

Response to:
**Digital dividend: 600 MHz band and geographic interleaved spectrum
Consultation on potential uses**

The BBC welcomes the opportunity to respond to this consultation.

The BBC welcomes spectrum being made available for new services, provided that this is done in a manner which minimises interference to existing services – particularly digital terrestrial television (DTT) and programme-making and special events (PMSE).

There is one issue that we wish to highlight; the use of frequency offsets with DVB-T2 EC modes. The BBC strongly supports the retention of the use of frequency offsets with such modes. The continued use of such modes is the best way of meeting Ofcom's objectives on spectrum efficiency at least cost. Abandoning the use of offsets and EC modes would lead to the loss of 2% of the capacity available for HD services on PSB3 nationwide (to the detriment of viewers of terrestrial HD services and the DTT platform overall), or prohibitively costly infrastructure changes. Based on our initial analysis, we believe that any issues to geographic interleaved spectrum are likely to be limited in number, highly localised and relatively low-cost to mitigate.

Question 1: Do you have any comments on the application of the protection clause to all new licences for the 600 MHz band and geographic interleaved spectrum?

The BBC considers the protection clause essential to protect DTT coverage from interference resulting from new licensees of the 600 MHz band and the geographic interleaved spectrum.

The BBC also considers that the procedures to invoke the protection clause will be paramount to its success. Potential licensees of interleaved spectrum will need to plan their network infrastructure with a high degree of confidence of non-interference to DTT coverage, well beyond simply complying with technical licence conditions. If this were not the case, the protection clause could only be applied retrospectively, creating a situation where costly infrastructure might have to be re-engineered or abandoned.

Wherever possible, new networks should be co-ordinated with the existing DTT network at the earliest possible stage to prevent interference. This requires consideration of planned DTT signal levels, the C/I performance of DTT receivers (and the corresponding ACS values) and the out of band characteristics of the new transmitters (and corresponding ACLR values). In this way, it should be possible to avoid costly re-engineering of new services that are found to interfere with existing networks after deployment. Although this is a potentially complex task, we believe that this is the most effective way of preventing interference in practice. The BBC therefore supports the statement in Section 4.25 of the current consultation document, and encourages Ofcom to continue the required technical studies necessary in pursuit of this.

The BBC notes that future DTT networks may carry the least risk of interference as they would naturally be co-ordinated with the existing networks whose service offering they would be seeking to enhance. Since Ofcom regards DTT as the most likely application for this spectrum (paragraph 4.21) the BBC notes that co-location of DTT services may be regarded as a special case.

Question 2: Do you have any comments on our approach to technical licence conditions for the 600 MHz band and for geographic interleaved spectrum?

Ofcom's previous studies on spectrum usage rights concluded that different SUR values would be required for each candidate radio technology¹. Consequently, it is difficult to see how a simple SUR approach would facilitate a technology-neutral award. The approach of using SURs might facilitate spectrum trading, but given the complex interference scenarios that are possible and the requirement to observe a protection clause, the approach would have limited benefits and network coordination would still be required. We note that Ofcom chose SURs for the TLCs in the 1452-1492MHz award² in 2008 and this band was (all) purchased by one firm and has since lain fallow and no attempts have been made to trade the spectrum. As such, the success of the SUR approach remains unproven.

We support Ofcom's conclusions concerning the transitory nature of interference from mobile transceivers and the need to protect DTT from the sporadic picture break up that might result. We are however concerned by the suggestion that a guard band of 8MHz from existing DTT services might be sufficient to prevent interference, and are unclear how Ofcom has reached such a view. Due consideration of the ACS performance of DTT receivers (taking into account at least $N\pm 1$, $N\pm 2$ and $N+9$ (image channel) offsets), the interference characteristics of the new services, the ACLR of the handsets and the coupling mechanisms between DTT installations and mobile will be required to provide the necessary protection.

Initial work on the interference characteristics of mobile handsets within ITU-TG4 suggests that increased protection ratios (i.e. reduced ACS values) will be necessary when considering handset (UE) interference into DTT receivers³. Ongoing studies within TG4 suggest that DTT receivers may require additional protection margins for LTE signals. This work suggests that different EIRP limits and consequent TLCs will be required for different candidate technologies.

We note the ongoing consideration of the 800 MHz band and the concerns regarding mobile-to-DTT interference arising from image channel performance of existing super-heterodyne architecture DTT receivers, and believe similar factors will affect the 600 MHz band. The situation is in fact potentially much worse than for the 800 MHz band as there are two adjacencies to consider. Given this, and with reference to our answer to Question 1, we conclude that compliance with technical licence conditions will not in itself guarantee protection of existing DTT.

Question 3: Do you have any evidence that using frequency offsets with DVB-T2 EC signals might have an adverse impact on uses of adjacent interleaved spectrum?

In view of the analysis of paragraph 4.34, the BBC believes that DVB-T2 EC signals with frequency offsets do not generally have any greater impact on adjacent channels than DVB-T signals with frequency offsets. In practice the reverse may be true. In our opinion, the restricted frequency axis of Figure 4 does not indicate the true extent of "area B", within which a DVB-T2 signal generates less energy in the adjacent channel than DVB-T. This area comprises the greater part of the adjacent channel and offers a positive benefit to uses of adjacent interleaved spectrum.

The BBC wrote to Ofcom in October 2009 on a number of matters including the use of frequency offsets with DVB-T2 EC and its implications for IR2022, which were covered in an attached technical paper. The conclusions of this paper still stand and the BBC would welcome the opportunity to discuss these further with Ofcom.

¹ <http://www.ofcom.org.uk/consult/condocs/clearedaward/transfinite.pdf>

² http://www.ofcom.org.uk/consult/condocs/1452_1492/1452_1492.pdf

³ ECC Report 138 discusses the C/I characteristics for UMTS signals into DTT receivers. See <http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP138.PDF>

To address the questions for geographic interleaved spectrum in more detail, the following analysis compares the potential impact of two different scenarios. In the first, we consider continued use of frequency offsets with DVB-T2 EC signals. In the second, the impact of discontinuing this practice is considered.

Continued use of frequency offsets with DVB-T2 EC signals

Ofcom identifies two main categories of potential use for the interleaved spectrum; these are further DTT, and non-DTT use.

i. Further DTT.

In order to derive maximum benefit from the existing receiver base, the BBC believes that further DTT services are most likely to use DVB-T (consider for example the launch of early geographic interleaved services such as Channel M in Manchester). If deployed in the adjacent channel to an existing DTT service with a frequency offset, it is most likely itself to be offset in the same direction. Under these circumstances there would be no relative offset between the new and existing DTT service.

Ofcom highlights the potential for a limited number of instances in which a new DTT service may be in a “sandwich” channel, with services offset towards it on either side. The BBC notes that, even in the case of two DVB-T services offset towards each other, the protection ratios demonstrated by modern DVB-T receivers typically meet or exceed the criteria used in the UK planning model. Concerns about this case may therefore be driven primarily by infrastructure considerations, rather than reception considerations.

The BBC has analysed the indicative channels identified in the consultation document to determine whether there is any evidence that a problem might occur due to the use of an offset with a DVB-T2 EC signal. The results of this analysis were:

- According to current assumptions, the indicative channel is adjacent to PSB3 in approximately 1/6 of the instances
- Most of these give no particular cause for concern
- In a few isolated cases, an offset applied to the DVB-T2 signal implies that the adjacent, geographic interleaved signal would also need to carry the same offset. (In some cases this could also imply that it might be desirable for the same offset to be applied to a signal in the other channel adjacent to the geographic interleaved channel. However, as noted above, for two DVB-T signals this is not strictly necessary for the operation of receivers as intended and as such may be driven more by the demands of infrastructure than coverage.)
- In only two cases, a more significant issue was identified:
 - At Caldbeck, nine multiplexes occupying channels 22 to 30 all carry a negative offset, due to the policy of applying offsets at band-edges (in this case channel 30) and the consequent use of offsets on other adjacent channels. Channel 21 is one of two geographic interleaved channels and, being band-edge, would carry a positive offset. In this case, PSB3 occupies channel 22, and there would therefore be a small spectral overlap of the PSB3 and geographic interleaved signals.

Even under these conditions, it seems unlikely that significant reception difficulties would be encountered in practice in the target area. The BBC believes that receiver protection ratio would still be sufficient to deliver the intended geographical interleaved coverage in all but rare circumstances, particularly if, as seems likely, a more robust DVB-T transmission mode such

as 16-QAM rate $\frac{3}{4}$ is used. In addition, in this case the PSB3 service in channel 22 is intended to serve southern Scotland, and uses a directional antenna. This may afford some small but useful additional reduction of the channel 22 signal towards the intended target area for geographical interleaved award (Carlisle).

As further mitigation it may also be appropriate to consider whether an exception to band-edge offset policy could be permitted for channel 21 in this specific case.

- At Stockland Hill, PSB3 occupies channel 29 with a positive offset, and the indicative channel for geographic interleaved (channel 30) would be expected to carry a negative offset according to current band-edge policy, again creating a small spectral overlap. As above, an appropriate measure to address this could be to consider whether an exception to band-edge offset policy could be permitted in this case. Alternatively, the rationale for use of the frequency offset in channel 29 could be re-examined to establish whether it could be removed.

In summary, therefore, the BBC believes that the use of frequency offsets with DVB-T2 EC will not cause adverse effects on the use of geographic interleaved spectrum for further DTT other than in highly unusual circumstances; and that in practice, work-arounds are likely to be available should any such problems become apparent.

On this evidence, we consider that there is no case for a change in policy and that the use of DVB-T2 EC with frequency offsets should continue to be permitted.

ii. Non-DTT use.

As Ofcom notes, for existing known uses such as PMSE a guard band of a few hundred kHz from any high-power DTT use may already be necessary and under these circumstances, the BBC's view is that the reduced energy of DVB-T2 (relative to DVB-T) in the large majority of the adjacent channel is a benefit rather than an impediment to such uses. Overall, the BBC feels that this benefit would more than outweigh any disadvantages to such uses from the slightly wider occupied bandwidth of the DVB-T2 EC signal.

The BBC agrees with Ofcom's view that the same is likely to be true of other potential uses such as cognitive devices, for the same reasons.

Use of frequency offsets with DVB-T2 EC no longer permitted

Ofcom states (paragraph 4.36) that ceasing the use of EC mode would carry the lowest risk and cost to DSO if the use of EC is shown to have a negative impact on uses of adjacent interleaved spectrum. As Ofcom is aware, the BBC has instigated the introduction of suitable non-EC modes into the UK D-Book published by the DTG, to reduce the chances of this option being precluded by the emergence of an early legacy issue with receivers.

Nevertheless, the BBC feels that this option is still likely to carry considerable cost and risk and should not be exercised without the utmost care and consideration of all relevant factors. These include:

- Loss of capacity. As Ofcom has noted in paragraph 4.35, the adoption of a non extended carrier mode would result in a loss of 2% of multiplex capacity, nationwide.

- As Ofcom correctly points out, such a reduction in capacity would delay the deployment of four and subsequently five HD services in PSB3 to all DTT viewers across the UK
- Ability of equipment at transmitting stations to work on the non-EC modes recently specified by the DTG is not yet proven. Such equipment could require costly upgrade or replacement.
- Similarly, receivers in the market have not been tested against the non-EC modes recently specified by the DTG. As yet the need to test receivers against these modes has not been agreed by DTG members and accepted into the receiver test specifications, as they are concerned among other things about the increased test costs that may result. Accordingly it is not certain that there is not already a legacy, although compatibility with early silicon has been demonstrated.

Conclusion

Our analysis has shown that the continued use of frequency offsets with DVB-T2 EC would at worst have small scale, highly localised impact on the use of geographic interleaved spectrum and that suitable mitigation measures are likely to be available in such isolated cases. Therefore the BBC believes that the case for continued use of frequency offsets with EC modes is compelling. Conversely the consequences of a change of policy on the use of offset with EC modes would have a highly significant adverse impact on the capacity available for HD services on PSB3 nationwide, to the detriment of all viewers of terrestrial HD services and the health of the DTT platform overall.

The long established use of offsets within UK DTT frequency planning, and the fact that the DVB-T2 modes specified for validation for use in the UK and adopted into the reference parameters by Ofcom were EC modes, set a clear expectation in 2009 regarding the continued use of both EC mode and frequency offsets. The BBC strongly believes that this decision should not be revisited in the case of PSB3 because of the significant impact that such a reversal would have on the undertakings made on service development on PSB3 (to provide 5 HD services by 2012) and the resulting adverse impact on the development of Freeview HD.

The BBC remains supportive of the adoption of non-EC DVB-T2 modes into the test regime for UK receivers to maintain maximum flexibility for the increased adoption of DVB-T2 on other UK multiplexes in the future.

Finally, the BBC suggests that Ofcom may wish to revisit the policy for band-edge offsets once the outcome of the 600 MHz and geographic interleaved spectrum awards are known. If the spectrum is used for DTT or a similar application, there is likely to be no need for the additional protection afforded by band-edge offsetting.

Question 4: Do you have any evidence mobile services using the 600 MHz band and geographic interleaved spectrum could cause harmful interference to cable television?

The BBC is aware of a number of studies providing evidence of interference to cabled TV services from mobile transmitters. The BBC understands that this is part of a wider problem affecting not only cable television in the 600 MHz band but potentially also television reception in general in other parts of the UHF spectrum, as mobile services are considered for deployment in spectrum traditionally used for broadcasting.

With specific reference to the question of interference to cable television, the FCC investigated this problem in 2005⁴ and concluded that a continuous DVB-H source operating at a power as low as 6dBm could interfere with a DTV receiver at 2m. Increasing the power to 15dBm resulted in interference at 10m.

Studies commissioned by Cable Europe in more controlled conditions within an RF anechoic chamber have indicated co-channel interference problems at 3m for an LTE EIRP of 5dBm. Image channel (N+9) interference has been recorded at 3m for an LTE EIRP of 12dBm. This is relevant to both CATV and DTT protection, as devices operating in the 600MHz band could interfere with DTT services at 72MHz offset (i.e. UHF CH22 to 30).

Research by the Dutch regulator⁵, Agentschap Telecom, concluded that an LTE handset operating at 25dBm ERP within 3m of a CATV installation will cause interference to 3 out of 4 television sets.

Ofcom's own recent report⁶ on LTE interference to DTT concluded that UHF distribution systems for distributing subscription services to second TV sets in the home were vulnerable to co-channel interference. It was also noted that LTE transmitters operating at 28dBm in the N+9 channel of a super-heterodyne DTT tuner could provoke picture failure at a distance of 1.4m from the flylead. A combination of lowpass filters and double screened coax cables are proposed to mitigate against this problem in the 800MHz band, but this effect will be much harder to deal with in the 600MHz and interleaved award bands. TV white space devices could also generate problems.

It is likely that portable receivers, often used for second sets, will be vulnerable to interference from LTE handsets, both from blocking effects and from adjacent channel or image channel C/I degradation. Ofcom's market research (December 2009) indicates that 33% of homes use DTT for second TV sets⁷, so up to 8.5 million households could be affected. For LTE deployed in the 800 MHz band, this issue is primarily a concern for the higher UHF channels retained for broadcasting following clearance (e.g. channels 57 – 60) but any deployment of mobile services in the 600 MHz band could cause equally significant effects to reception in channel 30 and below.

In summary, we believe there is a growing body of evidence to indicate that interference to cable and terrestrial TV services from mobile transmitters could be a significant problem.

Question 5: Do you have any comments on protecting PMSE in channel 38?

The BBC supports the use of channel 38 for PMSE and indeed this will be essential for our ongoing ENG operations once access to channel 69 is terminated. Accordingly we believe that a similar degree of protection to that currently enjoyed in channel 69 must be provided. We note that channel 38 is potentially vulnerable to interference from new services deployed in channel 37 (600 MHz cleared award) and channel 39 (displacement from channel 49 as a result of 61/62 clearance, and potentially geographic interleaved award). Further technical studies on the C/I characteristics of PMSE receivers (analogue and digital) are required to

⁴ FCC/OET 07-TR-1005: "Direct-Pickup Interference Tests of Three Consumer Digital Cable Television Receivers Available in 2005" (http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-275668A1.pdf)

⁵ Agentschap Telecom 2009: "Study of interference to digital cable TV caused by 800 MHz mobile LTE applications" (<http://www.agentschaptelecom.nl/english/Documents/Report%20study%20interference%20cable%20tv-LTE%20tranche%201%20and%202.pdf>)

⁶ ERA Report 2010-0026: "LTE Interference into Domestic Digital Television Systems",. (<http://www.ofcom.org.uk/consult/condocs/800mhz/2010-0026.pdf>)

⁷ http://www.ofcom.org.uk/research/tv/reports/dtv/dtv_2009_q4/dtv_2009_q4.pdf

properly understand the interference susceptibility of these devices. We are aware that Ofcom commissioned such work from ERA-Cobham in 2009, but are concerned that the results of these studies remain unpublished.

The out-of-band characteristics of mobile transmitters potentially deployed in channel 37 and 39 are also of concern, as this energy will degrade the sensitivity and subsequent range of our PMSE receivers. Sparse broadcast networks, designed for fixed reception, are likely to have the least impact on PMSE operations in channel 38, while mobile TDD and FDD devices are likely to be more destructive.

Question 6: Do you have any comments on non-technical licence issues and the way we propose to approach them?

The BBC responded at length on non-technical licence conditions in our previous responses to Ofcom consultations regarding cleared and interleaved awards. Among our key conclusions were:

- That similar rules should apply to all licensed multiplex operators, whether they have obtained their licence as a result of a selection organised by the then regulator, the ITC, or as part of a spectrum award. In particular the BBC believes that operators of a Television Multiplex Service as defined in the Communications Act 2003 should be required by the Wireless Telegraphy Act to hold a Broadcasting Act licence.
- That there are strong arguments for including competition provisions in all WTA licences, and in particular for retaining the BA licence competition clauses in the WTA multiplex licences.
- That existing and potential new DTT multiplex operators should operate under the same technical framework, including technical code and operating parameters.

With regard to the last point particularly, it is important to stress that technical interoperability is an essential requirement for new multiplex operators seeking to provide a service, for existing multiplex operators to have their service protected from new services, and for viewers of these services to enjoy a seamless experience. The logic of providing a new service to existing aeriels can only prevail if new and existing services are interoperable. Technical Licence Conditions addressing only the use of the radio frequency spectrum are insufficient to provide such a guarantee of interoperability. For example, if the Service Information on new multiplexes is not of sufficient quality it could adversely affect the availability of the existing services. The scope for disruption of viewing and reputational damage to existing multiplex operators from minor inconsistencies in SI should not be underestimated.

Consequently the BBC does not regard the inclusion of the concept of interoperability in paragraph 4.41 – “... to facilitate technical interoperability between any new and existing DTT services” – as sufficient. In order to protect both the existing users and viewers, interoperability must be guaranteed and must therefore be a requirement of licence conditions.

Similarly, the BBC does not believe that the absence of restrictions on use represents a safe approach without an absolute guarantee that such use will not disrupt the legitimate reception of existing multiplexes elsewhere in the UHF spectrum. As argued above, in the case of a DTT signal, the requirement is for guaranteed interoperability; if the signal in the awarded spectrum is not DTT, then it must not pose any threat to the correct operation of a DTT receiver that might encounter it during e.g. a frequency scan.

The BBC would also urge Ofcom to ensure that licence conditions require licensees to provide information sufficient for Ofcom to determine whether or not restrictions on interference are being adhered to, in the event of disputes.

Question 7: Do you have any comments on our assessment of the most likely uses of the 600 MHz band and geographic interleaved spectrum? Are there any potential uses we have not mentioned that should be considered?

The BBC believes that the consultation document includes the most likely uses of the 600 MHz band and geographic interleaved spectrum.

Question 8: Are there any distinctive considerations and uses for this spectrum in the nations and regions of the UK?

The availability of geographic interleaved spectrum would appear particularly suited to the provision of services tailored to local needs, such as national television services and broadband wireless access (e.g. to sparsely populated areas, where the business case for providing high speed broadband through DSL or cable is difficult).

Question 9: Do you have any comments on our continued inclusion of channel 36 in the award of the 600 MHz band?

The BBC agrees with Ofcom's assessment that, compared to when Ofcom previously considered this issue, the arguments in favour of an early release of channel 36 (for a mobile television service for example) are considerably less compelling. (We also note that the "L Band" spectrum purchased by Qualcomm has not been used to launch mobile television services).

The BBC also agrees that it is substantially less likely that channel 36 might be needed to facilitate Digital Switchover or roll-out of DVB-T2, in the light of recent decisions taken by Ofcom with regards to the use of spectrum. However, as described more fully in our answer to Question 10 below we view the 600 MHz band in particular as having potentially great value to the DTT platform.

Question 10: Do you have any comments on our intention to maintain a market-led approach to awarding the 600 MHz band and geographic interleaved spectrum?

The BBC has made its views on this approach clear in previous responses to consultations on the award of this spectrum.

However, we wish to re-state here the possibility that a purely market-based award of this spectrum may fail to allocate it to uses which maximise public (rather than private) value. The 600 MHz band in particular is potentially of great value to the DTT platform, as it enables an expansion of terrestrial provision of HD services using DVB-T2; should this band be lost to a non-broadcast application, future expansion of HD services on DTT beyond the PSB3 multiplex could prove very difficult.

In addition, the BBC remains concerned that a market-led approach may not provide adequate protection against spectrum hoarding and thus present a risk to the overall objective of efficient use of the spectrum.

Question 11: What information can you provide on packaging and award-design considerations?

The BBC notes that Ofcom will be considering these issues in detail in a further consultation document. However, at this stage, we would urge Ofcom to package spectrum and design the award in such a way that it can be used for a broad range of services, including DTT and PMSE.

Question 12: When would you like to start operating new services using the 600 MHz band and/or geographic interleaved spectrum?

The BBC notes that the geographic interleaved spectrum identified in the consultation document is described as “indicative” and that it may not be completely clear what frequencies are available for this purpose until the planning for channel 61 and 62 clearance is at a much more advanced stage. The BBC believes that no attempt should be made to award such spectrum before the frequency plan is sufficiently stable to give potential bidders confidence that they fully understand what they are purchasing, and their protection obligations.

We also believe that the spectrum needs of the London Olympic and Paralympic Games in 2012 would make use of this spectrum in the London area prior to the conclusion of the London Games extremely difficult.