

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title: **Digital dividend: Cognitive access**

To (Ofcom contact): william.webb@ofcom.org.uk

Name of respondent: Andy Sago

Representing (self or organisation/s): **British Telecommunications plc**

Address (if not received by email):

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Name Andy Sago

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**BT Response to the Ofcom Consultation on:
Digital dividend: Cognitive access**

Summary of BT Views

In principle, BT is supportive of cognitive access using interleaved spectrum which would allow service providers and consumers to gain access to new spectrum which is highly suited to mobile applications and services. We are supportive of Ofcom's approach of promoting cognitive radio solutions involving either spectrum sensing or the use of a geolocation database. We agree that the construction of a beacon network is not a proportionate response to the problem of informing cognitive devices of available frequencies.

BT's current assessment is that the database approach may provide the greatest opportunities for facilitating cognitive radio in the medium term. We would urge Ofcom to expedite the specification and development of a database solution.

Although there may in theory be plenty of 'white space' interleaved spectrum for cognitive use, stringent sensitivity requirements for cognitive devices may remove a significant portion of the usable white space. Our own initial modelling studies for the UK agree with those of Ofcom in showing that, in some locations, a cognitive device with the sensitivity level proposed by Ofcom may in practice identify *all* Digital Terrestrial TV (DTT) channels as occupied and, therefore, will have no white space available for its operation. This leads to a high level of uncertainty for potential providers of services utilising cognitive devices in the interleaved spectrum.

Avoiding Programme Making and Special Events (PMSE) transmissions presents a significant challenge to cognitive use. We would like to see a fully transparent justification for the current requirement for PMSE to operate in any interleaved spectrum. Noting Ofcom's broader DDR activities, we would urge Ofcom to study whether justified PMSE requirements could be consolidated into a smaller amount of spectrum occupying specific DTT channels (such as in the US Federal Communications Commission (FCC) 'safe harbour' suggestion), or used only in the other frequency bands available to PMSE. This would greatly improve the potential utility of cognitive radio applications and improve overall spectrum efficiency.

BT agrees with Ofcom that politeness protocols are needed in order to ensure that the available spectrum is shared fairly between cognitive devices. However, ensuring politeness using the parameter values proposed by Ofcom may preclude delay-sensitive applications for cognitive devices, including wireless voice over IP (VoIP) and gaming. An approach to politeness may be required that takes into account not only airtime fairness but also differences in the quality of service (QoS) requirements for different applications. We believe that this issue may need to be studied in much greater detail by Ofcom to fully understand the tradeoffs between increased fairness and the exclusion of certain applications.

BT believes that Ofcom should follow the example of the US FCC in making a distinction between the operational requirements for fixed and mobile cognitive devices. For fixed devices with geolocation database access capability much higher power levels should be allowed in principle. Allowing higher powers is particularly important in order to enable the operation of cognitive base stations in scenarios similar to those specified by the IEEE 802.22 standard.

Answers to the questions in the consultation document

Executive summary

Question 1. The executive summary sets out our proposals for licence-exempting cognitive devices using interleaved spectrum. Do you agree with these proposals?

In general, BT is supportive of cognitive access using interleaved spectrum which would allow service providers and consumers to gain access to new spectrum which is highly suited to mobile applications and services. We agree with the general framework put forward in this consultation to facilitate cognitive access. Areas where we have differing views to Ofcom or provide additional information are highlighted in our responses to individual questions below.

Detection

Question 2. Do you agree that the sensitivity level for DTT should be -72 dBm?

BT tends to agree with the reasons stated for using the figure of -72 dBm. We note that, on Ofcom's own figures, many tens of thousands of citizens with fringe DTT reception may be inconvenienced from time to time by interference from cognitive devices, even using this sensitivity level. Ofcom should consider what mitigation measures, industry support, consumer advice and engineering resource may need to be put in place to deal with queries and complaints.

Question 3. Do you agree with an additional margin of 35 dB resulting in a sensitivity requirement for cognitive devices of -114 dBm?

The sensitivity requirement for cognitive devices is the key figure for protection of licensed services from harmful interference, and BT agrees with Ofcom that such sensitivity requirements are necessary in order to protect the primary user in worst case fading scenarios. However, we wish to make the observation in the following paragraph regarding the resultant level.

Although there may in theory be plenty of 'white space' interleaved spectrum for cognitive use, such stringent sensitivity requirements for cognitive devices may remove a significant portion of the usable white space. Very recent studies in the US, for example, indicate that a threshold of -114 dBm reduced the recoverable white space by a factor of three¹. Furthermore, our own initial modelling studies for the UK agree with those of Ofcom detailed in section 2.3 in showing that, in some locations, a cognitive device with a -114 dBm sensitivity level will identify *all* DTT channels as occupied and, therefore, will have no white space available for its operation. This leads to a high level of uncertainty for operators wishing to provide services utilising cognitive devices in the interleaved spectrum.

Question 4. Do you agree with a maximum transmit power level of 13 dBm EIRP on adjacent channels and 20 dBm on non-adjacent channels?

BT tends to agree that such power levels are appropriate for devices that use sensing alone in order to provide protection to primary DTT receivers operating in adjacent or non-adjacent channels.

BT believes that Ofcom should follow the example of the US FCC in making a distinction between the operational requirements for fixed and mobile cognitive devices. For fixed devices with geolocation database access capability much higher power levels should be allowed in principle. For example the FCC specifies that fixed devices may operate at up to 4 Watts EIRP. Allowing higher powers is particularly important in order to enable the operation of cognitive base stations in scenarios similar to those specified by the IEEE 802.22 standard.

BT further considers that Transmit Power Control (TPC) should be a requirement for all cognitive devices, regardless of their maximum transmit power level.

¹ M. Mishra and A. Sahai, How much white space is there, Technical Report, Electrical Engineering and Computer Science, University of California at Berkeley, January 11, 2009, <http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-3.html>

Question 5. Would it be appropriate to expect DTT equipment manufacturers to improve their receiver specifications over time? If so, what is the best mechanism to influence this?

Manufacturers will not improve DTT receiver performance without good reason. The current approach within the TV industry to DTT receiver performance stems from the near-exclusive right to spectrum that has been enjoyed from the start of TV transmissions. Ofcom has statutory duties under the Communications Act 2003 to ensure the optimal use of the electro-magnetic spectrum and to ensure that a wide range of electronic communications services - including high speed data services - is available throughout the UK. To bring industry around to a more efficient use of spectrum (thereby enabling increased cognitive use) will require pressure. One route to achieving this could be through Ofcom working with appropriate bodies such as the DVB Project to agree tighter performance levels for receivers.

Question 6. Do you agree that the reference receive level for wireless microphones should be -67 dBm?

BT has no comment on this figure. We would however make the broader point that a requirement to avoid causing interference into spectrum occupied by PMSE transmissions that may commence at any point in time presents a significant challenge to cognitive use. We would like to see a fully transparent justification for the current requirement for PMSE to operate in any interleaved spectrum. Noting Ofcom's broader DDR activities, we would urge Ofcom to study whether justified PMSE requirements could be consolidated into a smaller amount of spectrum occupying specific DTT channels (such as in the FCC 'safe harbour' suggestion), or used only in the other frequency bands available to PMSE. This would greatly improve the potential utility of cognitive radio applications and may improve overall spectrum efficiency.

Question 7. Do you agree with an additional margin of 59 dB for wireless microphones?

BT has no comment on this question.

Question 8. Do you agree with a sensitivity requirement for -126 dB (in a 200 kHz channel) for wireless microphones?

BT has no comment on this question.

Question 9. Do you agree with a maximum transmit power level in line with that for DTT? Are there likely to be any issues associated with front end overload?

BT tends to agree that the same power level should apply.

Further detail around front end overload and the design of wireless microphones needs to be provided before BT is able to comment on this aspect.

Question 10. Do you agree that the sensitivity level for mobile television receivers should be -86.5 dBm?

BT has no comment on this question.

Question 11. Do you agree with an additional margin of 20 dB for mobile television?

BT has no comment on this question in relation to mobile television. Please see our response to Question 3 for wider comments, in which we note that large implementation margins and consequent stringent detection levels can result in a cognitive device identifying *all* DTT channels as occupied and, therefore, it will have no white space available for its operation. This leads to a high level of uncertainty for operators wishing to provide services utilising cognitive devices in the interleaved spectrum.

Question 12. Is it likely that mobile television will be deployed in the interleaved spectrum? If so, would it be proportionate to provide full protection from cognitive access?

BT has no comment on this question.

Question 13. Should we take cooperative detection into account now, or await further developments and consult further as the means for its deployment become clearer?

Cooperative detection could greatly improve the probability of detection and may allow relaxation of the DTT detection sensitivity requirement at individual cognitive devices. However, the technique is still in the research domain, and has so far only been demonstrated through analysis and computer simulations, and not in laboratory or field tests. Cooperative detection could be incorporated as an additional detection tool at a later date. Thus BT agrees that further consultation may be necessary on this topic.

One regulatory issue we foresee with cooperative detection is that the achievable detection level depends on several factors, including the number of cooperating cognitive devices and their spatial arrangement². Therefore it would be difficult to test the detection capability of such cooperating cognitive devices on an individual basis to check device compliance before placing on the market.

Geolocation databases

Question 14. How could the database approach accommodate ENG and other similar applications?

To maximise the optimal use of the spectrum, short notice PMSE (such as ENG) should be updated in the database as quickly as possible, and spectrum sensing should additionally be used to avoid channels in use that have not yet been updated in the database. Our preference would be for all PMSE usage to be consolidated in part of the interleaved spectrum or operated in the other bands available to PMSE, which would avoid the problem altogether (see our response to Q.6).

Question 15. What positional accuracy should be specified?

BT tends to agree with the requirements for positional accuracy being somewhere in the region of 100 metres. We believe that this level of accuracy is more than adequate for the protection of DTT. Requiring much higher positional accuracy may preclude the use by cognitive devices of alternatives to GPS, such as mobile network triangulation. Such alternatives may be required in situations where GPS is either not available or its use is not cost-effective.

Question 16. How rapidly should the database be updated? What should its minimum availability be? What protocols should be used for database enquiries?

To account for PMSE usage, databases (including mirrors) should be updated within a set period after notification that particular frequencies are to be used. The period for updating will be dependent on the services included in the database, for example, if only DTT services are included then changes can be infrequent. The set period should be mandated by Ofcom.

The reliability and availability of the service must be mandated in an SLA. BT has no view at this stage on the required availability.

BT agrees that widely used protocols should be employed for querying the database.

Question 17. Is funding likely to be needed to enable the database approach to work? If so, where should this funding come from?

The operation of the database can be a commercial undertaking, and could be outsourced under an SLA agreed with Ofcom. Depending on the level of cost, it may be appropriate for Ofcom to fund this as part of its general spectrum management responsibilities.

Question 18. Should the capability to use the database for spectrum management purposes be retained? Under what circumstances might its use be appropriate?

² E. Viskotsy, S. Kuffner, R. Peterson, On collaborative detection of TV transmissions in support of dynamic spectrum sharing, In Proc. IEEE DySPAN, 2005, pp 338-345.

It would seem reasonable not to exclude this possibility, but it should be used sparingly and where properly justified, possibly after consultation. The example given of disabling a rogue device/model seems unlikely to be workable in practice. A true rogue device might fake its identity. Make and model would not be enough to identify individual devices, and thus if only this information is available then there would need to be clear guidelines as to what instances of interference would justify disabling all devices of one model from a particular manufacturer. If the database is to be run from outside Ofcom as a commercial operation, disabling a device or a model would require Ofcom to serve notice on the database operator to effect the disablement.

Overall BT considers that requirements placed on the manufacturers of cognitive devices for the provision and protection over-the-air of serial numbers, model numbers, MAC addresses and the like could be out of proportion to the benefits to any of the users of the interleaved spectrum, but there may be potential scenarios where control of all cognitive devices in a particular geographical area or in a particular channel could be justified.

Question 19. Should any special measures be taken to facilitate the deployment of cognitive base stations?

We acknowledge that use of fixed cognitive base stations (and fixed terminals) could be possible with significantly higher power levels than for mobile cognitive devices. The cognitive base station should include appropriate power control mechanisms. The maximum power level permitted for a particular location could be returned from the database lookup as suggested, but it could be problematic for a network already in operation if a subsequent check of the database returned a lower power limit. Restricting PMSE usage to certain parts of the spectrum would be beneficial for this scenario. Please see our note on this matter in our response to Question 6.

Beacon reception

Question 20. Where might the funding come from to cover the cost of provision of a beacon frequency?

Considering the balance of benefits and drawbacks, BT tends to disagree that the construction of a beacon network is an appropriate method of informing cognitive devices of free frequencies. If such a network were to be built, BT has no view on the source of funding.

Question 21. Is a reliability of 99.99% in any one location appropriate? Does reliability need to be specified in any further detail?

BT has no view on this question.

Comparing the different options

Question 22. Do you agree with our proposal to enable both detection and geolocation as alternative approaches to cognitive access?

Either method has its own drawbacks. At this stage BT agrees that detection and geolocation should be alternative approaches. We recognise that the development of a database solution could take some time to implement, but we consider that, in the fullness of time and for appropriate scenarios, the industry should work towards using geolocation and detection together to facilitate cognitive access.

Other important parameters

Question 23. Should we restrict cognitive use of the interleaved spectrum at the edge of these bands? If so, what form should these restrictions take?

BT does not consider that restriction of cognitive use at the band edges is necessary.

Question 24. Do you agree that there should be no limits on bandwidth?

BT agrees that the use of available bandwidth should be under the control of individual service providers. The 8 MHz channel plan used by DTT should not be a limitation for non-DTT services.

Question 25. Do you agree that a maximum time between checks for channel availability should be 1s?

For detection of wireless microphones, a one second channel availability check seems reasonable. A lower figure could be prohibitive for acceptable performance of a cognitive device. In practice, stage shows using wireless microphones (for example) could suffer some interference (lasting one second or less) even with a one second check time, and such interference may be unacceptable. Interference could be avoided by limiting wireless microphone usage to a small number of designated 8 MHz channels, which cognitive devices would be aware, perhaps through a geolocation database. Please see our note on this matter in our response to Question 6.

Question 26. Do you agree that the out-of-band performance should be -44 dBm?

BT notes that this value is similar to the performance requirements resulting from similar work in the US³.

Question 27. Is a maximum transmission time of 400ms and a minimum silence time of 100ms appropriate?

We agree with Ofcom that politeness protocols are needed in order to ensure that the available spectrum is shared fairly between cognitive devices. However, ensuring politeness by enforcing a maximum transmission time of 400 ms and minimum silence time of 100 ms may preclude delay-sensitive applications for cognitive devices, including wireless voice over IP (VoIP) and gaming. Our initial modeling indicates, for example, that with the above parameters the proposed politeness mechanism can result in unacceptable delays in VoIP services. A more refined approach to politeness may be required (e.g. the use of application classes) that takes into account not only airtime fairness but also differences in the quality of service (QoS) requirements for different applications. In view of this potential conflict, we believe that this issue may need to be studied in much greater detail by Ofcom to fully understand the tradeoffs between increased fairness and the exclusion of certain applications.

Question 28. Is it appropriate to allow "slave" operation where a "master" device has used a geolocation database to verify spectrum availability?

Yes, BT would be in favour of allowing slave operation to enable some future applications of the technology as mentioned in the consultation, for example in home networks and slave terminals operating to fixed based stations.

³ DePardo et al, Quantifying the impact of unlicensed devices on digital TV receivers, Technical Report ITTC-FY2007-44910-01, The University of Kansas, Kansas, USA, Study Commissioned by the New America Foundation, available from http://www.newamerica.net/files/NAF%20Spectrum%20Technical%20Report%20_FINALSUBMITTED_0.pdf

Conclusions

In principle, BT is supportive of cognitive access using interleaved spectrum which would allow service providers and consumers to gain access to new spectrum which is highly suited to mobile applications and services. We are supportive of Ofcom's approach of promoting cognitive radio solutions involving either spectrum sensing or the use of a geolocation database. BT feels that the latter option is the most promising in the medium term. We see that a combination of both approaches would be beneficial in the medium to long term. We agree that the construction of a beacon network is not a proportionate response to the problem of informing cognitive devices of available frequencies.

Although there may in theory be plenty of 'white space' interleaved spectrum for cognitive use, stringent sensitivity requirements for cognitive devices may remove a significant portion of the usable white space. Our own initial modelling studies for the UK agree with those of Ofcom in showing that, in some locations, a cognitive device with the sensitivity level proposed by Ofcom may in practice identify *all* Digital Terrestrial TV (DTT) channels as occupied and, therefore, will have no white space available for its operation. This leads to a high level of uncertainty for potential providers of services utilising cognitive devices in the interleaved spectrum.

Avoiding Programme Making and Special Events (PMSE) transmissions presents a significant challenge to cognitive use. We would like to see a fully transparent justification for the current requirement for PMSE to operate in any interleaved spectrum. Noting Ofcom's broader DDR activities, we would urge Ofcom to study whether justified PMSE requirements could be consolidated into a smaller amount of spectrum occupying specific DTT channels (such as in the US Federal Communications Commission (FCC) 'safe harbour' suggestion), or used only in the other frequency bands available to PMSE. This would greatly improve the potential utility of cognitive radio applications and improve overall spectrum efficiency.

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