Coexistence of new services in the 800 MHz band with digital terrestrial television

Consultation

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Contents

Section 1

Executive Summary

1.1 Consumers in the UK continue to demand faster and better mobile broadband. They are doing this through increasing their use of smartphones, laptops, tablets and dongles and increasing their use of applications and services on those phones that need both fast and mobile internet connections. The result is increasing demand for faster speeds, better coverage and more capacity across the UK's mobile networks.

1.2 An important raw material for meeting this demand is spectrum, the invisible radio waves that enable your mobile phone to operate without a wire. The spectrum is divided into different frequencies. Some frequencies are better at carrying more data. Other frequencies are better at travelling long distances and penetrating into homes and offices. The particular frequencies that combine the ideal balance between carrying more data and the ability to travel long distances and penetrate into buildings are the most important for meeting this demand for faster and better mobile broadband. The 800 MHz spectrum frequencies fall into this category.

1.3 One of the ways that we are helping to meet this demand is to release 800 MHz spectrum. Historically this spectrum has been used for terrestrial television broadcasting. However as a result of digital switchover (DSO), and more recently clearance of channels 61 and 62 (a project to change the parts of the spectrum DSO will free up), this spectrum will be available for the first time for mobile services.

1.4 When the 800 MHz spectrum starts being used for mobile services they will be close in frequency to the spectrum used for digital terrestrial television (DTT). This means that there will be potential interference from mobile base stations that could affect the ability of some people to receive DTT.

1.5 Many of the issues we consider require us to balance the needs of different groups of stakeholders and consumers. In this instance we want to ensure that mobile services can be used effectively in the 800 MHz band but at the same time not restrict the ability of DTT broadcasting to function properly. We must consider the needs of consumers of mobile services alongside the needs of consumers of DTT services.

1.6 We have undertaken an extensive research exercise that has indicated that the potential impact of interference on DTT consumers is of such a level that we must take mitigating actions. Therefore, after careful consideration of the problem in the context of our duties under the Communications Act 2003 and European legislation, we are setting out a framework of proposals within this consultation document that we consider best balance the competing interests of those involved in using the 800 MHz spectrum and DTT.

1.7 The analysis we have undertaken shows that there are many different options and approaches to reduce the potential interference affecting DTT viewers.

1.8 Our proposals centre around establishing an implementation body to manage the delivery of some of these mitigating measures. This will be a single body that will act both to aggregate and provide information to and from consumers, broadcasters, and new 800 MHz licensees, as well as co-ordinate the use of mitigation options to reduce the potential interference.

1.9 The measures that are likely to be necessary and which we set out in the document include:

- Filters for DTT consumer equipment
- Filters for mobile base stations
- Changes to aerials including reorientation and cross polarisation
- Platform changes
- Mobile base station power reductions

1.10 We propose that the costs of creating this body and the work that it carries out should be borne predominantly by the new licensees of the 800 MHz spectrum.

1.11 In this consultation we also set out our proposals for conditions that should be included in new 800MHz licences.

1.12 We recognise that it will be important for potential bidders in the forthcoming combined auction of 800MHz and 2.6GHz spectrum to be as clear and certain as possible in advance of that auction regarding the level of such costs and the details of any associated licence conditions.

1.13 The purpose of this consultation is to seek input from stakeholders and any other interested parties. In particular, whilst this consultation document contains a number of specific questions, we are not seeking to limit the issues on which respondents may wish to comment and respondents are invited to include representations on any issues which they consider to be relevant.

1.14 It is our intention to publish further analysis, and where appropriate address these issues in a second consultation, in the autumn. Not all of the issues raised in this consultation have proposals associated with them. This is because we consider that we are not yet in a position to make certain decisions, or that these decisions are for us to consider in conjunction with Government or for the Government itself to take.

Section 2

Introduction

Background

2.1 We published a consultation on proposals for the award of 800 MHz and 2.6 GHz spectrum (the combined award consultation) on 22 March 2011[1]. That consultation covered many of the key issues in relation to the award including a competition assessment, spectrum packaging and auction design proposals. The consultation noted the need for further consultations on:

- detailed proposals regarding the coexistence of future mobile services in the 800 MHz band with the adjacent DTT use; and
- proposals for the technical conditions for use of the 800 MHz and 2.6 GHz bands.

2.2 This document presents the results of our work looking at the first point, i.e. coexistence of future mobile services in the 800 MHz band with adjacent DTT use. In parallel to this document, we have also published a consultation document on our proposals for technical conditions for the award.[2]

2.3 The proposals in this consultation supersede our proposals in the Digital Dividend Review (DDR) Cleared Award consultation published on 6 June 2008[3]. That document set out some initial proposals for dealing with the coexistence issue while recognising that further detailed work was needed.

2.4 Since then, international developments in spectrum resulted in several European countries identifying a digital dividend comprising the whole of the 800 MHz band (790-862 MHz). In order to realise the full benefits of harmonised use of this spectrum across Europe for two-way mobile services, we took the subsequent decision to clear 790-806 MHz (channels 61 and 62) and 854-862 MHz (channel 69) of use by DTT and programme making and special events respectively[4]. However, interference from new mobile services in the 800 MHz band into DTT use of channels 60 and below is still expected to need careful management.

2.5 In line with this, we have undertaken a programme of technical work to better understand the scale and nature of the coexistence issue. The results of this work are summarised in this document and described in detail in the accompanying technical report titled “Technical analysis of interference from mobile network base stations in the 800 MHz band to digital terrestrial services”.[5]

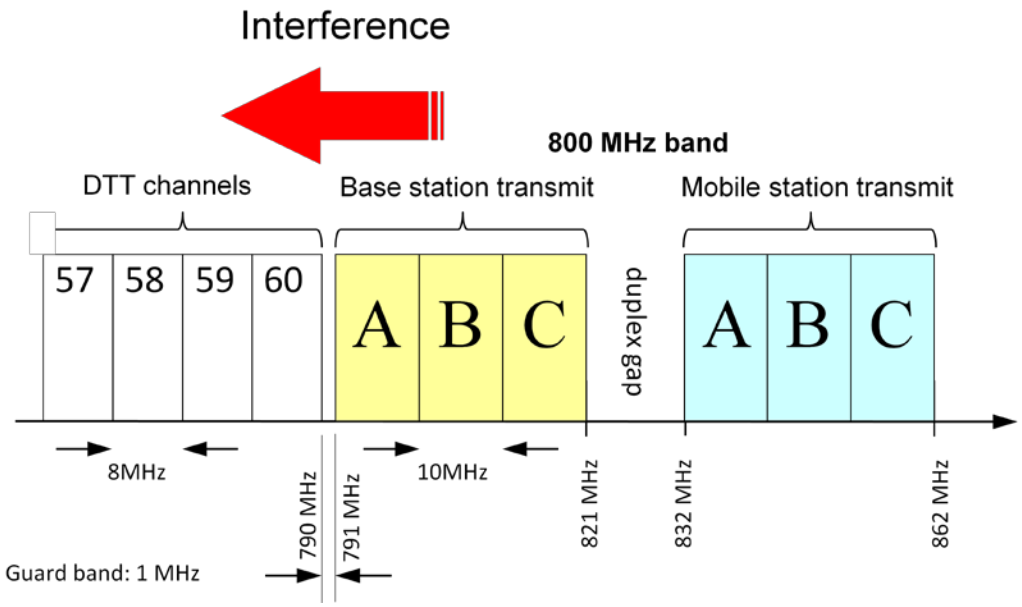
2.6 In practice, use of the 800 MHz band and, therefore, any coexistence issues are unlikely to occur before the completion of digital switchover and the clearance of DTT from channels 61 and 62. We currently expect that this will mean that coexistence issues are unlikely to start occurring until the second half of 2013 although there may be localised instances before this.

[1] http://stakeholders.ofcom.org.uk/consultations/combined-award/
[2] http://stakeholders.ofcom.org.uk/consultations/technical-licence-conditions/
[3] http://stakeholders.ofcom.org.uk/binaries/consultations/clearedaward/summary/condoc.pdf
[4] http://stakeholders.ofcom.org.uk/binaries/consultations/800 MHz/statement/clearing.pdf
[5] This will be available from http://stakeholders.ofcom.org.uk/consultations/coexistence-with-dtt/

The interference issue

2.7 The main coexistence issue is at the lower boundary of the 800 MHz band, between the base station transmit frequencies in the 800 MHz band and the uppermost DTT channels. This is shown in the figure below.

Figure 2.1: Adjacency between the 800 MHz band and existing DTT services



2.8 The main interference mechanism is from new mobile base stations into existing DTT receivers. Existing DTT receivers and aerials were designed to receive signals across UHF Bands IV and V (470-862 MHz), including the whole of the 800 MHz band. This means that, in addition to receiving the wanted DTT signal, they may also pick up unwanted signals from new mobile base stations that could result in interference and degraded DTT reception. Our modelling shows that, absent any mitigation, up to 760,000 households could potentially be affected by this interference problem, although we believe there are ways of reducing this number substantially. Section 4 describes this issue in more detail.

2.9 There is a smaller risk of interference from mobile phones transmitting at the upper end of the 800 MHz band into DTT receivers. The risk is smaller for two main reasons:

a) because there is a larger frequency separation between the mobile phones and DTT receivers; and

b) because mobile phones transmit at lower powers than mobile base stations.

2.10 In 2010 we commissioned a set of measurements to investigate the potential for mobile phones in the 800 MHz band to interfere with DTT receivers. The main findings were that mobile phones were very unlikely to cause interference to roof-top DTT reception but could potentially cause interference to set-top aerials if the mobile phone was close to the aerial. Such interference would be transient and could be

simply resolved by moving away from the TV. Further details can be found in the technical report published on our website.[6]

Implications of the interference issue

2.11 If new licensees in the 800 MHz band were to roll out new mobile services and no action was taken to manage the interference risk, on the basis on our current analysis up to 760,000 DTT consumers could be affected by interference. They could lose reception of one or more television channels, either for some or all of the time. Some could lose reception of all TV channels.

2.12 Our principal duty under the Communications Act is to further the interests of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition. We are also required to secure the optimal use for wireless telegraphy of the electromagnetic spectrum. We consider that allowing large numbers of households to face interference when there are cost effective and proportionate solutions available to reduce and fix this issue would conflict with this duty. It is on this basis that we have carried out the analysis set out in this document.

2.13 In addition, we note that if no action was taken, interference could result in a reduction of the coverage of DTT networks. For Public Service Broadcasting (PSB) DTT networks, broadcasters are currently required by their licences to provide DTT coverage to broadly the same proportion of UK households as reached by their analogue TV networks prior to DSO.[7] They are therefore required to broadcast from a specified list of transmitters. Ofcom has previously estimated that if the PSB DTT networks did this, the coverage of DTT services after DSO should be around 98.5% of UK households.[8] While commercial broadcasters do not have specific coverage obligations beyond the requirement not to reduce their existing coverage at DSO, they are planning on the basis of reaching approximately 90% of UK households.

2.14 The extent of DTT coverage after DSO remains an important Government policy issue. In assessing options therefore, we will also need to consider what effects these will have on DTT coverage and the implications for DTT coverage policy.

The European dimension

2.15 In recognition of the decision of several European Union (EU) Member States, including the UK, to create a digital dividend in the 800 MHz band, the European Commission initiated technical work to produce harmonised technical conditions for its use. This work culminated in Commission Decision 2010/267/EU on harmonised technical conditions of use in the 790-862 MHz frequency band for terrestrial systems capable of providing electronic communications services in the European Union (the Decision)[9]. Where they decide to make the spectrum available, Member States are required to do so in compliance with the parameters set out in the annex to the Decision.

2.16 The Decision recognises the possible need for national measures to deal with harmful interference:

[6] http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/statement/2010-0026.pdf
[7] http://stakeholders.ofcom.org.uk/consultations/dtt_changes/statement/
[8] See paragraph 2.11 of http://stakeholders.ofcom.org.uk/binaries/consultations/dtt_changes/statement/statement.pdf
[9] Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32010D0267:EN:NOT

> "BEMs[10] shall be applied as an essential requirement of the technical conditions necessary to ensure coexistence between services at national level. However, it should be understood that the derived BEMs do not always provide the required level of protection of victim services and additional mitigation techniques would need to be applied in a proportionate manner at national level in order to resolve any remaining cases of interference"

2.17 Some EU Member States have already imposed such additional 'national' measures when awarding licences in the 800 MHz band. For example, Sweden awarded 800 MHz licences in March 2011. Licensees there are, among other things, expected to ensure that base station transmissions do not exceed specified levels at the DTT receiver. In practice, licensees in Sweden need to use appropriate mitigation to ensure compliance with this condition. In Germany, new licensees are required to provide details of planned base station deployments to the regulator in advance of deployment. The regulator then checks whether these deployments are likely to cause interference and can require licensees to take appropriate measures to mitigate interference.

2.18 It is important to note the differences between the UK's DTT market to that in Germany and Sweden. In particular the UK has much higher DTT usage. For example in 2009 the UK had 41% of main sets connected to DTT while Germany had only 7%[11]. This and other differences mean that approaches to coexistence taken in other EU countries are not necessarily suitable for the UK.

Structure of this document

2.19 This document as a whole comprises an impact assessment.

2.20 As part of our work on the coexistence issue, we have undertaken an Equality Impact Assessment (EIA). We have provisionally identified that the proposals set out in this document may have a particular impact on elderly and disabled people insofar as being able to implement potential consumer-based mitigation techniques (as proposed in Section 5 on the choice of mitigation measures and in Section 6 on the level of consumer support and delivery mechanisms). Where relevant, we have identified these impacts in the text of the document. We consider that a key decision for these groups will be with respect to the level of support provided to consumers. As noted in Section 6, we intend to do further work on this over the summer. We will continue to review our EIA and update it as our work progresses.

2.21 The rest of this document is structured as follows.

- In section 3, we set out the legal framework within which we operate and how we propose to apply our duties in considering the coexistence of DTT services and new services in the 800 MHz band.
- In section 4, we describe in detail the interference issue and our work to understand the scale of the issue, including estimates of the numbers of households that might be affected if no action was taken.

[10] Block edge masks. Block edge masks are a set of technical parameters that define the in-band and out-of-band power profile of a licensee's transmitters.
[11] Ofcom international Communications Market report 2010. http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr10/international/

- In section 5, we discuss the mitigation measures that could potentially be used, assess their effectiveness and draw some high level conclusions on what action should be taken.

- In section 6, we explain the options for implementing our preferred option and set out high level proposals for how this might be achieved.

- In section 7, we set out next steps.

Section 3

Legal framework

3.1 This section describes our functions, duties and objectives in assessing how best to manage the interaction between the potential future use of the 800 MHz band and the use of adjacent spectrum to provide DTT services. Our decisions are made within a framework defined in both EU and UK law. This sets out general duties that apply across all our functions, together with a number of specific duties.

3.2 This section should be read in conjunction with section 3 of the combined-award consultation, which sets out the legal framework for conducting the award of the 800MHz spectrum band.

European Regulatory Framework

3.3 Article 8 of Directive 2002/21/EC on a common framework for electronic communications networks and services (the Framework Directive[12]) sets out the objectives that national regulatory authorities (NRAs) must take all reasonable steps to achieve. These include:

- the promotion of competition in the provision of electronic communications networks and services by, among other things, encouraging efficient investment in infrastructure and promoting innovation, and encouraging efficient use of radio frequencies; and

- contributing to the development of the internal market by, among other things, removing obstacles to the provision of electronic communications networks and services at a European level, encouraging the interoperability of pan-European services and ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing electronic communications networks and services.

3.4 Article 8 also requires EU Member States to ensure that in carrying out their regulatory tasks, NRAs take the utmost account of the desirability of making regulations technologically neutral.

Our general duties under the Communications Act

3.5 Section 3 of the Communications Act provides that our principal duty is:

- to further the interests of citizens in relation to communications matters; and

- to further the interests of consumers in relevant markets, where appropriate by promoting competition.

3.6 In carrying out our functions, section 3(2) provides that we are required, amongst other things, to secure the optimal use for wireless telegraphy of the electromagnetic spectrum; the availability throughout the UK of a wide range of electronic communication services; and the availability throughout the UK of a wide range of television and radio services.

[12] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2002L0021:20091219:EN:PDF

3.7 Section 3(3) provides that, in performing our duties, we must in all cases have regard to the principles of transparency, accountability, proportionality and consistency as well as ensure that our actions are targeted only at cases in which action is needed.

3.8 Section 3(4) requires us, in carrying out our functions, to have regard to certain factors as appear relevant in the circumstances. In the present case, these factors include the need to have regard to: the different needs and interests of everyone who may wish to use the spectrum for wireless telegraphy; the desirability of encouraging investment and innovation in relevant markets; and encouraging the availability and use of high-speed data-transfer services throughout the UK.

3.9 Section 3(7) states that where it appears to us that any of our general duties conflict with each other in a particular case, we must secure that the conflict is resolved in the manner which we think is best in the circumstances. In practice, this involves a balancing exercise, taking into account the relative weight and importance of each competing objective and applying the principle of proportionality.

3.10 Section 4 implements the requirements of article 8 of the Framework Directive (set out above). Our duties under section 3 of the Communications Act will always be subject to the EU requirements as set out in section 4.

Our duties under the Wireless Telegraphy Act 2006

3.11 Section 3 of the Wireless Telegraphy Act imposes a number of further duties relating to spectrum management. Amongst other things, in carrying out our spectrum functions, we are required to have regard to the extent to which the spectrum is available for use and to the demand, both current and future, for the use of the spectrum.

3.12 In addition, section 3 also requires us to have regard to the desirability of promoting the development of innovative services and competition in the provision of electronic communications services.

3.13 Where it appears to us that any of our duties in section 3 of the Wireless Telegraphy Act conflict with one or more of our general duties under section 3 of the Communications Act, priority must be given to our duties under the latter.

Granting wireless telegraphy licences

3.14 The Wireless Telegraphy Act sets out our legal powers to grant wireless telegraphy licences. Section 8(1) makes it an offence for any person to establish or use any station for wireless telegraphy or to install or use any apparatus for wireless telegraphy except under and in accordance with a licence granted by us under that section (a wireless telegraphy licence).

3.15 Section 9(1) gives us the power to grant wireless telegraphy licences subject to such terms as we think fit.

3.16 However, our broad discretion in relation to the terms that can be imposed in a wireless telegraphy licence is subject to the rule that we must impose only those terms that we are satisfied are objectively justifiable in relation to the networks and services to which they relate, not unduly discriminatory and proportionate and transparent as to what they are intended to achieve (see section 9(7)).

3.17 In addition, our discretion under section 9 must be interpreted in a way that is consistent with the licence conditions permitted under Directive 2002/20/EC on the authorisation of electronic communications networks and services (the Authorisation Directive[13]).

Application of our duties in future use of the 800MHz band and existing DTT use of the adjacent band

3.18 In satisfying our principal duties set out in section 3(1) of the Communications Act, we must determine how best to further a range of potentially competing citizen and consumer interests. These include in particular:

- the benefits that are likely to accrue to citizens and consumers from the deployment of new technologies in the 800 MHz band, for example, enhanced mobile communications services; and
- the enjoyment of DTT services.

3.19 There may be a conflict between the two groups of citizen and consumer interests listed above if the use of the 800 MHz band adversely affects the ability to receive DTT services. We note that these interests are not necessarily mutually exclusive, in that the same citizens and consumers may well have an interest in *both* the efficient use of the 800 MHz band and the continued reception of DTT services. Our aim is to ensure, as far as possible, that use of both frequency bands for the above purposes can co-exist without undue interference between them.

3.20 Our statutory duties do not, of themselves, provide a clear answer as to how best to resolve this tension. We note however that in all cases our regulatory decisions should be transparent, accountable, proportionate, consistent and targeted only at cases where action is needed (see section 3(3) of the Communications Act).

3.21 We have considered carefully the competing citizen and consumer interests identified at paragraph 3.18, and the range of options available to us.

3.22 Accordingly, having carefully balanced our statutory duties and the matters with which we must have regard, and having consulted with Government as to the level of DTT coverage that UK citizens and consumers may reasonably expect, we have set out in this document the range of potential solutions which we consider best meets those duties. Our proposals are fully detailed in the following sections.

[13] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2002L0020:20091219:EN:PDF

Section 4

The interference issue

Introduction

4.1 Effectively managing radio spectrum is one of our core functions. In doing so, we are required to secure the optimal use for wireless telegraphy of the electromagnetic spectrum.

4.2 Securing optimal use of the spectrum includes taking steps where necessary to manage the risk of harmful interference. We normally do this by including technical conditions in licences which define the parameters within which wireless telegraphy equipment should operate.

4.3 In parallel with this document, we are consulting on the main technical licence conditions (TLCs) which should be included in licences for the use of the 800 MHz and 2.6 GHz bands.[14]

4.4 Our preparatory work for the release of the 800 MHz band has revealed that there is a significant risk of interference from new services in the 800 MHz band to some existing DTT users. This risk primarily relates to transmissions from base stations operated by new licensees in the lower part of the 800 MHz band being picked up by some existing DTT receivers in the adjacent band.

4.5 The TLCs set out in the parallel document referred to above derive from work undertaken by the European Conference of Postal and Telecommunications Administrations. This body was commissioned by the European Commission to, among other things, define common and minimal (least restrictive) technical conditions to be applied to the 800 MHz band. This work culminated in the Decision which sets out the TLCs that should be included in 800 MHz band licences.

4.6 These conditions were agreed in the knowledge that adherence to them would not completely remove the interference risk. The Decision recognised that further measures tailored to fit the specific circumstances of Member States could be applied at a national level to mitigate this risk.

4.7 Our technical modelling indicates that, even if new licensees adhered to the TLCs in the Decision, interference to DTT receivers could still result such that, absent any mitigation, up to 760,000 households might lose the ability to receive some or all DTT services.

4.8 This indicates that it may be necessary to include additional conditions in licences to manage the interference risk. These could take the form of either additional technical conditions or non-technical licence conditions.

4.9 To help us understand what additional licence conditions if any should be included in new licences, it is helpful to first understand the nature and scale of the interference issue that could occur.

4.10 In this section we:

[14] http://stakeholders.ofcom.org.uk/consultations/technical-licence-conditions/

- provide some background information on the DTT network in the UK;
- explain how interference is likely to affect DTT reception;
- describe how we have modelled interference;
- present the results of our technical modelling; and
- explain how and why the modelling is subject to uncertainty.

The DTT network

4.11 In the UK, television services are provided on three main platforms: terrestrial, satellite and cable. In the last few years, services provided over the internet or via internet protocol TV (IPTV) have started to become available but currently make up only a small part of the UK market.

4.12 Digital or analogue terrestrial television is the most popular means of receiving subscription-free TV. A recent development has been the introduction of Freesat, a free-to-view satellite television service. Free-to-view satellite television services are also available from Sky and other providers. Over 1.5 million UK households now receive free-to-view TV services via satellite.[15] DTT is also used to deliver subscription services to less than half a million households in the UK.

4.13 The terrestrial network consists of a number of high power TV broadcast transmitters distributed across the UK. The transmitters are generally sited on the top of hills or tall masts to reach as many households as possible. These 'high power, high tower' transmitters are supplemented by a large number of smaller transmitters which fill gaps in the coverage of the larger transmitters.

4.14 DTT services have been available in the UK since 1998, but were only available from a limited number of TV transmitters. In 2007, the UK commenced DSO. This process involves switching off the analogue terrestrial network and making modifications to the DTT network so that DTT services will be available from all TV transmitters. Some TV viewers have also needed to change their TV equipment in order to be able to receive new digital signals.

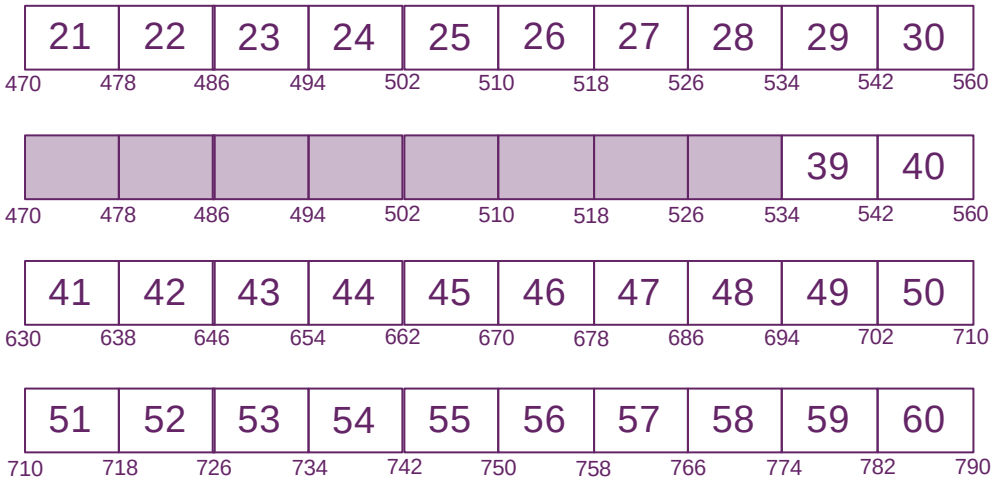
4.15 One of the key benefits of DTT over the old analogue TV network is that it is more spectrally efficient. Following DSO, the total amount of spectrum utilised by the terrestrial TV network will have reduced from 368 MHz to 256 MHz. The upper part of the spectrum released for new uses constitutes the 800 MHz band.

4.16 DTT channels each occupy 8 MHz of spectrum and are referred to by their channel number. Figure 4.1 below shows the channels used for DTT in the UK post-DSO.[16]

[15] http://stakeholders.ofcom.org.uk/binaries/research/tv-research/tv-data/dig-tv-updates/charts-q4-2010.pdf

[16] A "channel" refers here to the spectrum used to provide the services rather than a "TV channel" such as BBC ONE.

Figure 4.1: UK DTT channels post switchover (greyed out not used for DTT)



Channel numbers in bold, band edges (in MHz) in subscript

4.17 DTT broadcasting also employs the use of a 'multiplex'. A multiplex aggregates several digital television signals together into a single digital signal which is then transmitted in a single 8 MHz channel. In the UK, six multiplexes support all of the existing TV services available on the DTT network. Three of these multiplexes are used for PSB services and three are used for commercial (COM) services.

4.18 The UK DTT network is a multi-frequency network. This means that each DTT Multiplex is transmitted across the UK on different frequencies in different geographic areas. The opposite of this would be a Single Frequency Network where each DTT Multiplex is transmitted on the same frequency everywhere in the country. A consequence of this is that at each transmitter the 6 Multiplexes are transmitted on different frequencies (which vary from transmitter to transmitter across the country). Therefore depending on where you live you will receive your DTT services on different channels. The Crystal Palace TV transmitter currently broadcasts both analogue and digital services, but will cease analogue transmission in 2012 and will transmit on six channels after DSO as shown in Table 4.1.[17]

Table 4.1: Crystal Palace channel usage

Multiplex	Channel used
PSB1	23 (486-494 MHz)
PSB2	26 (510-518 MHz)
PSB3	30 (542-550 MHz)
COM4	25 (502-510 MHz)
COM5	22 (478-486 MHz)
COM6	28 (526-534 MHz)

Interference to DTT reception

4.19 Interference from base stations in the 800 MHz band to the reception of DTT services is expected to occur in two main ways.

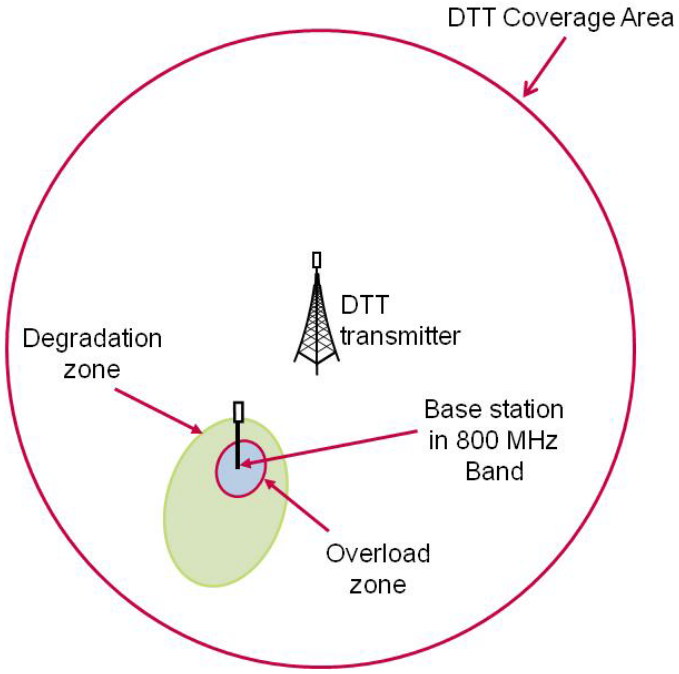
[17] The DTT services from Crystal Palace prior to DSO transmit on different channels.

i) **Overload.** A DTT receiver becomes overloaded if the power of the signals at its input exceeds a certain threshold. In the presence of overload, a DTT receiver stops working altogether and reception of **all** DTT services is lost.

ii) **SINR degradation.**[18] A DTT receiver may also experience SINR degradation in the presence of unwanted interference. If the ratio of the wanted signal power to that of interference power (i.e. the SINR) at the receiver input reduces below a specific threshold in a given channel, then the DTT receiver will fail to operate correctly and reception of that multiplex is lost or degraded. In most cases, one, but in a smaller number of cases, two or three, DTT multiplexes may be lost or degraded.

4.20 Figure 4.2 below provides a basic (not to scale) illustration of this issue as it applies to interference from the 800 MHz band into DTT use of the adjacent band.

Figure 4.2: Overload and SINR degradation



4.21 Households located in close proximity to the base station in the 800 MHz band could expect to be affected by overload. SINR degradation will generally affect households over a wider geographic area.

4.22 In the modelling results presented in this document, we have presented the total number of households likely to be affected by interference (i.e. the total numbers affected by SINR degradation and overload). Our accompanying technical report[19] provides greater detail including the numbers affected by overload.

4.23 For the DTT consumer, the main difference between these two types of interference will be in the number of multiplexes affected. As stated, overload will result in

[18] Signal to interference plus noise ratio.
[19] Technical analysis of interference from mobile network base stations in the 800 MHz band to digital terrestrial services. http://stakeholders.ofcom.org.uk/consultations/coexistence-with-dtt/

reception of all multiplexes being lost or degraded. SINR degradation will result in reception of one or more multiplexes being lost or degraded.[20]

4.24 The viewing experience will also depend on the level of the interfering signal. Where the interfering signal is strong in relation to the wanted TV signal, DTT reception is likely to be completely lost and interference will manifest itself as a black screen for most or all of the time on the affected channels. Where the interfering signal is less strong, DTT reception may be lost or degraded for some of the time and could manifest itself as some pixelation of the TV picture. In our modelling, our estimates of affected households include all households that receive degradation to their picture ranging from some pixelation up to complete loss of picture.

Modelling the interference effect

4.25 To help us understand the numbers of households that might be affected by interference from new mobile services in the 800 MHz band, we have undertaken an extensive programme of technical research using both internal technical expertise and externally commissioned studies. The full details of this technical research are presented in the technical report[19] that accompanies this document and is summarised at a high level in this section. We have also conducted a field trial to test and verify the results of our theoretical modelling. A separate report on the field trial titled "The co-existence of LTE and DTT services at UHF: a field trial" will be published on our website in due course. Both documents can be found at http://stakeholders.ofcom.org.uk/consultations/coexistence-with-dtt/

Technical modelling

4.26 Interference between the 800 MHz band and DTT use of the adjacent band will only occur after DSO has occurred as the 800 MHz band will not be made available for new services until after DSO. Therefore our technical modelling is based on future DTT networks, rather than the current DTT network which is evolving due to DSO.

4.27 One of the key enablers for the technical modelling work has been the creation of a technical modelling tool with which we can model the effect of new mobile networks in the 800 MHz band on DTT networks. This tool, which we call Punch, was created in collaboration with Arqiva and incorporates data from the planning tool used by broadcast planners to plan the current and future DTT network (the UK Planning Model or UKPM). It allows us to see how new mobile networks in the 800 MHz band are likely to affect DTT networks after DSO.

4.28 To help us refine our approach, we have shared our modelling methodology, assumptions and parameters with stakeholders from both the mobile and broadcast industries via the establishment of a technical working group. Regular meetings have been held between May 2010 and March 2011 with technical representatives to share latest results and ideas and to obtain feedback and critical appraisal of the ongoing work. This has been very helpful and enabled us to draw on the considerable technical expertise and knowledge in the UK mobile and broadcast sectors.

[20] The loss of a multiplex would mean that a household would lose groups of channels that they currently receive. For example losing the BBC's main multiplex would result in the loss of BBC One, BBC Two, BBC Three, BBC Four, CBBC, CBeebies, BBC News and BBC Parliament.

4.29 We have also undertaken a programme of additional technical research which has helped to inform our technical modelling. We provide a high level description of this work below.

Equipment measurements and studies

4.30 We have commissioned laboratory measurements of DTT equipment to understand how well it performs in the presence of interfering mobile signals. The devices we have tested include:

- DTT receivers including set top boxes (STBs), integrated TVs (IDTVs) and personal video recorders (PVRs);
- a representative launch amplifier (as used in communal aerial systems, e.g. blocks of flats); and
- a representative mast-head amplifier (as used in domestic TV installations, e.g. to boost the TV signal to feed multiple TV outlets around the home).

4.31 In parallel with this we also commissioned independent studies to better understand the effect of interference on:

- communal aerial systems (e.g. blocks of flats, hotels, etc); and
- households which use amplifiers in their TV installation.

Field trial

4.32 Starting in January 2011 and running through to May 2011, we commissioned and managed a field trial to investigate the real world effect of new mobile services on DTT services. A test DTT transmitter was set up at Arqiva's Lichfield transmitter and a test mobile base station was set up in the surrounding area to transmit mobile signals in the 800 MHz band. We then investigated the effect of this by taking measurements of the wanted DTT signal and interfering mobile signal at several test points in the area. Testing included visual tests of how real TVs were affected by the interference. Further tests involved the use of various mitigation tools and how these performed in reducing interference.

4.33 This testing accomplished two important objectives:

- it allowed us to check whether the parameters and assumptions used in our technical modelling were reasonably accurate; and
- it enabled us to verify the performance of various mitigation techniques and confirm that they performed as expected.

4.34 One of the key findings of our field trial and equipment testing was that the type of TV installation employed by households has a large bearing on the susceptibility of the installation to interference and the type of interference experienced.

4.35 The tests revealed that households which use an amplifier will be more susceptible to interference than those that do not. The main problem occurs because amplifiers are more easily overloaded than TV receivers. Where an amplifier is used, the overload zone shown in figure 4.2 becomes larger. In other words, households further from the mobile base station will be affected by overload and lose reception of all multiplexes.

What we have modelled

4.36 In DTT planning, it is estimated that after DSO there will be approximately 27 million households in the UK that will have the ability to receive DTT.[21] These estimates of numbers of households effected are based on this total number of households who have the ability or potential to receive DTT. In practice, not all households will make use of this ability. This means that our estimates include:

- households which will use DTT as their only means of receiving TV;
- households which will use DTT in addition to other platforms;
- households which will not use DTT.

4.37 As of the final quarter of 2010, 38% of households used DTT as their primary means of receiving television and 73% of UK households made use of DTT equipment[22]. These percentages could rise by the end of DSO as the remaining analogue households switch to digital television.

4.38 As noted, not all households will use the same type of TV installation. In order to assess the interference effect, we have split our estimates of households affected into three main categories corresponding to three types of TV installation.

i) **Standard domestic installations.** These households are assumed to use a professionally installed roof-top aerial at a height of 10 metres, and a single piece of coaxial cable feeding their television (but no amplifier). This is consistent with the assumptions used by broadcast planners for the purposes of planning DTT coverage. We estimate that approximately 16.3 million households in the UK have standard domestic installations.

ii) **Communal aerial systems.** These are households located in blocks of flats or other communal dwellings, e.g. hospitals or hotels. A typical communal aerial system has a single DTT receive aerial on the roof of the building. The signal is then boosted using a launch amplifier and distributed to outlets in each flat or dwelling. We estimate that approximately 5.2 million households in the UK make use of communal aerial systems. Approximately two-thirds of these systems are integrated reception systems and provide the potential for households to access both DTT and satellite/cable signals. Approximately one third of these systems are master antenna TV (MATV) systems and provide access to DTT services only.

iii) **Domestic installations with amplifiers.** These are households which use an amplifier to boost the DTT signal, including mast head, booster, set-back amplifiers etc. We estimate that approximately 5.7 million households in the UK have domestic installations with amplifiers.

4.39 We note that we have investigated the effect of interference on households based on the use of an external roof-top aerial. We have not modelled the effect of interference on TVs using indoor or set-top aerials.[23] Where indoor or set-top aerials are used,

[21] This estimate includes commercial premises that are included in the definition of "household".
[22] http://stakeholders.ofcom.org.uk/binaries/research/tv-research/tv-data/dig-tv-updates/charts-q4-2010.pdf
[23] We have not modelled these partly because we do not have reliable data on the likelihood of indoor DTT reception and also because the directivity and gain of indoor or set-top aerials is unknown.

the interference may be expected to be somewhat higher due to the generally lower quality of the aerials compared to a roof-top aerial, although the interfering signal may also be reduced to the attenuation through walls etc.

4.40 Full details of the modelling and parameter values that we have used can be found in the accompanying technical report[19]. However, the following key points should be noted.

- The presented results are for the example of a UK-wide deployment of mobile base stations (three 10 MHz licensees, each with roughly 9,000 base stations). The base station power (EIRP[24]) assumed is 59 dBm[25]. Antenna heights and locations are based on a current 900 MHz GSM[26] network deployment[27]. Site-sharing between the three licensees is assumed.

- For various channels, a number of main and relay DTT transmitters were examined. The percentage of households affected was then weighted by the relative proportion of population served by each transmitter, and used to extrapolate across the UK.

- The number of households within communal aerial systems was derived via census information relating to the number of flats at a pixel-by-pixel (100 metre x 100 metre) level in the coverage area of the DTT transmitter. Of the remaining households, the proportion (constant across pixels) with domestically installed amplifiers was derived based on an estimate of the number of domestic amplifiers in use with primary DTT receivers throughout the UK. The remaining households were assumed to have standard installations.

- The susceptibility to interference of standard domestic installations against adjacent channel interferers was modelled base on the worst-case measured performance of five DTT receivers [28] The corresponding susceptibility to interference of communal aerial systems and domestic installations with amplifiers was modelled on the measurements of an MATV amplifier and a domestic amplifier, respectively.

General approach to modelling and uncertainty

4.41 The interference effect figures presented later in this section are our current best estimates of the interference effect based on available information. It is important to understand that these numbers are subject to a degree of uncertainty.

4.42 The technical modelling is by necessity based on making assumptions about key parameters such as the quality of DTT coverage, performance of DTT equipment, signal propagation, mobile network deployment and transmit powers to name a few. In practice, there will be a range of values possible for each of these parameters. We

[24] Equivalent isotropically radiated power.
[25] We have excluded femtocells, picocells and microcells from our analysis. Typically these types of cells would operate at lower powers than macrocells.
[26] Global System for Mobile Communications.
[27] We note that some operators may choose to deploy a denser network of sites, but basing the numbers of sites on a 900 MHz network is likely to be reasonable as 800 MHz and 900 MHz spectrum will have similar propagation characteristics.
[28] Three of these were super-heterodyne receivers and two were silicon receivers. Super-heterodyne and silicon receivers work in slightly different ways that can affect how sensitive they are to interference.

provide a full description of the parameter values used in our technical modelling in the accompanying technical report[19].

4.43 In particular we note that there are varying levels of uncertainty depending on the type of DTT installation in use.

- **Standard domestic installations.** Of the three DTT installation types, we have most certainty for this category. In particular we note that we have been able to test a range of DTT receivers and we have a reasonably good understanding of the market share of the tested receivers. There are, however, some general uncertainties common to modelling of all types that apply equally to this category.

- **Communal aerial systems.** As noted, we have been able to identify the geographic location of these systems by cross-referencing our modelling with census data. However, there is some uncertainty around the estimates of households that might be affected in this category for several reasons including:

  - greater variability in the set-up and configuration of such systems; and

  - less available information on market share of the amplifiers used in these systems.

- **Domestic installations with amplifiers.** There is least certainty around the estimates of households affected in this category. This is for several reasons including:

  - a wide range of available amplifiers on the market;

  - limited reliable information on actual numbers of amplifiers in use; and

  - little information on the geographic distribution of these amplifiers.

4.44 **In view of this uncertainty, we have generally adopted a worst case approach in our modelling. For example, in modelling standard domestic installations, we have used the worst performance contour of the tested DTT receivers as the basis for our analysis. We expect that the numbers presented are more towards the upper end of the range of estimates. The numbers of households affected in reality may be lower than those presented here.**

Distribution of interference

4.45 The distribution of interference effects across the UK will not be even. Rather, in any given geographic area, it will be influenced by a number of factors including:

- the type and quality of DTT receive installations used by households in the area;

- the channels used to transmit multiplexes in the area;

- the quality of the DTT coverage in the area;

- the frequency used for mobile services in the area; and

- the density and transmit power of mobile base stations in the area.

Type and quality of DTT installations

4.46 The prevalence of interference in any given area will depend, among other things, on the type and quality of DTT installations used by households.

4.47 We have split households into three categories based on the type of TV installation that they have. Our tests have shown that households in the 'communal aerial systems' and 'domestic installations with amplifiers' categories are likely to be more susceptible to interference than households with standard installations. Therefore, areas where there are a greater proportion of these households would, all other things being equal, tend to have a higher proportion of households that experience interference.

Channels used by multiplexes

4.48 Interference is most likely to occur in areas served by channels which are closer (in frequency terms) to the 800 MHz band, i.e. those channels at the top of the band used for DTT. Reception of channel 60 (the highest channel used for DTT, 782-790 MHz) is predicted to be the worst affected, followed by channels 52 to 59, then lower channels. This means that a larger proportion of households in areas which receive their DTT service from one or more of these upper channels are likely to experience interference.

Quality of DTT coverage

4.49 Interference due to SINR degradation is a function of DTT signal strength. This means that households at the edge of DTT coverage would be more susceptible to interference. This would mean that the degradation zone in figure 4.2 would be larger for mobile base stations operating in these areas.

Frequency used for mobile services

4.50 The probability of interference is also affected by the frequency used for mobile services in the local area. In general, mobile base stations transmitting in the lowest frequency block in the 800 MHz band (e.g. block A in figure 2.1) are likely to contribute more interference than base stations operating in higher frequency blocks. This is because there is a smaller frequency separation between this block and channels used for DTT. The worst case interference will be in areas where channel 60 is used for DTT and mobile base stations transmit in the lowest frequency block in the 800 MHz band.

4.51 The extent of the interference effect will depend in part on the aggregate effect of all 800 MHz network deployments in the local area. This effect means that it would be difficult for individual operators to estimate with full precision the interference effect that will result from their planned network deployment in isolation.

Density and transmit power of mobile base stations

4.52 A higher density of mobile base stations (with unchanged powers) is likely to cause more interference to DTT coverage. As mobile base stations are likely to be located in densely populated areas, a higher proportion of households in these areas could be affected.

4.53 The higher the power of a mobile base station, the more likely it is to cause interference to DTT. In our analysis we have modelled all base stations as operating

at 59 dBm. In practice, base stations in a mobile network operate at different powers, but with the majority operating close to the maximum permitted power level.

Modelling results

4.54 In this sub-section we present the interference effect figures produced by our technical modelling in terms of the numbers of households predicted to be affected. We present the following information:

- overall numbers of households affected; and
- interference effects by channel in use for DTT.

Overall numbers of households affected

4.55 In the tables below, we present our estimates derived from our technical modelling of the number of households that could be affected by interference if no mitigating action is taken.

Table 4.2: Estimated number of UK households affected absent any mitigation

	Standard installations	Communal aerial systems	Domestic installations with amplifiers	Total
Total number of households	16,300,000	5,210,000	5,660,000	27,170,000
No. of households affected by interference	110,000	550,000	100,000	760,000

Interference effects by channel used for DTT

4.56 The tables below set out the number of households likely to be effected split by the worst affected channel in use for DTT for each category of household.

Table 4.3: Estimated number of UK households affected in the absence of mitigation

Channel used for DTT	Number of households affected by interference			
	Standard domestic installations	Communal aerial systems	Domestic installations with amplifiers	Total
60	34,000	44,000	12,000	90,000
59	<100	56,000	14,000	70,000
58	5,000	19,000	4,000	28,000
57-51	26,000	27,000	8,000	61,000
≤50	48,000	400,000	64,000	510,000
Total	110,000	550,000	100,000	760,000

Consultation question 1: Do you have any comments on our modelling approach and assessment of numbers of households affected?

Section 5

Assessment of mitigation options

Introduction

5.1 This section presents and assesses the options for dealing with the interference issue described in Section 4. There are a number of measures which we have identified which could potentially be used to either mitigate interference or manage the consequences of interference. Some of these are adjustments to mobile networks. Others are consumer-based measures and involve adjustments to consumers' TV installations. These measures form the basis of our options.

5.2 Drawing on the statutory duties set out in Section 3, we first describe our objectives and high level framework within which we propose to assess options. We go on to identify the available options and evaluate them against some key criteria including how well they deal with the interference issue, how cost effective they are and how much certainty there is about their effectiveness. We then present our initial conclusions on a preferred set of measures.

Framework

5.3 In this section we identify and assess options that could deal with the coexistence issue between new mobile services in the 800 MHz band and existing DTT services in the adjacent band.

5.4 In determining our approach to the future use of the 800 MHz band, we are mindful of the fact that citizens and consumers will benefit from the use of both the 800 MHz band for new mobile services and the adjacent band for DTT. In considering how and whether to resolve the interference issue we therefore seek to maximise the total value that could be achieved through the use of both bands.

5.5 "Total value" in this context means overall value for consumers and citizens derived from the use of both DTT services and new mobile services. Total value from either use reflects a number of key elements, and it is not in general straightforward to express total value purely in monetary terms[29]. The key components of total value are:

- Consumer value. This includes the value we derive as consumers when we engage in markets by using goods or services. This is derived from serving consumer interests in relation to both access to and participation in markets;
- Producer value. This includes value derived by producers where they engage in markets by producing goods or services; and
- Broader social value. This includes the value we derive as citizens from goods or services. This is derived from the provision of and access to goods or services that meet social goals.

[29] For a fuller exposition of the total value framework, see our DDR consultation of 19 December 2006 and our DDR statement of 13 December 2007, at: http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/summary/ddrmain.pdf and http://stakeholders.ofcom.org.uk/consultations/ddr/statement/

5.6 In seeking to maximise total value in this specific context we have taken the following approach. We have assessed a series of "mitigation measures" that could be used to restore access to TV services that might be lost due to interference that occurs between the 800 MHz and adjacent bands. Some of these measures do this by preventing or curing the interference to DTT reception while others deal with the problem by restoring access to TV services through some other means.

5.7 In order to compare options with one another we have considered the total costs of restoring TV services relative to the number of households that have their TV service restored. This allows us to make relative comparison of options. In this assessment "costs" includes not just cash expenditure but also the effects on total value for citizens and consumer using both the 800 MHz and adjacent bands.

5.8 Given the nature of the available evidence we have largely taken a qualitative approach to our assessment. Where the analysis is sufficiently robust and will aid our analysis or can be used to illustrate the potential scale of effects, we have included quantified estimates.

5.9 When we have been able to quantify elements of total value we have generally taken a conservative approach. This means that, where there is uncertainty around any given element and therefore a range of possible values, we have tended to use the upper end of our estimated range in our analysis. This is consistent with our approach to technical modelling as described in Section 4. However, it is still possible that we have underestimated the number of households affected by interference and, if so, the estimated costs of our preferred approach may be higher than we currently anticipate. We believe our estimates of the total costs to be a reasonable estimate based on the information we have available at this time, but there are reasons why they may prove to be higher or lower than anticipated.

5.10 We assess each of the approaches for dealing with interference against the case where we take no regulatory action. We do this in order to establish a common frame of reference so that options can be compared with one another.

Overview of measures for dealing with interference

5.11 In this sub-section we outline the available measures for dealing with interference. There are two broad types of measure.

- **Measures that restore DTT services.** Measures in this category directly fix or repair the interference problem so that consumers continue to receive DTT services.

- **Measures that restore TV services, but do not restore DTT.** Where fixing the interference problem is not possible, or too expensive, it may be preferable to maintain the consumers' access to TV while accepting the loss of the DTT service. This could be done by using an alternative method for receiving TV, such as satellite or cable.

Measures that restore DTT services

5.12 The following is a list of mitigation measures that could be used to restore DTT services. More detailed descriptions can be found in the accompanying technical report[19].

- **Filtering at the DTT receiver ("DTT receiver filtering").** A filter at the DTT receiver could be used to increase the frequency selectivity of the receiver and reduce the level of interference. In installations which include wideband amplifiers, the filter would need to be located between the aerial and the amplifier. The complexity and effectiveness of such filters depends on the highest channel that needs to be received by the DTT receiver (and hence the frequency separation between the DTT and interferer signals). Reducing interference into higher channels is expected to be more challenging. For communal aerial systems, it may be possible and appropriate to use larger and more complex filters which should fix interference even in higher channels.

- **Filtering at the base station transmitter ("Base station transmit filtering").** All mobile base station transmitters use filtering to reduce the level of out-of-block emissions into adjacent bands. Base stations in the 800 MHz band need to use filters in order to comply with the BEMs specified in the Decision. If additional filtering was used we expect there would be less interference into DTT services.

- **Improvements and alterations to DTT equipment.** The quality of DTT receiving equipment could be improved to make DTT installations less susceptible to interference. Examples include the use of DTT aerials with increased directionality, and DTT amplifiers and receivers with better immunity to adjacent channel interference.

- **Re-orientating DTT aerials.** In locations where DTT signals from two or more transmitters can be received, DTT aerials could be re-orientated towards alternative transmitters to decrease the level of interference from mobile base stations.

- **Opposite to DTT polarisation.** Base stations could transmit signals that are polarised in an orthogonal plane to DTT signals. On the basis of our current analysis, we expect that this would make DTT aerials less susceptible to interference. The larger DTT transmitters tends to be horizontally polarised, in which case the mobile base stations would need to transmit with vertical polarisation in order for opposite to DTT polarisation to be an effective mitigation technique.[30]

- **On-channel repeaters (OCRs).** OCRs could be used to amplify and re-broadcast the DTT signal to increase the field strength of the DTT signal relative to the interfering mobile signal. When used in isolation, OCRs would repair SINR degradation but not overload issues. OCRs used in combination with attenuators inserted at the consumers' DTT installation could be used to solve both SINR and overload issues. Where interference effects more than one channel used for DTT, a multi-channel OCR may be required.

- **Base station power reductions.** By reducing the in-block power of mobile base stations, interference to DTT services could be reduced. Depending on the extent of power reduction, this could result in degradations in the mobile service.

5.13 We note that there are other adjustments that could be made to a particular base station which may reduce the level of interference such as adjusting the height of a mobile base station antenna, altering the antenna downtilt, or moving base stations to alternative locations.

[30] Around 10% of UK households are served by DTT transmitters that transmit with vertical polarisation.

5.14 On the basis of available evidence, if the above measures listed above were used they should all act to reduce the number of households that experience interference to their DTT services. Individual mitigation measures on their own are unlikely to restore DTT service to all households and so mitigation measures would probably need to be used in combination with one another in order to be effective.

Measures that restore TV services, but not DTT

5.15 We consider that there are two broad ways of restoring TV services other than by restoring DTT:

- **Satellite and cable services.** These offer a similar range of TV services to DTT;
- **Internet-based or IPTV services** – There are a variety of services that offer TV services over the internet (such as the BBC iPlayer) or using dedicated IPTV bandwidth.

5.16 In the remainder of this document, we refer to the above methods of restoring TV service as "platform changes".

Categorisation of mitigation measures

5.17 Some of the above mitigation measures involve interactions with DTT consumers and we refer to these as "DTT consumer-based mitigation measures". Other mitigation measures involve changes to mobile networks and we refer to these as "network-based mitigation measures. Table 5.1 below shows which mitigation measures fall in each category.

Table 5.1 – Categorisation of mitigation measures

DTT consumer-based mitigation measures	Network-based mitigation measures
DTT receiver filtering	Base station transmit filtering
Improvements and alterations to DTT installations	Opposite to DTT polarisation
Re-orientation of DTT aerials	OCRs[31]
Platform changes	Base station power reductions

5.18 The mitigation measures listed above may also have effects on mobile consumers but the distinction that we draw here is whether a mitigation measure involves interactions with DTT consumers. This distinction is important as DTT consumer based mitigations may involve some degree of interaction between a third party and DTT consumers and we would need to consider that interaction carefully. We discuss this more fully later in this document.

Evaluation of mitigation measures

5.19 In this sub-section we assess the potential effect on total value of using various mitigation measures to try to restore TV services to consumers who are affected by interference. We do this by looking at all the effects associated with each mitigation measure and compare this to the situation where we take no regulatory action.

[31] OCRs in some circumstances may impact on DTT consumers as they may have to make modifications to their DTT systems for the OCR to function correctly (e.g. DTT consumers may require attenuators, or OCRs may affect reception of other DTT multiplexes).

Effects of using mitigation measures

5.20 The broad groups of stakeholders most likely to be affected by the choice of measures are the existing users of spectrum for DTT, and the users of the 800 MHz spectrum.

5.21 The users of spectrum for DTT in this case include both the multiplex licensees and also consumers of the TV services supplied over DTT multiplexes. The users of the 800 MHz spectrum include the new licensees and also the consumers of the services that will be supplied using the band. Any effects on producers may be passed onto end consumers of the downstream markets that the producers operate in.

5.22 As both DTT services and mobile services will be used by wide groups of consumers, we expect there to be a significant crossover between these stakeholder groups.

5.23 The choice of mitigating against DTT interference, providing a platform change, or not undertaking any form of regulatory intervention at all will have effects on different stakeholder groups. In evaluating the mitigation measures we take account of the following factors:

- Technical efficacy
    - We consider the extent to which mitigation measures can resolve the interference or restore TV services in some other manner.
- Direct cash costs
    - These are the actual cash costs of providing mitigation measures.
    - These costs could be incurred by DTT consumers, mobile consumers or new licensees[32].
- Non-cash costs
    - Loss of access to TV services (permanent or temporary).
    - Consumer time and hassle associated with mitigation measures, e.g. in fitting a receiver filter or arranging platform changes.
    - Loss of consumer value associated with lower quality mobile networks.
- Spectrum utility
    - The use of some mitigation measures could affect the utility of spectrum for mobile services by limiting or constraining its current or future use.
    - It is possible that some measures could affect the future use of spectrum for DTT.
- Effect on coverage of DTT or mobile services
    - If interference to DTT services is allowed to occur and is not fixed the coverage of DTT networks may decrease.

[32] We discuss who should bear these later in this document.

- Restrictions on mobile networks may affect the coverage of these networks.

- Effect on competition
  - We consider whether the mitigation measures might have any effect on competition in either mobile or broadcasting markets.

- Certainty
  - We consider the degree of certainty around the technical and economic efficiency of mitigation techniques.

Effect of no regulatory intervention

5.24 In assessing mitigation measures, we consider them relative to a situation where we 'do nothing', i.e. we make no regulatory intervention. In this situation, DTT consumers would have to deal with the interference issues themselves. We consider the effects of making no regulatory intervention below.

5.25 If no additional conditions were applied beyond those set out in the Decision we estimate that up to 760,000 households might be affected by interference. Some householders might be able to take steps to fix the interference themselves, e.g. by self-installing DTT receiver filters, but most are unlikely to have sufficient technical knowledge to do this.[33] It is more likely that they would arrange access to an alternative TV platform even though this may not be the most efficient choice. If all households who experienced interference decided to change platforms, the total cash cost of this could be up to £250 million.

5.26 A large number of households switching to an alternative platform could also have implications for DTT coverage and the DTT platform. Where households use mitigation measures that restore DTT, coverage could be considered to be repaired. Where households do not fix the interference issue and instead switch to an alternative platform, coverage could be considered to be reduced. In addition to households actually affected by interference, unmanaged interference could result in a wider perception that the DTT platform is unreliable and cause more consumers to switch to alternative platforms.

5.27 Even where consumers were able to arrange to restore the DTT service, they would be likely to temporarily lose access to DTT services while the problem is investigated and solved. If there is a low awareness of the potential interference problem because no information is made available, consumers could lose access to DTT services for an extended period of time. These effects could be especially severe for elderly and disabled people who may find it more difficult to take the actions necessary to restore their TV service or take longer to do so.

5.28 If no mitigation measures were used, or consumers through lack of information did not use the most appropriate DTT consumer mitigation measure then some consumers may use an alternative platform, despite it being more appropriate for them to remain on the DTT platform. Fewer consumers would be using the DTT platform, despite it being efficient for them to do so, so spectrum allocated for DTT use might not be used in the most efficient manner.

[33] DTT receiver filters are channel specific; households would need to know which DTT transmitter they were receiving their signals from and what channels were in use.

5.29 On the basis of our current analysis we consider that, while doing nothing may have no direct effects on mobile networks, it will have significant negative effects on DTT consumers as well as on DTT coverage and the DTT platform. We consider that there are likely to be other options for dealing with the interference issue that are more likely to fulfil our policy objective of maximising total value from the 800 MHz and adjacent bands.

Analysis of individual mitigation measures

5.30 In this section we analyse the effects of the mitigation measures we have identified. We first briefly discuss the technical effectiveness of DTT receiver and base station transmit filtering, before considering the technical and economic effects of each of the mitigation measures in turn.

Technical effectiveness of DTT receiver and base station transmit filtering

5.31 The technical effectiveness of DTT receiver filtering and base station transmit filtering is enhanced when they are used together.

5.32 Table 5.2 below shows the number of households potentially affected by interference to DTT, split by the type of installation for the following three scenarios:

- Where neither DTT receiver or base station transmit filtering is used;
- Where DTT receiver filters only are used; and
- Where both DTT receiver and base station transmit filters are used [34]

Table 5.2 – Number of households potentially affected by interference using different combinations of filtering

	No. of households affected by interference			
	Standard domestic installations	Communal aerial systems	Domestic installations with amplifiers	Total
Neither DTT receiver or base station transmit filtering is used	110,000	550,000	100,000	760,000
DTT receiver filters only are used	33,000	5,000	46,000	84,000
Both DTT receiver and base station transmit filters are used	23,000	<1k	7,000	30,000

5.33 On the basis of our current analysis and modelling we estimate that DTT receiver filtering could reduce the number of potentially affected households by around 90%. It is likely to be particularly effective at reducing interference into communal aerial systems as larger DTT receiver filters can be installed. If DTT receiver filtering is used in combination with base station receiver filtering, the number of potentially affected households could reduce by around 95%.

[34] Base station transmit filtering in isolation is unlikely to be particularly effective as the interference is dominated by the relatively poor selectivity of DTT receivers.

DTT receiver filters

5.34 The cost of producing and distributing DTT receiver filters depends upon their size and complexity. On the basis of our current analysis, most domestic systems (including those with amplifiers) could be fixed with a relatively small filter that we estimate would cost around £10.[35] The cost of a filter for a communal aerial system will depend on the channels that are used to receive DTT in the local area. In general the higher the channel used, the more expensive and bulkier the filter will be. Based on quotes from a manufacturer of these filters, unit costs could be between £10 and £750.

5.35 Filters could be purchased and installed either in advance of mobile networks being switched on or only when consumers actually experience interference. We refer to the former as "proactive" installation, and the latter as "reactive" installation. It will be more expensive to install DTT receiver filters proactively as it is not possible to target the households who may be affected by interference very accurately. If DTT receiver filters are only installed after interference has occurred and experienced, then consumers will face disruption to DTT services for the time between when the interference is noticed and when the DTT receiver filter is installed.

5.36 For the purposes of our cost estimates, we have estimated cash costs of filtering on the basis that standard households are sent filters in advance of new network switch-on, whereas households using communal aerial systems or domestic installations with amplifiers have filters installed after interference has occurred.[36] The additional cost of DTT receiver filters being purchased, and in some cases installed, in advance is around £10 million.

5.37 We estimate that 16 households on average share each communal aerial system[37] so that, although 550,000 households could be affected by interference, only around 34,000 filters would be needed.

5.38 The cost of installing DTT receiver filters will vary between the categories of household affected. We have assumed that households with standard domestic installations would in 80% of cases be able to self-install filters as the filters can be installed either near the STB or IDTV. Old or disabled consumers may find this challenging, and some additional support for these consumers may be appropriate.

5.39 The costs of installing a filter in a domestic household where an amplifier is used could be as high as £200 as installation may require access to the roof. The installation costs particular may be lower than this, but we consider £200 to be a reasonable upper estimate.

5.40 The use of DTT receiver filters will have an effect on DTT consumers. Consumers may have to source, and in some cases install, DTT receiver filters. Consumers may

[35] This cost includes the purchase price of filters plus an allowance for distribution costs.

[36] As Punch only works on a 100m * 100m grid, it is not easy to map the 100m * 100m grid onto actual addresses. If DTT receiver filters were purchased and installed in advance (proactively), we have assumed that up to ten DTT receiver filters would be required for every household that Punch predicts to be affected. We have further estimated an additional 1.5 filters for reactively managed households. For domestic installations with amplifiers we have assumed 2.5 filters per household based on average of 2.4 TV sets per household. We note that we have not made any decisions on whether DTT receiver filters would be purchased and installed in advance. We consider this matter further in section 6.

[37] Source: "The impact of LTE on communal aerial systems" http://stakeholders.ofcom.org.uk/consultations/coexistence-with-dtt/ .

also temporarily lose access to DTT services if there is a time gap between interference being experienced and a DTT receiver filter being installed.

5.41 We have estimated the total expenditure needed to purchase and install DTT receiver filters. This is shown in table 5.3 below. These costs are an estimate of the direct cash costs only and do not include an estimate of the non-cash costs that occur as a result of filtering.[38] The costs we have estimated tend towards the upper end of the range and could be reduced if filters were sent out after network activation or if installation of filters was simpler than we currently anticipate.

Table 5.3 – Cash costs of DTT receiver filtering[39]

	Standard domestic installations	Communal aerial systems	Domestic installations with amplifiers	Total
Number of households[40] estimated to need DTT receiver filtering (see footnotes)	1,140,000[41]	550,000[42]	100,000[43]	1,790,000
Total number of DTT receiver filters required (see footnotes)	1,310,000[44]	34,000[45]	250,000[46]	1,600,000
Purchase cost of DTT receiver filters	£13 million	£4 million	£3 million	£20 million
Installation cost of DTT receiver filters	£5 million	£9 million	£20 million	£33 million

5.42 Some DTT receiver filters will prevent use of the upper part of the spectrum reserved for DTT, in particularly channels 59 and 60. This could limit the ability of operators to use this spectrum as some consumers may no longer be able to receive them. This could have an effect on the usability of interleaved spectrum for new DTT services.

5.43 There are some uncertainties in relation to the cost of DTT receiver filtering but it would appear proportionate relative to using other mitigation measures, even when our upper estimates of costs are used.

5.44 We provisionally conclude that DTT receiver filtering is likely to be efficient in terms of the cost per household of mitigating interference and that it will be one of the mitigation measures used in dealing with DTT interference.

[38] These costs could be funded from a number of sources, and we do not assume at this stage what level of consumer support would be appropriate. We consider this later in this document.
[39] Results may not add up due to rounding.
[40] Note households used here as proxy for calculating costs – not necessarily reflects actual households affected.
[41] Based on assumption that 10 filters needed on average for every household predicted to be affected.
[42] Direct from modelling see Table 5.2
[43] Direct from modelling see Table 5.2
[44] Based on additional 1.5 filters per household needed to be installed reactively after interference occurs.
[45] See para 5.37
[46] Based on estimating 2.5 filters needed per household

Base station transmit filtering

5.45 Our technical modelling indicates that additional base station transmit filtering on its own is not particularly effective in reducing the number of potentially affected households. When used in combination with DTT receiver filtering however its effectiveness is enhanced. We note that it is particularly effective when used in combination with DTT filtering in areas which use either channel 59 or 60 for DTT[47]. We also note that it could be particularly helpful in reducing the potential effect on systems that use amplifiers such as communal aerial systems or domestic installation with amplifiers.

5.46 We estimate that the incremental cost of higher quality filters (over and above those needed to comply with the out-of-block emission limits set by the Decision) is around £40-£70 per antenna, or £240-£420 per base station.[48] Across all of the UK, we estimate that enhanced base station filtering might cost up to around £11 million, based on three networks each having their own set of higher quality filters.

5.47 Other than the additional cost in purchasing these filters, we do not expect that there would be any other notable effects on any group of stakeholders.

5.48 We initially conclude that base station transmit filtering is a technically effective solution that is relatively low cost in terms of cost per household mitigated. We expect that this form of mitigation should be applied in most cases. We note that base station transmit filtering is particularly effective when used in combination with DTT filtering, and in areas which use either channel 59 or 60 for DTT.

Improvements or adjustments to DTT equipment

5.49 Our current technical analysis of the interference issue is based on a set of generally worst case assumptions about how susceptible DTT equipment is to interference and the quality of DTT installations. If households which currently use equipment that is either poorly installed or intrinsically more susceptible to interference were to upgrade their equipment, this could resolve interference issues in some cases. There are a large number of variables that could be considered here and it has not been practical to explicitly model this measure in our technical modelling work.

5.50 The cost of improving these installations will depend on the modifications needed to improve the DTT installation up to the planning level. The susceptibility to interference of DTT equipment such as STBs or IDTVs is not necessarily related to their purchase price. A new STB could cost as little as £15 and may be less susceptible to interference. However, it would probably require the visit of a qualified professional to identify the most appropriate system improvement method and this would involve extra cost that we estimate could be up to £200. Consumers may also face service disruption and other non-cash costs during this process, especially if they are responsible for managing the process themselves.

5.51 The cost for each household will depend on the specific installations and will be difficult to predict in advance.

5.52 We initially conclude that given the efficacy of DTT receiver and base station transmit filtering, improvements to DTT installations would not be needed in a significant

[47] Modelling results showing the effectiveness of base station filtering paired with DTT receiver filtering by channel are presented in the accompanying technical report[19].
[48] Assuming a tri-sectored base station deploying 2 antennas per sector.

number of cases. The efficiency of this would have to be dealt with on a case by case basis, given the uncertainty. We have therefore not included it in our core proposals.

Re-orientation of DTT aerials

5.53 We estimate that up to 20% of households can receive an acceptable DTT signal from two or more transmitters, although there is some uncertainty in this figure and further analysis could refine this figure and to see how it aligns with where DTT interference will occur. We estimate that re-orientating the DTT aerial could cost around £50-£100.

5.54 While re-orientation of aerials could be used to restore DTT services to a household, it could in some cases result in consumers no longer receiving their preferred regional or national TV variants of ITV 1, BBC One, BBC Two, or Channel 4.[49]

5.55 The efficacy of this measure will be particular to the local geography and cannot be guaranteed. Re-orientation of DTT aerials is likely to be more expensive than DTT filtering, but may be a useful element in reducing the number of households that experience interference.

5.56 We provisionally conclude that aerial re-orientation may in some cases be a proportionate response to dealing with DTT interference, but there is some uncertainty about where it will be effective. For example it could potentially be used in a limited number of cases where DTT filtering has proven ineffective.

OCRs

5.57 The technical efficacy of OCRs is uncertain. In our field trial, we tested single channel OCRs and these were shown to work. However, we have not tested multi-channel OCRs and these may be needed in areas where SINR degradation affects more than one channel used for DTT. As noted, to fix overload, OCRs would need to be used in combination with attenuators inserted at the consumers' TV installation and this could be difficult to manage. We have also not tested how a network of OCRs might work. We note that as OCRs would operate in the band used for DTT we would need to consider how best to license their operation.

5.58 The cost of OCRs is uncertain as they are not currently in commercial use. Cost estimates from one manufacturer suggest that they may cost between £10,000 and £15,000, but we have received other quotes that are significantly higher than this. We expect that these costs could decrease over time, particularly if OCRs were used extensively in mobile networks.

5.59 The technical and economic effectiveness of OCRs will depend on the local geography of mobile base stations and the extent to which they might be used is uncertain. We consider that it would be more appropriate for new licensees to be incentivised to make use of them where they are more efficient than consumer-based forms of mitigation. We consider how this could be done in Section 6.

5.60 We provisionally conclude that due to the uncertainties surrounding their use, OCRs will not form a key part of the proposed mitigation measures, but that they may be useful on a case by case basis.

[49] There are some regional variations of ITV 1 and Channel 4 that affect only TV advertising, rather than editorial content.

Opposite to DTT polarisation

5.61 The use of opposite to DTT polarisation can reduce the level of interference into DTT. In practice, this can only be achieved in areas where horizontal DTT polarisation is used by installing vertically polarised mobile antennas.[50] On the basis of our modelling, we expect that the use of opposite to DTT polarisation could reduce the level of interference into DTT systems by a factor of three or four. These results are based on a theoretical model and have not been tested in real life scenarios. It is possible that the benefit of opposite to DTT polarisation is reduced in urban or suburban areas.[51]

5.62 The use of opposite to DTT polarisation may mean that operators have to install additional antennas at base stations. Existing network operators have also informed us it may be difficult to use multi-band antennas (those that operate across more than one mobile band) that require the use of opposite to DTT polarisation.

5.63 These factors could limit the ability of operators to make use of MIMO (multiple-in-multiple out) techniques that enhance the speed of mobile services. If the usability of MIMO techniques were limited then this could reduce the quality of networks that use 800 MHz spectrum. This reduction in network quality could affect consumers of mobile services if the reduction in quality were material enough. If these limitations were widespread this could affect the ability of operators to compete with operators with access to unconstrained sub-1 GHz spectrum. We would welcome views on the extent to which the use of opposite to DTT polarisation could affect the ability of operators to use MIMO techniques.

5.64 Opposite to DTT polarisation can reduce the impact on DTT interference but at the cost of installing additional antennas and limiting the capabilities of mobile networks. Whether this trade-off is efficient will depend on the particular circumstances of a given base station such as location, antenna height, power and whether it is large enough to support spatially separated antennas. We think new licensees would be better placed than us to make this decision, although we note the uncertainty of the effectiveness of this technique.

5.65 We initially conclude that given the uncertainty in the effects associated with opposite to DTT polarisation, opposite to DTT polarisation will not be a core mitigation measure, but it may be useful in certain circumstances.

Base station power reductions

5.66 By reducing the in-band power of base stations, it would be possible to reduce the number of households that experience interference. If the transmit power of mobile base stations were reduced to a low enough level, it would in theory be possible to eliminate all interference into DTT. However, in order to achieve this it may be necessary to reduce the power of base stations so significantly as to affect the quality of the mobile network.

5.67 Mobile operators use a range of base station powers depending on various factors but generally tend to transmit close to their licensed powers. Reducing the permitted in-band power of base stations would generally decrease the potential speeds that

[50] In areas where DTT transmissions are vertically polarised, mobile transmissions would have to be horizontally polarised and we are not aware of any mobile networks that use horizontal polarisation.
[51] Mobile signals are more likely to be scattered in urban or suburban areas.

consumers would experience across mobile networks and could also have an effect on network coverage.

5.68 Mobile operators could choose to compensate for their loss in coverage by increasing the density of their networks. If this required operators to build new sites, this would be significantly more expensive than if operators were able to reuse existing base stations.

5.69 As discussed in the combined-award consultation, sub-1 GHz spectrum enables operators to provide additional coverage beyond that which could be easily achieved using alternative higher frequency spectrum. If the restrictions on 800 MHz were extensive enough that they had a material effect on mobile broadband coverage, this could affect the ability of operators who have 800 MHz spectrum but no other sub-1 GHz spectrum to compete with operators who have unrestricted sub-1 GHz spectrum. Power reductions could directly affect mobile consumers if the network quality that operators would otherwise have offered is decreased.

5.70 We provisionally conclude that extensive power restrictions could limit operators' ability to make efficient use of 800 MHz spectrum and could ultimately decrease the quality of mobile networks that consumers may experience. It could also have a negative effect competition in mobile markets. We do not consider that extensive use of power restrictions would be a proportionate response to the DTT interference issue.

Platform changes

5.71 There are a number of alternative methods of restoring TV services that do not use DTT. We first discuss the extent to which these alternatives provide a TV service that is reasonably equivalent to that provided by DTT.

5.72 We consider that both free satellite services and the entry level cable subscription services would offer a range of TV channels and services that is at least as extensive as DTT. There are some TV channels and services that are available on these alternative platforms but not on DTT. We have not considered the extent to which consumers may find alternative platforms to be preferable to DTT in our analysis.

5.73 IPTV services typically have dedicated bandwidth to ensure that picture quality and reliability are as good as the traditional platforms of DTT, satellite and cable.[52] However, most currently available IPTV services in the UK do not provide access to real-time broadcast TV channels such as BBC One or ITV 1, but offer a selection of "catch-up" TV services or access to additional services such as sports and films.[53] While these additional services are valuable to consumers, we do not consider that they replicate access to real-time TV services, but act as a complement to these services. We are not currently aware of any operators actively marketing an IPTV service that includes access to real-time broadcast channels although we note that this may change in the future. At this point in time, therefore, we do not consider that there is sufficient evidence to support the conclusion that IPTV services will be a valid substitute for real-time TV services after DSO.

[52] The ability to offer IPTV services is therefore affected by the ability to obtain the necessary bandwidth to support services.
[53] BT Vision offers traditional real time services using DTT, but offers additional subscriptions using IPTV.

5.74 Other TV services are currently available over the internet such as the BBC iPlayer[54] and ITV Player. These currently offer lower viewing quality than that available on DTT, satellite or cable platforms and we do not consider that they can be considered as a reasonable substitute to the three main platforms.

5.75 We note that both internet based and IPTV services are evolving, but we do not consider that we can conclude with sufficient certainty that they will provide a reasonable substitute to DTT by the time mobile networks are rolled out.

5.76 We therefore only include free satellite services and entry level cable subscriptions in our assessment of platform changes.[55]

5.77 The cash cost of providing an alternative platform consists of the cost of installing the system, acquiring the necessary equipment to use the service and in the case of a cable subscription, any ongoing charge.[56] The cash cost of a platform change depends on the number of TVs that the alternative platform is supplied to. We list our assumptions relating to platform changes in table 5.4 below.

Table 5.4 – Current estimated prices for the installation and ongoing charges of alternative platforms

	Installation and initial equipment charges	Monthly charges
Freesat costs[57]		
To one TV	£165	-
To two TVs	£285	-
To three TVs	£405	-
Entry level cable service[58]		
To one TV	£40	£20
To two TVs	£90	£26
To three TVs	£140	£33

5.78 DTT households may have DTT specific equipment such as PVRs (or video recorders) that they may wish to replace if they move to an alternative platform. Freesat+ boxes can cost up to £200-£300.[59]

5.79 Some platform changes may require the ongoing costs associated with a cable subscription where Freesat is not available. The cost of the platform change will also depend on how many TVs are connected to the service. The number of TVs connected to the service will depend partly on whether consumers already have access to an alternative platform on some or all of their TVs. Where DTT is the primary form of reception we expect that a household could require up to 2 or 3 TVs to be connected. Where satellite or cable is available on a main set, but not on secondary sets, in most cases either 1 or 2 TVs would need to be connected.

[54] Virgin customers can also use the BBC iPlayer via their STB.
[55] Pay TV services are available from Sky, but we do not consider them in our analysis. Entry level Sky subscriptions offer a more extensive range of TV channels than either Freesat or DTT but at a monthly fee. For the purposes of this analysis we do not think that DTT and pay satellite services are directly comparable.
[56] In estimating the cash costs of platform changes we have used retail prices wherever possible, rather than an estimate of the resource costs in supplying a service.
[57] Estimate of installation costs and purchase of boxes based on retailers prices.
[58] Estimate based on Virgin Media's prices.
[59] Source: Freesat.

5.80 Taking the above into account the average cost of a platform change is expected to be around £350 per household[60]. This figure is increased by the case where free satellite services are not available and a higher cost cable subscription is required.

5.81 We estimate that up to 30,000 platform changes may be necessary where DTT receiver and base station transmit filtering do not resolve the interference issues. On this basis we estimate that the total cost of platform changes could be up to £10 million although we note that this depends on the level of consumer support provided. Restoring TV services with an alternative platform will have an effect on coverage but this is discussed later in this document.

5.82 Consumers may experience loss of TV services while a platform change is being organised. Although the channel line-up of DTT, Freesat and cable are different, there is sufficient overlap for us to consider them broadly equivalent. Some consumers may intrinsically prefer DTT to alternative platforms or place high value on the services available on DTT, but we consider that on average consumers should be in a broadly equivalent position if DTT services are replaced with an alternative platform.

5.83 The reduction in DTT coverage associated with platform changes may have an effect on broadcasters and DTT multiplex operators. Broadcasters who use the DTT platform may experience a reduction in advertising revenues as viewing to channels on DTT may decrease slightly. We do not consider that this would be a particularly material effect as the number of households moving platform is a relatively small percentage of the UK population. There is a possibility that if the attractiveness of the DTT platform were degraded then broadcasters would be less willing to transmit on the DTT platform. We consider that this would only have a material economic effect if this meant that "DTT slots" on multiplexes were left unfilled. Given that there is limited capacity on the DTT platform, we do not consider that this is particularly likely.

5.84 Platform changes are likely to be able to restore some form of TV service in most cases, although there are circumstances in which a platform change will not be possible. We consider this in more detail below.

5.85 We initially conclude that platform changes are likely to be a cost effective way of restoring TV services, where filtering and other forms of DTT adaptations fail to restore DTT reception.

Other bespoke mitigation measures

5.86 Where an alternative platform is not available and the approaches to restoring DTT services listed above are either disproportionate or impractical, other bespoke solutions may be appropriate. Some of these will seek to restore DTT coverage, while some will seek to restore TV services using another method.

5.87 Ability to obtain access to an alternative platform is affected by:

- Terrain (hills can obscure satellite signals);
- Obstacles (high buildings, or trees can obscure satellite signals);

[60] This is the estimate of the economic cost of the providing the platform change. The extent to which consumers may contribute towards a proportion of this should not affect the size of this economic cost.

- Planning regulations; and
- Access to the cable network (the cable network covers only 50% of the UK population, primarily in urban and suburban areas).

5.88 We have previously estimated that 94-98%[61] of households are able to receive a reasonable satellite signal. However, since 2004 when we considered this in the context of the digital replacement licences, planning regulations have been relaxed in England and Wales so these are less likely to constrain households ability to install a satellite dish than previously estimated. In order to be conservative we have used 94% as our estimate of the availability of satellite for the purposes of this consultation.

5.89 Even though we can obtain a reasonable estimate of how many households could only use DTT as a means of accessing linear TV services, the exact locations of these households is unknown. We have used the upper estimate that 6% of the UK cannot obtain access to satellite, with 50% of these households being able to access the cable network. We have therefore used 3% as an upper estimate of the proportion of the UK where no alternative platform is available, although we note that there is significant uncertainty surrounding this figure.

5.90 Some of the potential approaches to restoring TV services or preventing interference to households are listed below:

- Installing additional DTT relays;
- Installing "self-help" relays (traditionally used to serve small isolated communities);
- Fibre access to households; and
- Other restrictions placed on mobile networks such as:
  - A requirement to pre-notify base station rollout in these areas; and
  - A requirement to re-site base stations if households experience undue interference.

5.91 There is always the potential that there could be a large number of interference issues near a particular base station. In areas where no alternative platforms are available, the effect on consumer value due to losing access to TV services could be quite high. It may therefore be reasonable to place additional restrictions on new licensees where there are known areas where alternative platforms cannot be received. The exact form of these restrictions is still to be determined, but it could be reasonable to ensure that new licensees have base stations in or near these areas "pre-approved" by an appropriate body, or for an appropriate body to be able to ensure a base station can be re-sited or other restrictions placed on it.

5.92 Where the above restrictions would not be proportionate, for example where a base station could not be easily moved or was serving a large number of consumers, it may be appropriate to consider some of the other mitigation measures listed above.

[61] http://stakeholders.ofcom.org.uk/binaries/consultations/drl/summary/drl.pdf

5.93 Whether any of these mitigation measures are proportionate in that they would maximise the total value from the 800 MHz and adjacent bands will depend on the specific circumstances of a base station. We consider that it would be appropriate to consider these on a case by case basis.

5.94 We initially conclude that bespoke measures may be appropriate, but the extent and the nature of these will need to be considered further.

Effect of choice of mitigation measures on DTT coverage

5.95 In assessing the effect on DTT coverage of the choice of mitigation measures, it is best to assess the effect when all suitable mitigation measures have been applied, rather than assessing the isolated effect on coverage of any one mitigation measure.

5.96 The estimation of the level of DTT coverage to be achieved at the end of DSO is based on the UKPM. This model makes an assumption that every household uses a "planning standard" quality installation.[62] This standard assumes that communal aerial systems and domestic installations that use amplifiers meet the same requirement as a standard installation. Our limited technical analysis suggests that many communal aerial systems and domestic installation with amplifiers do not meet the planning standard. We note however, that households who use a system that does not meet the planning standard but who are still able to receive a usable service after DSO may expect that this would continue in the future. They would not anticipate that mobile interference would affect their reception of DTT services. We therefore consider the effect on DTT coverage in two ways:

- Based on the UKPM planning standard; and
- Based on our expectations of the installed base of communal aerial systems and domestic installations using amplifiers.

5.97 When considering the effect on DTT coverage we also need to consider the split between PSB and COM multiplexes. In estimating PSB coverage and COM coverage, the UKPM uses a particular modelling methodology. In assessing the effect of mobile interference into DTT, we have used a slightly different methodology that is appropriate for the purposes of estimating the number of households that may be affected by interference but is not directly comparable with the approach taken in the UKPM.

5.98 All of the mitigation methods we have discussed, with the exception of platform changes, contribute to restoring DTT coverage. Platform changes while returning TV services to the consumer, do not restore the option to receive DTT services. Therefore the households left over after other mitigations are the ones to focus on. We showed earlier that after just using filters we estimate around 30,000 households (around 0.1% of total households) could still lose one or more multiplexes. Further mitigation measures could reduce this number further.

5.99 Based on this and the considerations noted above we initially conclude that the mitigation options are capable of minimising the effect on DTT coverage to the extent that it is unlikely to result in the overall targets for PSB and COM multiplexes failing to be met after DSO has concluded. However, this will be dictated to a degree by the approach to mitigation the implementation body adopts and decisions it takes on

[62] The assumptions that relate to the planning standards are noted in paragraph 4.40.

which options deliver the best value for money alongside the need to deliver other aims.

Summary of analysis of mitigation measures

5.100 Table 5.5 overleaf provides a summary of the analysis considered in this section.

Table 5.5 – Summary of mitigation measures, including no regulatory intervention

Mitigation measure	Direct costs	Non-cash costs	Spectrum utility	Effect on coverage of DTT or mobile	Effect on competition	Technical efficacy	Certainty	Overall
No regulatory intervention	Up to £250 million if consumers exclusively relied on platform changes	Disruption and loss of services could be potentially very widespread.	Mobile access to spectrum is unrestricted. Widespread switching to alternative platforms could limit the efficient use of spectrum for DTT.	Could reduce DTT coverage by up to 3%.	If the effect on the DTT platform were severe enough it could effect on the ability of DTT to compete effectively with other platforms.	Consumers would have to choose the most appropriate method of dealing with the interference issue.	Given the lack of consumer information it is not clear exactly how consumers would respond.	Unlikely to fulfil our statutory duties given that effective alternatives exist, so intervention is necessary.
DTT filters	Relatively low purchase costs but installation costs could be up to £200 for some households.	Some temporary loss of DTT and some inconvenience associated with installation.	Could reduce the usability of higher channels for new DTT services.	Should help restore DTT coverage.	Little or no effect.	Can cure up to 90-95% of interference issues.	Number of filters required is uncertain, but still likely to be cost effective in most situations.	Likely to be a key part of proposals.
Base station filtering	Low, just over £400 per base station.	Little direct effect on consumers.	Little or no effect	Improves DTT coverage	Little or no effect.	Fairly effective in the presence of DTT receiver filtering.	Reasonable degree of certainty in how effective mitigation measure is.	Likely to be a key part of proposals.
Improvements and alterations to DTT systems	Could be up to £150 per household, depending on complexity of installation.	Some temporary loss of DTT and some inconvenience associated with installation.	No direct effect.	Should help restore DTT coverage, although removal of amplifiers may mean that only a single TV per household can be served.	Little or no effect.	Effective in restoring DTT service but only necessary in a limited number of cases.	Efficacy of mitigation is uncertain as depends on specific deployment of DTT equipment.	Uncertain whether this is efficient, may be used on a limited basis.

Mitigation measure	Direct costs	Non-cash costs	Spectrum utility	Effect on coverage of DTT or mobile	Effect on competition	Technical efficacy	Certainty	Overall
Re-orientation of DTT aerials	Around £50-100 per household.	Temporary loss of DTT likely, plus some households will switch TV region.	No direct effect.	Notionally households may move out of coverage, but by re-orientating aerials, households are able to receive a DTT service.	Little or no effect.	Could potentially cure up to 20% of residual cases.	Technically, re-orientation of aerials will work, but we are uncertain as to exactly where.	Uncertain whether this is efficient, may be used on a limited basis.
Cross polarisation	Purchase cost of additional antennas may be relatively low but additional installation and other infrastructure costs could arise	Would affect mobile consumers if network quality was reduced.	Could reduce the ability to make full use of spectrum efficiency techniques in the 800 MHz band, reducing network quality.	Improves DTT coverage, but could affect mobile coverage if MIMO cannot be used.	Depending on the extent of limitations to use of MIMO could affect operators' ability to compete with operators using other spectrum bands.	Can be very effective in certain mobile blocks and DTT transmitter locations.	Technical efficacy likely to depend on local geography.	Uncertain whether this is efficient, may be used on a limited basis.
Base station power reductions	Low, unless operators were to build additional sites to restore coverage.	Potentially a high impact on mobile consumers through reduced network quality.	Has the potential to severely limit the spectrum utility of the 800 MHz band.	Could completely restore DTT coverage, but this could limit mobile coverage.	Has the potential to harm competition in mobile markets.	Has the potential to cure all interference cases.	Efficacy likely to depend on specifics of each base station and would need to be assessed on a case by case basis.	Very unlikely to be efficient to do this.
Platform changes	On average, up to £350 per household as some may require more expensive cable subscriptions.	Some temporary loss of TV service and inconvenience associated with service.	Little or no effect.	Has negative effect on DTT coverage.	Little or no effect.	Can be used in up to 99% of cases.	Should work in the majority of cases, but the situations in which they are not possible will depend on the local geography.	Likely to form part of our core proposals.

Illustration of effects after mitigation measures in place

5.101 Although there is some uncertainty around the costs of our proposed mitigation measures, we consider that it is useful to provide an illustration of the possible costs of implementing our preferred mitigation measures. We have tended towards the pessimistic side and these costs should be interpreted as towards the upper end of our expected range rather than a "best estimate".

5.102 The purpose of this illustration is to illustrate the potential economic costs of the proposed mitigation measures. We have not made a particular decision on whether consumers should bear any of these costs.

5.103 We do not currently include any costs of making alterations and improvements to DTT installations. This may be a useful technique, but further work is required to understand where this would be efficient. We also do not include any cost estimates for network based mitigation, as we are unsure as to how extensive any implementation of this will be. If network based mitigation were to be used, we would expect this to be the case only when it is more efficient than other mitigation techniques.

5.104 The estimates of costs are based on:

- A form of scheme needed to implement the consumer based mitigation;
- DTT receiver filtering;
- Enhanced base station transmit filtering;
- Platform changes where the above do not work; and

5.105 Table 5.6 below outlines our estimate of the number of households affected by interference after each of our proposed mitigation approaches has been used.

Table 5.6[63] – Estimate of number of UK households potentially affected when mitigation measures are in place

-	Number of households
With no mitigation	760,000
After DTT receiver and base station filtering	30,000
Number of households offered a platform change	29,000
Bespoke methods to restore TV	<1,000

5.106 Table 5.7 below outlines our current estimate of the total costs of implementing the preferred mitigation measures[64].

[63] Figures may not add up due to rounding.
[64] All cost estimates are based on 2011 prices and have not been adjusted for future expected inflation.

Table 5.7 – Estimated cost of implementing our preferred mitigation measures to illustrate potential economic costs. (Note: no decision has been made on whether consumers should bear any of these costs.)

	Total cost
Set up of implementation body	£25 million
Base station filtering	£11 million
DTT receiver filtering - purchase of filters	£20 million
DTT receiver filtering – installation	£33 million
Platform changes	£10 million
Total	£100 million

5.107 As can be seen from the above tables, after DTT receiver and base station transmit filtering have been used up to 30,000 households may experience interference to DTT systems. Of these 30,000 households most will need a platform change in order to continue to receive digital TV. We expect that a significant majority of households will be able to obtain access to either satellite or cable services, but a limited number (probably less than 1,000 households) may need to have TV services restored in a bespoke manner.

Conclusions

5.108 Based on our knowledge of the problem so far, we initially conclude that:

- DTT receiver filtering and base station transmit filtering will form a core part of our preferred mitigation options;
- A platform change or adjustments to DTT equipment could fix most of the remaining problems but platform changes could affect the PSB and COM coverage levels;
- A limited number of households may experience loss of some or all of their DTT services and it may not be possible to restore them with an alternative platform; and
- Some additional mitigation options may be preferable in some cases, but this will depend on the specifics of where the base station is located and the local geography and we will not know this in advance of the auction of the 800 MHz band. In these cases rather than mandate mitigation techniques at this time, we think it would be more appropriate to use some form of incentive mechanism to ensure new licensees undertake network based mitigation where it is efficient to do so.

Consultation question 2: Do you agree with our high level conclusions on mitigation options?

Section 6

Implementation

Introduction

6.1 This section discusses how we might implement the use of the mitigation measures discussed in the previous section. We think there are four main areas that will need consideration:

- Consumer support – how and to what extent should consumers be supported in resolving interference issues;
- Delivery mechanism – what arrangements might best deliver the mitigation measures;
- Funding – who should bear the costs of mitigation; and
- Licence conditions – what licence conditions, if any, should be placed on new licensees in the 800 MHz band to support the chosen implementation strategy?

6.2 We note that these areas have some interdependencies. For example, the extent of consumer support has implications for who pays. If full support is not provided, consumers will by default have to bear some of the costs. However, we have found it useful to consider each item separately to assist our analysis and cross-refer to different areas where appropriate.

Consumer support

6.3 Some of the mitigation measures that we have identified will require action by, or interaction with, consumers of DTT services. Hereafter we refer to these mitigation measures generically as consumer-based mitigation:

- DTT receiver filters;
- Platform changes;
- Re-orientating DTT aerials and improvements; and
- Adjustments to the DTT installation.

6.4 We also noted that other mitigation measures would require action by the new licensees and hereafter we refer to these as network based mitigation, including:

- Base station transmit filtering;
- Use of OCRs;
- Opposite to DTT polarisation; and
- Density and location of base station sites.

6.5 In the previous section we proposed that DTT receiver filters should be a core part of the solution and that other measures could be used where filters do not work. There is clearly a minimum level of consumer support implied in this proposal. Providing no consumer support would equate to doing nothing.

6.6 There is a range of possible levels of consumer support that could be offered over and above doing nothing. At one end of the range, consumers could simply be provided with information and be expected to arrange and obtain viewer-based mitigation themselves. At the other extreme, consumers could be provided with full support such that every single household was assisted on an unlimited basis including the provision of information, consumer-based mitigation and installation assistance.

6.7 While it might be desirable for all consumers to be assisted as much as possible, providing a high level of support might be inefficient and could impose extra costs on the party responsible for funding the provision of consumer support. We therefore need to bear in mind our duty to have regard to the principle of proportionality. For example, in providing small DTT receiver filters, the cheapest solution would be to mail the filter to the householder. A more expensive solution would be to send an installer to every affected household to install the filter on behalf of the householder. If the householder could in most cases fit the filter fairly easily themselves, it would probably be disproportionate to choose the more expensive solution.

6.8 In any consumer support solution, we consider that information and advice should be provided to consumers. This is likely to, at a minimum, require the provision of a telephone call centre and a dedicated website. The main requirements for information would occur in advance of any interference (i.e. before new networks were activated), so that consumers were aware of the issue and knew what action to take. There would still be a need, albeit reduced, after interference has occurred, to provide advice and support.

6.9 We note that the uncertainty around the modelling results and the distribution of interference means that it will be difficult to predict exactly which households will be affected in advance. Interference could potentially occur for any household in any area. This indicates that information needs to be provided to all households who are in the area of new network roll-out. We also note that new mobile network roll-out may take place in an organic way and over an extended period of time. Therefore a single UK-wide communications campaign at a given point in time is unlikely to be sufficient. Rather, targeted information campaigns are likely to be required in advance of network roll-out in any given area. Additionally, as several operators may be involved, it will be important for these campaigns to take place in a coordinated way. Our discussion on delivery mechanisms notes the need for this to be reflected in any delivery mechanism design.

6.10 In addition to information, there are two main areas where consumer support might be offered:

- First, in the provision of DTT receiver filters. This could include both distributing and installing the filters; and

- Second, where DTT receiver filters do not work, arranging for and providing alternative viewer-based mitigation, e.g. platform changes, re-pointing receive antennas, etc.

6.11 Across these areas, there are a number of questions relevant to the level of consumer support that is provided.

- **Quality of DTT installations** – should support be provided to everybody or only to those whose DTT installation meets certain standards?

  - DTT planning is based on an assumption that all TV installations are of a certain standard. In practice, many household installations do not reach this standard but are still currently able to receive a DTT service. For example, many thousands of households rely on indoor or set-top aerials rather than a roof-top aerial. Once new mobile networks switch on, households with poorer quality installations may experience interference issues that would otherwise be avoided if their installation reached the standard quality assumed in planning. It could be argued that these types of household should be responsible for fixing the problem themselves. However, this may be difficult to implement in practice as it would require a qualified person to visit and check the householder's installation and make a decision on whether the householder's installation meets the required standard. This might only be proportionate if a visit was already planned, e.g., to provide support where the installation of a cheap filter has not resolved the interference issue.

- **Number of multiplexes lost**– should support be provided to everybody or just to those who have lost only PSB multiplexes?

  - As explained in section 4, interference could result in households losing reception of one or more multiplexes. In some cases, households may lose one or more COM multiplexes but retain reception of everything else. It may be considered proportionate to provide a cheap filter to such a household. However, it may be less proportionate to provide further support, e.g. installation assistance or a platform change, in these circumstances.

- **What TV services, equipment and platforms the householder already uses** – should support to households be different according to whether a household uses an alternative platform on its primary set and/or whether it relies on DTT on any other TV sets?

  - A household's use of TVs, equipment and platforms can vary widely. A household choosing to use only DTT for example might access this on their primary and other TV sets. A household using satellite or cable TV services might use this platform on its primary TV set but view DTT services on other TV sets it may have. Other combinations are possible, including use of equipment or services that enable a platform to be viewed on secondary TV sets. A further issue concerns use of Standard Definition (SD) and High Definition (HD) reception equipment; for example if a DTT viewer has an HD receiver but interference causes loss only of SD services, should provision of any alternative platform be limited to SD services? The question arises of what support should be provided in which circumstances.

- **Proactive or reactive help** – should householders be provided with mitigation in advance of interference occurring or after?

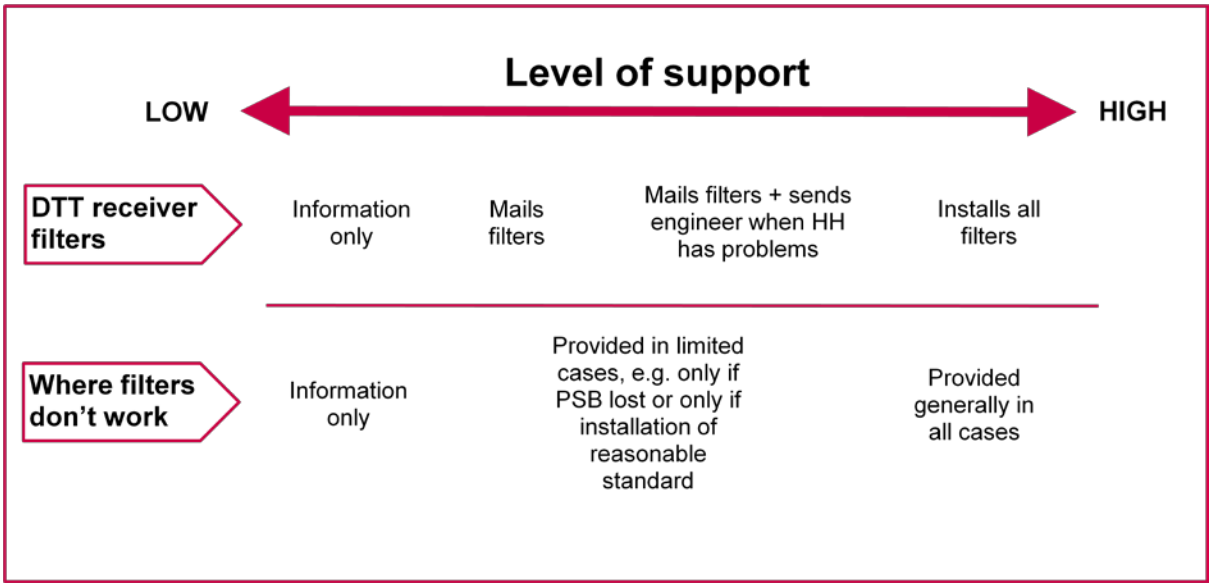
  - Filters could either be provided in advance of interference occurring (proactively) or after interference has occurred (reactively). The benefit of providing filters proactively is that households would suffer less disruption. Filters provided reactively may take some time to arrive and be fitted and the

household may be without a TV service for this period of time. One drawback of the proactive approach is that more households receive a filter than need one. This is because it is difficult to identify in advance which households will require a filter. This is likely to significantly increase the costs of the exercise.

- **How able the householder is to fix the problem** – should the same level of support be provided to everybody?
  - While many householders may have minimal problems installing DTT receiver filters behind their TV, some householders, e.g. those with disabilities, may find this more difficult. It may be appropriate to provide an enhanced level of support for these households. It may also be the case that fitting a filter to a flat panel screen mounted close to a wall requires expensive additional work. Should this be covered?
- **Timescale –** over what period of time should support be offered?
  - New mobile networks will take time to roll out and could continue to introduce interference effects over this time period. This raises the question of the period over which support should be available for consumers.

6.12 In figure 6.1 below, we illustrate at a high level the range of consumer support that could be offered:

Figure 6.1 – Illustrative range of possible consumer support



6.13 The way in which the interference to DTT viewers is managed will also depend on the type of DTT installation in use and the way in which TV reception equipment is configured. It is helpful to recall the different types of DTT installation that may be affected and the actions that could be needed for each:

- **Standard domestic installations** - For these households, a small DTT receiver filter inserted between the TV and the wall-plate should fix most problems. Different types of filter may be needed depending on which is the highest channel used for DTT in that area. Installation of these filters should be relatively simple in most cases and could potentially be carried out by consumers;

- **Communal aerial systems** - For these households, a filter will need to be inserted before the launch amplifier. For systems where the highest channel used for DTT is around channel 56 or below, a small DTT receiver filter will probably work. For systems in areas where the highest channel used for DTT is channel 57-60, a larger, heavier and more expensive filter will probably need to be fitted, again before the launch amplifier. Installation of filters for communal aerial systems will probably require the services of a qualified installer; and

- **Domestic installations with amplifiers** – For these households, a small DTT receiver filter will fix most of the problems. As with standard installations, different types of filter may be needed depending on which is the highest channel used for DTT in that area. However, the filter must be fitted in front of the amplifier. Installation of filters in these households may be more difficult than for standard domestic installations, particularly where the amplifier is a mast-head or loft amplifier. In these cases, the services of a qualified installer will probably be required.

Initial conclusions on consumer support

6.14 Interference into DTT from new mobile services is likely to affect some DTT consumers to varying degrees. Our view, as set out in section 5, is that mitigation in the form of DTT receiver filters is likely to be cost effective; this will necessarily involve direct contact and interaction with DTT consumers. In view of these factors, we presently suggest that:

- Information and advice should be made available to all DTT households that are likely to be affected in advance of new network roll-out and for a period thereafter. At a minimum, this should include coordinated information campaigns and the availability of a dedicated call centre and website; and

- Consumer-based mitigation including DTT receiver filters should be provided to households in some manner.

6.15 We are not making a firm proposal in this consultation on the level of consumer support that should be offered because we do not think there is currently sufficient evidence at this stage to do so.

6.16 We will therefore undertake further work over the summer to consider this issue in greater detail. As part of this, we expect to undertake further research to investigate the costs and impacts of the choices and options set out above. One of our key objectives will be to provide as much certainty as possible as soon as possible and in particular before the auction for the 800 MHz band begins.

Consultation question 3: Do you have any comments, views or evidence that you would wish to be considered in our further work looking at the appropriate level of consumer support?

The delivery mechanism

6.17 We set out in section 5 that it is likely to be cost effective to use base station transmit and DTT receiver filtering in any approach to mitigation. We noted immediately above that there is also an additional question as to the type and level of consumer support that will be needed. We set out here our current views on the best way to deliver the necessary mitigation measures.

The need for a single organisation – MitCo

6.18 Any approach to providing consumer based mitigation will need to involve informing DTT viewers about the issues and managing viewer based mitigation. These activities will be needed irrespective of the level of consumer support that is offered. It is also the case that viewer based mitigation is likely to require knowledge of, and coordination with, network rollout activities undertaken by new licensees, for example concerning when and where receiver filters are likely to be needed as a result of new network deployment.

6.19 We consider that it will be necessary for a single mitigation body – referred to here as 'MitCo' – to be established to manage the provision of information and support to DTT consumers. It would deal with informing DTT consumers and handling DTT consumer based mitigation, including coordination with new licensees.

6.20 Anything other than a single body for managing consumer-based mitigations and aggregating information would lead to significantly higher risks of a lack of coordination. For information provision this would raise risks that DTT consumers were given conflicting advice, given the same advice multiple times, or in the worst case missed entirely. Multiple bodies would also be very confusing for DTT consumers as to whom they should contact and in what circumstance. Co-ordination would also be needed with DTT stakeholders over issues such as indentifying whether interference is mobile related or generated from something else. Similarly in respect of mitigation, consumers are more likely to receive several DTT receiver filters or no DTT receiver filters if multiple bodies are present. There would also be a likelihood of inefficiencies from different bodies solving problems in the same area in different ways. A single body would avoid or reduce these difficulties.

6.21 It will be necessary to consider how MitCo might best interact with new licensees regarding, for example, exchange of necessary information and the handling of the timing of provision of consumer based mitigation against the timing of new licensees' roll out and activation of networks.

The role of MitCo

6.22 MitCo will in most cases have to make decisions about when and where to use different mitigations. Every time it deals with an interference issue it will have choices to make between using either network or DTT consumer based mitigations. Furthermore within these categories it will have to choose which mitigation option is best.

6.23 Regardless of how MitCo is designed and constituted it will need to take these decisions within a set of targets and objectives. These targets and objectives would in essence translate the decisions on mitigation options and consumer support we discussed earlier into Terms of Reference (ToR) for MitCo to operate under.

6.24 There are different ways that MitCo could get these ToR. We (or Government) could do this directly by setting them. It could alternatively be done by licensees via a set of targets and objectives we insert into their licences and they have to meet.

6.25 How the ToR for MitCo are set determines how MitCo makes decisions about mitigation options and ultimately who is responsible for the decision making. We believe that there are three options for doing this and we consider them next.

Options for who takes responsibility for decision making within MitCo

6.26 Responsibility for setting the ToR and determining how MitCo makes decisions can be divided between the new licensees and us/Government in three different ways:

i) New licensees – set the ToR and take all decisions;

ii) MitCo – we/Government set ToR for MitCo, which takes all decisions; and

iii) Hybrid – we/Government set ToR but new licensees take decisions with respect to network mitigations(via tariff), and MitCo with respect to consumer based mitigation.

6.27 Table 6.1 below summarises how responsibilities might fall under these three approaches.

Table 6.1 – Key features of responsibility

	(1) New licensees	(2) MitCo	(3) Hybrid
Decision	• We/Govnerment specify extent of necessary mitigation in new licences, but licensees choose mix of mitigation measures to be used and set the mix via ToR they place on MitCo.	• We/Government chooses extent of necessary mitigation and specifies ToR for MitCo which is then responsible for all mitigation decisions	• We/Government specify tariff to be paid by new licensees in respect of individual elements of network roll-out, and set (more restricted) terms of reference for MitCo
Responsible party	• New licensees responsible for all choices of mitigation	• MitCo responsible for all choices of mitigation	• New licensees responsible for choices in respect of network mitigations • MitCo responsible for all other choices of mitigation
Key features	• Each new licensee free to choose mobile network or viewer based mitigation, within overall constraint we/Government specify • Each new licensee would be responsible for achieving or procuring chosen mitigation • New licensees must work together in context of MitCo which they create and constitute	• MitCo chooses extent and mix of consumer versus network based mitigation • MitCo directs the new licensees in respect of chosen network based mitigation	• Each new licensee chooses network based mitigation, guided by tariff mechanism • MitCo chooses between consumer based mitigations, with option to negotiate changes to network mitigation with new licensees if desirable

6.28 Under (1) new licensees have conditions in their licences which define targets and objectives they must meet for mitigating interference. Within the targets and objectives each new licensee would determine what they consider to be the right balance between network and consumer based mitigation. They would then be responsible for organising and funding information and interaction with DTT consumers via MitCo. MitCo would have to be a single body and we would expect the new licensees to create and constitute it.

6.29 Under approach (2) we/Government would set ToR for MitCo so it could then decide on the balance between network and DTT consumer mitigation options. MitCo would also determine and mandate the extent of mobile network mitigation that it sees as necessary and cost effective for achieving the overall objective of meeting its ToR.

6.30 Under (3) we/Government would determine a tariff to be paid by each new licensee for each element of network roll-out (each additional base station). We/Government would also set ToR for MitCo, but the important difference from approach (2) is that the responsibilities for DTT consumer mitigations are determined by MitCo while network mitigations are determined by new licensees.

6.31 If new licensees are to make efficient choices about the use of network mitigation measures they need to factor into their decisions the costs implied for others of their choices. The way we propose to do this is to implement some kind of tariff mechanism that links the interference they cause to the costs of mitigating that interference. We outline some options for how this tariff might work next.

Tariff mechanism

6.32 One mechanism for ensuring that new licensees factor into their decisions the costs implied for others of their choices could be to require new licensees to pay a 'tariff' that reflects these likely costs. The more accurately that any such tariff reflects the true costs that others will incur as a consequence of decisions made by the new licensees, the better (i.e. more efficient) the decisions taken by the new licensees could potentially be. Costs might, for example, include non-cash costs to consumers of dealing with the effects of interference such as the value of any temporary loss of TV services. A tariff that reflects these costs would encourage new licensees to make decisions about their network roll out that reflects these effects.

6.33 Costs arising as a result of interference will vary according to the parameters of network roll out and base station operation and their interaction with the DTT transmission. For example the frequency range over which a network transmits will be a key determiner of the extent and costs of interference in some geographic areas. So a more complex tariff mechanism where tariffs vary to reflect the effect of different parameters may provide a better link between the new licensees' decisions and the costs of interference. However the more complex the tariff mechanism is, the more challenging it is likely to be to implement and make accurate.

6.34 We note that where the tariff is set inaccurately, the result could be that new licensees' actions are inefficient or that overall costs arising from interference effects are increased rather than decreased.

6.35 It should also not be forgotten that there is, and will likely remain, significant uncertainty about the likely costs of mitigation and remediation, particularly when it comes to any estimate of the costs arising in any particular area (and even more so as regards those arising from, for example, the deployment of a single base station). Any such tariff mechanism would therefore have to balance our desire to promote efficient decision making on the one hand, with the costs and other challenges of implementation, and the reality of significant uncertainty over costs on the other.

6.36 Bearing these issues in mind, we suggest that potential options for such a tariff mechanism include:

- A simple tariff per base station deployed, which might vary according to the frequency range over which the base station transmits;
- A tariff per base station deployed, which varies according to certain characteristics of the base station – such as the local density of households, the power of the base station, whether additional base station filtering is employed,

whether an OCR is deployed at the same site, and the frequency range over which the base station transmits;

- Use of a model to predict the number of households that could be impacted in each case, with a specified amount payable in respect of each such household; and

- Use of a more complex model to predict not only the number of households that could be impacted, but also the likely cost of mitigation or remediation – depending for example on the type of housing stock concerned (houses or flats). The tariff would reflect these costs.

6.37 We intend to set out our view on an appropriate tariff mechanism and the possible parameters for this in our subsequent consultation.

Assessment of approaches for responsibility

6.38 We undertake below a qualitative assessment of the positive and negative aspects of each option in turn.

Approach 1: New licensees

6.39 The benefits of this approach are centred around the ability of the licensees to make all the decisions themselves. They are best placed to make the most efficient decisions and choices about which mitigation option to use where. As they also manage the mobile network roll out they can make the most efficient trade off in respect of how quickly they apply mitigation measures and where they do this first.

6.40 The biggest negative aspect of approach 1 arises as a direct consequence of new licensees making the decisions. They will be making decisions about someone else's customers, i.e. DTT consumers. They have no direct incentive to do the best for these consumers other than the targets and objectives put in their licences. This presents a significant risk of consumers receiving sub standard assistance and also means that we will need to police the mitigations. These risks may be compounded by the fact that the new licensees will need to coordinate appropriately in delivering mitigation.

Approach 2: MitCo

6.41 The main benefit here is that complete control is in the hands of MitCo meaning it can use any combination of consumer or network mitigation to resolve the interference problems. As a result it should be better placed to protect consumers and therefore we would expect this option to deliver the highest levels of DTT consumer protection.

6.42 In this model MitCo would be able to dictate the changes to the new licensees' networks that it considered best able to manage interference. This would present significant risk of both delaying network roll outs but also imposing significant additional costs on new licensees. It would also place a lot of uncertainty on new licensees as to how they could use their spectrum as they would have no prior knowledge of the decisions MitCo might take. This could distort their bids at auction, and consequently possibly distort subsequent competition in downstream markets.

Approach 3: Hybrid

6.43 One of the key advantages of the hybrid approach is that it should provide the highest level of cost certainty to bidders for new licences. This is because by knowing the tariff mechanism in advance they should be able to predict most accurately the likely range of costs they would face in different deployment scenarios. This approach also balances the benefits of protecting DTT consumers through not having new licensees choose consumer mitigations while allowing the new licensees to make decisions about their network as they are the ones best placed to make those decisions.

6.44 The biggest challenge is getting a tariff mechanism that works effectively. We described some different approaches to tariff mechanisms earlier but whatever approach is taken calculating the charges that it places on new licensees is vital as otherwise it could distort the decision new licensees take. Under this approach as MitCo is not run by the new licensees as in approach 1 there is a risk, albeit a lesser one than in approach 2, that the inability of MitCo to implement mitigations fast enougth could delay network roll out.

Provisional Conclusions

6.45 We provisionally consider that the hybrid approach 3 is the best choice and should be adopted as it will provide the best opportunity of obtaining a successful outcome.

6.46 While it is not without significant challenges it avoids the major problems of approaches 1 and 2. For approach 1 new licensees making decisions presents too much risk of harm to DTT consumers and other stakeholders' businesses and therefore is not tenable. For approach 2 a regulatory body mandating the parameters of network roll out, perhaps on a site by site basis, presents too much of a risk of both delay to roll out and significant and unpredictable costs being imposed on those new licensees.

6.47 Subject to this consultation, we will need to develop the details and parameters of approach 3, including:

- the functions and duties of MitCo and how it is created (this may require the involvement of Government);
- how viewers might best be communicated with and helped on an ongoing basis;
- the form and parameters of the tariff mechanism;
- how licensees interact with MitCo regarding provision of information and coordinated timing of network rollout and activation with provision of consumer based mitigation measures; and
- the circumstances under which a 'backstop power' to impose restrictions on network roll out or site deployment in specific cases might be exercised.

6.48 Assuming we decide to pursue this option further, these details will be the subject of a further consultation in the autumn.

Consultation question 4: Do you have any comments or views on how we have assessed the approaches and our preference for the hybrid approach?

Funding

6.49 We seek to introduce funding arrangements that are most likely to encourage decisions and resource allocations by relevant parties that best achieve our objectives. Placing costs on parties most able to control or predict them will be the principal way of achieving this.

6.50 Placing costs on parties unable to control or predict them on the other hand could introduce a significant risk of distorting those parties' decisions and encouraging an inefficient outcome. For example making new licensees responsible for costs that are significantly uncertain and beyond their control would be likely to distort the auction for the 800 MHz band. This is because new licensees would be likely to reflect the uncertainty through discounted bids and also because different bidders would discount bids in different ways, even though the uncertainty faced was common to all. Distortion of bids in the auction could lead to spectrum being inefficiently awarded.

Where costs and uncertainties arise

6.51 Costs of mitigation will broadly speaking fall to the following categories and in each of these, costs will be influenced by a number of factors.

Consumer information and interaction – these include costs of establishing MitCo to provide information to DTT consumers about the possible impact of interference to DTT services and any consumer based mitigation that might be needed. It is likely to include, for example, costs of an information campaign, telephone helpline, and website. It will also need to reflect specific protection of vulnerable groups. For example, it may be decided that there is a need to arrange home visits by engineers for some vulnerable DTT consumers who need to fit receive filters. Costs here could be influenced by the way in which MitCo is established and run, and what it is responsible for. The extent of any help and how it is taken up will also inform costs.

Mobile network based mitigation – the costs of base station filtering and adjusting or modifying mobile base stations or roll out in order to mitigate interference effects. These costs will be determined by choices about what network based mitigation is used, which may be influenced by choices made elsewhere about the extent of consumer based mitigation used and the degree of consumer support needed.

DTT consumer based mitigation – the costs of providing DTT consumer based mitigation, for example purchase and distribution of receiver filters. Costs may vary for example according to choice of consumer based mitigation used, and the degree to which different types of DTT household may require different measures, e.g. the extent of households connected through a standard TV aerial or communal aerial system, or using an amplifier.

6.52 It is not at all clear that these cost elements will be fully predictable because there are uncertainties in how these costs may actually turn out. The following are key examples of what might underlie these uncertainties:

- **Take up and costs of consumer support** – it will be difficult to know in advance how many consumers may take up offers of help and in particular the extent to which vulnerable groups need or in the event take up offers of support;

- **Number of households that may be affected** – technical modelling of interference effects cannot be fully accurate about the scale of interference effects and costs;

- **Outturn costs of consumer based mitigation** – there are for example uncertainties around the logistics and costs of providing receive filters which make it difficult to predict the costs of these measures;

- **Outturn costs of network based mitigation** – it is difficult to fully predict the effectiveness and costs of some measures such as OCRs and cross polar discrimination; and

- **Potential changes in future policy** – it is possible that views and policy regarding the acceptability of certain mitigation measures or the level of consumer support to be provided will in future change, with consequences for the costs of these items.

Who pays

6.53 In the light of the above, we suggest that it is appropriate to seek to recoup costs, to the extent that they are predictable and controllable, from new licensees. This is for the following reasons:

- In respect of network based mitigation, new licensees will in any case control and bear these;

- Our preferred approach for assigning responsibility for mitigation measures – the hybrid approach – already sets out a way in which expected costs of interference may be funded, i.e. from new licensees via the tariff mechanism. Moreover the tariff mechanism is explicitly intended to link controllable and predictable costs of interference and mitigation measures to the new licensees; and

- In respect of certain other costs such as the likely fixed costs of mitigation (e.g. costs of establishing MitCo), these could in principle be efficiently recouped through requiring each new licensee to pay a lump sum in addition to any funds generated through the tariff mechanism. That is, the lump sum would be separate from and independent of network roll out and the number of base stations deployed. A lump sum could be efficient as long as it is set before the auction and it is not set at such a high a level that it would discourage otherwise-efficient participation in the auction.

6.54 The attribution of costs to new licensees in these ways would necessarily leave some degree of residual cost risk. To the extent that such risks are reasonably fixed relative to the scale of interference effects and costs, they might be efficiently accommodated through a contingency fund built into the lump sum (also assuming this is not so large as to discourage otherwise efficient participation in the auction). To the extent that cost risks are driven by the scale of interference effects and costs, they might be accommodated through an adjustment to tariffs in the tariff mechanism. However this raises risks of inefficiently distorting choices about network roll out and site deployment. It might also be possible to adjust the tariff over time and in the light of discovery of the scale of any costs risks, although this would introduce uncertainty for bidders at the time of the auction and so could distort bids.

6.55 If we were to adopt such an approach then it would be necessary to implement it through licence conditions. The following sub-section discusses what these might be.

Initial conclusions on funding

6.56 We suggest that there are good reasons for attributing controllable and predictable costs to new licensees, including a lump sum intended to recoup fixed costs of mitigation. The tariff mechanism would play a key role in determining and attributing costs to new licensees. This approach would necessarily leave a residual cost risk and it is for consideration how these might best be borne.

Consultation question 5: Do you agree with the options, the assessment approach and our initial conclusions? What are your views on cost risks and how to deal with them?

Licence conditions

6.57 In order to implement the proposals set out above, we would need to include certain conditions in the 800 MHz licences.

TLCs

6.58 The Decision sets out the technical conditions under which the 800 MHz band may be made available, bearing in mind potential interference to users in adjacent blocks (particularly broadcasters). It prescribes technical parameters for BEMs, which consist of "in block" and "out of block" components. In particular, it sets out baseline requirements with which Member States must comply when setting out of block limits for the purposes of protecting television broadcasting from interference. These are set out in table 6.2 below and further discussed in our "*Consultation and information document on technical licence conditions for 800 MHz and 2.6 GHz spectrum and related matters*" (the TLC Consultation) published on 2 June 2011 http://stakeholders.ofcom.org.uk/consultations/technical-licence-conditions/. Table 4 to the Annex of the Decision sets out the baseline requirements for base station BEM out-of-block EIRP[65] limits over frequencies below 790 MHz in the case (as here) for TV channels where broadcasting is protected. Specifically the table implies an Adjacent Channel Leakage Ratio (ACLR)[66] of 59 dB for in-block levels of between 36 and 59 dBm.

Table 6.2 – Table 4 of the Annex to the Decision – Baseline requirements – base station out-of-block EIRP limits over frequencies below 790 MHz

Frequency range of out-of-block emissions	Condition on base station in-block EIRP, P dBm/10 MHz	Maximum mean out-of-block EIRP	Measurement bandwidth
470 to 790 MHz	$P \geq 59$	0 dBm	8 MHz
	$36 \leq P < 59$	(P-59) dBm	8 MHz
	$P < 36$	-23 dBm	8 MHz

6.59 The Decision however recognises that the BEMs set out in the Annex do not always provide the level of mitigation necessary to protect services (such as DTT in this case) and that additional mitigation techniques may be necessary. Where that is the case, the Decision provides that these mitigation measures would need to be applied in a proportionate manner at national level in order to resolve any remaining cases of interference.

[65] Equivalent Isotropically Radiated Power.
[66] This is the difference between the in-block and the out of block levels.

6.60 As set out in the TLC Consultation, we are proposing to set a maximum in-block emission level of 61 dBm/(5 MHz).

6.61 On the basis of the technical modelling that we have carried out to date, the mitigation approaches detailed in sections 5 and 6 of this consultation would work most effectively if out of block emission levels are limited at 76 dB below the in-block emission levels. Where out of block emission levels are higher than this, DTT receiver filters cease to be as effective. This could result in additional costs as alternative mitigation measures are likely to be necessary in order for affected consumers to continue to receive DTT services. Alternatively, where consumers still cannot receive DTT services, platform changes may be needed for them to continue to receive services otherwise broadcast on DTT.

6.62 For the reasons set out sections 5 and 6 we consider that a combination of DTT receiver filters (i.e. applied to consumers' televisions) and base station filtering is likely to be the most effective and proportionate means of ensuring that use of the 800 MHz band for electronic communications services does not prevent a high number of consumers from continuing to receive DTT services. As such, we provisionally consider that it may be proportionate to include licence conditions imposing further restrictions in certain geographic areas (for example, where DTT services are broadcast on channel 60) on the out of block emission levels in the 800 MHz licences. These further restrictions would correspond to an ACLR of 76 dB for Block A, an ACLR of 87 dB for Block B and an ACLR of 99 dB for Block C notwithstanding that these are additional to the ACLR of 59 dB set out in table 6.2 above. We set these out in table 6.3 below.

Table 6.3 – Provisional proposals for additional mitigation in certain geographic areas

Frequency range of out-of-block emissions	Condition on base station in-block EIRP, P dBm/10 MHz	Maximum mean out-of-block EIRP			
		Decision	Provisional proposal for additional mitigation in specific geographic areas		
			Block A	Block B	Block C
470 to 790 MHz	$P \geq 59$	0 dBm	-17 dBm	-28 dBm	-40 dBm
	$36 \leq P < 59$	(P-59) dBm	(P-76) dBm	(P-87) dBm	(P-99) dBm
	$P < 36$	-23 dBm	-40 dBm	-51 dBm	-63 dBm

6.63 Additionally, we provisionally consider that it may be necessary and proportionate to include licence conditions imposing further restrictions, in certain geographic areas, on the in block emission levels in the 800 MHz licences. We are still considering this issue and would welcome stakeholders views on such conditions.

6.64 The alternative to including licence conditions imposing further restrictions is that we might need to include specific conditions requiring new licensees to make greater financial payments to MitCo to fund the (more expensive) filters and platform changes that would be required if lower power restrictions were to be included in the relevant licences.

Conditions governing co-ordination between licensees, MitCo and us

6.65 In order to ensure that MitCo is able effectively to provide the necessary support to consumers, it would need new licensees to interact with it on a constructive basis. In this regard, we are considering including the following conditions in the 800 MHz licences.

6.66 First, we propose to include a licence condition that requires licensees to comply with the tariff system described above. We envisage that this would entail a requirement for licensees to make payments directly to MitCo. MitCo would then use this money to provide an effective information scheme for consumers and undertake other measures such as sending out filters as is deemed necessary via the later decision on the level of consumer support.

6.67 Secondly, MitCo would need licensees to provide it with certain information, such as that relating to the deployment of the licensee's network, in order to predict the number of filters and platform changes that consumers may require. We envisage that we would therefore need to include a licence condition requiring licensees to provide MitCo with full details as to their existing network and base-stations, as well as plans for any future deployment that are known to them, as at the time that the licence is awarded. Where licensees are not aware of any plans for future deployment at that time, but become aware at any point subsequently, they would be required to give MitCo prior notice of such plans before any steps were taken to implement them. We are still considering the period of time for which MitCo would be likely to need advance notice.

6.68 Further, MitCo might also need information as to individual licensees' intended transmission levels so that it could apply the tariff system for the purposes of supplying consumers with more expensive filters, or arranging platform changes as necessary.

6.69 There may also be circumstances where MitCo wouldrequire additional information not contemplated at the time of the award of the licence, but which subsequently becomes necessary in order for it to undertake its work. We propose including a licence condition that would incorporate all of these "information-related" obligations set out in this section.

6.70 Thirdly, there may be instances where interference can only be properly mitigated through the use of an OCR. In these circumstances MitCo would be likely to need access to a licensee's base station in order to attach the device. We need to consider further how best to enable this, but it is possible that it might be through the inclusion of a licence condition to that effect.

6.71 Fourthly, we wwould need new licensees generally to co-ordinate with MitCo, from time to time, as may reasonably be required. This would include (although not necessarily be limited to) meeting with representatives from MitCo, responding to requests for information in a timely manner, and providing such assistance to MitCo as it may need in order to carry out its work. We propose to include a licence condition that would require licensees to co-ordinate with MitCo for these purposes.

6.72 Finally, we are aware that there is likely to be a very small number of areas of the UK where DTT receivers are likely to be susceptible to interference from new licensees and where, given the particular geographic location of the affected households, it will be very difficult to mitigate this interference in a cost-effective way. For example, satellite and cable may be unavailable in those areas, which would mean that

platform changes would not be possible. We will undertake further research in order to compile a list identifying all such areas and propose to include a licence condition requiring new licensees to seek our approval before they establish base stations in these areas. Licensees would also be required to follow any direction we give for the purposes of avoiding interference, such as siting of the base station. In addition, we propose to include a licence condition requiring new licensees to comply with any direction that we may provide generally; this is a standard condition in our existing licences, and in this context may be used where a base station has already been established, but is causing interference which can only be mitigated by, for example, re-siting it.

6.73 We consider that the above licence conditions are appropriate to mitigate the interference which would otherwise be likely to occur, and proportionate to meeting that aim. We further consider that they are consistent with the relevant provisions of the Communications and Wireless Telegraphy Acts and the underlying EU legislation, including in particular the Authorisation Directive which expressly envisages the inclusion in licences of conditions covering such matters as:

- the effective and efficient use of frequencies;
- technical and operational conditions necessary for the avoidance of harmful interference; and
- commitments which an undertaking obtaining the usage right under a licence has made in the course of a competitive selection procedure.

Annex 1

Responding to this consultation

How to respond

A1.1 We invite written views and comments on the issues raised in this document, to be made **by 5pm on Thursday 11 August 2011**.

A1.2 We strongly prefer to receive responses using the online web form at https://stakeholders.ofcom.org.uk/consultations/coexistence-with-dtt/howtorespond/form, 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 **Coexistence@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.

Reuben Braddock
Floor 3
Spectrum Policy 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. We 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 our 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 Reuben Braddock on 0207 981 3108.

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 us to use. Our approach on intellectual property rights is explained further on our website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.11 Following the end of the consultation period, Ofcom will review the responses and expects to publish a statement in the autumn. We also expect to publish a further consultation on certain issues raised in this consultation in the autumn too.

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/static/subscribe/select_list.htm

Our consultation processes

A1.13 We seek 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 we conduct our 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 we 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 our consultation processes more generally you can alternatively contact Graham Howell, Corporation Secretary, who is our 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

Our consultation principles

A2.1 We have published the following seven principles that we 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. Our '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 we would encourage respondents to complete their coversheet in a way that allows us 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 www.ofcom.org.uk/consult/.

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

Consultation question 1: Do you have any comments on our modelling approach and assessment of numbers of households affected?

Consultation question 2: Do you agree with our high level conclusions on mitigation options?

Consultation question 3: Do you have any comments, views or evidence that you would wish to be considered in our further work looking at the appropriate level of consumer support?

Consultation question 4: Do you have any comments or views on how we have assessed the approaches and our preference for the hybrid approach?

Consultation question 5: Do you agree with the options, the assessment approach and our initial conclusions? What are your views on cost risks and how to deal with them?

Annex 5

Glossary of abbreviations

ACLR Adjacent Channel Leakage Ratio

BEM Block edge mask

COM Commercial

dB Decibel
dBm Decibels relative to milliwatts
DDR Digital Dividend Review
DSO Digital switchover
DTT Digital terrestrial television

EIA Equality Impact Assessment
EIRP Equivalent isotropically radiated power
EU European Union

GHz Gigahertz

HD High Definition

IDTV Integrated TV
IPTV Internet Protocol TV

MATV Master antenna TV
MHz Megahertz
MIMO Multiple-in-multiple-out

NRA National regulatory authority

OCR On-channel repeater

PSB Public Service Broadcasting
PVR Personal video recorder

SD Standard Definition
SINR Signal to interference plus noise ratio
STB Set top box

TLC Technical licence condition
ToR Terms of reference

UHF Ultra High Frequency
UKPM UK Planning Model