

## Cover sheet for response to an Ofcom consultation

### BASIC DETAILS

Consultation title: Digital Dividend: cognitive access

To (Ofcom contact): William Webb

Name of respondent: Arqiva Limited

Representing (self or organisation/s): Organisation

Address (if not received by email):

### CONFIDENTIALITY

What do you want Ofcom to keep confidential?

Nothing

Name/contact details/job title

Whole response

Organisation

Part of the response

If there is no separate annex, which parts? **As**

**highlighted** [removed from this version by William Webb]

If you want part of your response, your name or your organisation to be confidential, 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

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Name Peter Couch

Signed (if hard copy)

Head of Strategy Development, for and on behalf of Arqiva Limited

## Arqiva response to Digital dividend: cognitive access

### About Arqiva

Arqiva has its headquarters in Hampshire, with other major UK offices in Warwick, London, Buckinghamshire and Yorkshire. It now has 9 international satellite teleports, over 70 other manned locations, and around 9000 shared radio sites throughout the UK and Ireland including masts, towers and rooftops from under 30 to over 300 metres tall.

The company is owned by a consortium of long-term investors led by Macquarie Communications Infrastructure Group and has 3 operating divisions: Terrestrial Broadcast, Satellite & Media and Wireless Access.

Arqiva is technology- and service-neutral and operates at the heart of the broadcast and mobile communications industry. We are at the forefront of network solutions and services in an increasingly digital world. The company provides much of the infrastructure behind television, radio and wireless communications in the UK and has a growing presence in Ireland, mainland Europe and the USA.

Arqiva is a founder member of Freeview (Arqiva broadcasts all 6 Freeview multiplexes and is the licensed operator of 2 of them) and was a key launch technology partner for Freesat. Arqiva is also the licensed operator of the Digital One national commercial DAB multiplex.

Alongside the BBC, Arqiva's Spectrum Planning Group plays a critical role in planning Digital Switch Over (DSO).

In addition, for broadcasters, media companies and corporate enterprises Arqiva provides end-to-end capability ranging from;

- outside broadcasts (10 trucks including HD, used for such popular programmes as Antiques Roadshow, Question Time, Proms in the Park, a wide range of sporting events and the IIFA Awards 2007 "BollyWood Oscars" with a huge worldwide audience);
- satellite newsgathering (30 international broadcast SNG trucks);
- spectrum management for Programme-Making & Special Events (PMSE) through subsidiary JFMG;
- 10 TV studios;
- playout (capacity to play out over 70 channels including HD);
- digital signage, including managing the output for CBS Outdoor's digital escalators and cross track projection on the London Underground; to
- satellite distribution (over 1200 services delivered).

In the communications sector the company supports cellular, wireless broadband, video, voice and data solutions for the mobile phone, public safety, public sector, public space and transport markets.

Major customers include the BBC, ITV, Channel 4, Five, BSkyB, Classic FM, the five UK mobile operators, Viacom, Turner Broadcasting, Metropolitan Police and RNLI.

## Introduction

Arqiva welcome the opportunity to respond to Ofcom's technical analysis and proposals relating to the introduction of Cognitive Access (CA) based services into the 'white space' of UHF spectrum. Whilst, Arqiva supports the principle of cognitive access to the UHF spectrum, as an element in securing optimal use of spectrum, it is important to acknowledge the rights of licensed users to protection from interference.

To this end, we are supportive of the ongoing work programme to qualify the conditions under which CA devices may be introduced and in particular the role that a geolocation data base may have in ensuring protection of licensed users. We consider ourselves ideally placed to facilitate such a solution, given our responsibilities for the planning of the High Power Digital Terrestrial Television (DTT) networks and through our ownership of the PMSE spectrum manager JFMG.

However, to prove the effectiveness of the geolocation based solution in conjunction with the proposed performance levels, as determined through the work undertaken to date, we would recommend extensive trials to provide the necessary certainty of protection for licensed users to ensure industry support for CA.

With reference to Ofcom's proposals we have responded to the specific questions raised within the consultation on a case by case basis and highlight the key technical/operational issues noted as;

- Sensitivity levels for Cognitive Access systems require further clarification
- Impact on adjacent and non-adjacent channels needs further work
- Uncertainties over path loss calculations need to be resolved
- Geolocation in combination with sensing would seem the most appropriate approach for the introduction of Cognitive Access systems
- How to achieve an appropriate level of power in Cognitive Access devices whilst not compromising licensed use

In addition to these technical/operational issues, we feel it important to emphasise the broader policy issues that result from the proposals to introduce Cognitive Access arrangements to the UHF spectrum. These issues fall into three categories;

1. timing;
2. access to spectrum on licence exempt (free) basis; and
3. protection for licensed users.

## Timing

This is an extremely busy time for the planning of Digital Terrestrial Television in the UK to achieve the Government's public policy objectives and facilitate the release of Digital Dividend spectrum. To this end we emphasise to Ofcom that priority should be given to the ongoing flexibility necessary to accommodate re-planning / redeployment of licensed use:

- Ofcom's recent consultation – clearance of 800MHz spectrum and the ongoing planning activity associated with the proposed displacement of DTT from channels 61 & 62
- Ofcom's proposals for the early launch of DVB-T2 services in interleaved spectrum before DSO completes
- Redeployment of PMSE services from channels 61-69 in a co-ordinated manner
- Ongoing planning changes to the DSO process.

## **Licence exempt (free) access to spectrum**

The opportunity cost of negatively impacting or displacing licensed use of retained spectrum will become clearer as a result of a range of uses and releases of spectrum for which Ofcom has or is due to establish a pricing mechanism in order to establish its value:

- Ofcom plans to release Digital Dividend Review spectrum (including a range of interleaved packages) via auctions to quantify the economic value of the spectrum to UK plc
- PMSE use is chargeable, with Ofcom proposing that the general level of charges to PMSE users should increase over the medium term
- Existing licensed DTT multiplex operators will be levied Administered Incentive Pricing (AIP), with the level informed by spectrum values identified via the DDR auctions
- MNOs planning to deploy wireless broadband applications in the 800 MHz block of DDR spectrum.

On the basis of the above it seems inconsistent that Ofcom should seek to facilitate Cognitive Access use of retained spectrum on a free basis prior to the conclusion of the above activities, as the true economic value of licensed use of this spectrum will not yet have been determined.

## **Protection for Licensed Users**

- Significant investment committed by broadcasters and Arqiva to the Digital Terrestrial Television service in the UK. DTT has become the default digital platform from a consumer perspective
- Licensed PMSE users create significant value for UK plc and also enrich citizen-consumers' lives
- Wireless Broadband provided by the MNOs is proving to be an attractive service to the consumer and continued investment is encouraged through initiatives such as 'Digital Britain'
- Licence exemption of interleaved spectrum for Cognitive Access use has no envisaged term even though licensed use is limited to 2026 – potentially impacting future spectrum flexibility

## **Summary**

There still remain a broad range of issues, both technical and policy related, that need to be addressed prior to the introduction of Cognitive Access based services into the UK market. We urge Ofcom to address these issues, and further relevant issues as they arise, to ensure that the timing and terms of introduction of Cognitive Access services can be considered appropriately.

## Consultation questions – Cognitive Access

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

Partially. See responses to individual questions.

In addition we note the following observations against the consultation;

- 2.5 It does not seem implicit in the second bullet point that Ofcom still intends to offer a combined award of 25 interleaved packages. – what is Ofcom’s latest thinking?
- 2.14 Third bullet. No reason for DVB-T2 to be described as ‘fragile’ since the mode intended for selection will have coverage/robustness closely equivalent to current DVB-T performance.
- 5.3 The consultation document does not mention what DVB-T mode is assumed for the quoted -84 dBm receiver sensitivity, although it appears from other published information that it may be 16QAM 3/4. In order to protect all licensed DTT operators from interference (for example digital RTSL operators who would be likely to use a rugged QPSK mode to maximise coverage at the expense of unneeded capacity) an assumption of up to a further 11 dB greater sensitivity may be required.

Whilst, we have provided our best current understanding of the technical operating conditions specific to licensed users we urge Ofcom to consider deploying extensive trials of Cognitive Access technology with full engagement of all stakeholders prior to its full introduction. Without this those wishing to deploy CA devices will face wide-ranging opposition based on the absence of proof of concept where it matters most: in the field.

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

No on the basis of the observations outlined below;

The interpretation of the predictions from which the -72 dBm figure has been derived needs to be clarified. The calculated extent of DTT coverage is based on interference limited predictions - the wanted signal having to exceed the sum of the interference, including the system protection ratio, for 99% of time to 70% of locations. It is unclear if Ofcom has considered location variation and predicted levels of interference when deriving the level to protect 99.9% of DTT receivers. In addition, the distribution due to location variation and prediction error does not appear to have been factored in, but this can only be ignored if ERA has included it in the shadowing loss figure of 35 dB. Ofcom please confirm the basis of this number’s derivation.

Ofcom uses a mix of dBi and dBd in paragraph 5.12. Receiving antenna gain is normally assumed to be 12 dBd; the 0 dBi gain of the isotropic antenna is equivalent to -2 dBd. As such, the figures used both in this paragraph and in 5.24 appear to be 2 dB in error. The assumptions in both paragraphs need to be clarified.

In addition we note that -114 dBm is below the receiving noise floor and a noise-like DTT signal cannot therefore be detected reliably at this level. This implies that the Cognitive device could not function by sensing alone and hence supports sensing in combination with geolocation as a minimum, see response to Question 3.

The data used for signal variations within a room of ‘never greater than 5 dB’ appear very optimistic compared with other studies (for example, the Divitronics study on the ERO website), which have shown up to 16 dB variation.

Finally, the assumption that viewers can control the use of cognitive devices ‘within their own homes’ is not necessarily valid since the problem also needs to be controlled in blocks of flats, terraced houses, communal dwellings, etc. Further, it needs to be recognised that broadband is an “always on” service and, if CA devices are to be used in a similar manner to WiFi then many consumers will never switch them off.

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

As noted in response to Question 2, -114 dBm is below the receiving noise floor and a noise-like DTT signal cannot therefore be detected reliably at this level. A sensitivity of -114 dBm will not adequately protect the use of interleaved spectrum where a more rugged mode (for example, QPSK 1/2, requiring an additional 14 dB protection over 64QAM 2/3) may be used. This in turn may impact on the value of interleaved spectrum for Local TV or other broadcast applications.

In addition to the above we make the following observations;

**Adjacent and non-adjacent channels**

We encourage Ofcom to consider protection for the DTT receiver image channel ‘N+9’ in addition to the adjacent and non-adjacent channels in their further work. Furthermore, although the receiver adjacent channel performance figures used by ERA are consistent with those found in the DTG’s “D Book”, account will need to be taken of DTT frequency offsets, which are used on band-edge channels. For DVB-T, these erode the protection ratio by 1 to 2 dB. Arqiva is not aware of any equivalent figures currently published for DVB-T2.

**Path Loss Issues**

In 5.24 the Cognitive device appears to have a receive antenna gain of 2 dBi (inconsistent with 5.12) and the VRP of a dipole. If the Cognitive device is handheld then it would ideally use an antenna with close to an isotropic pattern, to this end it would not be valid to make any assumption about any VRP reduction at 45 degrees. It is also not safe to make any particular assumption about the orientation of the antenna in a hand-held device, should it be directional. So, the path loss is arguably 4 dB in error: 2 dB for the hand-held device antenna and 2 dB for the receive antenna gain. We encourage Ofcom to clarify the issues noted here.

***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?***

The maximum powers that could be permitted will depend on the way that issues raised previously in this response are treated. The above comments relating to ‘Path Loss Issues’ – see Question 3 above – suggest that the limits may be set 4dB too high, and these may need to be amended further, depending on whether or not ERA has taken into account location variations in its calculations (as noted in our response to Question 2). The potential introduction of master/slave operation may also affect the usable power levels.

In addition, although adjacent channel selectivity is the main challenge for receiver performance, there is no mention in the consultation of other potential performance issues such as the 'N+9' channel offset performance, which will be relevant to the majority of conventional tuners in use. The proposed power limits may, however, allow sufficient margin to prevent this being a problem but we urge Ofcom to clarify this point.

***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?***

The significant challenge here is the legacy STB universe likely to be in use for many years to come and hence although tighter specifications could be adopted going forward it is imperative to note that proposed performance levels now should not compromise the performance of existing consumer equipment.

In addition it would appear unreasonable to expect receiver manufacturers to improve their products' performance, and hence increase equipment costs (and indeed the price to the end consumer) to support a market sector from which they are unlikely to benefit.

As consumers increasingly adopt higher specification receivers (PVRs, HDTV, broadband-enabled) for connection to their main displays, this could present an opportunity for manufacturers to absorb the incremental cost of improving the performance of the receiver "front end". But even if they saw merit in doing this for higher specification receivers there would still be many consumers unwilling or unable to pay for that higher specification.

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

It seems odd that a 'typical' minimum signal level, 24.5 dB greater than the minimum sensitivity level, should be used as the reference receive level. This leaves no margin in the 'typical' case, for systems where any interference at all is regarded as critical. Please refer to JFMG's response for more detailed feedback.

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

No comment. JFMG are better placed to provide detailed feedback.

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

No comment specifically to the question raised, JFMG are better placed to provide detailed feedback, but we do wonder why Ofcom assumes a 4 MHz minimum separation (Paragraph 5.3) between a cognitive device and a wireless microphone operating at the adjacent channel edge. If the cognitive device uses a wideband transmission mode (i.e. 8 MHz bandwidth) then it would appear that there will be no separation at all.

***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?***

No comment. JFMG are better placed to provide detailed feedback.

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

Although no source is quoted for the -86.5 dBm sensitivity suggested for mobile television receivers, this would appear to be a reasonable assumption.

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

The BMCO (Broadcast Mobile Convergence) Forum quotes a range of 11 to 17 dB for 'light' to 'deep' building UHF penetration in its link budget paper. The Divitronics study as noted in our response to Question 2 above measured an average building penetration loss of approximately 12 dB with a standard deviation of 4.2 dB. The Ofcom figure of 15 dB rounded up to 20 dB is therefore probably not unreasonable in this context.

With regard to the co-existence of cognitive devices with mobile television; if we take the free-space path loss as 35 dB at 3 metres, that extrapolates to 115dB at 30 kilometres. The equation then becomes  $-86.5 + 40 + 115 = +68.5$  dBm for adjacent channels, i.e. around 7 kW transmit power (or 70 kW for non-adjacent channels). This suggests that not only is interleaved mobile TV incompatible with cognitive devices, it is also incompatible with high power DTT (except when deployed on a very local basis, i.e. remote locations such as Glastonbury) which can operate six multiplexes each at up to 200kW ERP. More work appears to be needed to determine if these systems are actually able to co-exist.

**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?**

The application to which the spectrum is being deployed is largely academic. If the application is consistent with the designated SURs and the service is licensed then full protection should be afforded whether the service is mobile television or some other type of service.

**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?**

With the development of cognitive devices in any form still in its infancy, it appears premature to consider co-operative detection as a part of this current consultation. It would seem more appropriate to consult further once the means of deployment have become clearer.

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

Arqiva believes that a combination of signal sensing and a geolocation database approach will be essential to avoid interference. See response to Question 22. Please refer to JFMG's response for more detailed feedback.

**Question 15. What positional accuracy should be specified?**

Arqiva supports the suggestion that database positional accuracy should be 100 metres. This is consistent with the planning parameters used for DTT coverage prediction. Although it is acknowledged that the limit of coverage of DTT in the

'real world' may be difficult to define with accuracy, viewers at the limit are likely to be working close to minimum field strength and will thus be most prone to interference. An exclusion zone for cognitive devices of, say, 1 kilometre beyond the defined edge of coverage (acknowledging that the actual edge of service will be 'fuzzy') will be needed to minimise interference. Regional programme variations in an area may also need to be taken into account for protection.

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

The frequency of updates depends on the type of licensed use, i.e. for DTT, the frequency of updates to the database (even taking account of potential new local TV stations) is of little consequence in comparison with the more transient requirements of PMSE. Therefore, we suggest that the update frequency should be consistent with the most dynamic licensed use.

Likewise the database availability is of little importance (this is a question for the cognitive device operator), providing that, as specified in paragraph 7.4, the default condition is that spectrum may not be used without positive confirmation that it is available for a specific location on a suitably frequent basis.

Arqiva has no view on the database protocols to be used.

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

Any funding that may be necessary for the database approach should not be required from the licensed users of spectrum (DTT, PMSE, etc), but should come in some way from the manufacturers/operators/users of cognitive devices, i.e. the parties deriving benefit from its use.

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

The use of the database for spectrum management use, with appropriate controls, will be valuable for a number of reasons as described in the consultation and particularly in situations where severe interference is caused to licensed services such as DTT. It is of great concern to Arqiva that on occasions significant interference will occur, due to equipment malfunction or perhaps the illegal use of cognitive devices at higher power levels than those permitted by Ofcom. It is imperative that Ofcom has some means of overall control to ensure that interfering devices can be rapidly disabled and to this end it seems critical that the operation of all Cognitive Access devices in the UK should be subject to a positive confirmation regime, via the geolocation database arrangement, before transmissions are permitted.

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

The deployment of base stations is again something that will need to be approached with care, since there is the potential for much more wide-ranging interference to be caused to licensed services. At a higher power level, the topography and clutter of the terrain in the vicinity of each base station would need to be taken into account in determining its transmitter power. It is suggested that any use of higher-powered base stations should be considered in more detail once cognitive device technologies have been well established and tested. Whilst the inclusion of information to support the future deployment of base stations should

not be precluded in the design of the geolocation database, it should not be implemented until more experience of cognitive device operation is available.

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

Any funding that may be necessary for the implementation of a beacon system for cognitive devices should not be required from the licensed users of spectrum (DTT, PMSE, etc), but should come in some way from the manufacturers/operators/users of cognitive devices, who are the parties that would derive benefit from its use.

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

The availability of the beacon system is of little consequence to Arqiva as a user of licensed spectrum (it is a question for the cognitive device operator) providing that, as specified in paragraph 7.4, the default condition is that spectrum may not be used without positive confirmation that it is available for a specific location. As with the geolocation database, there will need to be an exclusion zone of, say, 1 kilometre beyond the defined edge of coverage for licensed services, to reduce the possibility of interference from cognitive devices.

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

Arqiva agrees that the beacon approach seems to offer no advantage over the detection and geolocation approaches, and because of its high cost it is unlikely to be deployed.

However, Arqiva disagrees that the choice of detection or geolocation should be left to stakeholders and believes that the amalgamated approach using both will be essential in order to prevent harmful interference, for the reasons detailed below. We therefore believe that the amalgamated approach should be mandated in the design of cognitive devices.

As already noted in our response to Question 3, it is likely that the sensitivity requirement for the detection of channel use will be below the noise floor in many locations and therefore unachievable. It is equally likely that there will be locations (for example, indoor) where systems such as GPS will not be available to determine the location of the cognitive device. The amalgamation of both of these systems will be critical / key to harmful interference being avoided.

***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?***

The use of cognitive devices in band-edge interleaved spectrum will again create uncertainty in the spectrum auction process since it is not presently known what technologies will use the spectrum adjacent to the band-edge channels, or what protection these might require. Arqiva believes, at least until the adjacent technologies to be initially deployed post-auction have been determined, that cognitive device use should not be permitted in the band-edge channels. Even when the new technologies are known there is still the possibility that they may change in the future, for example due to spectrum trading.

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

As long as the appropriate measures are maintained to prevent interference with licensed services, Arqiva sees no reason to limit the bandwidth or number of channels used by cognitive devices. It may be, however, that different devices using different bandwidths makes for a much more complex inter-device spectrum management issue, with a greater possibility of failure and hence interference.

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

With a geolocation system providing positional accuracy of around 100 metres for the cognitive device, 1 second checks of channel availability would seem appropriate. However, the relevance of these performance characteristics may be dependent on whether the device is moving or static and we encourage Ofcom to consider this point in further work.

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

Arqiva agrees with the Ofcom derivation in relation to the assumptions used for the derivation of maximum power levels. The -44 dBm figure accounts for the worst case scenario.

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

No comment. This is a question for the cognitive device operator.

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

The use of ‘slave’ operation would only seem appropriate where the distance from ‘master’ to ‘slave’ is considerably less than the 100 metre geolocation resolution, in order to avoid potential interference into adjacent locations (depending on any exclusion zone to be implemented). As for co-operative detection: with the development of cognitive devices in any form still in its infancy, it appears premature to consider ‘master’/‘slave’ operation as a part of this current consultation. It would seem more appropriate to consult further once more experience of cognitive device operation is available.