Future access to interleaved spectrum for programme making and special events

Statement

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Section 1

Executive summary

Digital switchover and impact on programme making and special events

1.1 Analogue transmission of television is in the process of being switched off and replaced by digital terrestrial television (DTT). This is known as digital switchover (DSO) and has been completed in several TV regions including Wales, West Country, Grampian Border and others.

1.2 DSO has three major consequences:

- there is an expansion in the number and range of services available via terrestrial television across the UK;
- a large amount of spectrum – the digital dividend – will become available for new uses; and
- the pattern of interleaved spectrum shared with DTT by PMSE between 470 and 854 MHz (also called "whitespace") is changing.

1.3 Programme making and special events (PMSE) comprises a wide variety of organisations and individuals who use spectrum for an equally wide variety of uses. This ranges from audio users, such as professional theatre companies and community users (often, churches and schools), to video users such as broadcasters and special events organisers.

1.4 PMSE use of interleaved spectrum primarily consists of wireless microphones and in-ear monitors, although there is some use of talkback and other audio links.

1.5 One of the consequences of DSO is a replanning of the frequencies used by television in the UK. As a result, there is a change in the configuration of interleaved spectrum which will, inevitably, lead to a change in the frequencies that can be used by PMSE users. These users may find that they need to change or modify their existing equipment. To assist the PMSE industry plan ahead we published a statement in January 2008[1] which set out the likely available frequencies for the sector after switchover has taken place in each region. At that time we indicated that, because of some uncertainties relating to DSO, the picture given would be both conservative in nature (that is, likely to underestimate the amount of spectrum which would be available for PMSE) and subject to change.

1.6 This statement gives an updated picture of the likely available interleaved spectrum for PMSE in the light of developments since January 2008. In particular we have altered some key technical assumptions to reflect how wireless microphones are actually licensed in areas which have already switched-over.

[1] Access to interleaved spectrum for programme-making and special events after digital switchover, 16 January 2008: http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement/statement1.pdf

We have concluded that there is sufficient spectrum for PMSE to meet its reasonable requirements

1.7 Our January 2008 statement was somewhat conservative in its assumptions. It suggested that a number of locations in the UK could have a quantity of available interleaved spectrum which was lower than peak historic demand. However, our revised assessment is more realistic and indicates that, in all indoor PMSE locations, there will be significantly more spectrum available than historic peak demand suggests is needed. In those few outdoor locations where we there may be nominal constraints on spectrum supply, we suggest measures which can be taken to identify additional spectrum. These measures are consistent with current practice where spectrum demand can also exceed published spectrum availability[2].

1.8 We consider that the revised assessment as set out in this statement provides sufficient comfort for wireless microphone users, such that they should be able to invest for the future with confidence that their spectrum needs can be met.

Users can check which freqencies are available in which locations

1.9 Separate to this statement, we have published details of which frequencies are available in which locations after switchover has taken place. These can be found by using a look-up tool on the JFMG website at www.jfmg.co.uk. JFMG licenses spectrum to the PMSE sector on our behalf and can also give further advice on suitable frequencies on 020 7299 8660.

1.10 This resource is of particular importance to users who need to prepare for the changing configuration of interleaved spectrum by purchasing new equipment.

[2] Such as at the British Grand Prix at Silverstone.

Section 2

Introduction

Background

2.1 In our December 2007 digital dividend review (DDR) statement[3], (the December 2007 statement) we outlined our decisions on the future use of the spectrum made available as a result of DSO. This statement was the culmination of a period of consultation which started with wider proposals published in December 2006 and a PMSE-specific consultation published in June 2007. The December 2007 statement concluded, amongst other things, that most interleaved spectrum should be reserved for continued PMSE use after DSO and until 2018.

2.2 Since that time, we have consulted extensively on the future institutional arrangements for future PMSE access to spectrum. One of the key decisions that we made and set out in full in our August 2010 statement[4] on PMSE spectrum access (the PMSE Spectrum Access statement), was that the sector should be able to access the spectrum which we allocate to it until at least September 2021, with a five year notice period not to be triggered before September 2016.

2.3 These provisions apply to PMSE use of interleaved spectrum. One benefit of this is that PMSE users should have sufficient certainty of the future to be able to make efficient investment decisions when approaching the changes to their spectrum use brought about by DSO.

2.4 PMSE use of the UK-wide channel directly adjacent to interleaved spectrum – channel 69 (854-862 MHz) - will cease, at the earliest, in July 2012. This is with the exception of London, Northern Ireland and North East England where access can be retained until at least October 2012. Channel 38 has been made available as the replacement UK-wide channel for the PMSE sector and there is already significant geographical availability. It will be available for indoor use of low power wireless microphones (10mW hand-held or 50 mW body-worn) on a UK-wide basis from 21 September 2011. Full UK- wide access for outdoor use of low power wireless microphones will be available for a 5·6MHz range in channel 38 from the same date. This reduced bandwidth is to protect remaining analogue television reception. Once DSO is complete, channel 38 will become fully available for outdoor use on a UK-wide basis.

2.5 Use of the 600 MHz band (550-606 MHz) will cease at the end of DSO in late 2012. (We may give 12 months' notice to cease PMSE use of channel 36 before then.) Use of the 800 MHz band (790-862 MHz) will, like channel 69 within it, cease during the second half of 2012. In our interim statement in April 2010[5], we said we did not want to clear PMSE users from channel 69 unless it was to allow its use for new services. We said we would review in 2011 whether PMSE access to channel 69 could be allowed beyond the 1 July and 1 October 2012 dates. On 22 March we published a

[3] Digital Dividend Review: a statement on our approach to awarding the digital dividend, 13 December 2007: http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement/statement.pdf

[4] Programme-Making and Special Events Future Spectrum Access, 31 August 2010: http://stakeholders.ofcom.org.uk/binaries/consultations/bandmanager09/statement/statement310810.pdf

[5] Programme-making and special events: future spectrum management, access and availability: http://stakeholders.ofcom.org.uk/binaries/consultations/bandmanager09/statement/statement.pdf

consultation on our assessment of future mobile competition and proposals for the awards of 800 MHz and 2.6 GHz spectrum[6] in which we explained we are now seeking evidence from stakeholders of the likelihood that there would be use of the top 2 x 10 MHz of the 800 MHz band in the period between 1 October 2012 and 31 December 2012 in London, Northern Ireland and north east England, and in the period between 1 July 2012 and 31 December 2012 in the rest of the UK (noting that in both cases there would likely have to be interim restrictions on use to protect terrestrial TV reception in areas that have not yet switched over or been cleared). Once we have assessed the demand for use of this spectrum, we will be able to update PMSE stakeholders on whether we would be able to extend the availability of channel 69 beyond these dates (but not later than 31 December 2012).

We set out our initial assessment of interleaved spectrum for PMSE in 2008

2.6 The January 2008 PMSE Whitespace statement[7] (the January 2008 statement) on access to interleaved spectrum for PMSE after DSO outlined our best assessment at that time on the likely configuration of spectrum in each location used by PMSE in the UK. We stated that, with a small number of exceptions, there would be sufficient spectrum to meet the needs of PMSE users based on evidence[8] of historical peak demand.

2.7 At that time, we also published a "look-up tool" on the JFMG[9] website that allowed stakeholders to check which frequencies would be available in which locations after DSO had completed. This was in response to representations from the PMSE sector that it would need sufficient time to plan for any necessary investment in equipment modification or replacement to tune to these new confirmed frequencies.

2.8 In the January 2008 statement we also noted that the assumptions underlying our analysis were likely to lead to a conservative view of the quantity of available spectrum for PMSE post DSO. As a result, since the January 2008 statement we have been refining our assessment in light of our enhanced understanding of how the digital dividend is likely be used.

2.9 We received representations from members of the PMSE community at that time, expressing concerns over the published quantity of spectrum in specific locations within the UK. This statement, amongst other things, seeks to address those concerns.

There were changes to the digital dividend

2.10 The January 2008 statement was based on the original UK digital dividend: two bands of spectrum – a lower band at 550-630 MHz and an upper band at 806-854 MHz – cleared for new uses.

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[6] Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 MHz spectrum and related issues: http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/summary/combined-award.pdf

[7] Access to interleaved spectrum for programme-making and special events after digital switchover, 16 January 2008: http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement/statement1.pdf

[8] We used the PMSE licensing database to determine the levels of historic peak demand in each key PMSE location. At that time, we based that assessment on data from 2005 only.

[9] JFMG licenses spectrum to the PMSE sector on behalf of Ofcom.

2.11 However, on 2 February 2009 we published a consultation[10] outlining revised plans for the future of the upper band but which could also have an impact on the configuration of the lower band. This was in reaction to developments at a European level which saw a number of Member States considering and/or identifying digital dividends of their own.

2.12 This was both welcome and to be expected given the increasing value attached to wireless (particularly mobile) services. But the way a critical mass of other European countries approached their digital dividends – identifying a single, 800 MHz band – had important implications for the UK. Maintaining a different approach of our own would fragment spectrum availability and preclude the possibility for services to cross borders and manufacturers to exploit international economies of scale.

2.13 In light of these considerations, we published our decision[11] on clearing the 800 MHz band in July 2009 (the 800 MHz statement), confirming that:

- we should clear DTT from channels 61 and 62 and make channels 39 and 40 available for use as a replacement; and
- we should clear PMSE users from channel 69 and make channel 38 available as a replacement channel for UK-wide PMSE use.

2.14 As a result of this decision, the arrangements for interleaved spectrum between 470-854 MHz, as well as the current PMSE-exclusive channel between 854-862 MHz (channel 69) changed. These are set out in Figure 1.

Figure 1: 470-862 MHz after DSO

We had to re-plan switchover, changing the configuration of interleaved spectrum

2.15 The original UK DSO frequency plan was agreed and recorded in the ITU Geneva 2006 (GE06) plan. It has undergone a number of changes in order to facilitate the decision to clear DTT from the 800 MHz band.

2.16 The process of technical re-planning to clear terrestrial television from the 800 MHz band is also being carried out across most of Europe, including by some of our nearest neighbours. As television transmitter plans in Europe are interdependently linked, any planned change of main station frequencies in either the UK or

[10] Consultation on Digital dividend: clearing the 800 MHz band: http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/summary/800mhz.pdf
[11] Digital dividend: clearing the 800 MHz band, statement published 30 June 2009: http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/statement/clearing.pdf

neighbouring country can ripple across other country plans and requires international engagement in the form of bilateral and multilateral co-ordination meetings to negotiate and agree the change.

2.17 A consequence of the necessary planned changes to the frequency plan of DTT in the UK is that the configuration of available interleaved spectrum has also changed

2.18 International co-ordination of the UK 800 MHz clearance plan has been proceeding since the 800 MHz statement was published in June 2009. These are now advanced and the plan is reasonably stable. The configuration of interleaved spectrum is also sufficiently stable, such that we are in a position to revise our assessment of the interleaved frequencies that should be available for PMSE after digital switchover. However it should be noted that there is a possibility that some of the available frequencies may change since the international process is not yet finalised.

Structure of this document

2.19 Section 3 sets out a summary of our revised assessment of how much interleaved spectrum will be available for PMSE post switchover. This includes highlighting those locations where spectrum availability may not always meet historic peak demand and descriptions on what approach could be taken to address such potential shortfalls.

2.20 Section 4 explains the technical parameters that we have adopted to underpin our analysis.

Section 3

Summary of revised assessment

3.1 In the January 2008 statement, we stated that we believed there would be "broadly sufficient capacity in interleaved spectrum after DSO to accommodate existing wireless microphone use". We also stated that there was some uncertainty inherent in our analysis caused by a possibility that other proposed uses of this spectrum (notably DTT) may change over time. As a result we only included those frequencies that we thought had a relatively high probability of being available for PMSE use. This created a somewhat conservative picture of spectrum availability for wireless microphone users.

3.2 We now have an enhanced understanding of how these services will operate in the future. This has allowed us to revise our assessment of how much interleaved spectrum is likely to be available for PMSE use post DSO. In particular we have adopted the protection criteria for TV coverage areas consistent with established principles used by JFMG and which they have been using successfully since switchover started in 2008. This means our analysis gives a more realistic picture of what that spectrum availability will be.

3.3 The effect of adopting this approach indicates an increase in the quantity of available interleaved spectrum for PMSE. The magnitude of this increase is such that we are now confident that the spectrum requirements of wirless microphone users will be met.

Wireless microphones will have access to all 32 interleaved channels post-DSO indoor

3.4 DTT transmission is more robust against interference from wireless microphones than analogue TV transmission. JFMG already takes this into account when making assignments for indoor low power PMSE use (typically 50 mW body worn or 10 mW hand held devices). As a result of this, and taking into account the shielding effect of walls, we consider that wireless microphones can operate co-channel with terrestrial television indoors without significant risk of harmful interference into DTT.

3.5 This is borne out by the experience of making wireless microphone assignments on this basis since 1998 and the start of the low power DTT network, long before DSO commenced. There have been no reports of interference issues between PMSE and DTT.

3.6 Therefore, on the standard PMSE terms of being licensed on a no-interference and no-protection basis to the primary service (in this case, DTT), all 32 interleaved channels (a quantity of 256 MHz) will be made available for indoor PMSE use in each location.

We have given information on "spectrum quality"

3.7 We are conscious that PMSE users need to make a judgement as to which frequencies should be used when they buy new equipment. With all 32 channels being available indoors, we asked JFMG to assess which of those channels would be most likely to offer users the best "quality" spectrum when taking into account potential interference from DTT *into* PMSE.

3.8 The benefit for users of identifying which channels are most likely to suffer the least interference from DTT is that they could deploy wireless microphones without adopting technical mitigations to avoid higher DTT field strengths.

3.9 The look-up tool on JFMG's website sets out a four bar quality indicator. The meaning of this indicator is set out in more detail in section 4 and Annex 1 of this document. However, simply put, the quality of the spectrum increases with each incremenetal bar shown as the level of potential interference from DTT decreases.

3.10 The worst case scenario for PMSE indoor use is that there may be some locations where there is an increased number of channels suffering high levels of DTT interference. This is likely to be the case in locations that are relatively close to more than one main DTT transmitter and may lead to a significant number of channels that are marked as being "one-bar" on the JFMG look-up tool. This is not a function of DSO, however, and would have already been the case as a result of existing analogue TV transmissions. Where necessary, in the future we would expect PMSE users to take similar measures to mitigate this spectrum environment as they have done in the past.

Outdoor wireless microphones will continue to require – and have access to – significant quantities of interleaved spectrum post-DSO

3.11 Because of the need to protect DTT and the absence of walls to shield wireless microphone transmissions, there will inevitably continue to be less available spectrum for outdoor use than for indoor use. Peak outdoor interleaved spectrum use is usually found at set-piece major events which require a significant amount of planning work in advance.

3.12 JFMG publishes on its website[12] the key major events that it licenses throughout the year in the UK. For 2011, the major events identified by JFMG include the Royal Wedding and the UEFA Champions League Final as well as established events such as Glastonbury and the Formula One Grand Prix. Many of these events are typified by increased demand for wireless *cameras* as opposed to wireless *microphones* (for example, with most prestigious sporting events). Wireless cameras usually operate between 2 and 7 GHz and, as a result, these events do not see a major increase in PMSE demand for interleaved spectrum.

3.13 Those events that do see marked increases in PMSE demand for wireless microphone use of interleaved spectrum are typically ones such as Glastonbury, T-in-the Park or the Hyde Park Proms. JFMG already have established methods of ensuring that sufficient interleaved spectrum is made available for these events. For example, it will often conduct a site survey to assess the potential impact of operating in TV frequencies that are nominally unavailable for PMSE use. For example, in Silverstone, there may be no households within distance of the range of the wireless microphone being deployed and there will therefore be less risk of interfering into DTT services.

3.14 Furthermore, as set out in our August 2010 statement, we can, where necessary, adopt an approach to protecting DTT whereby we only protect the preferred DTT service in any given area (with some exceptions where there are national

[12] http://www.jfmg.co.uk/pages/events/Eventslist.htm

considerations)[13]. In locations where PMSE demand is particularly high, this may lead to an increase in available spectrum.

3.15 Our experience to date is that even where there is a very high demand for interleaved spectrum, there are always means to meet this demand in a reasonable way. After DSO this should continue to be possible in most cases, though for certain outdoor applications, particularly where the PMSE receive antennas are elevated, high levels of DTT in the fewer remaining Interleaved channels will limit availability.The move from analogue to digital TV should not impact on this.

GI award spectrum

3.16 In the January 2008 Statement, we provided a list of channels which we had identified as suitable for separate award. These were part of the geographic interleaved (GI) awards. As these channels were not being reserved for PMSE use, we needed to ensure that our assessment of available PMSE spectrum excluded them.

3.17 One of the implications of the ongoing replanning of the DTT network to clear the 800 MHz band (as described above in paragraphs 2.15-2.18) means that we do not yet know which channels will be available for future award, whether at our initiative or in response to Government policy. As a result, it is possible that some interleaved spectrum marked as currently being available for outdoor use will not be available for use long term in given locations.

3.18 Because our analysis of available spectrum shows that all DTT channels will be available for indoor use, any separate award would not lead to spectrum being made unavailable for continued indoor PMSE use. However, it would likely lead to a reduction in the quality of that spectrum for wireless microphone use This impact will depend on the technical conditions of the award and the local conditions in which the wireless microphones are being deployed. We would expect this to be specific and different for every case.

3.19 The lack of information at this time means that we cannot exclude interleaved spectrum potentially subject to alternative award from the analysis of available spectrum for PMSE. However we consider that we should publish our assessment now in light of the time pressures on those users who have to buy new equipment. JFMG will update the look-up tool as the spectrum and locations for any alternative awards are identified.

3.20 However, PMSE users should be aware that if they buy equipment before we know the frequencies and locations for alternative awards of interleaved spectrum, the following risks will apply:

- indoor spectrum in a given location may degrade in quality; and/or
- outdoor spectrum in a given location may become unavailable for PMSE use.

The configuration of interleaved spectrum may change marginally over the coming months

3.21 A number of PMSE representatives have emphasised the urgency of publishing our revised assessment of interleaved spectrum availability for PMSE post-DSO as soon

[13] This is known as the “median” approach.

as possible. This is because they need to make preparations for new equipment purchases in good time before they have to clear the spectrum in late 2012.

3.22 However, the re-planning of DSO is not yet fully complete and Government policy on the detailed delivery of local TV has not yet been settled, so it is important to note that there is some residual uncertainty over whether some of the spectrum plan might change. We have, therefore, had to strike a balance between publishing an assessment based on a sufficiently advanced picture of the new spectrum plan against giving PMSE users enough time to make their investment decisions. We consider that the timing of this revised assessment balances both these issues and is stable enough to present to wireless microphone users.

3.23 Users may wish to bear in mind that the risk of changes to the spectrum plan remains. Some frequencies which we are publishing as being available for wireless microphone use now may be subject to alternative award in the future. The impact of this will be that indoor channels may become “lower quality” in given locations whilst outdoor channels may become unavailable altogether. We recommend that you discuss this issue with JFMG at the point where you are planning your equipment purchases. However, any impact is likely to be marginal as the changes to the spectrum plan would probably involve low power relays with limited coverage area.

Summary

3.24 We consider that the above represents encouraging news for wireless microphone users and will give them the certainty to plan for the future whilst making informed investment decisions. In short:

- there is sufficient spectrum available to meet the needs of the PMSE sector in all indoor locations;
- measures can be taken, copying existing practice, to remedy any identified spectrum shortfall in those outdoor venues as set out above;
- users know with signficant certainty which frequencies they should consider buying equipment to tune to; and
- users also know the risks associated with the decisions they take.

Section 4

Technical assumptions

4.1 To provide guidance to the PMSE sector we asked JFMG to calculate spectrum availability for wireless microphones, once DSO and clearance is complete. We requested that this be represented through a website look-up tool. Wireless microphone users will then be able to make future inverestment decisions based on a reliable picture of spectrum availability in each relevant location.

4.2 JFMG calculates the geographical availability of interleaved spectrum and determines compatible assignments through bespoke on-line tools and by using in-house planners. These calculations are regularly updated to reflect changes to the UK DTT network as DSO progresses. The approach to predicting spectrum availability for wireless microphones post-DSO is based on the latest version of the DSO and Clearance Plan as provided by the Joint Planning Project[14].

4.3 Originally, in the years leading up to the start of DSO in 2008, the BBC provided JFMG with geographical availability data to determine the compatibility of wireless microphone assignments with TV broadcasting. To prepare for the major and regular changes to the TV network during DSO, JFMG developed its own capability to produce the geographical availability data. This was implemented in a software package known as the Radio Microphone Co-ordination Tool (RMCT). However, the BBC approach was closely replicated with protection based on analogue and digital terrestrial TV coverage produced in-house using an ICS-Telecom propagation modelling tool.

4.4 The same method and tools have now been used to produce geographical availability data for interleaved spectrum when DSO and clearance has been completed. This data supports an on-line lookup tool where future spectrum availability can be determined for any location within the UK to a resolution of 1km. The availability indicated via the on-line tool reflects the best and latest information supplied by the JPP. While this plan is largely stable, there remains a small risk that some channels may change, most likely as a result of changes to TV broadcast relays.

4.5 JFMG's approach is based on the following principles:

- wireless microphone assignments are permitted, provided TV reception remains protected up to the edge of the noise limited coverage for outdoor antennas at 10m above ground level. No assumptions are made regarding households' preferred services and protection is afforded to all transmissions that can be received;

- protection from a single wireless microphone interferer is used. It remains valid for multiple wireless microphones as their combined interference potential is not correlated and a single device will be the dominant interferer;

[14] UK DTT spectrum planning is carried out by the Joint Planning Project (JPP), which was established in 1999 to produce the frequency plan for DSO, and is now undertaking the frequency planning for clearing DTT from 800MHz spectrum. The JPP project team consists of Arqiva, BBC and Ofcom. The project team is overseen by a management board consisting of Ofcom and the DTT multiplex licensees

- an interference range is derived from propagation curves and a maximum interfering field strength at the edge of the service area;

- the worst case interference range at the edge of service falls below 250m permitting indoor co-channel use within the service area, but not outdoor co-channel use which has a greater interference range; and

- the approach has been supplemented with an additional feature that characterises the interference potential of digital television transmissions into wireless microphones for indoor use.

Process

4.6 JFMG predict television coverage by using using the ICS-Telecom radio planning tool and network data from latest JPP DSO and Clearance Plan. This uses 200m terrain and clutter data, with the 'Fresnel' propagation model and Deygout 94 diffraction geometry. Further details can be found in Annex 1.

4.7 The Radio Microphone Co-ordination Tool (RMCT), an additional bespoke piece of software, uses these TV coverage predicitions to calculate UK-wide protection data for each channel to a resolution of 1km.

4.8 Further ICS-Telecom coverage runs have been carried out modifying the radiated powers of the entire network by multiples of 7dB to simulate higher field strength contours. RMCT runs were then completed to derive protection data to identify increasing thresholds.

4.9 The data was then incorporated into a database in a suitable format to support the web look-up tool. The spectrum availability reflects the available frequency ranges within each channel according to adjacent channel relationships. The four-bar 'quality' indicator was derived using the RMCT protection data identifying higher field strength contours.

Four bar quality indicator

4.10 We set out guidance as to what the four bar quality indicator (as used on the JFMG web look-up tool) represents below:

- bar level 4: the channel is not used for TV broadcast reception at this location. Background signal levels for TV would not normally be expected to cause interference to operation of typical wireless microphone or personal monitor systems.

- bar level 3: the channel is used for TV broadcast reception at this location. Expected signal levels for TV are low representing edge-of-service area. Use of typical wireless microphone or personal monitor systems within a building of predominately brick, block, stone or metal construction is unlikely to be affected.

- bar level 2: the channel is used for TV broadcast reception at this location. Expected signal levels for TV are moderate representing main coverage area. Use of typical wireless microphone or personal monitor systems within a building having substantial construction to reduce penetration of TV signals may be successful.

- bar level 1: the channel is used for TV broadcast reception at this location. Expected signal levels for TV are high representing nearby high power broadcast station. Use of typical wireless microphone or personal monitor systems is not generally recommended unless extreme care in deployment is taken to minimise the risk of interference from TV signals.

Annex 1

Deriving post DSO availability of interleaved spectrum

Digital coverage

A1.1 The digital coverage threshold is determined from the minimum equivalent field strength:

- **56 + 20 log (f/500) dBμV/m**, where f is the frequency of the digital assignment in MHz[15]

A1.2 The protection ratios in table 1. are used to determine protection of domestic reception:

Table 1: 'Protection Criteria for DVB-T', Chester '97: Annex 5, Section 3

Wanted	DVB-T/8 MHz								
Unwanted	Radiomic (Companded)		Default e.r.p. (dBW)		-13		Default Transmitting antenna height (m)		1.5
Service Identifier	NR8								
Δf (MHz)	-12.0	-4.5	-3.9	0.0	3.9	4.5	12.0		
PR (dB)	-32.0	-27.0	4.0	4.0	4.0	-27.0	-32.0		

A1.3 UK planners subsequently relaxed protection ratios by 3dB and the values in table 2. were used by the BBC for the geographical availability data supplied after 2002 and by JFMG.

Table 2: Extract from 'Parameters to be used in the production of the SAB overlays', BBC

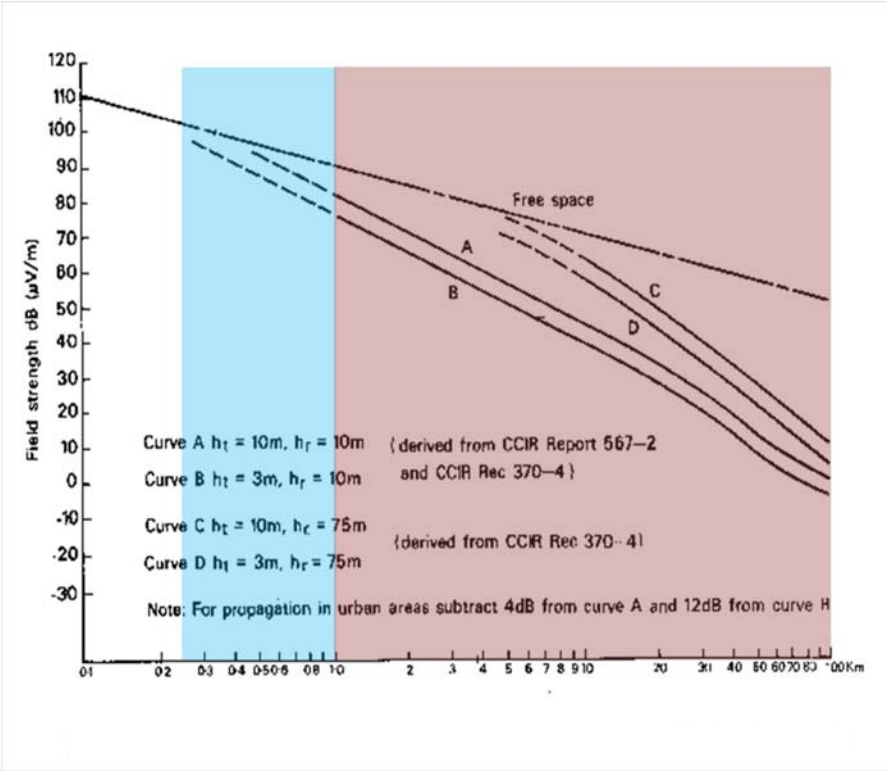
Channel	N	N+1	N-1
Protection Ratio	1dB	-31dB	-31dB

Interference Ranges

A1.4 For interference ranges above 1km no co-channel wireless microphones are permitted to be assigned indoors or outdoors. It is deemed that with the interferer so remote from the viewing household there is little possibility of determining the source of interference to reception. This range is indicated in Red on the propagation curves in Figure 2.

[15] Reference reception conditions for digital television', Chester '97: Annex 1, Table A1.50

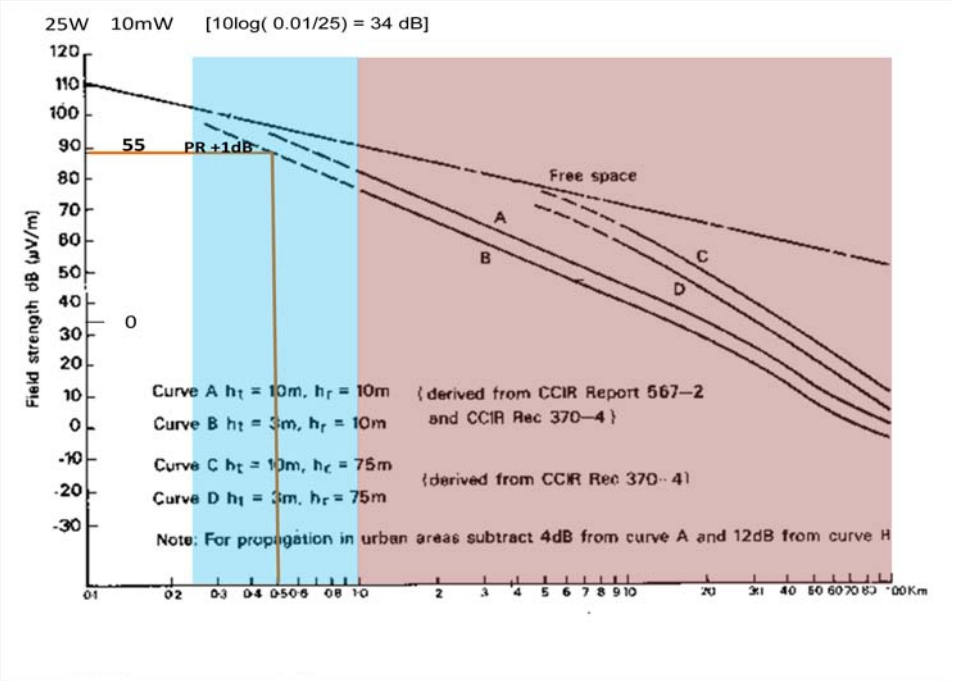
Figure 2: UHF Propagation curves – 25 W ERP (50% time, 10% locations, rural)



A1.5 For interference ranges between 250m and 1km there may be the possibility to identify the cause of interference to reception but no wireless microphones are permitted to be assigned outdoors. Considering indoor use however, an additional building loss, typically 7dB [Chester '97] decreases the interference range of the wireless microphone such that it falls below 250m. The assumption is then made that the wireless microphone is part or very close to the production if not including the domestic receiving location. In these circumstances the wireless microphone would be assigned for indoor use, but not outdoors where the interfering range is higher. The interference range from 250m to 1km is indicated in Cyan on the propagation curves

A1.6 The worst case where domestic reception at the edge of the service area requires protection is shown in Figure 3. Though the threshold varies according to frequency across the UHF TV bands, taking the minimum equivalent field strength to be a nominal 56dBμV/m and applying the 1dB protection ratio we have a maximum interfering field strength of 55dBμV/m. Scaling the propagation curves for a 10mW ERP wireless microphone we derive an interference range of around 500m. Curve B reflects a wireless microphone transmitter at height 3m and the victim domestic receive antenna at 10m. As the interference range falls within the Cyan co-channel outdoor use is therefore not permitted within the noise limited service area, but with additional building shielding the interference range decreases below 250m. As a result co-channel indoor assignments are permitted within the service area of a digital station

Figure 3: Worked example showing interference range of a wireless microphone at the edge of a digital service area



A1.7 RMCT automates the process of applying the appropriate protection distances extending beyond the edge of noise limited coverage for every 1km square across the UK for every channel in the Interleaved Spectrum, producing the appropriate data files to reflect geographical availability. Given 1km resolution the minimum protection distance around the edge of coverage is 1km, comfortably more that the calculated figure and affording additional protection to digital reception.

A1.8 The result is that the compatibility model permits, for the post DSO network, any channel to be assigned indoors regardless of location. Whilst good for geographical availability of interleaved spectrum, this is a weakness of the legacy approach which considers only protection of television reception. Assigning a wireless microphone receiver which may be subject to high levels of incoming digital television transmissions could compromise its performance. The legacy approach was originally devised to protect reception of analogue television where protection ratios are substantially higher and interference ranges much greater than for digital television. As a result wireless microphones are not assigned and used where analogue television field strengths are high. This isn't the case with a digital only network and further availability guidance is therefore required to best advise applicants of the most suitable channels where incoming interference is minimised. It may be that with substantial building shielding or other installation measures very high levels of incoming digital television interference can be tolerated so it would be disproportionate to prohibit wireless microphones access to particular channels, but by giving the information via the look-up tool, the applicant can decide for themselves.

A1.9 Additionally, a four bar indicator has therefore been incorporated to indicate spectrum 'quality' for indoor availability, based on increasing levels of predicted digital transmissions. Each bar reflects a 7dB increase in digital television interference from four green indicating a minimal level less than 56dBµV/m through to one green indicating protection for field strengths greater than 70dBµV/m. It isn't intended to be a rigorous indicator but it does give sufficient information to guide

applicants to identify the best spectrum with respect to incoming levels of digital television interference.

Adjacent guard bands

A1.10 The outdoor availability of spectrum for wireless microphones is also dependent upon availability in adjacent channels and according to the recommendation of ERC Report 088, a 500kHz guard band may be applied in the wanted channel. If the adjacent channel is occupied by DTT, a guard band is applied at the edge of the wanted channel to protect the wireless microphone. Depending therefore upon the adjacent channels, the available frequency range in the channel may be 8MHz, 7·5MHz or 7MHz.

A1.11 The use of spectrum adjacent to the Interleaved bands is not certain so to avoid assigning wireless microphones which may be vulnerable to adjacent channel interference, now or in the future, 500kHz guard bands have also been universally applied at these spectrum boundaries, namely at the bottom of Ch21, the top of Ch30 and the top of Ch60.