Maximising the benefits of 700MHz clearance

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

Consultation

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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. However, our analysis suggests that benefits to citizens and consumers would be greater if it was available sooner.

In this document we set out proposals which would enable us to bring forward the point at which this spectrum is nationally available for mobile data by up to 18 months - to a target of no later than Q2 2020. This would involve changing the frequencies used by some temporary DTT services, known as interim multiplexes, which operate in the 600MHz band (550-606MHz).

This document also considers the future of part of the 700MHz band called the centre gap. It sets out proposals to make this spectrum available for mobile data.

Our November 2014 Statement made a decision on use of the main part of the 700MHz, called the ‘paired spectrum’. However, it did not decide what the 25MHz in the middle of the band, the ‘centre gap’, should be used for. We have considered a range of applications which could use the centre gap and reached a provisional view that mobile data is likely to be the use that maximises benefits to citizens and consumers.

Contents

Section 1

Executive Summary

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

1.1 In November 2014, we published a Statement (the '2014 Statement') setting out our decision to re-plan the frequencies which Digital Terrestrial Television (DTT) and wireless microphones (commonly referred to as 'audio PMSE devices') use and make valuable spectrum between 694 and 790MHz (the '700MHz 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]

1.2 We have set up a major programme of work (the '700MHz clearance programme') to implement this decision. We are committed to ensuring that the programme does not cause undue disruption to DTT viewers. In order to achieve this, we are developing a revised DTT frequency plan which allows for the continued delivery of all the main national DTT services with coverage broadly matching today.

1.3 We are also committed to safeguarding the ongoing delivery of the benefits PMSE provides. The concerts and performances which rely on audio PMSE devices make an important contribution to the creative economy and cultural life of the UK. We wish to ensure that after the 700MHz clearance programme is complete they have access to the spectrum they need to continue staging these events without materially compromising production values. To this end, we have decided to make a significant amount of new spectrum available to PMSE users, see: http://stakeholders.ofcom.org.uk/consultations/new-spectrum-audio-PMSE/statement/

1.4 In this document we consider two key aspects of the 700MHz clearance programme:

- The timescales on which we aim to clear and release the band; and
- The future of part of the band, called the centre gap, whose use we did not make a decision on in our 2014 Statement.

We propose to accelerate clearance by varying the frequencies the interim multiplexes are authorised to use

1.5 In our 2014 Statement we decided to make the 700MHz band available for mobile data as soon as practicably possible. Initial plans indicated that it would be possible to clear the band by the end of 2021. However, we have been looking for ways to accelerate the programme.

1.6 In this document we set out proposals which would enable us to bring forward the point at which the 700MHz band is nationally available for mobile data to a target of no later than Q2 2020. These proposals involve changing the frequencies which are

used by some temporary DTT services which currently operate in the 600MHz band (550-606MHz).

1.7 The 700MHz clearance programme involves us moving some of the main national DTT services from the 700MHz band into the 600MHz band. In 2013 we awarded Arqiva Services Limited a licence to use the 600MHz band to provide some additional DTT services (over and above the main national channels) on an interim basis. We refer to these services as the 'interim multiplexes'. The interim multiplexes' licence runs until 2026. At the time of the award we explained that we might need to revoke the interim multiplexes' licence at the time of 700MHz clearance and in our 2014 Statement we explained that we would not seek to ensure continued delivery of the interim multiplexes following clearance. We have the power to revoke the interim multiplexes' licence at 2 years notice. However, revocation cannot take effect until the end of 2018.

1.8 We cannot start moving the main national DTT services into the 600MHz band while the interim multiplexes are using this spectrum. Initial plans for the 700MHz clearance programme assumed that the interim multiplexes would remain in the 600MHz band until the minimum term of their licence expires at the end of 2018. We propose to move the interim multiplexes to alternative frequencies from the end of 2017 onwards. This would enable us to start changing the main national DTT services' frequencies earlier than originally planned. Taken together with other acceleration measures, this would enable us to bring forward the point at which the 700MHz band is available for mobile data use by around 18 months – targeting no later than Q2 2020.

1.9 This would increase the benefits of the 700MHz clearance programme but would also have an impact on three cost categories. First, it would mean Arqiva Transco, the transmission infrastructure provider, needs to modify the infrastructure used to broadcast the interim multiplexes.

1.10 Second, there will be implications for viewers. For most, the only impact of 700MHz clearance is that they will need to retune their televisions. As we explained in our 2014 Statement a very small proportion of viewers will also need to change their roof top aerials as a result of clearance. Accelerating the programme, as proposed in this consultation, will mean that viewers have to undertake these changes between 2018 and 2020, whereas they would otherwise have had to do so between 2019 and 2021. We do not consider that this change in timetable is likely to be material to viewers.

1.11 Third, our proposals would have an effect on PMSE users. As set out in our 2014 Statement, some PMSE users will need to change their equipment as a result of 700MHz clearance. The proposals in this document would mean that they have to do this by Q2 2020 as opposed to by the end of 2021. We consider that it would be possible for them to accelerate PMSE clearance in this way. We note in particular that we have now published a statement[2] making additional spectrum available for PMSE use. In our view, there is sufficient time between now and Q2 2020 for manufacturers to develop and bring to market equipment that operates in the new band we made available to PMSE today.

[2] See: http://stakeholders.ofcom.org.uk/consultations/new-spectrum-audio-PMSE/statement/

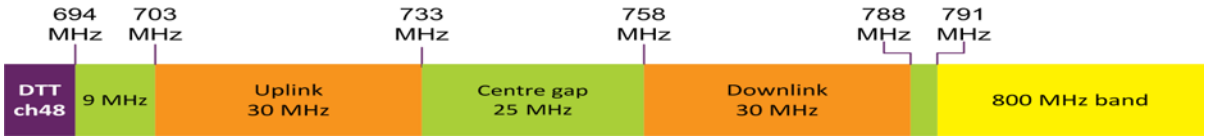
1.12 Our provisional view is that the benefits of accelerating the programme in the manner set out above would outweigh the costs. Some elements of the 700MHz clearance programme are publicly funded (e.g. the costs of DTT infrastructure modifications that are necessary for the 700MHz clearance programme). Given that accelerating the programme could impact on costs to the public purse, we will engage with Government before a final decision is taken on the proposal discussed above.

1.13 Any decisions as to whether to provide public funding to support PMSE clearance or to support viewers affected by clearance are a matter for Government. Government is considering the case for providing public funding and has asked us for advice on the impact on existing users (including PMSE) of clearance of the 700MHz band. We will continue to liaise with it on this issue.

Our 2014 Statement did not decide on future use of the centre gap

1.14 When the 700MHz band becomes available for mobile data, it will be divided into the following components: a 9MHz 'guard band' to protect DTT from interference; 30MHz of 'uplink', which mobile devices will use to communicate with base stations and 30MHz of 'downlink' which base stations will use to communicate with mobile devices; a 3MHz 'guard band' between 700MHz and 800MHz band; and a 25MHz 'centre gap' in between the uplink and the downlink. Taken together, the uplink and the downlink are referred to as the 'paired spectrum'. The 2014 Statement focussed mainly on the paired spectrum and did not make a decision about use of the centre gap. We consider the future of the centre gap in this document.

Figure 1: Future configuration of 700MHz band



We propose allocating the centre gap to mobile data

1.15 We have considered five potential uses of the centre gap: Audio PMSE; Emergency Services communications networks; machine to machine communications; DTT; and mobile data – specifically the provision of additional mobile downlink services. We provisionally consider that mobile data is likely to be the optimal use of the centre gap.

1.16 In contrast, our provisional view is that allocating the centre gap to PMSE, DTT or the emergency services would not support optimal use of spectrum:

1.16.1 Today we made a significant amount of additional spectrum available to PMSE. We believe that this will ensure the PMSE sector has access to sufficient spectrum to address its needs for the foreseeable future. We therefore do not consider that there is a need to allocate PMSE spectrum in the centre gap.

1.16.2 We do not anticipate there being demand for additional dedicated spectrum for the emergency services in the UK.

1.16.3 We have already taken a number of steps to address machine to machine communications' spectrum needs. In the light of the measures we have

taken thus far, we do not at this time believe there is a need to make spectrum in the centre gap available for machine to machine users.

1.16.4 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. Moreover, there is a risk that use of DTT in the centre gap could cause harmful interference to mobile data services in the 700MHz paired spectrum.

1.17 By contrast, demand for mobile data is growing rapidly. Between March 2011 and June 2015 mobile data traffic increased by 710%.[3] There is a general consensus that this rapid growth will continue for the foreseeable future. For example, Analysys Mason forecasts that mobile data traffic could increase by a factor of more than 45 between 2014 and 2030.[4] 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. Typically, mobile data traffic is asymmetric, with consumers downloading significantly more content than they upload. Demand for downlink spectrum is therefore likely to be high in future.

1.18 Making additional mobile spectrum available will allow MNOs to meet growth in demand for mobile data more cost-effectively than they otherwise would have and will also allow them to increase network speeds more cheaply. We would expect competition in the market to result in a significant proportion of these benefits being passed on to consumers through lower prices and better quality mobile data services. We have not estimated directly the magnitude of the benefits of making the centre gap available for mobile data. However, recent market benchmarks suggest they would be well in excess of £100m over 20 years. All this considered, we propose allocating the centre gap to mobile data.

We propose to discontinue the interim multiplexes at the end of Q1 2020

1.19 Some DTT stakeholders have proposed delaying the point at which the centre gap is available for mobile data and allowing the interim multiplexes to use it until the end of 2023. Our provisional view is that the case doing so is weak.

1.20 As we explained in our 2014 discussion document on the future of Free to View TV,[5] we consider that the loss of the interim multiplexes will be manageable for the DTT platform. As we explain in section 4, the interim multiplexes only account for 0.5% of DTT viewing.[6] Moreover, in the medium term there are a range of ways in which the

[3] See: http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2015/downloads/connected_nations2015.pdf
[4] See: http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/statement/700-mhz-statement.pdf
[5] See: http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/discussion/ftv.pdf
[6] Source: BARB, Digital terrestrial individuals watching through the DTT reception mode
*The available channels reported by BARB are Viva, Community Channel, Motors TV, Rishtey, Talking Pictures, BBC4 HD, BBC News HD, Channel 4 + 1HD, 4seven HD and CBeebies HD
+Reach criteria is based on at least 15 consecutive minutes of viewing in a week.
Note: In April 2015 Viva ceased transmitting 24 hours on Freeview to only 9am to 11am.

DTT platform could offset the loss of capacity on the interim multiplexes. For example broadcasters could start using more efficient transmission technology to transmit some of the main national DTT services.

1.21 Allowing the interim multiplexes to continue operating in the centre gap until 2023 would have two main downsides. First, it would delay the point at which this spectrum became available for mobile data. Our working assumption, which we seek to test through this consultation, is that this would significantly reduce benefits to citizens and consumers. Second, there is likely to be a material risk that DTT transmissions in the centre gap would cause harmful interference to mobile data services in the paired part of the 700MHz band. If this happened, it would impair the performance of mobile networks, to the detriment of citizens and consumers using these networks. Our provisional view is that allowing the interim multiplexes to continue operating in the centre gap beyond the point at which the paired spectrum becomes available for mobile data is unlikely to be consistent with our duty to ensure efficient management and use of the spectrum.

1.22 As set out above, we can revoke the interim multiplexes' licence effective from the end of 2018. However, in practice we propose that where there are suitable vacant frequencies outside of the 600MHz band we will continue to make these available to the interim multiplexes until the end of Q1 2020 provided that doing so does not in any way impair our ability to meet the objectives of the 700MHz clearance programme (including early clearance of the band). Under this proposal we would revoke the interim multiplexes' licence effective from the end of Q1 2020.

Section 2

Introduction

This consultation considers the timing of 700MHz clearance and the future of the centre gap

2.1 Digital Terrestrial Television (DTT), audio Programme Making and Special Events (PMSE) services[7] and White Space Devices (WSDs)[8] currently use the spectrum between 470 and 790MHz. In November 2014, we published a statement (the '2014 Statement') 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. We believe this change will deliver significant net benefits.[9]

2.2 Working with Government and the DTT multiplex operators, we have initiated a major programme of work to implement this change (the '700MHz clearance programme'). In its 2015 Autumn Statement, Government announced it was making up to £550m available during the term of this Parliament to support this programme. The objectives of the programme are:

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

2.2.2 To deliver 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 minimise disruption to DTT viewers; and

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

2.3 In this document we discuss three key aspect of our implementation plan. Firstly, in section 3, we update on the anticipated timing of change of use of the 700MHz band and consult on proposals which would enable us to accelerate completion of the 700MHz clearance programme by 18 months or more. Secondly, in section 4, we set out proposals for the future use of part of the 700MHz band called the 'centre gap' which we did not consider in detail in our 2014 Statement. Thirdly, we discuss the future of the interim multiplexes. In the remainder of this introduction we give an overview of the background against which we are considering these issues and explain the legal context which informs our analysis.

[7] 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.
[8] WSDs are innovative new devices which are able to identify and make use of previously unused gaps in frequency bands.
[9] We discuss these benefits in detail in http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/statement/700-mhz-statement.pdf

Background to the 700MHz clearance programme

The 700MHz clearance programme is a key part of our mobile data strategy

2.4 The widespread uptake of smartphones and tablets has led to very large growth in demand for mobile data services. For example, between March 2011 and June 2015 mobile data traffic increased by 710%.[10] Forecasts of future levels of demand for mobile data vary. However, there is a broad consensus that demand will continue to grow rapidly for the foreseeable future. For instance, Analysys Mason forecast that by 2030 levels of mobile data traffic before WiFi off-load could be more than 45x greater than in 2014.

2.5 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, but these are significant investments. If they are to meet the increase in demand efficiently they will also need access to more spectrum.

2.6 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 response to the challenges posed by the growth in demand for mobile data. These include:

- 2.6.1 Awarding the 2.3 GHz and 3.4 GHz bands for mobile data use;[11]
- 2.6.2 Exploring opportunities to make further spectrum bands available for mobile data use, either on an exclusive or a shared basis.[12]

In order to safeguard the ongoing delivery of the benefits provided by DTT we will aim to broadly match current coverage of the main national DTT services

2.7 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:

- 2.7.1 Three PSB multiplexes – BBC and D3&4[13] 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.
- 2.7.2 Three commercial multiplexes – these are licensed to Arqiva and SDN. They broadcast from the largest 80 transmitters achieving coverage of

[10] See: http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2015/downloads/connected_nations2015.pdf
[11] See: http://stakeholders.ofcom.org.uk/spectrum/public-sector-spectrum-release/
[12] See http://stakeholders.ofcom.org.uk/consultations/mobile-data-strategy/statement/
[13] D3&4 is a joint venture between ITV and Channel 4.

around 90% of households. These carry a wide range of channels including ITV 2+1, 3+1 and 4+1

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

2.7.4 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.

2.7.5 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.

2.7.6 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.[14]

2.8 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[15] 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).

2.9 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:

2.9.1 Near-universal coverage for PSB services;

2.9.2 Six national multiplexes with coverage broadly matching today;

2.9.3 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

2.9.4 The services carried on the Northern Ireland multiplex.

2.10 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

[14] See Fig. 42: http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2015/downloads/connected_nations2015.pdf

[15] 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).

ability to provide the citizen and consumer benefits that it does today. The basis for this was that:

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

2.11 Since publication of our 2014 Statement, Arqiva has proposed that there is a case for allowing the interim multiplexes to move into the 700MHz centre gap and continue operating there after completion of the 700MHz clearance programme. We have reviewed this proposal and we assess its merits in section 4 of this document.

We have decided to make additional spectrum available for PMSE devices – this is a key part of our work to safeguard the ongoing delivery of benefits provided by PMSE

2.12 The concerts and performances which rely on audio PMSE devices make an important contribution to the creative economy and cultural life of the UK. As explained in our 2014 Statement, we therefore wish to ensure that audio PMSE devices have access to sufficient spectrum to continue delivering the benefits they provide following change of use of the 700MHz band.

2.13 The 700MHz band accounts for around 30% of the spectrum currently used by audio PMSE devices. They will no longer be able to use this spectrum once it becomes available for mobile data.

2.14 Given the heavy usage of audio PMSE in the 700MHz band and in order to ensure the PMSE sector remains able to deliver high quality events, we recently decided to allow audio PMSE users to share the 960-1164MHz band with aeronautical users. See http://stakeholders.ofcom.org.uk/consultations/new-spectrum-audio-PMSE/statement/. We believe that this will ensure the audio PMSE sector has access to sufficient spectrum to address its needs for the foreseeable future.

Our 2014 Statement did not decide on future use of the centre gap

2.15 As set out in Section 1 (see figure 1 above), when the 700MHz clearance programme is complete, the 700MHz band will be divided into:

a) 60MHz of paired mobile spectrum (30MHz of uplink and 30MHz of downlink);[16]

b) a 9MHz guard band to protect DTT from interference;

c) a 3MHz guard band between mobile services in the 700MHz band and mobile services in the 800MHz band; and

[16] The uplink is the portion of the spectrum mobile devices use to communicate with base stations. The downlink is the portion of the spectrum base stations use to communicate with mobile devices.

d) a 25MHz centre gap between the uplink and the downlink.

2.16 Our 2014 Statement focussed primarily on the paired spectrum and did not reach a decision on the centre gap. As set out above, we turn to this issue in this consultation.

There is an important European dimension to the 700MHz clearance programme

2.17 Decisions on the use of the 700MHz band within the European Union, are taking place in two fora.

2.17.1 First, within the EU's Radio Spectrum Committee (RSC) which will issue an RSC Harmonisation Decision dealing with the technically harmonised conditions of use of the band, including the centre gap;[17]

2.17.2 Secondly, within the European Council and European Parliament (EP). This will lead to a joint Council and EP Decision dealing in particular with the timing of release of the 700MHz band.

2.18 The RSC Decision is currently under discussion. Following recommendations from the CEPT[18] to the Radio Spectrum Committee (RSC), the European Commission's draft RSC Decision proposes that decisions regarding the use of the centre gap be taken at national level, but that Member States should choose from the following four options:

2.18.1 **Emergency service communications:** The Commission proposals provide flexibility on the use that emergency services communications systems may make of spectrum in the 700MHz band including the centre gap. The current draft proposals allow emergency services communications systems to use the frequencies between 753MHz and 758MHz but also potentially 698-703MHz, 733-736MHz, and 788-791MHz, or a subset thereof, subject to technical conditions.

2.18.2 **PMSE:** The proposals would allow member states to allocate some or all, of the centre gap for audio PMSE use.

2.18.3 **Machine-to-Machine communications ('M2M'):** The proposals would allow member states to allocate 2 x 3MHz (788 – 791MHz and 733 – 736MHz) of spectrum to M2M use.

2.18.4 **Supplemental Downlink (SDL):** Supplemental Downlink (SDL) is a technology which provides additional mobile downlink capacity. The proposals allow for up to 20MHz of the centre gap to be used for SDL.

2.19 These options are not necessarily mutually exclusive. For example, member states could choose to use 15MHz of the centre gap for SDL and 5MHz for emergency

[17] RSC: Radio Spectrum Committee – the body that assists the European Commission in the development of technical implementing decisions and will establish the technical parameters for use of the cleared 700MHz spectrum

[18] CEPT: European Conference of Postal and Telecommunications Administrations – undertakes work to determine technical conditions, which are used in the development of EU harmonisation measures

services communications. It is not yet clear what decisions individual member states will take about future use of the centre gap.

2.20 When assessing the options for use of the centre gap in the UK, we have sought to identify which options would best serve the interests of UK citizens and consumers. Where relevant, we will use the consultation process to help inform our position in European discussions. Our final decision on these matters will need to conform with our legal obligations arising from the final EU decisions.

2.21 In addition to the draft RSC Decision, the European Commission recently published a draft EP and Council Decision which includes proposals that would require member states to allow the use of the 700MHz band for electronic communications services (including mobile data) under harmonised technical conditions by 30 June 2020.[19] These proposals are under discussion within the European Council at present and it is possible that this date may change according to member states' requirements. We do not yet have a fixed timetable for the conclusion of these discussions but we would expect them to be concluded by autumn 2016.

Legal context and analytical framework

Ofcom's specific duties and powers related to spectrum management

2.22 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').[20]

2.23 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.

2.24 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.

2.25 We have reached the proposals set out in this document by reference to these statutory duties.

[20] 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.

Impact Assessment

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

2.27 The analysis presented in this document constitutes an impact assessment as defined in section 7 of the 2003 Act.

2.28 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.

Equality Impact Assessment

2.29 Ofcom is required by statute to assess the potential impact of all its functions, policies, projects and practices on the following equality groups: age, disability, gender, gender reassignment, pregnancy and maternity, race, religion or belief and sexual orientation. Equality Impact Assessments (EIAs) also assist us in making sure that we are meeting our principal duty of further the interests of citizens and consumers regardless of their background or identity.

2.30 The proposals 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.

2.31 In relation to the proposals set out in this consultation, we have not identified any further differential impact of our proposals (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.

Section 3

Timelines and plan for 700MHz clearance

3.1 In the 2014 Statement we decided to change use of the 700MHz band 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/the beginning of 2022. We have been working with the multiplex operators and Arqiva Transco to identify ways of accelerating these plans.

3.2 In this section, we consider some of the provisional results of this work. We set out proposals to move the interim multiplexes out of the 600MHz band and on to alternative frequencies. Taken together with other measures, we believe this would allow us to make the 700MHz band available for mobile data from Q2 2020 onwards.

3.3 Some elements of the 700MHz clearance programme are publicly funded (e.g. the costs of DTT infrastructure modifications that are necessary for the 700MHz clearance programme). As we go on to explain, accelerating delivery in the manner discussed in this section could affect the costs of the programme. We will therefore engage with Government before a final decision is taken on the proposal we set out below.

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

3.4 In our 2014 Statement, we explained that change of use of the 700MHz band will involve:[21]

- **Changes to the frequencies DTT uses:** As set out in section 2, 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:** 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**

[21] For a detailed overview of what change of use of the 700MHz will entail and the associated costs and benefits see: http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/statement/700-mhz-statement.pdf

700MHz band: There is a risk that mobile signals in the 700MHz band could cause interference to DTT viewing in a small number of households.

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

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

3.5 Our 2014 Statement decided to make the 700MHz band available for mobile data as soon as practicably possible. The initial plans which we discussed in the 2014 Statement indicated that it would be possible to clear the 700MHz band of DTT and PMSE services by the end of 2021. This plan (the 'end 2021 plan') pre-supposed that viewers would need to retune their televisions between 2019 and 2021 and the interim multiplexes would switch off at the end of 2018.

However, varying the frequencies in the interim multiplexes' licence would enable us to bring completion of the programme forward to Q2 2020

3.6 The 2014 Statement concluded that completing change of use of the 700MHz band as early as possible would maximise benefits to citizens and consumers. Over the past months Ofcom, the multiplex operators and Arqiva Transco have therefore been looking for ways of accelerating the end 2021 plan.

3.7 We consider the provisional outcomes of this work on acceleration below. We first assess options for accelerating DTT clearance. Then we discuss whether it would be possible to accelerate PMSE clearance.

In conjunction with other measures, moving the interim multiplexes would allow us to complete DTT clearance in Q2 2020

3.8 The DTT re-planning process involves the main DTT multiplexes moving out of the 700MHz band and into the 600MHz band in some regions. It is not possible for them to do this while the interim multiplexes are operating in the 600MHz band.

3.9 The licence for the interim multiplexes is held by Arqiva Services Limited and runs until 2026. We can revoke the licence with two years' notice but the licence has a minimum term which runs until the end of 2018 and a revocation cannot come into effect before this point.

3.10 We had originally intended to allow the interim multiplexes to remain in the 600MHz band until the end of 2018 and revoke the licence effective from this point. The end 2021 plan therefore starts from the assumption that in many areas Arqiva Transco

will not be able to start making the DTT frequency changes associated with the 700MHz clearance programme until 2019 at the earliest.

3.11 The analysis we have conducted with Arqiva Transco and the multiplex operators suggests that if the main national multiplexes could use the 600MHz band sooner we could accelerate DTT clearance. As set out above, we cannot revoke Arqiva Services' spectrum licence before end 2018. However, if we were to vary the frequencies in the licence this would enable these multiplexes to move out of the 600MHz band before their minimum licence term expires.

3.12 This would enable the frequency changes needed for 700MHz clearance to start in late 2017 (as opposed to early 2019). Initial analysis suggests that taken in conjunction with other acceleration measures, this would make it possible to complete the process of clearing DTT services from the 700MHz band in Q2 2020, and potentially sooner. Around one year of this acceleration is attributable to moving the interim multiplexes.

3.13 If we proceed with this proposal, we expect that in the majority of instances the alternative frequencies we would make available to the interim multiplexes would be in the 700MHz band. There is likely to be a 2 year time lag between the DTT frequency changes starting and the 700MHz band being available for mobile data. During this period frequencies in the 700MHz band which have been cleared of the main national DTT services will be temporarily vacant in some areas. Therefore they will be available for use, for example, by the interim multiplexes.

3.14 As set out above, we can revoke the interim multiplexes' licence effective from the end of 2018. In order to allow the main national multiplexes to access the 600MHz band early and enable the acceleration of the programme we therefore only need to make alternative frequencies available to the interim multiplexes until the end of 2018. Thereafter we could in principle achieve our objective of accelerating the programme by revoking the interim multiplexes' licence.

3.15 In practice, we propose that where there are suitable vacant frequencies we will continue to make these available to the interim multiplexes until the end of Q1 2020 – shortly before the 700MHz band would become available for mobile data – provided that doing so does not in any way impair our ability to meet the objectives of the 700MHz clearance programme (including early clearance of the band).

3.16 However, because we do not need to make these alternative frequencies available for the interim multiplexes after the end of 2018 in order to accelerate 700MHz clearance or more broadly to deliver the clearance programme, we do not consider that work done to change interim multiplex frequencies after the end of 2018 constitutes part of the programme. It would be for Arqiva to decide whether to use any new frequencies available to it at the sites broadcasting the interim multiplexes from the end of 2018.

We consider that it would be possible for PMSE users to clear the band on this accelerated timescale

3.17 As set out above, a large number of PMSE stakeholders will need to replace their equipment as a result of the 700MHz clearance programme. Following clearance, the remaining interleaved spectrum in the 470-694MHz band is likely to be sufficient to serve the needs of the majority of events. We would therefore expect most users to replace their equipment with radio microphones which function in this band. However, the remaining interleaved spectrum may not be sufficient for some very

spectrum-intensive events (e.g. NFL games at Wembley, music festivals and concerts, and some West End theatre productions). We anticipate these events will use the 960-1164MHz band (which we today made available for shared use by PMSE) immediately following clearance. We therefore envisage that the organisers of these events and/or the hire companies that equip them will procure equipment that operates in this new band.

3.18 The 960-1164MHz band has not previously been used for PMSE in any country. Manufacturers will therefore need to develop and produce new equipment that functions in this spectrum. Based on engagement with manufacturers, we believe it would be technically feasible to develop and bring to market equipment that functions in the new band by 2020. We therefore consider that it would be possible to require PMSE users to cease using the 700MHz band by Q2 2020.

3.19 Any decisions as to whether to provide public funding to support PMSE clearance are a matter for Government. Government is considering the case for providing public funding and has asked us for advice on the impact on existing users (including PMSE) of clearance of the 700MHz band. We will continue to liaise with it on this issue.

3.20 We will look at all material facts affecting PMSE users including their conditions of access to the band before coming to a final decision on the proposals set out in this section.

Our provisional view is that this would deliver net benefits

3.21 In view of the analysis set out above, our provisional view is that, if we vary the frequencies in the interim multiplexes' licence, it will be possible to accelerate the 700MHz clearance programme and make the band available for mobile data use nationwide from Q2 2020.

3.22 We now consider the costs and benefits of accelerating the programme in this way. We use the end 2021 plan as the counterfactual against which we assess these costs and benefits (i.e. we consider the costs and benefits of accelerating this plan by 18 months). As set out above, in this counterfactual, we would have revoked the interim multiplexes' licence at the end of 2018.

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

3.23 The table below summarises the main benefits of change of use of the 700MHz band which we identified in our 2014 Statement.

Table 1: Benefits of change of use of the 700MHz band in 1st January 2016 NPV[22]

Benefit	Magnitude
Network cost savings: Access to the 700MHz band will enable MNOs to meet increases in demand for mobile data at a lower cost than would	£480m-770m

[22] These figures correspond to the update published on 11-3-2015

otherwise have been the case. We would expect a significant proportion of these benefits to be passed to consumers as a result of competition in the market.	
Performance benefits: Improvement in the performance (e.g. download speeds) that mobile users would experience.	£390m-480m
Use of centre gap: Our analysis focussed on the benefits of change of use of the paired spectrum. Additionally, there would be some benefits from use of the centre gap. We discuss these in this consultation.	Unquantified
Coverage benefits: Broader economic and social benefits if a 700MHz award included a coverage obligation.	Unquantified
Access to new services: Change of use of the 700MHz band could facilitate the launch of new services.	Unquantified. Could be significant, but could be 0.

3.24 As we explain in annex 5, our provisional analysis suggests that bringing forward availability of the 700MHz band by 18 months would increase these benefits in the following ways:

3.24.1 We estimate that the network cost savings and performance benefits would increase by approximately £19m to £55m if the 700MHz band was available 18 months earlier.

3.24.2 It would bring forward the point at which the centre gap was available for use. We did not quantify the value of the centre gap in our 2014 Statement. However, as we explain in section 4, recent market benchmarks suggest that use of the centre gap could deliver benefits in excess of £100m over 20 years. This would imply that accelerating availability of the centre gap by 18 months has the potential to deliver benefits in excess of £5m.

3.24.3 If we decided to impose a coverage obligation in any of the 700MHz licences, bringing forward the point at which the band was available could increase the coverage benefits flowing from the award. We have not sought to quantify these benefits.

3.24.4 It is also possible that bringing forward availability of the 700MHz 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.

3.25 In addition, by allowing the interim multiplexes to continue operating in alternative frequencies until the end of Q1 2020 viewers retain access to the services they carry for an additional 15 months. The size of the associated viewer benefits would depend on what services the multiplexes carried after 2018 and how popular these were.

It would also increase the costs

3.26 The proposal under consideration would have a number of costs.

3.27 In order to comply with a licence variation changing the frequencies on which the interim multiplexes operate, Arqiva Services would need to commission modifications to some of the infrastructure used to transmit the multiplexes. Given the proportion of the network affected and the typical cost of modifying DTT equipment, we estimate that it would cost £5m-£10m to change the frequencies at all of the sites on which the interim multiplexes operate. This estimate is broadly consistent with feedback we have received from industry sources about the cost of moving the interim multiplexes. In practice, we consider the costs are likely to fall towards the lower end of this range.

3.28 We do not consider that changes to the interim multiplexes' frequencies which occur after the end of 2018 are necessary to accelerate the 700MHz clearance programme. Therefore, costs of moving the interim multiplexes are only linked to acceleration of the programme to the extent that Arqiva Services incurs them before the end of 2018. Based on current plans, we anticipate that around half of the sites used by the interim multiplexes would need to change frequency before the end of 2018 under an accelerated plan.

3.29 Therefore we only consider around half of the costs of modifying the interim multiplexes' infrastructure (£2.5m-5m) for our proposal to enable the acceleration of the 700MHz clearance programme. We currently consider that the costs are likely to fall towards the lower bound of the range.

3.30 The multiplex operators have not yet been able to produce a detailed estimate of the impact accelerating 700MHz clearance would have on the costs of the main DTT infrastructure modification. It is therefore difficult to be certain of the scale of this impact. When assessing this cost we have made the following working assumptions, which our DTT infrastructure experts consider to be reasonable given their knowledge and experience:

- accelerating clearance might result in a slight increase in the costs of procuring transportable transmitters to facilitate the transition process;
- set against this, programme management costs would be likely to decrease because the programme would last for 18 months less than it would have in the counterfactual;
- these two effects would broadly balance one another out.

3.31 Our provisional view is therefore that accelerating clearance in the manner discussed would not materially change the cash costs of the main DTT infrastructure modification programme and in any event would not increase the cost by more than £5m in 2016 NPV terms. We would welcome feedback from stakeholders on these points.

3.32 In addition to the infrastructure costs, accelerating the programme would mean that PMSE users have to replace their equipment 18 months earlier than they otherwise would. We estimate that this would result in an additional cost of ca. £2-5m (2016 NPV).

3.33 As we explain in annex 5, acceleration would also mean that ca. 15,000 more households needed to replace their aerials. In total we estimate that the cost of aerial replacements would increase by ca. £1m (2016 NPV) as a result.

3.34 Finally, as we discuss in annex 5, not all households that can receive the 600MHz band are likely to be able to receive transmissions at the new frequencies we propose moving the interim multiplexes to. In total, we estimate that the proposal under consideration would mean that between 1% and 5% of households that currently receive the interim multiplexes would lose access to them before they would have done in our counterfactual.[23]

3.35 Protecting viewers from undue disruption is a key objective of the 700MHz clearance programme. However, we consider that the viewer costs under consideration would be more than outweighed by the viewer benefits associated with extending the life of the interim multiplexes. This is because only 1-5% of those households that can currently receive the interim multiplexes will lose access early. The remaining 95-99% of viewers that currently receive the interim multiplexes will retain access to them for longer than they would have in the counterfactual. On balance, therefore, we consider that moving the interim multiplexes will deliver net benefits to viewers as a whole.

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

Table 2: Summary of costs and benefits of moving interim multiplexes in 1st January 2016 NPV

Benefits	Quantified Benefits	Total Benefits
18 months extra national availability of paired spectrum	£19m – 55m quantified benefits.[24] Some unquantified benefits on top of this.	£24m – 60m of quantified benefits Some unquantified benefits which could be small but could also prove significant
18 months extra availability of centre gap	Scale of benefits uncertain but estimated at £5m	
95-99% of households retain access to interim multiplexes for 15 months longer than under end 2021 plan	Scale of benefits not quantified	

[23] See annex 5 for a detailed description of how we have calculated this figure.
[24] This estimate of the benefits of acceleration is derived from the CBA we undertook for 700MHz clearance.

Costs	Quantified Costs	Total Costs
Incremental costs of increase to PMSE costs	£2m-5m	£13m-18m of quantified costs Some unquantified costs, likely to be outweighed by unquantified benefits
Aerial replacement	Ca. 1m	
Infrastructure cost of moving interim multiplexes	£3m-5m	
Increase in cost of main DTT infrastructure build programme	< £5m	
Other costs	Ca. 2m	
1-5% households lose access to interim multiplexes early	Unquantified – not likely to be material to our analysis. Outweighed by viewer benefits.	

3.36 The upper bound of the range of the costs of our proposals is less than the lower bound of our estimated range of benefits. We took a cautious approach to the analysis which underpins the estimates in the table above and tended to make pessimistic assumptions about the size of both the costs and benefits. Moreover, there are a number of unquantified benefits, some of which could be significant. Consequently, we believe the benefits are likely to lie towards the top end of the range we have identified, and could exceed it. By contrast, we do not believe that the costs will exceed our estimate.

3.37 Our provisional view is therefore that accelerating the 700MHz clearance programme by changing the frequencies the interim multiplexes operate on is likely to result in net economic benefits and benefits to citizens and consumers. Consequently, we believe that this is likely to represent an efficient use of the spectrum.

3.38 On this basis, we are consulting on a proposals to enable the acceleration of the 700MHz clearance programme by varying the frequencies in the interim multiplexes' licence as and when the main DTT multiplexes need access to the 600MHz band.

3.39 As we have explained, we do not yet have detailed information on some of the cost categories discussed above (in particular DTT infrastructure costs). We wish to use

this consultation to gather better information on these cost categories in order to inform decisions on our proposals. We would therefore welcome stakeholder feedback and evidence on the analysis provided above. In particular, we would welcome evidence on our assessment of the incremental DTT infrastructure costs associated with accelerating the 700MHz clearance programme.

3.40 We will update our analysis in the light of evidence we receive during the consultation process and will take this updated analysis into account when producing our statement.

3.41 As set out above, accelerating the 700MHz clearance programme in the manner discussed could affect the costs of the programme and by extension the public funding required to deliver it. We will therefore engage with Government before a final decision is taken on the proposal we set out above.

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

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

In all your responses, please state your reasons and provide evidence to support your views.

At this time we do not envisage pursuing regional release of the 700MHz band

3.42 In our 2014 Statement we noted that we would explore whether there is scope to release the 700MHz band on a regionally phased basis. This would have involved making the band available for mobile data early in regions which change frequencies early in the programme.

3.43 Regional release would mean that mobile data was using the 700MHz band in some areas at the same time that DTT was using it in other areas. In order to mitigate the risk of the two services interfering with one another, we would need to leave buffer zones between these areas.

3.44 This means there will only be scope for meaningful regional release if we can clear DTT from the 700MHz band in sizeable contiguous blocks of territory significantly before the spectrum is available nationwide. Based on the accelerated version of the plan for the DTT infrastructure modifications, it appears doubtful whether this is achievable. At this time we therefore do not envisage pursuing regional release. However, we will keep this under review as the programme progresses.

Section 4

Use of the centre gap

4.1 In this section we discuss our proposals for the future use of the centre gap. We compare a range of options and set out our provisional view that SDL is likely to be the option which results in optimal use of the spectrum and maximises benefits to UK citizens and consumers. On this basis, we are consulting on a proposal to allocate the centre gap to SDL.

4.2 Arqiva has proposed that we allow the interim multiplexes to use the centre gap for a transitional period before we make this spectrum available for SDL. It has expressed the view that this transitional period should last until at least the end of 2023. We consider this proposal below. We explain that our provisional view is that such transitional use would not secure optimal use of spectrum.

We have considered a range of options for the centre gap

4.3 Using our statutory duties set out in section 2, we have assessed the case for each of the options for use of the centre gap which feature in the current draft of the RSC harmonisation decision. In addition, we have considered the case for allocating the centre gap for DTT. We now give an overview of our analysis of these options.

Emergency Services communications

4.4 As set out in section 2, one of the options in the RSC draft decision is for member states to allocate 5MHz of the centre gap to emergency services communications networks. This would be paired with 5MHz in the guard band. The current draft of the RSC harmonisation 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.

4.5 The UK Government has decided against using a dedicated network for emergency services communications. Rather it has decided to procure capacity for the next generation of emergency services communications technology on commercial mobile networks.

4.6 In light of this decision, we do not envisage there being any demand for us to reserve spectrum exclusively for the emergency services' use.

4.7 We do not therefore consider that allocating spectrum in the centre gap to the emergency services would secure optimal use of spectrum.

Audio PMSE

4.8 Audio PMSE supports many important social and cultural events that take place in the UK. By doing so, it delivers important benefits to UK citizens and consumers. We are committed to ensuring that PMSE users have access to an appropriate amount of spectrum to be able to continue delivering these benefits. We have therefore conducted a strategic review of the sector’s long term spectrum needs. As part of this

review, we have been exploring the possibility of users moving to an alternative band once they lose access to the 700MHz band.

4.9 As discussed in section 2, we have published a statement setting out our decision to allow audio PMSE users to share the 960-1164MHz band with aeronautical users. See http://stakeholders.ofcom.org.uk/consultations/new-spectrum-audio-PMSE/statement/. We believe that this will ensure the PMSE sector has access to sufficient spectrum to address its needs for the foreseeable future.

4.10 Given that demand for PMSE spectrum can be satisfied by other bands we have made available, we do not consider that allocating the centre gap to PMSE would be an efficient use of spectrum.

Machine-to-Machine

4.11 Machine-to-Machine (M2M) communication is a developing technology that involves providing connectivity to machines whose primary purpose does not require connectivity. M2M is often seen as the precursor to the Internet of Things (IoT) which involves adding connectivity to passive objects.

4.12 M2M applications are currently used in sectors such as utilities (smart meters), automotive (car parking recommendations), health (heartbeat or blood sugar monitoring) and security (alarms or CCTV). Data transfer between these machines is usually initiated without human intervention.

4.13 Some devices will be physically mobile (e.g. cars), whilst some will be stationary ("fixed"). Both mobile and fixed M2M devices could place demands on the networks used to provide mobile data services, fixed devices could also use wired networks or fixed wireless communications (including short range devices), depending on practicability, performance and cost.

4.14 Compared to mobile broadband consumption, projected per-connection M2M data volumes, possibly with the exception of video surveillance, are likely to be low and can sometimes be scheduled off peak.

4.15 We have taken a number of steps to ensure that M2M technology has access to sufficient spectrum to address its future needs. For example, in September 2015 we published a consultation entitled "*More radio spectrum for the Internet of Things".*[25] The document set out our proposals to encourage innovation and investment in M2M applications by making up to 10.1MHz of spectrum available in the VHF frequency bands. We will be publishing the associated statement shortly. In addition, we recently made spectrum available to support M2M applications at 870MHz and 915MHz. [26]

[25] See: http://stakeholders.ofcom.org.uk/binaries/consultations/radio-spectrum-internet-of-things/summary/more_radio_spectrum_internet_of_things.pdf

[26] See: http://stakeholders.ofcom.org.uk/consultations/short-range-devices/statement/ http://stakeholders.ofcom.org.uk/consultations/network-relay-points/statement

4.16 In view of these initiatives, we do not consider that there is a pressing short-to-medium term need to allocate spectrum in the centre gap to M2M. However, we will keep this situation under review.

DTT

4.17 Allocating the centre gap to DTT would allow the interim multiplexes to continue broadcasting after the completion of the 700MHz clearance programme. Continued access to these two multiplexes would enable the DTT platform to offer a wider range of services than it can currently deliver on the 6 national multiplexes. In particular, it would allow the platform to offer more HD services.

4.18 In the long term we do not consider that allocating the centre gap to the interim multiplexes would be an efficient use of spectrum. There are two main reasons for this:

4.18.1 **Risk of interference:** As we explain below, there is a risk of DTT services in the centre gap causing harmful interference to mobile data services in the paired part of the 700MHz band.

4.18.2 **More efficient ways to deliver services:** The evidence on DTT viewers' demand for HD services is mixed. The proportion of viewers that have HD televisions is growing over time. However, as set out in our 2015 Connected Nations report DTT households with HD consistently spend 80% or more of their time watching SD services and appear to value HD for specific types of content rather than all types of content.[27] Set against this, screen sizes are growing and HD is increasingly becoming the default proposition for pay-TV platforms.[28] As we explained in our discussion document on Future of Free to View TV, on balance we therefore believe it is possible that over time HD could increasingly become the basic expectation of many DTT viewers.[29] That could mean that there is demand for the capacity the interim multiplexes provide. One way of meeting this demand would be for the interim multiplexes to continue transmitting. However, in the medium-to-long term there are a number of other, more efficient, options. These include upgrading some or all of the 5 national DVB-T multiplexes to more efficient DVB-T2 technology (thereby enabling them to carry HD services) and/or delivering a broader range of HD content using IPTV.

4.19 In our 2014 Statement we estimated the benefits of the DTT platform being able to deliver two additional national multiplexes to be £80-100m (2014 NPV) over 20 years.[30] The interim multiplexes cover around 76% of households, whereas the national commercial multiplexes cover around 90% of the population. We therefore believe the benefits of maintaining the interim multiplexes would be materially lower than the £80-100m estimate in our 2014 Statement.

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[27] http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2015/downloads/evolution-tv.pdf
[28] http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/discussion/Mediatique.pdf
[29] http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/discussion/ftv.pdf

4.20 Given the existence of more efficient alternative ways to deliver services and the risk of interference, we do not consider that allocating the centre gap to DTT would secure the optimal use of the spectrum.

4.21 The analysis above focuses on the case for using the centre gap for DTT in the medium to long term. Arqiva has proposed that in the short term there is a case for allowing the interim multiplexes to use the centre gap on a transitional basis before it becomes available for SDL. We consider this proposal separately below. We note that any decision to allocate the centre gap to DTT would be subject to the outcome of European legislative process discussed earlier this document.

Supplemental Downlink

4.22 The final option we have considered is making 20MHz of the centre gap available for a technology called Supplemental Downlink (SDL). SDL is a new mobile broadband technology which provides additional downlink bandwidth to the capacity of paired spectrum in another frequency band. It is likely to be particularly suited for applications such as streaming videos.

4.23 We expect Mobile Network Operators ('MNOs') to start using SDL in the 1452-1492MHz band in the relatively near future.

4.24 To date there has been less focus on possible use of SDL in the centre gap and there is currently no SDL equipment on the market which is designed to operate in this spectrum. However, similar frequencies are already available for SDL use in the USA and equipment manufacturers recently started developing a technical specification for SDL in the centre gap.

4.25 We have a number of reasons to believe that in the long term there will be strong demand for spectrum for SDL:

4.25.1 As discussed in section 2, demand for mobile data services is growing rapidly and is likely to continue doing so in the future. We believe MNOs will require access to additional spectrum to meet this demand in an efficient manner.

4.25.2 Typically, consumers download significantly more data than they upload.[31] A key driver of this is demand for video content, which last year accounted for 50% of all mobile data use and is forecast to account for around 70% of all mobile data use in 2021.[32] Therefore demand for downlink spectrum is likely to be particularly high.

4.26 We believe that allocating the centre gap to SDL would deliver economic benefits, including benefits to citizens and consumers. As we explained in our 2014 Statement, making additional mobile spectrum available will allow MNOs to meet growth in demand for mobile data more cost effectively than they otherwise would have and will also allow them to increase network speeds more cheaply. We would expect competition in the market to result in a significant proportion of these benefits being passed on to consumers.

[31] There are some exceptions to this. For example, outdoor concerts where significant numbers of people upload photos or videos of what they are watching.

[32] Source: Ericsson Mobility Report, November 2015

4.27 It is difficult to be certain of the precise magnitude of the economic benefits of allocating the centre gap to SDL. However, SDL spectrum licences in the 1452-1492MHz band were included in recent spectrum auctions in Germany and Italy where they were acquired by MNOs for €330m and €460m respectively. Our working assumption is that MNOs' valuation of SDL spectrum in the 1452-1492MHz band in the German and Italian auctions provides an indication of the order of magnitude of the benefits of allocating the 700MHz centre gap for SDL. If this assumption holds true, a simple extrapolation (adjusting for the relative size of the UK, Italian and German markets) would imply that SDL use of the centre gap would deliver economic benefits in excess of £100m over 20 years.[33]

Summary of analysis

4.28 Table 3, below, summarises our analysis of the options for use of the centre gap.

Table 3: Summary of 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 960-1164MHz band available for PMSE
Machine-to-Machine	• Demand is likely to be low and there is possible of scheduling data consumption during off-peak periods
DTT	• Questionable whether option is conducive to efficient management and use of spectrum given interference risk; • Potential demand for HD services, but platform has other more efficient options for meeting this demand; and • Benefits of allocation to DTT likely to be less than £80m.
SDL	• Clear evidence of demand for mobile spectrum, in particular for downlink • Allocation could benefit consumers through lower prices and improved mobile data download speeds • Recent market benchmarks would suggest economic benefits in excess of £100m over 20 years

[33] Press comment that the 1452-1492MHz licence in UK was recently sold by Qualcomm for £200m would be consistent with this assessment.

We believe SDL is likely to be the optimal use of the centre gap

4.29 Having had regard to the statutory criteria set out in section 2, we consider that, consistent with our duties, allocating the centre gap to SDL is likely to secure optimal use of this spectrum. In particular, we have had regard to the evidence of likely future demand for SDL to serve the growing needs of consumers for mobile data. Unlike for some of the other options identified above we have not identified any evidence of concerns relating to interference with mobile services that will be operating in the paired spectrum. Moreover, our assessment indicates that allocating the centre gap to SDL is likely to result in material economic benefits. The analysis we have conducted suggests that these are likely to be greater than the benefits of allocating the centre gap to other services such as DTT. We therefore propose to allocate the centre gap to SDL. This is consistent with the general principle that mobile data is the highest value user of the 700MHz band, which we established in our 2014 Statement.

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?

In all your responses, please state your reasons and provide evidence to support your views.

Arqiva has proposed that we should allow the interim multiplexes to use the centre gap for a transitional period before SDL launches

4.30 Arqiva has proposed that we allocate the centre gap to the interim multiplexes on a transitional basis before this spectrum becomes available for SDL. It has suggested that this transitional period should last until at least the end of 2023. Under this proposal (the 'Arqiva proposal') the paired spectrum would still become available for mobile data from Q2 2020. We now consider the merits of the Arqiva proposal. The counterfactual we compare it against is one in which:

4.30.1 the interim multiplexes switch off at the end of Q1 2020; and

4.30.2 both the paired spectrum and the centre gap become available for mobile data from Q2 2020.

Arqiva has expressed the view that extending the life of the interim multiplexes in this way is important for the future of the DTT platform

4.31 Discontinuing the interim multiplexes will reduce the DTT platform's capacity from 249 Mbps to 169 Mbps. It will also reduce the range of HD channels the platform is able to deliver. As explained above, it would be possible for multiplex operators to offset this loss of capacity and maintain the range of HD channels available by upgrading more of their DVB-T multiplexes to DVB-T2. An alternative option in the future may be for broadcasters to offer additional channels - including HD services - through a broadband connection, using a 'hybrid' of DTT and IPTV. Some hybrid

platforms – such as YouView and Freeview Play – are already available to consumers.

Table 4: DTT platform capacity

	(a) 6 muxes - no further DVB-T2 upgrade	(b) 6 muxes - Partial DVB-T2 upgrade*	(c) 6 muxes - Full DVB-T2 upgrade	(d) 8 muxes - no further DVB-T2 upgrade
DVB-T multiplexes	5	2	0	5
DVB-T2 multiplexes	1	4	6	3
Total capacity (Mbps)	169	208	240	249
Number of channels				
SD	56	70	116	72
HD	8	20	20	20

4.32 However, currently not all televisions can decode DVB-T2 signals. Arqiva has expressed the view that uptake of DVB-T2 compatible televisions will not reach a high enough level to make a full transition of the DTT platform to DVB-T2 a credible option until end 2023 at the earliest. It has asserted that the viewer disruption associated with replacing legacy DVB-T televisions would be too great before this point.

4.33 Consequently, it has told us that if the interim multiplexes switched off before then, the platform's HD offering would temporarily shrink substantially. It considers that this would have a material adverse impact on the DTT's ability to compete with other platforms. On this argument, maintaining the interim multiplexes until the end of 2023 would mitigate this risk as it would allow the platform to maintain a wider HD offering until it was able to increase its capacity through a technology upgrade to DVB-T2

We are not persuaded by this argument

4.34 When we issued the licence for the interim multiplexes we clearly stated that we expected to revoke it at the time of change of use of the 700MHz band. In both our 2012 UHF Strategy Statement, and our subsequent 2014 discussion document on the Future of Free to View Television, we considered the DTT platform's future capacity requirements in detail.[34] We explained that the impact of any change of use of 700MHz spectrum should be manageable from the perspective of the development of DTT.

[34] See http://stakeholders.ofcom.org.uk/binaries/consultations/uhf-strategy/statement/UHF_statement.pdf

4.35 We reaffirmed this view in our 2014 Statement. We have not seen evidence that would lead us to change our position on this issue. Indeed, there are a number of factors which reinforce our view:

- The channels carried on the interim multiplexes collectively account for 0.5% of DTT viewing.[35] In this context, it is questionable whether loss of the interim multiplexes would fundamentally undermine the DTT platform's ability to compete.

- A number of the main DTT broadcasters have chosen to make some of their most attractive HD content available exclusively to pay platforms. This appears inconsistent with the argument that access to the capacity on the interim multiplexes is essential for the competitiveness of the DTT platform.

4.36 In addition, it is possible that within these timeframes the multiplex operators could respond to the capacity loss by migrating some of their DVB-T multiplexes to DVB-T2.

4.37 In view of the factors listed above, we do not consider that discontinuing the interim multiplexes in 2020 would materially impair the DTT platform's ability to compete.

Our provisional view is that allowing the interim multiplexes to use the centre gap on a transitional basis would not secure optimal use of spectrum

4.38 Notwithstanding our assessment that switching off the interim multiplexes would not have a material adverse effect on the DTT platform's competitiveness, we recognise that the Arqiva proposal could deliver some benefit. It would mean that viewers would retain access to the channels on the interim multiplexes until end 2023. On the other hand if the interim multiplexes ceased broadcasting in 2020 viewers might have lost these channels temporarily (subject to decisions broadcasters take about timing of DVB-T2 transition and delivery of services via IPTV).

4.39 Set against this viewer benefit, the Arqiva proposal would have two costs.

4.40 First, it would delay the point at which the centre gap would be available for SDL. We cannot be certain about the impact this would have. For the purposes of this analysis, our working assumption, which we want to test in this consultation, is that there will be significant demand for SDL spectrum in the centre gap in the period between 2020 and 2023 and that significant benefits would flow from meeting this demand. The basis for this assumption is as follows:

4.40.1 There are some indications that momentum is building behind the development of SDL equipment, including equipment that operates in the

[35] Source: BARB, Digital terrestrial individuals watching through the DTT reception mode
*The available channels reported by BARB are Viva, Community Channel, Motors TV, Rishtey, Talking Pictures, BBC4 HD, BBC News HD, Channel 4 + 1HD, 4seven HD and CBeebies HD
+Reach criteria is based on at least 15 consecutive minutes of viewing in a week.
Note: In April 2015 Viva ceased transmitting 24 hours on Freeview to only 9am to 11am.

centre gap. For example, we understand that equipment manufacturers have now started developing a common technical standard for SDL equipment that operates in the centre gap.

4.40.2 The current rapid growth in mobile data traffic suggests that there is a strong possibility that MNOs will require access to additional spectrum in the early 2020s in order to meet consumer demand in an efficient manner. In this context, we note that downlink spectrum has potential to be particularly valuable, given the asymmetric nature of data traffic.

4.41 Second, there is a risk of the interim multiplexes causing interference to mobile data services in the paired part of the 700MHz band. We discuss this in annex 6. As we explain in the annex, we cannot yet be certain of the scale of potential interference. However, we believe there is a significant risk it would materially degrade the performance of mobile data services carried in the 700MHz band. This could substantially reduce the consumer benefits of change of use of the 700MHz band that we identified in our 2014 Statement.

4.42 In light of this risk of harmful interference and our assumptions about future demand for SDL, we are not persuaded that allowing the interim multiplexes to operate in the centre gap beyond the point at which the 700MHz band becomes available for mobile data would result in efficient use of spectrum. Having had regard to our duties, we therefore propose that we should revoke the interim multiplexes licence effective from end Q1 2020 (shortly before we expect the 700MHz band to become available for mobile data, should the proposals set out in Section 3 proceed).

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 700MHz band to become available for mobile data, in line with our proposals)?

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 700MHz band?

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?

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

In all your responses, please state your reasons and provide evidence to support your views.

4.43 We recognise that there is some uncertainty about the costs and benefits of the Arqiva proposal. We hope that the consultation process will reduce this uncertainty. However, it may not eliminate it. As industry participants develop their thinking, it may be that there is a commercial benefit to Arqiva and the MNOs that hold licences in the 700MHz band from reaching agreement to extend the period during which the centre gap is available to the interim multiplexes. Subject to EU decisions permitting use of DTT in the centre gap, we would consider mechanisms by which these arrangements could be achieved.

Section 5

Conclusion and next steps

5.1 In this document we have set out the following proposals:

5.1.1 To accelerate clearance by varying the frequencies the interim multiplexes are authorised to use.

5.1.2 To allocate the centre gap to mobile data use.

5.1.3 To discontinue use of the interim multiplexes at the end of Q1 2020. This proposal is consistent with the position set out at the time of licence award. If the proposals are confirmed, we will issue formal notice to the licensee.

5.2 Our consultation closes on 20 May 2016. Following careful consideration of responses we intend to publish a statement in Q3 2016 setting out our decision as to whether to proceed with these proposals.

5.3 In parallel to progressing this consultation, we will continue our work on other aspects of the 700MHz clearance programme. For example, we will continue to work with the multiplex operators to develop a revised DTT frequency plan. In addition, we will continue to assist Government in its thinking as to whether there is a case for providing support for viewers affected by clearance and/or funding to support PMSE that need to replace their equipment due to clearance. We note that any decisions as to whether to make public funding available to support these or any other aspects of the programme are a matter for Government.

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 20 May 2016**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at http://stakeholders.ofcom.org.uk/consultations/maximising-benefits-700MHz-clearance/howtorespond/ , as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email UHFSI@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Jon Higham
Spectrum Group
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Jon Higham on 020 7981 3673.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether

all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/terms-of-use/

Next steps

A1.11 Following the end of the consultation period, Ofcom intends to publish a statement in Q3 2016.

A1.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/email-updates/

Ofcom's consultation processes

A1.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Graham Howell, Secretary to the Corporation, who is Ofcom's consultation champion:

Graham Howell
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email: Graham.Howell@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at http://stakeholders.ofcom.org.uk/consultations/consultation-response-coversheet/.

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

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

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

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

DECLARATION

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

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

Name

Signed (if hard copy)

Annex 4

Consultation questions

A4.1 This annex provides a complete list of the questions we are asking in the sections of this document.

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

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

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 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 700MHz band to become available for mobile data, in line with our proposals)?

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 700MHz band?

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?

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

Annex 5

Incremental benefits and cost of making 700MHz spectrum available for mobile data earlier

A5.1 In section 3 of this consultation we presented the incremental benefits and costs of bringing forward the availability of the 700MHz band to mid- 2020 instead of end of 2021. We have based these estimations on the models that were developed as part of the 2014 700MHz decision.

A5.2 In this annex we discuss the logic underpinning these cost and benefit calculations in more detail. We present the value of the benefits and costs under the base case scenario (i.e. spectrum available at the end of 2021), including a number of adjustments that have been made since the Statement was published, and then under the accelerated clearance scenario (i.e. spectrum available at the end of June 2020).

A5.3 In the base case scenario the interim multiplexes would be switched off by the end of 2018 with DTT retunes starting in early 2019, allowing for the spectrum band to be clear by the end of Q4 2021. In the accelerated clearance scenario the interim multiplexes would move to a different frequency during the course of 2017, 2018 and 2019 and fully shut off by the end of Q2 2020, at which the band would be clear.

A5.4 Comparing these two scenarios will allow for the estimation of the incremental benefits and costs of moving forward the date that the spectrum will be made available for mobile use.

General approach to estimate the incremental benefits and costs of accelerated clearance

A5.5 The benefits and cost models that were developed as part of the original 700MHz decision were annual models, i.e. calculations were carried out on a whole year basis rather than monthly or quarterly. For the estimation of the incremental benefits and costs we need to calculate the effect over an 18 month period split between six months of 2020 and all of 2021 (i.e. from end of June 2020 to end of December 2021).In order to estimate these partial-year values, we have run the models for three scenarios: spectrum being made available at the beginning of years 2020, 2021 and 2022[36].

[36] For some cost elements, e.g. consumer information costs, the different scenarios only cause a shift in the year in which the costs are incurred. On the other hand, for other categories such as the benefits, aerial costs and PMSE-related costs, the benefit cost levels vary depending on when the spectrum band is cleared.

A5.6 Given that we are interested in the period from the end of Q2 2020 to the end of Q4 2021, the incremental benefits and costs will effectively correspond to one half of the increment from 2020 to 2021 and the total increment from 2021 to 2022.

A5.7 All the results presented in this annex are based on the estimation of Net Present Values (NPV) as of 1 January 2016–, based on Spackman discounting. The estimates for both benefits and costs are based on the "central range high" and "central range low" scenarios, consistent with the figures in the 2014 Statement.

Incremental benefits estimation

A5.8 The benefits estimates in our 2014 Statement are from a model by Analysys Mason (AM), and are a combination of network cost savings and network performance improvements. On 11/03/2015 we published an update relating to an error that had been found in the original benefits model and the updated benefits resulting from the correction. We have used this corrected model for the benefits calculations in this consultation. The figures in the 2014 Statement (and the 2015 correction) related to the benefits resulting from the release of the 700MHz spectrum in early 2022.

A5.9 For the present analysis we also estimated the benefits of making spectrum available at the start of 2020, 2021and 2022[37] in order to determine the incremental benefits of making the spectrum available early.

A5.10 We also estimated that the potential benefits of early access to the centre gap would be around £5m.

A5.11 Following the process described above, we estimate that the incremental benefits from network cost savings as a result of the accelerated release of the spectrum will be between **£12m-38m** while the incremental performance benefits will be between **£7m-16m** for total incremental benefits of approximately **£24m-60m** including the benefits as a result of clearing the centre gap early.

Incremental cost estimation

A5.12 For consumer information, retuning, aerial replacements and PMSE replacement costs we have carried out a similar analysis for the estimation of the incremental costs, running scenarios for 2020, 2021 and 2022 based on the original model, with some minor adjustments[38], and estimating the incremental costs of releasing the spectrum early.

A5.13 Our DTT incremental cost estimation has been based on our latest understanding of the likely costs of DTT infrastructure change.

A5.14 For the reasons outlined in section 3 of this document, our provisional view is that accelerating the programme in the manner discussed would not increase the 2016 NPV cost of the main part DTT infrastructure modification by more than £5m

[37] Running different scenarios in the AM model for different years of spectrum release does not simply assume that benefits are shifted through time but rather that network deployment will be different in each scenario, i.e. it is not just a time-value effect.

[38] E.g. Where relevant, CPI figures have been updated to the latest available (December 2015).

A5.15 In the 2014 statement we indicated that some PMSE users would need to undergo training/upskilling as a result of having to move their equipment to new bands. We estimated the associated cost to be between £10m-13m[39]. The proposals in this document would not affect the extent of this upskilling but they would bring forward the point at which the costs are incurred. Therefore we need to make a time-value adjustment to our estimate. This adjustment results in a Ca. £1m uplift in the upskilling costs in 2016 NPV terms.

A5.16 In some cases running the scenarios for the different years for some cost categories simply implied a shift in the year when costs were incurred. For other cost categories, cost levels were a function of the spectrum release date and, therefore, specific scenarios needed to be run.

5.16.1 In the case of PMSE replacement costs, bringing forward the date at which the 700MHz band has to be cleared has a material impact on the costs. Bringing forward the date not only increases the number of PMSE equipment pieces that will need to be replaced, but also the remaining useful life of this equipment, thereby increasing the cost.

5.16.2 Similarly, specific scenarios for each year need to be run for the cost of aerial replacements as the number that will need to be replaced will be a function of the year when the clearance takes place.

5.16.3 The acceleration of the spectrum release will also lead to additional costs relating to the interim multiplexes. Under this scenario, moving the interim multiplexes will generate an infrastructure cost of approximately £5-10m. As we explain in section 3, we consider £2.5m-5m of this to be attributable to acceleration of the programme. Therefore, £2.5-5m is the relevant cost to consider in this assessment of the costs and benefits of acceleration the programme

A5.17 If the interim multiplexes move into the centre gap spectrum, some households that could receive them previously will be unable to do so. This is due to two principal mechanisms. The first is that moving into another part of the frequency plan with differing levels of spectrum use rights and interference from transmitters in Europe will result in changes to the coverage of the multiplexes. Secondly, not all households have wideband aerials and some older 'grouped' aerials may not work efficiently when receiving services in the alternative frequencies the interim multiplexes move to. Some households with grouped aerials may therefore not be able to receive the interim multiplexes, despite having an adequate signal in their area.

A5.18 It is difficult to quantify the impact of these two mechanisms, as the technical parameters that the interim multiplexes would adopt in the centre gap are not yet known. Based on initial studies, we estimate that the combined impact would be that between 1% and 5% of households would no longer be able to receive the interim multiplexes.

A5.19 Therefore, this cost in unlikely to be material relative to the benefits and is more than offset by the fact that, in the accelerated plan, the vast majority of viewers will

[39] NPV January 1st 2015

continue to view the interim multiplexes for 15 months longer than they would have in the base case scenario.

A5.20 We have not made an estimation of the incremental cost of the DTT loss of value net of operating cost savings (i.e. DTT opportunity costs). We consider that the incremental opportunity cost is unlikely to be material as the early switchover would only be curtailing access to some channels for a short time, and those channels have a very low viewing share.

A5.21 By running the analysis described above, we have found the incremental cost of accelerated release for each cost category as summarised below[40].

5.21.1 Cost of DTT infrastructure, including local TV cost of **< £5m.**

5.21.2 Consumer information costs of **£1m**.

5.21.3 Retuning costs of less than **£1m**.

5.21.4 Aerial replacement costs of **£1m**.

5.21.5 PMSE replacement costs of **£1m-4m**.

5.21.6 PMSE upskilling costs of less than **£1m**.

5.21.7 Interim multiplexer infrastructure costs of **£3m-5m**.

As a result, the overall incremental costs of accelerated release would be between **£13m-18m.**

[40] Numbers rounded to the nearest £1m. Costs do not sum to the total costs shown due to rounding.

Annex 6

Coexistence between DTT use of the centre gap and adjacent paired spectrum for mobile services

A6.1 In this annex we assess the extent to which DTT services in the centre gap would cause interference to mobile data services in the paired part of the 700MHz band. In doing so, we consider evidence which Arqiva has presented to us on this issue. Our provisional conclusions are:

6.1.1 We cannot at this stage be certain of the extent to which DTT services would cause interference to mobile services in the paired spectrum;

6.1.2 Notwithstanding this uncertainty, the there is sufficient uncertainty about the scale of the interference that, absent further evidence, we do not consider allowing DTT services to use the centre gap would be consistent with our duty to ensure efficient use of spectrum.

A6.2 We would particularly welcome consultation responses that provide further evidence and analysis which sheds further light on the likelihood of interference occurring.

There are two potential effects we are concerned about

A6.3 Broadly there are two key risks to consider in assessing the coexistence of DTT and 700 FDD LTE services:

1) Whether mobile base stations are robust to DTT interference. The key question is whether base stations will be deployed with sufficient filtering to ensure an acceptable level of performance in the network alongside DTT. If not, then MNOs would need to take potentially costly and disruptive remedial action (e.g. fitting improved filters) to ensure base stations are sufficiently protected.

2) Whether mobile handsets are robust to DTT interference. This is in some ways the larger risk, as the economies of scale achieved through harmonised international standards & production methods for mobile handsets mean there would be no realistic possibility of any UK specific variations of handsets were ordinary mobile handsets found to be susceptible. Susceptible mobile handsets could be unable to use the 700MHz LTE mobile services in areas around high power DTT transmitters.

The available analysis show that if equipment performed to the 3GPP standard the interim multiplexes would cause interference

A6.4 Arqiva's own analysis shows that there is a risk of interference to both base station and mobile handsets with equipment as it is currently standardised[41].

A6.5 We agree with this assessment on the basis of equipment just meeting the minimum performance characteristics standardised in 3GPP.

Arqiva says that in practice base stations will exceed the standard by a sufficient margin to protect them from interference

A6.6 However, Arqiva has expressed the view that in practice base stations will out-perform the 3 GPP standards by a sufficient margin that they will be robust to interference from DTT transmissions in the centre gap.

A6.7 It argues that MNOs will need to deploy base stations with better filtering than the current standard provides for in order to enable FDD services in the paired spectrum to be able to coexist with SDL in the centre gap. Arqiva has expressed the view that the improved filters MNOs will need to fit to deal with SDL interference will be sufficiently robust to address the risk of interference from DTT services in the centre gap. Arqiva considers that if this holds true, the risk of interference highlighted above should not in practice materialise.

A6.8 The key basis of their argument is that, in their view, interference caused by DTT into the mobile base station will be no worse than that caused by the eventual use of the lower SDL channels described in the CEPT channel plan. Regarding the interference into the mobile handset, Arqiva's analysis predicts that it will be no worse than that of an adjacent cellular operator if they tailor the power spectra from emissions in channel 56.

We cannot be confident that this will be the case

A6.9 We accept that base station filters are likely to perform better than the 3GPP standard. However, we have not seen any evidence that gives us confidence that they will exceed the standards by a sufficient margin to be robust against interference from transmissions in the centre gap.

A6.10 There are a number of reasons why we cannot be confident in Arqiva's argument that filters MNOs deploy to protect FDD services in the paired spectrum from SDL will necessarily provide immunity to interference from DTT in the centre gap. These include:

1) We have not been provided with any specifications that incorporate improved filtering for either base stations, nor do we have characterisations of mobile handsets and how their filtering performs in the presence of DTT interference.

2) We do not know the technical specification of SDL. There is a material possibility that DTT interference will be more aggressive than interference from

[41] Presentation made to Ofcom and UK MNO's at Riverside House on 13th January 2016.

SDL services - for example because DTT's radiated power is higher. Therefore we cannot assume that filters which protect against SDL interference would necessarily provide sufficient immunity against DTT interference.

3) We do not know the actual SDL deployment scenarios and the way an operator or operators may use this spectrum. Differing ways the spectrum is integrated into networks could dictate differing filtering requirements than that which Arqiva suggests is necessary. Also MNOs operate services of broadly similar power and deployment densities, and have relied upon the ability to coordinate their deployments and services to achieve coexistence.

A6.11 Moreover, we note that we are not aware of any situations in which high power DTT services operate in the centre gap of a mobile service. We therefore have no evidence to suggest that duplex gap filtering is designed to provide protection against such services.

Absent better evidence, we therefore do not believe it would be appropriate to allow DTT to use the centre gap

A6.12 Noting the uncertainties as above, there are some factors which could offer mitigation.

1) Arqiva predicts that the interference would be localised to geographical areas where channel 55/56 use is planned, and would only affect operation around the DTT transmitter.

2) Operators may be able to use other lightly loaded bands to provide a service in areas where the 700MHz band is suffering interference. In regions where base stations were affected they may offload to other frequency layers in the network.

A6.13 However, on balance these mitigations do not go far enough to allay our concerns, because:

1) Some transmitters serve heavily urbanised zones, so even localised interference may cause degradation to a significant population of mobile users.

2) We cannot be certain that operators will have access to other appropriate bands in areas where the 700MHz band suffers interference. Where they do, we cannot guarantee that these bands will be lightly loaded.

A6.14 We therefore conclude that in the absence of additional evidence, there is a material risk of interference. This being so, we do not consider allowing DTT services to use the centre gap would be consistent with our duty to ensure efficient use of spectrum.

Annex 7

Glossary of terms

4G	Fourth generation mobile phone standards and technology
CBA	Cost benefit analysis
CEPT	The European Conference of Postal and Telecommunications Administrations
COM 7/8	Refers to the two multiplexes awarded on an interim basis to Arqiva and licensed under the name of 'Multiplex E'
Communications Act	The Communications Act 2003, which came into force in July 2003
DTT	Digital Terrestrial Television - Broadcasting delivered by digital means. In the UK and Europe, DTT transmissions use the DVB-T and DVB-T2 technical standards.
DVB-T	Digital video broadcasting – Terrestrial. A standard for terrestrial transmission of digital television developed by the DVB consortium
DVB-T2	Digital video broadcasting – Terrestrial 2. The latest digital terrestrial transmission technology developed by DVB.
EU	European Union
EP	European Parliament
FDD	Frequency Division Duplex – A transmission method where the downlink/downstream path and the uplink/upstream path are separated by frequency
GI	Geographically Interleaved spectrum – spectrum that is unused in a particular area by transmitters in a multi-frequency network
HD	High Definition - A television or other video service with at least 720 lines of vertical resolution. This higher resolution picture can provide enhanced quality and more detailed pictures, particularly on larger displays
IoT	Internet of Things – Refers to the interconnection (wirelessly) of uniquely identifiable embedded computing-like devices within the existing internet infrastructure.
IPTV	Internet protocol television. The term used for television and/or video signals that are delivered to subscribers or viewers using internet protocol (IP), the technology that is also used to access the internet. Typically used in the context of streamed linear and on-demand content, but also sometimes for downloaded video clips.

ITU	International Telecommunications Union - Part of the United Nations with a membership of 193 countries and over 700 private-sector entities and academic institutions. ITU is headquartered in Geneva, Switzerland.
LTE	Long Term Evolution – Part of the development of 4G mobile systems that started with 2G and 3G networks. Aims to achieve an upgraded version of 3G services having up to 100 Mbps downlink speeds and 50Mbps uplink speeds.
M2M	Machine-to-Machine – an emerging technology that involves providing connectivity to machines whose primary purpose does not require connectivity, used in sectors such as utilities (smart meters), and health (heartbeat or blood sugar monitoring)
MHz	Megahertz. A unit of frequency of one million cycles per second
MNO	Mobile network operator
MPEG	Moving Picture Experts Group – A set of international standards for compression and transmission of digital audio-visual content. Most digital television services in the UK use MPEG2, but MPEG4 offers greater efficiency and is likely to be used for new services including TV over DSL (Digital Subscriber Line – a broadband delivery mechanism) and high definition TV.
PMSE	Programme-making and special events. A class of radio application that support a wide range of activities in entertainment, broadcasting, news gathering and community events.
PSB	Public Service Broadcasting or Public Service Broadcaster – The Communications Act in the UK defines the PSBs as including the BBC, ITV1 (including GMTV1) Channel 4, Five and S4C
RSC	Radio Spectrum Committee – the body that assists the Commission in the development of technical implementing decisions
RTÉ	Raidió Teilifís Éireann – Ireland's national public service media organisation
SD	Standard Definition -The lower, and currently most common, of the picture resolutions used for television broadcasting. Standard definition TV services in the UK and Europe have a vertical resolution of 576 (interlaced) lines
SDL	Supplemental down link – where a separate spectrum block is used to provide additional downlink resource to support the normal symmetrical arrangement.

TG4 A public service broadcaster for Irish-language speakers