared by Real Wireless for UK Spectrum Policy Forum.

[25] http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/Huawei_Technologies.pdf

[26] http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/Hutchison_3G_UK.pdf

We anticipate that demand for the other candidate use cases can be satisfied in other spectrum

There is unlikely to be demand for emergency services spectrum in the centre gap

4.13 As set out in section 2, one of the options in the Commission Decision is for member states to allocate 5 MHz of the centre gap to emergency services communications networks. This would be paired with 5 MHz in the guard band. The Commission Decision envisages that this spectrum would be used exclusively by the emergency services. It could facilitate voice communications between emergency services personnel. The emergency services could also use it to deliver mobile data services to their personnel.

4.14 The UK Government has decided against using a dedicated network for emergency services. Rather it has opted to use commercial mobile networks to deliver these services.

4.15 This being the case, we do not envisage a demand for additional dedicated spectrum for emergency services. Therefore, having had regard to the relevant statutory criteria, we do not consider there is a need for us to reserve spectrum for exclusive use by the emergency services. We set this view out in our 2016 consultation. No respondents disagreed with our provisional conclusions regarding use of the centre gap for emergency services.

Demand for PMSE spectrum can be met by other frequency bands

4.16 We have previously stated that safeguarding the ongoing delivery of the benefits PMSE provides is a priority for us. As we explained in section 2, in support of this objective we have recently decided to allow PMSE users to share spectrum in the 960 – 1164 MHz band with aeronautical users. In our 2016 consultation we set out the provisional view that, taken together with the remaining PMSE allocations between 470 and 694 MHz, this would be sufficient to meet future demand for audio PMSE spectrum and that the case for allocating the centre gap to PMSE was therefore weak.

4.17 In their responses to our 2016 consultation a number of PMSE stakeholders, including BEIRG and Copsey Communications,27 disagreed with this position. They argued that it is still uncertain whether the newly allocated band was commercially or technically viable for use by the PMSE sector. On this basis they said that it was premature to conclude that the centre gap would not be required in order to meet demand for PMSE spectrum.

4.18 We undertook extensive technical analysis as part of our 2015 statement on new spectrum for PMSE[28]. This concluded that the 960-1164 MHz band was usable by PMSE and that it would adequately serve the needs of PMSE stakeholders. We demonstrated the utility of the band to PMSE stakeholders at the PMSE workshop held at our Baldock offices on 28 April 2016. In addition, as set out in section 3, testing by PMSE stakeholders shows that the band can support the high quality requirements of PMSE.

[27] http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/Copsey_Communications.pdf
[28] https://www.ofcom.org.uk/consultations-and-statements/category-2/new-spectrum-audio-pmse

4.19 Based on the available evidence we therefore do not agree that there is uncertainty around the technical viability of the band. We remain of the view that this spectrum, along with the remaining 470-694 MHz band, adequately provides for the needs of PMSE and we do not consider that allocating the centre gap to PMSE would be an efficient use of the spectrum.

4.20 We cannot know for certain what commercial decisions manufacturers will take about whether to produce equipment that operates in the 960-1164 MHz band. However, two major equipment manufacturers and one smaller manufacturer have expressed an interest in using the band. One of the equipment manufacturers is now trialling prototype test equipment and another is looking to start trials in the near future. Based on manufacturer activity and sentiment to date, on balance we consider it likely that manufacturers will develop and bring to market equipment that operates in the 960-1164 MHz band.

M2M

4.21 As we explained in Section 2, the Commission Decision gives the option of allocating 3 MHz at the bottom of the centre gap for M2M use. In our 2016 consultation we set out the steps that we have taken to encourage innovation and investment in M2M technology, including making sure it has access to sufficient spectrum to address its future needs. The 2016 consultation focussed primarily on the top 20 MHz of the centre gap and did not focus in detail on use of the bottom 3 MHz; however, we said that we would keep the situation under review.

4.22 We will publish a brief consultation on the possibility of using the bottom of the centre gap for M2M uses separately in due course.

In the long term there is unlikely to be demand for DTT spectrum in the centre gap

4.23 Below we consider the case for long term DTT use of the centre gap. We consider the case for extended interim use of the centre gap separately in section 5.

4.24 If we allocated the centre gap to DTT it would allow the interim multiplexes to continue broadcasting beyond the end of the 700 MHz clearance programme. This would enable the DTT platform to continue to deliver the services these multiplexes carry and offer a wider range of services than can be currently delivered on the 6 national multiplexes (including more HD services).

4.25 In our 2016 consultation we noted that the services on the interim multiplexes do not currently account for a significant proportion of DTT viewing, suggesting that demand for these services may not be that high. Moreover, we explained that if demand for the services the interim multiplexes carry were to increase over time, in the longer term Arqiva Services Limited could deliver these on its two main national DTT multiplexes by upgrading these to DVB-T2. We said that this would likely be more spectrum efficient than continuing to transmit the interim multiplexes alongside two national DVB-T multiplexes.

4.26 Broadcast stakeholders such as Arqiva Services Limited and Digital UK focussed their responses on the nearer term future of the interim multiplexes, arguing that we should allow them to operate in the centre gap until the end of 2022. They did not make a case for us allocating the centre gap to the interim multiplexes thereafter. This could be interpreted as suggesting that in the long term there is not likely to be strong demand for the interim multiplexes to continue using the centre gap.

4.27 Having considered these responses we do not believe that allocating the centre gap to the interim multiplexes would constitute optimal use of spectrum.

4.28 We also note that, given the Commission Decision, allowing the interim multiplexes to remain in the centre gap after 2022 is unlikely to be a viable option.

4.29 The table below sets out each option and summarises our assessment of them, in light of stakeholder responses

Table 3: Summary assessment of options for use of the centre gap

Centre gap option	Assessment of options
Emergency services	• Unlikely to be demand for dedicated spectrum for emergency services in centre gap
PMSE	• Demand for PMSE spectrum can be met with other bands, given our decision to make spectrum in 960-1164 MHz band available for PMSE
Machine-to-Machine	• Addressed in separate publication
DTT	• Potential demand for capacity the centre gap would provide, but platform has other more efficient options for meeting this demand in the longer term (e.g. T2 transition for main national multiplexes); and • No expressed desire for long term allocation of centre gap spectrum to DTT, though there is a debate about interim use of the centre gap (see section 5) • Questionable whether long term use is viable option, given the Commission Decision
Mobile downlink	• Clear evidence of demand for mobile data, in particular downlink • Allocation could benefit consumers through lower prices and improved mobile data download speeds • Allocation could also play a role in sustaining competition

We have decided to allocate the centre gap for mobile downlink

4.30 The analysis above suggests that in the future there is likely to be significant demand for additional mobile spectrum, including spectrum in the centre gap. Conversely, it also indicates that in the long term there is not likely to be significant demand for use of the centre gap by the other types of user we have considered and which are permitted by the Commission Decision. Consequently, we consider that allocating the centre gap for mobile downlink as part of the 700 MHz clearance process will best secure the optimal use of spectrum in the UK. In section 5, we consider when this allocation should start from.

4.31 In our 2016 consultation we proposed to allocate the centre gap to SDL. In its response Cisco argued that we should not restrict use to just SDL, but should be neutral about what type of mobile technology uses the centre gap.[29] This view was shared by UK Broadband. UK Broadband said that 'market players are better placed to identify use cases than regulatory authorities' and that it is difficult to predict at this stage exactly how technology will evolve between now and release of the 700 MHz band.[30] On this basis it recommended that we take a technology neutral approach and refrain from specifying what type of mobile data technology should use the centre gap.

4.32 We acknowledge the points Cisco and UK Broadband have made and have considered whether adopting a more technology neutral approach would be consistent with our statutory duties and the framework set down in the Commission Decision. The Commission Decision states that any mobile data service in the centre gap should be downlink-only, but did not specify SDL. We therefore consider that there is scope for taking a broader view on how the centre gap should be allocated in the long-term, to take account that technologies may evolve between now and the release of the 700 MHz band. We have decided to allocate the centre gap for downlink use, without specifying that this necessarily be SDL. We envisage that this will be reflected in the technical licence conditions which will be imposed on the centre gap licences.

4.33 In practice the most likely form of downlink-only technology to use the centre gap is SDL band 67. However, in theory it could refer to other technologies, for example TDD downlink only services or MBMS.

[29] http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/Cisco.pdf

[30] http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/UKB_Networks.pdf

Section 5

When should the centre gap become available for mobile downlink?

5.1 In section 4, we set out our decision to allocate the centre gap for mobile downlink. In this section we consider when that allocation should start from and when the interim multiplexes should switch off. In particular, we consider Arqiva Services Limited's suggestion that the centre gap should become available for mobile downlink from 2023 onwards and that the interim multiplexes should be able to use this spectrum until then.

5.2 We explain that:

5.2.1 We have decided that the centre gap will become will become available for mobile downlink use in Q2 2020 at the same time as the paired spectrum becomes available for mobile data;

5.2.2 There is therefore scope the interim multiplexes will be able to operate in the centre gap until at least 1 May 2020, subject to the appropriate statutory licensing processes being undertaken; and

5.2.3 From 1 May 2020 onwards, we are minded to allow the interim multiplexes to remain in the centre gap until mobile downlink services in this spectrum switch on. This is subject to Arqiva Services Limited: being able to demonstrate that the interim multiplexes can operate in the centre gap without causing interference to mobile services in the paired spectrum; and satisfying us that it will take appropriate steps (at its own cost) to manage the impact of interference from mobile services in the paired spectrum into the interim multiplexes.

Some broadcast stakeholders argued that we should defer the point at which the centre gap becomes available for mobile downlink

5.3 There is a question about when the centre gap should become available for mobile downlink and, related to this, the steps we need to take in relation to the interim multiplexes' licence.

5.4 In their submissions, Arqiva and DUK have argued that rather than releasing the centre gap at the same time as the paired spectrum, we should defer the point at which it becomes available for mobile downlink until the beginning of 2023.They have argued that the interim multiplexes should be able to use the centre gap until this point.

5.5 In our consultation we considered this option but provisionally rejected it on two counts:

5.5.1 First, there was a risk of the interim multiplexes causing interference to mobile data services in the paired part of the 700 MHz band.

5.5.2 Second, our working assumption was that the opportunity cost of delaying the launch of mobile services in the centre gap was higher than the value of spectrum being available for DTT between 2020 and 2023.

5.6 On this basis, we proposed that the centre gap should be available for SDL from Q2 2020 and that the interim multiplexes should switch off at end of Q1 2020. Arqiva Services Limited, DUK and a number of other broadcast stakeholders disagreed with these arguments. In their consultation responses[31] they expressed the view that:

5.6.1 The risk of the interim multiplexes causing harmful interference to mobile data services is low;

5.6.2 Operators are likely to exhaust their other options (e.g. WiFi offload, use of small cells etc.) for meeting capacity requirements before they make use of the centre gap. They are therefore unlikely to need to access the centre gap until well into the 2020s. So there would be a risk of spectrum lying fallow if we allocated the centre gap to SDL from 2020 onwards; and

5.6.3 Arqiva is unlikely to be in a position to migrate its DVB-T multiplexes to DVB-T2 until at least the end of 2022. If the interim multiplexes switched off before then, viewers would lose access to most of the content they carry. This could cause detriment to viewers that valued those services, and undermine the competiveness of the DTT platform. Given that DTT offers a route to market for a wide range of broadcasters and platform operators (e.g. BT and Talk Talk), undermining DTT could weaken the broadcast sector and distort competition between TV platforms.

5.7 Moreover, Arqiva argued that even if we did allocate the spectrum to mobile downlink at the same time as the paired spectrum, there was no basis for discontinuing the interim multiplexes at the end of Q1 2020 as the paired spectrum will not be available for mobile until midway through Q2 2020.

We are not persuaded of the case for such a deferral

5.8 Below we consider the arguments for and against delaying the point at which an allocation of the centre gap to mobile downlink comes into effect. As SDL is the most likely form of downlink technology to use the centre gap, we have considered the arguments primarily with respect to that technology.

More work would be needed to establish whether the interim multiplexes would cause harmful interference to mobile data services

5.9 We set out our assessment of the arguments Arqiva has made about coexistence in annex 2 of this document. Arqiva's hypothesis that the interim multiplexes would not cause harmful interference into mobile data services in the paired part of the 700 MHz band does not appear unreasonable. However, it is predicated on a number of assumptions which we have not been able to validate at this time. Arqiva Services

[31] See for example http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/Arqiva.pdf; and http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/Digital_UK.pdf

Limited would need to do more work to prove that there is not a material risk of interference.

There is a risk of interference into DTT services in the centre gap

5.10 Since the consultation, we have also considered mobile interference into DTT in line with one of our programme objectives to avoid undue disruption to DTT viewers.

5.11 As we explain in annex 2, our analysis suggests that there is a significant risk mobile data services in the paired spectrum could cause interference to DTT services in the centre gap. This interference could impair some households' ability to view the interim multiplexes. We would not expect any scheme set up to deal with interference into the main national DTT multiplexes to bear any costs related to interference into the interim multiplexes. In order for us to consent to the interim multiplexes operating beyond 2020, we would need Arqiva to satisfy us that it would take appropriate steps (at its own cost) to manage the impact of interference into the interim multiplexes. This could for example involve providing viewers with information about interference into the interim multiplexes and bearing the cost of dealing with viewer enquiries any 700 MHz viewer support scheme received as a result of interference into the interim multiplexes.

We consider it likely that there will be demand for mobile downlink to use the centre gap by 2020

5.12 It is not possible to be certain precisely when demand will emerge for mobile downlink services, and specifically SDL, to access the centre gap. Nor can we be certain of the timelines on which an equipment ecosystem will develop.

5.13 However, given the relative rates of increase in spectrum supply and mobile data demand (see discussion above), we consider that, even allowing for use of other techniques for meeting capacity requirements, there will still be demand for additional mobile spectrum (over and above the releases already planned) by 2020. This view is consistent with the outputs of the model Analysys Mason designed to inform our 2014 Statement. This model indicates that making 20 MHz of additional mobile spectrum over and above the paired part of the 700 MHz band and other planned release available in 2020 (as opposed to 2023) could reduce the number of base stations MNOs needed to build in order to meet projected increases in mobile data traffic. This would potentially deliver further network cost savings on top of those already discussed in this document. The model factors in potential use of techniques for meeting capacity requirements such as WiFi offload and deployment of more efficient transmission technologies.

5.14 A number of mobile stakeholders put forward arguments in their responses to our 2016 consultation which support this view. For example, Telefónica, Huawei and Hutchison 3G UK expressed the view that there would be strong demand for SDL to access the centre gap by 2020. As we have noted, ensuring that sufficient spectrum is available for mobile stakeholders to meet increased demand for mobile data can play a role in sustaining competition in the mobile market.

5.15 As set out above, we cannot be certain of timelines on which an equipment ecosystem for SDL (or another downlink-only technology) in the centre gap will develop. We recognise that this will be dependent on international and national regulatory and market developments in the mobile sector over the next four years. However, we note that:

5.15.1 The international direction of travel suggests that a number of major European countries are likely to allocate the centre gap for SDL. For example, France has decided that ARCEP will have spectrum usage rights in 15 MHz of the centre gap to respond to SDL needs according to market demand. Similarly, Germany is considering making 15 MHz of the centre gap available for SDL as part of its next spectrum award, though a final decision is yet to be taken.

5.15.2 Equipment manufacturers whom we have spoken to have indicated that they do not envisage there being any technical barriers which would prevent such mobile equipment that works in the centre gap coming to market in advance of 2020. Many handsets, including the iPhone SE and the Galaxy S7, already support the use of SDL (the mobile data technology we consider most likely to use the centre gap) in similar frequencies (717-728 MHz).

5.15.3 The 700 MHz centre gap is already incorporated in release 13 of the 3GPP standard (as band 67). Precedent suggests that it is feasible for equipment to emerge on the market within a relatively short period of appearing in the 3GPP standard. Taking SDL in North America, this was standardised in 3GPP release 11 in December 2012, and the first handset appeared on the market in May 2014 (LG G3).

5.16 Given the developments in France and Germany; the fact that the centre gap is already in the 3GPP standard and the likely existence of demand to use this spectrum, we consider it is more likely than not that an equipment ecosystem in the centre gap will emerge by 2020. A number of consultation respondents echoed this view. For example, Hutchison 3G UK argued that '*there is high confidence that this spectrum will be usable for SDL by Q2 2020*' and that '*conditions favour the fast implementation and adoption of the 700 MHz centre band as soon as it is made available for mobile*'.[32]

We consider that switching the interim multiplexes off in 2020 would likely have only a modest effect on viewers and the overall attractiveness of the DTT platform

5.17 Table 4 below lists the services which are currently on the interim multiplexes

Table 4: Television services carried on the interim multiplexes

5USA+1	VIVA+1	RT HD
VIVA	Keep It Country	CBeebies HD
CBS Reality +1	BBC FOUR HD	5STAR+1
CBS Drama	BBC NEWS HD	The Craft Channel
Rishtey Europe	Al Jazeera Eng HD	QVC + 1 HD

[32] http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/Hutchison_3G_UK.pdf

TalkingPictures TV	Channel 4+1 HD	QVC Beauty HD
Vintage TV	4seven HD	Community Channel

5.17.1 Channel listing correct at 03/04/2016. Source: http://www.digitaluk.co.uk/industry

5.18 According to BARB, collectively these services have a viewing share of around 0.7%.

5.19 We recognise that, as Arqiva and Digital UK have noted, in order to remain competitive, it is important that the DTT platform remains able to offer a wide range of channels, including HD channels. However, we note that, even without the interim multiplexes, the DTT platform will be able to offer 6 national mutiplexes after clearance. In our 2012 UHF strategy statement, we set out the view that this should be sufficient for the platform to continue to deliver the benefits it does today following clearance. We have not seen any evidence that would warrant us revising this view.

5.20 The channels on the interim multiplexes deliver value to viewers, and we accept that, as Arqiva argued, this value could increase over time if their popularity increased and/or if popular new services came onto the multiplexes. However, we do not consider that the evidence available at the moment supports the view that switching the multiplexes off in 2020 would cause significant detriment to the DTT platform's attractiveness and ability to compete.

On balance, we consider that releasing the centre gap at the same time as the paired spectrum would secure optimal use of the spectrum

5.21 As set out above, we consider it likely that there will be demand for mobile downlink services (likely SDL) to access the centre gap by 2020 and that making the centre gap available at this point could help sustain competition in the mobile market. We also believe that making the centre gap available in Q2 2020 would be conducive to the efficient management of spectrum as it would mean we could auction it at the same time as the paired spectrum, thereby allowing auction participants to make a more holistic assessment of their overall spectrum requirements when bidding. Set against this, we are not persuaded that allowing the interim multiplexes to continue using the centre gap beyond 2020 is necessary to ensure the competitiveness of the DTT platform.

5.22 On balance, we therefore consider that allocating the centre gap to mobile data from Q2 2020 onwards is likely to secure optimal use of spectrum. We have therefore decided to allocate the centre gap to mobile data (downlink, including SDL) effective from Q2 2020.

But, subject to stronger evidence on interference risks, we are minded to allow the interim multiplexes to operate in the centre gap until licensees switch mobile data services on

5.23 This said, we accept that there is limited merit in requiring the interim multiplexes to vacate the centre gap before the paired spectrum is available for mobile data use. The current plan indicates that the paired spectrum will be clear and ready for mobile data at the end of April 2020. We are therefore minded to allow the interim multiplexes to remain in the centre gap until at least the 1 May 2020.

5.24 We accept there is a risk that an equipment eco-system for mobile downlink services (e.g. SDL) in the centre gap develops more slowly than we currently anticipate.

Rather than establishing 1 May 2020 as a fixed end date for the interim multiplexes, we therefore consider that it makes sense to take an agile approach. We are minded to allow the interim multiplexes to continue operating until such time as a mobile data licensee decides to switch on services in the centre gap. This is subject to Arqiva being able to demonstrate that:

5.24.1 There is no material risk of the interim multiplexes causing harmful interference to mobile data services in the paired part of the 700 MHz band; and

5.24.2 Arqiva has, at that point, put in place appropriate provisions for managing the impact of incoming interference received by viewers watching the interim multiplexes.

5.25 We will consider the detail of how to implement these arrangements, including any licensing implications, in due course.

Section 6

Next Steps

6.3 In the preceding sections, we have set out the two decisions we have taken. First in relation to the timing for clearing the 700 MHz band and second, how we intend to use the part of the band known as the centre gap following clearance. In order to implement these decisions, we will take the following steps:

6.3.1 We will initiate the process to vary the interim multiplexes licence to change the frequencies they use from July 2017 onwards in order to give effect to our decision to accelerate the clearance programme.

6.3.2 In August 2017 we will review the progress of infrastructure work and the target accelerated clearance date of Q2 2020.

6.3.3 We will continue working with Government as it considers what viewer support programmes might be necessary as part of the 700 MHz clearance programme.

6.3.4 Later this year we will consult on the details of a grant scheme to disburse funding to support PMSE users who have to vacate the 700 MHz band earlier than expected.

Annex 1

Summary of consultation responses

A1.1 This annex summarises the arguments stakeholders made in response to our consultation on enabling acceleration of 700 MHz clearance and use of the 700 MHz centre gap, together with our responses to their submissions. The consultation ran from 11 March to 20 May 2016 and we received 36 responses. Of these, six were fully confidential, four were partly confidential, and the remaining 26 were non-confidential.

A1.2 Organisations from whom we received non-confidential or partly-confidential responses are listed below:

Arqiva	Freeview	Samsung Electronics
The British Entertainment Industry Radio Group (BEIRG)	GSA Spectrum Group	The Scottish Futures Trust
BT plc & EE Ltd	Huawei Technologies	Strategy and Technology Ltd
Cisco	Hutchison 3G UK	Telefónica UK
The Commercial Broadcasters Association (COBA)	Motorola Solutions UK Ltd	The DTG
Copsey Communications	Mr F J Perkins	Trans World Radio Ltd
Digital UK	Mr J P Gilliver	UKB Networks
Discovery Communications	Mr S Pike	UKTV Media Ltd
Ericsson Ltd	Name withheld	Viacom International Media Networks
	Nimux	Voice of the Listener and Viewer (VLV)
	Qualcomm	

Question 1: Do you agree with our provisional assessment of the case for accelerating completion of the 700 MHz clearance programme by varying the frequencies allocated to the interim multiplexes?

Stakeholder comments	Ofcom response
The majority of respondents, from across both the mobile and broadcast sectors, broadly agreed with the plan to accelerate clearance by varying the interim multiplex frequencies. Mobile stakeholders in particular, including Motorola, BT/EE, Huawei, Hutchison 3G UK and Telefónica UK, were supportive of the plan. Qualcomm	As set out in Section 3, we believe there is a strong case for accelerating the clearance programme in the manner we describe. We believe that this will increase the net benefits offered by clearance.

suggested that early clearance of the 700 MHz band could be especially useful for swift development of 5G technologies.	
However, some respondents expressed concerns with our proposal. One concern was the impact that acceleration and the relocation of the interim multiplexes would have on viewers. In particular, broadcast stakeholders such as Freeview and UKTV warned that DTT viewers would experience additional disruption due to the need for additional retunes when the interim multiplexes are moved.	We discuss the impact acceleration will have on viewers in Section 3. As we explain in section 3, we do not consider that accelerating the clearance programme will have a material adverse effect on viewers.
UKTV also argued that bringing clearance forward poses a greater risk of disruption to viewers who may need to replace or repoint aerials, or install filters, as it reduces the time available for Ofcom and other bodies to work with these consumers.	Decisions on viewer support provision and the funding for any such programme are the responsibility of Government, but we consider that under the accelerated plan there is sufficient time for adequate information and viewer support programmes to be put in place before clearance.
Broadcast stakeholders Freeview, Arqiva, Digital UK and Viacom all agreed with our proposal to accelerate, however they also highlighted that accelerating clearance will put pressure on the timeframe involved and could increase the risk of delays to the programme. This is because the accelerated plan relies heavily on a significant amount of DTT infrastructure work taking place in summer 2017, and if this is delayed by bad weather there is a risk that the target clearance date of Q2 2020 could be missed.	We accept that there is a risk of the accelerated clearance programme being delayed in this way. However, as we explain in Section 3, we believe the risk of this is relatively small. As discussed in section 3, Ofcom and Government have agreed that we will review the target date for programme completion in August 2017.

Question 2: Do you have any comments on our provisional assessment of the implications the proposed accelerated clearance would have for PMSE users?

Stakeholder comments	**Ofcom response**
PMSE stakeholders including BEIRG, Digital UK and Copsey Communications argued that bringing clearance forward by 18 months would increase the risk that new PMSE equipment operating in the 960-1164 MHz band will not be on the market in time for clearance. BEIRG said that the consequence of this would be that PMSE users were 'forced to replace their 700 MHz equipment before any new equipment	Although we accept that acceleration puts increased pressure on the timeline for PMSE clearance, we do not agree with these arguments and do not consider that accelerating the programme will compromise our objective of safeguarding the benefits PMSE provides. We discuss our response to the issues raised regarding this topic in detail in Section 3.

operating in the 960-1164 MHz band arrives on the market'.[33] It expressed the view that this would mean that after clearance PMSE users would not have access to enough usable spectrum to be able to 'continue to deliver the quantity and quality of services that event producers and consumers have come to expect'. In addition, BEIRG argued that, even if equipment in the 960-1164 MHz band was available in time for clearance, acceleration would significantly reduce the time PMSE users had to test this equipment before they use. BEIRG expressed concern that this would increase the risk of problems with the sound system occurring at live events.	

Question 3: Do you agree with our provisional assessment that SDL is likely to represent the optimal use of the centre gap?

Question 4: When is the demand for spectrum for SDL first likely to arise?

Question 7: Do you agree with our working assumption that there will be significant demand for SDL spectrum in the centre gap in the early 2020s?

Stakeholder comments	**Ofcom response**
We discuss stakeholder responses to these questions and our reaction to them in sections 4 and 5 of this document.	

Question 5: Do you agree with our provisional view that the interim multiplexes should not operate in the centre gap beyond the end of Q1 2020 (that is, shortly before we expect the 700 MHz band to become available for mobile data, in line with our proposals)?

Stakeholder comments	**Ofcom response**
A number of broadcast stakeholders, such as Discovery Communications, Arqiva Services Limited, Freeview and Digital UK disagreed with our proposal to discontinue the interim multiplexes in 2020. Instead they argued that the interim multiplexes should be able to operate in the centre gap	We discuss these arguments and our response to them in detail in section 5.

[33] http://stakeholders.ofcom.org.uk/binaries/consultations/maximising-benefits-700-MHz-clearance/responses/BEIRG.pdf

until the end of 2022 and that the centre gap should not become available for SDL until this point. We explain the rationale for this proposal in section 5 of this document.	
Voice of the Listener and Viewer argued that since the interim multiplexes carry some PSB content, they should be allowed to remain on air indefinitely.	The PSB services on the interim multiplexes are HD versions of channels carried on the existing PSB1 multiplex in SD. Discontinuation of the interim multiplexes should therefore not result in the loss of access to PSB content.

Question 6: Do you have any evidence/analysis on the scale of the risk of DTT services in the centre gap causing harmful interference to mobile data services in the paired part of the 700 MHz band?

Stakeholder comments	**Ofcom response**
Arqiva's response included research which it argued showed that the risk of interference from DTT in the centre gap to mobile data operating in the paired spectrum is minimal. Some broadcast stakeholders including Digital UK and UKTV argued that it was for Ofcom to demonstrate that DTT services in the centre gap would interfere with mobile services, and that we had not carried out sufficient coexistence measurements to demonstrate this before concluding that DTT in the centre gap would cause interference to the paired spectrum. Conversely, a number of mobile stakeholders including Qualcomm, Cisco, Huawei, Hutchison 3G UK and Ericsson all considered that, based on their own assessments or those provided by CEPT Report 53, the risk of interference from DTT services into the paired spectrum would be unacceptable, or would render the paired spectrum far less valuable.	We discuss the various interference scenarios from SDL and other uses in the centre gap in Annex 2.

Question 8: Do you have any further comments or views on other aspects of this consultation which are not covered above?

Stakeholder comments	Ofcom response
Mobile stakeholders including Telefónica UK and Hutchison 3G UK suggested that, if clearance were to be accelerated, it would be beneficial for the centre gap spectrum to be awarded and released at the same time as the paired spectrum in the 700 MHz band.	We agree with this assessment, and discuss this in more detail in Section 4.

Annex 2

Coexistence between DTT in the centre gap and adjacent paired spectrum for mobile services.

A2.1 In this annex we assess the extent to which DTT services in the centre gap could cause interference to mobile data services in the paired part of the 700 MHz band and vice versa. In doing so, we consider technical evidence which Arqiva has presented in its response to our consultation.

In our consultation we expressed concerns about two major risks:

A2.2 Whether handsets are robust enough to withstand interference from DTT in the centre gap, because the potential impact could be large, and it is unrealistic to change the handset specification.

A2.3 Whether base stations are robust enough to reject interference from DTT in the centre gap and would additional filtering be needed beyond the minimum required.

A2.4 Since the consultation, we have also considered mobile interference to DTT and set out below our analysis and concerns.

The Arqiva evidence addresses the interference to mobile cases, however, we are also concerned with changes that DTT consumers could experience.

A2.5 We have received a technical proposal from Arqiva in response to the March consultation, which contains analyses of interference from DTT in the centre gap to mobile base stations and handsets in the paired spectrum.

A2.6 The DTT arrangement proposed considers an 8 MHz emission in channel 55 and an 8 MHz emission trimmed to 7 MHz in channel 56 operating in the centre gap between the FDD uplink and downlink bands (see figure A2.1).

A2.7 The analyses are theoretical studies which are largely predicated on a number of reasonable planning assumptions. For example, that mobile systems in 700 MHz will be implemented in a similar way to base stations in existing 800 MHz networks.

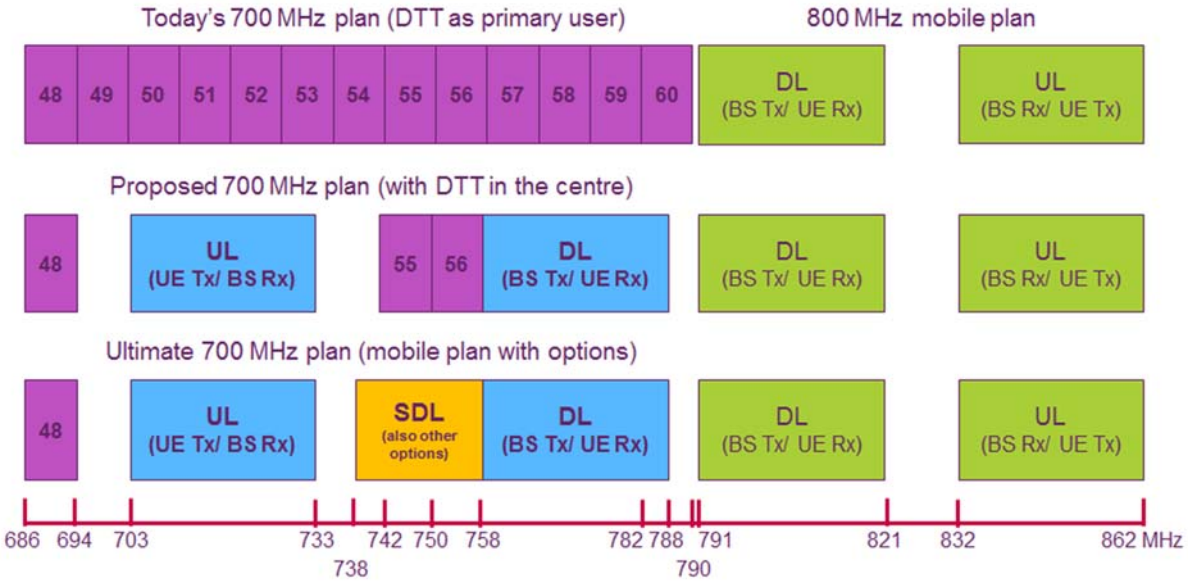
A2.8 Arqiva's broad conclusion is that its studies show a low risk of interference to mobile. However, these studies do not cover the case of interference to DTT.

To assess the Arqiva proposal, we did a comparative analysis of the likely mobile experience using measured data where possible.

A2.9 The proposed frequency arrangement in channel 55 is 9 MHz offset above the mobile uplink band which is a similar frequency offset to the ultimate coexistence case with DTT operating in channel 48, 9 MHz below the mobile uplink band (see figure A2.1).

A2.10 In channel 56 the proposed DTT emission will be trimmed to 7 MHz effectively creating an internal 1 MHz guard band to the 700 MHz mobile downlink. This situation is similar to the existing boundary between DTT in channel 60 adjacent to the 800 MHz mobile downlink band.

Figure A2.1: Existing, proposed and ultimate 700 MHz band arrangements.



A2.11 We measured the performance degradation of a single 700 MHz mobile handset in the laboratory when subjected to an adjacent 7 MHz DTT emission in channel 56 and compared this with the performance degradation when it was subjected to an adjacent 8 MHz DTT emission in channel 60.

A2.12 The results showed that the mobile behaved similarly to both DTT channels, so for this mobile the expectation is that the impact of an adjacent channel DTT transmission in the centre gap would be no worse than in current 800 MHz mobile networks when adjacent to DTT in channel 60.

A2.13 If other handsets were to perform in the same way over their full temperature range, then we believe the overall risk of DTT emissions to handsets is low on the basis that we have no relevant reports of interference to 800 MHz mobile networks from high power DTT emissions in channel 60.

A2.14 We could not perform measurements for base station receivers to compare the effect of DTT operating in channel 48 with DTT operating in channel 55, so we can only analyse the situation from a theoretical perspective.

A2.15 A conclusion of the CEPT report 53[34] that led to the least restrictive technical conditions for 700 MHz, is that an additional 40 dB of attenuation beyond 3GPP blocking requirements may be required to protect base stations from DTT emissions in channel 48. If implemented, the filtering implied may not be symmetrical about the lower mobile sub band resulting in less protection from DTT emissions in the centre gap.

[34] http://www.erodocdb.dk/Docs/doc98/official/pdf/CEPTREP053.PDF

A2.16 Whilst our measurements suggest that the risk of interference to mobile is likely to be low and we have no other evidence to contradict this, this is predicated upon the assumption that all handsets perform in a similar way to our test sample, and that base stations implement filtering symmetrically. We cannot at this stage be confident that either of these assumptions hold true, so we would require stronger evidence based upon representative products that will emerge on the market.

We also looked at interference into DTT to better understand the impact on the DTT consumer experience

A2.17 Since the consultation, we have also considered mobile interference into DTT in line with one of our programme objectives to minimise disruption to DTT viewers.

A2.18 We observed that for our test mobile, the handset emissions into DTT channels 48 and 55 were similar when measured at room temperature, implying that the interference to DTT receivers in the centre gap from mobile handsets would be no worse than the eventual coexistence situation in channel 48.

A2.19 We believe that this is an incidental benefit of dual-duplexer technology, and whilst it is likely, we cannot be certain that it is implemented the same way in all mobiles, because this upper-side performance is not demanded by the mobile conformance specifications.

A2.20 We could not measure base stations to compare the performance of leakage emissions into channel 56 from 700 MHz systems with those into channel 60 from 800 MHz systems, so we can only analyse the situation from a theoretical perspective.

A2.21 Comparing permissible emissions from the mobile conformance specifications to DTT receivers in channels 55/56 (from 700 MHz base stations), channel 48 (from 700 MHz base stations) and channel 60 (from 800 MHz base stations), the equipment specifications do not require the same performance and for a wide-area base station the channel 55/56 level requirement is circa 20 dB less restrictive than either the channel 48 and 60 requirements.

A2.22 Additionally, there is no market requirement for better performance, because the specifications are aimed at managing interference below 694 MHz, and the permissible levels of emissions falling into channel 56 are merely those required not to block other cellular operators rather than to protect DTT.

A2.23 The broadcast industry has consistently argued for lower leakage levels. Therefore an additional 20 dB leakage into DTT in the centre gap compared with that below the 700 MHz mobile allocation is very concerning.

A2.24 These out-of-band leakage emissions from LTE fall in-band for DTT and therefore cannot be mitigated with filters at the DTT receiver. The only mitigation would be to require better mobile base station performance. We do not envisage imposing any such requirement, because this would imply UK specific products rather than leveraging the economies of scale of the wider EU market.

A2.25 In view of the base station leakage potential, we consider that there is a significant risk of interference from mobile into DTT in the centre gap and there is no practical mitigation without applying specific additional requirements on mobile base stations. We do not intend to impose such requirement as it would impose additional costs on the mobile network operators and therefore increase costs to mobile consumers.

A2.26 In light of the coexistence risk highlighted above, we would need to see evidence that Arqiva has put in place appropriate provisions for managing the impact of incoming interference received by viewers watching the interim multiplexes before we could consent to allowing the interim multiplexes to operate in the centre gap after clearance.

Annex 3

Revised benefits and costs

A3.1 As discussed in section 3 of this Statement, we have made some minor adjustments to the benefit and cost estimates with respect to those that were originally included in the 2016 consultation.

A3.2 In this annex we discuss the changes to the estimation of the incremental benefits of early access to the centre gap and the adjustment to the incremental costs of acceleration for DTT infrastructure, PMSE, aerial replacement, consumer information and retunes. We have not made any changes to the estimation of the network cost savings and performance improvement benefits of acceleration.

Benefits of early use of the centre gap

A3.3 In our 2016 consultation we estimated that the potential benefits of early release of the centre gap would be £5m under both the high and low scenarios.

A3.4 We remain of the view that that mobile devices capable of using the centre gap are likely to be in the market by Q2 2020. This said, we accept there is a risk that an equipment eco-system for mobile downlink services (e.g. SDL) in the centre gap develops more slowly than we currently anticipate. In recognition of this risk, we have therefore assume that in the “low benefits” scenario the benefits of early release of the centre gap could be zero. Our revised range for these benefits is therefore £0m - £5m.

DTT Infrastructure costs

A3.5 For our 2016 consultation we used our most up to date understanding of the likely increase in DTT infrastructure costs associated with an accelerated program.

A3.6 In particular, in paragraph A5.16 of the 2016 consultation we identified that acceleration would increase the infrastructure costs related to moving the interim multiplexes. At the time we estimated that around £3m-£5m of the infrastructure costs related to the interim multiplexes could be attributed to acceleration.

A3.7 In addition, we estimated the time-value effects of acceleration on DTT infrastructure costs. At the time we estimated that this would be less than £5m, including local TV costs.

A3.8 Since then, DigitalUK (DUK) has provided cost estimation for the DTT infrastructure programme with and without acceleration, with a detailed schedule of year by year expenditure for each of these two scenarios.

A3.9 DUK’s estimates take into account both the higher infrastructure costs of acceleration but also the reduction of labour costs as a result of running a shorter program. DUK’s estimates include the costs related to moving the interim multiplexes, which we had treated separately in our 2016 consultation, as well as the costs related to the Local TV multiplexes.

A3.10 Overall, DUK estimates that its accelerated program will increase total cash costs by £3 million compared to the unaccelerated program, including the costs of the interim multiplexes and Local TV. However, because the costs of the accelerated

program take place earlier, there is less discounting when estimating the net present value (NPV), leading to an estimate of the economic costs of acceleration at £8m.

A3.11 While this number is higher than the number we estimated in our March consultation (less than £5m) it already includes the cost of the interim multiplexes, which in March 2016 we estimated at £3m to £5m.

PMSE costs

A3.12 Our current estimate of the incremental equipment replacement costs from acceleration is £5m.

A3.13 In our 2014 Statement we identified that some PMSE users may need to undertake additional training to use the new frequencies and equipment available to them after clearance. We identified that this could result in some training or upskilling costs.

A3.14 In our 2016 consultation we acknowledged that bringing forward clearance would also bring forward the date at which these upskilling costs would have to be incurred. As a result of this, the time-value effect would have increased the economic costs of upskilling by less than £1m (£500k-700k).

A3.15 We have reviewed this estimate in the light of our recent decision to make the 960-1164 MHz band available for the PMSE sector. Our analysis shows that the 960-1164 MHz band should be a benign operating environment. This view has been corroborated by the initial tests of equipment in this new band. We therefore no longer anticipate there being material upskilling costs. Consequently, we have no longer included incremental upskilling costs in our analysis of the case for accelerating clearance.

Aerial replacement costs

A3.16 Since our 2016 consultation we have made a minor modification to the parameters used to calculate aerial replacement costs. We have adjusted out estimate of the incremental costs of acceleration to reflect this modification.

A3.17 Consistent with our 2016 consultation, we have accounted for both the time-value effect as well as the impact of having to cut short the life of some 10,000 aerials, as we discussed in paragraph 3.28.

A3.18 Given the revised figures of the estimates of aerials likely to be affected we have estimated the increased economic cost of acceleration to be £1m-1.5m compared to a single value of £1m in our March 2016 consultation.

DTT consumer information

A3.19 We have also reviewed the costs of DTT consumer information, taking into account the latest information that we have received.

A3.20 As a result, we believe that the additional economic cost of acceleration will likely to decrease to around £200k compared to our March 2016 estimate of £1m. This is due to a downward revision in the total consumer information costs from earlier estimates.

Retuning costs

A3.21 In our March 2016 consultation we estimated the cost of retunes by assessing the time-value effect of having retunes taking place eighteen months earlier than under the late 2021 release plan.

A3.22 In its consultation response DUK suggested that ca. 20% of households would need additional retunes in the case of acceleration.

A3.23 We are mindful that there may be some additional retunes as a result of acceleration. However, we do not have detailed accelerated and unaccelerated retuning plans to accurately estimate the difference in the number of retunes. Furthermore, as we argued in the original 2014 consultation, retunes are generally easy to perform and, therefore, the impact on the cost is unlikely to be material.

A3.24 As a result, we have not quantified the cost of these additional retunes and maintained our original estimate of the incremental retuning cost of acceleration at ca. £200k, i.e. less than £1m as per the March 2016 consultation.

Annex 4

Current accelerated clearance plan