Response to Ofcom Consultation:
Digital Dividend Review: cognitive access
Consultation on licence exempting cognitive devices using interleaved spectrum

We would like to thank Ofcom for the opportunity to offer our views on the licence exemption of cognitive devices using interleaved spectrum. As the current PMSE band manager we are uniquely placed to highlight the impact these proposals may have on the use of PMSE equipment within interleaved spectrum.

The PMSE industry as a whole are concerned about the potential inclusion of cognitive devices within interleaved spectrum. Not least because after 2012 users of wireless microphones will be reliant almost solely on this spectrum; the availability and configuration of which is not yet known. This is especially poignant given that they will pay for access to interleaved, the very same spectrum that Ofcom propose being free for cognitive devices. Whilst we understand Ofcom's rationale for exempting devices that are not deemed to cause undue interference to other spectrum users, this does not sit well with an industry who expect the cost of spectrum access to increase in the future. The lack of definitive proof that cognitive devices will not cause interference to licensed users within interleaved spectrum further exacerbates these concerns.

This response focuses mainly on what we believe to be the main issues that concern the PMSE industry. However we have attempted to answer questions regarding the proposal's impact on DTT where appropriate.

1. Consultation Questions

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

The introduction of licence-exempt cognitive devices within interleaved spectrum could have a considerable impact on PMSE users' ability to access reliable, interference free spectrum for use by wireless microphones. It is therefore imperative that the technical parameters derived to allow such access should be as robust as possible in order to minimise the risk of interference.

We are not wholly convinced at present that the parameters proposed for detection-only apparatus would satisfy protection requirements for both PMSE and DTT operations, the details of which can be found within relevant responses below. We would therefore advocate the requirement for all cognitive devices to have a geolocation facility as standard, although a combination of geolocation and detection may be the optimum solution.

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

Setting a sensitivity level for the protection of DTT reception from cognitive devices and relying upon sensing alone does not result in the optimum use of interleaved spectrum.

The level of sensitivity chosen for protection of DTT fundamentally determines the quantity of available whitespace across the UK. Relying upon a set figure for sensitivity gives little flexibility and does not maximise the available whitespace. This is true for both cognitive devices and PMSE. Already in work to characterise and maximise the future whitespace for PMSE a more sophisticated approach has been considered. Instead a preferred DTT service is identified for each location and up to six UHF channels from the preferred transmission site claim protection from PMSE. This approach can be considered for PMSE as wireless microphone assignments will continue to be coordinated for location and time. In the same way, through geolocation instead of sensing alone, cognitive devices could exploit the greater whitespace capacity, whilst still protecting PMSE and DTT reception. The

concept of protecting only a preferred service does not necessarily disadvantage DTT reception. It can benefit DTT coverage, freeing up spectrum in the same way for additional broadcast services.

Cognitive devices using sensing alone would detect DTT transmissions not viewed in the locality and the result would be less whitespace spectrum to operate within. By contrast geolocation offers greater and more flexible spectrum access for cognitive devices without the need to rely upon complex detection techniques. Geolocation therefore has the ability to better protect licensed PMSE and DTT services than sensing on its own.

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

The figure of 35dB for additional margin has been derived from extensive measurement at locations within the Crystal Palace service area, a specific 'high tower/high power' scenario. Although there was agreement between predictions and measurements there was appreciable variation in the results for areas of different clutter. It may therefore be prudent to additionally investigate the hidden node margin in DTT coverage areas served by lower power relays radiated from lower antenna heights.

The proposed sensitivity figure of -114dBm is very stringent and therefore challenging for cognitive devices to reliably detect, particularly in the presence of the adjacent high power interferers found within the UHF TV bands.

***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 range of possible cognitive device applications remains unclear so much lower powers may be more appropriate in many cases. Rather than specify a fixed maximum power for devices a more dynamic approach using geolocation could be beneficial. Referencing a database drawing on data for licensed assignments and perhaps other cognitive devices, an appropriate maximum EIRP could be individually set for each device. There are circumstances where this flexible approach could favour the cognitive device and permit higher powers than a general cautious limit. It also provides the ability to dynamically manage the population of cognitive devices to better protect both PMSE and DTT reception.

***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?*

Currently DTT receivers tested to the DTG-D Book "Requirements for Interoperability V5.02" have generally been found to exceed the targets by some margin. It is therefore unlikely that manufacturers will see any incentive to further improve the performance of their products for the benefit of cognitive devices. There is in fact a trend towards more closely matching DTG targets for receiver performance as smaller and more portable products are developed.

The onus lies firmly with the cognitive device industry to develop their products to be compatible with the existing licensed services in interleaved spectrum.

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

The choice of reference receive level is based on the observation that wireless microphone receiver installations are engineered to operate with typical signal levels of -67dBm. Where large numbers of

transmitters are used in closed proximity, such as in studios and theatres, these relatively high receive levels are mainly chosen to overcome the impact of the resulting intermodulation products.

Operating ranges are kept short and receivers are placed to minimise the severity of fades and multipath. This is supported by ERC Report 42 'Handbook on Radio Equipment and Systems Radio Microphones and Simple Wide Band Audio Links'.

What is less clear is how successfully sensing could detect other wireless microphone scenarios. ERC Report 42 also characterises the other main application, outdoor production of sport, drama and documentaries. Smaller numbers of wireless microphones are deployed and the requirement is to achieve the maximum operating range. Receivers will typically operate down to the noise floor. Cognitive devices, which may be carried by a spectator at an outdoor event, close to wireless microphone receivers will need to detect much lower signal levels. Additional margins will further reduce the level which needs to be detected.

ERA has shown that detecting wireless microphones in the studio or theatre environment may be achievable by cognitive devices but for other key outdoor scenarios the requirement for a much lower detection threshold coupled with an additional margin will prove more difficult. The cognitive device will also require a measurement algorithm that can monitor the spectrum by cumulatively building up a historical picture of local spectrum use over a period of time. In this way wireless microphones not initially detected will subsequently be identified by the cognitive device.

Geolocation as the primary means of controlling cognitive devices overcomes these difficulties and again has distinct advantages over sensing alone.

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

The additional margins measured within a theatre and television studio characterise the indoor environment and make assumptions about receiver parameters based on practical equipment. ERC Report 42 uses a Carrier to Noise ratio of 20dB compared to 25dB used by ERA and a 'body loss' figure of 22dB compared to 20dB measured by ERA. 59dB is a reasonable figure based on the extensive measurements and fair assumptions but again only characterises the indoor environment.

To characterise the outdoor environment JFMG would be happy to facilitate a similar measurement exercise at a typical event, perhaps a golf tournament.

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

The sensitivity requirement is derived from two components, the reference receive level and the additional margin. The indoor environment has been well characterised but for the outdoor environment it has been shown that values for the two components are likely to differ. Taking a lower reference receive level for outdoor use of say, -89dBm and characterising the additional margin at an outdoor event, the sensitivity requirement for detecting an outdoor wireless microphone will be lower than 126dBm/200kHz.

***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?*

The consultation document uses a value of -70dB for the carrier to noise performance of a wireless microphone receiver for a cognitive device transmitting in the adjacent DTT channel. ERC Report 88, following a series of measurements in the UK and Germany, instead proposed a protection ratio of -35dB for adjacent channel DTT interference.

The maximum transmit power for a cognitive device based on a -35dB adjacent channel protection ratio would then be:

-67(Typical receive level) + 35 (PR) + 32 (path loss for 2m) = 0dBm

Levels higher than 0dBm would therefore risk overloading the wireless microphone receiver.

To prevent this happening geolocation methods should be employed to permit the transmit power of specific cognitive devices to be set at a compatible level to reduce the potential for front end overload of wireless microphone receivers.

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

No comment

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

No comment

***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?*

No comment.

***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 may become a useful additional means of protecting licensed users of the interleaved spectrum. However, for the time being it should be seen to supplement geolocation in individual cognitive devices as the primary means of co-ordination with licensed services. Further work should be done once the deployment of devices has become clearer.

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

We believe that the database approach can accommodate ENG and similar PMSE applications in most cases, provided devices connect to live data on a regular basis. Where there is any time-lag between database updates, detection could supplement the information in an area (only to check if new equipment had been turned on and not vice versa).

We believe that the use of geolocation is vital to ensure protection for PMSE equipment and to provide comfort to the PMSE industry who will be paying for access to this spectrum.

PMSE assignments in the interleaved bands are always coordinated for location and time to protect domestic TV reception and prevent mutual interference between users. Assignments are made for specific locations and are not for use over wide areas. The information is held on a database which facilitates the coordination of assignments and captures dynamically the detail of the entire population of licensed PMSE users. This arrangement will need to be continued by the Band Manager following Digital Switchover when PMSE continue to make use of the 'Whitespaces'.

The nature of all PMSE use (including ENG) is unpredictable and last-minute in nature with 40% of all assignments being required either immediately or by the next day. Therefore, in order to deal with short-term ad hoc PMSE use, it would be ideal if the master database were updated in 'real time'. This replicates our current system which holds DTT coverage and PMSE usage information with no delay. All 'mirror' sites could then update themselves in parallel with the master to ensure that the most dynamic and reliable information was available to any device at the point of enquiry/or indeed download. If devices sent enquiries to the mirrored databases at the point of operation this would capture all licensed short-term use to the exact minute.

On the other hand if there was a delay between the issue of licences and the updating of the master database then there would be no guarantee that devices would be accessing correct information,

even at the point of enquiry. Similarly this would also occur if the cognitive device downloaded versions of the database periodically throughout the day.

However, the potential room for error would be limited if the updates to the database etc were undertaken regularly enough throughout the day. We therefore believe that if the devices and/or database were updated on an hourly basis then there would be little potential to miss new users. We would however suggest that geolocation could be supplemented by detection in order for the device to check whether new users had switched on since the last hourly update.

Whilst we appreciate the suggestion of reserving some channels in every location for ENG applications we do not necessarily believe that this approach would work for short-term users. The channels reserved in each location would have to be carefully selected based on equipment volume levels and even then there may not be sufficient reserved for all occasions. In addition, users could not be prevented from using other channels that their equipment operated in. This would mean that additional, non-reserved channels may still need to be booked and more regular database enquiries/updates required anyway.

***Question 15)**: What positional accuracy should be specified?*

Accuracy in the region of 100m would be sufficient to ensure that devices can be located within a 1km square, a reasonable resolution for a geolocation database.

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

Applications from programme makers for interleaved spectrum can be received right up until the moment that the assignments are needed, although often a period of a day or more between the assignments being made and the time when they are to be used occurs. Database updates to cognitive devices would generally not need to be carried out more than every hour to capture the vast majority of changes. Cognitive devices close by the imminent assignment could still be instructed to use alternative spectrum before a licensed PMSE user is due to start.

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

We believe that funding is likely to be needed to enable the database approach to work as it would appear unreasonable for the licensees of interleaved spectrum to be inconvenienced financially by the provision of the necessary information.

There will certainly be costs involved in the provision of a master database, necessary hosting of mirror sites and ensuring consistent availability.

It should not be the primary users of interleaved spectrum that bare the costs; instead it should be shouldered by those who stand to gain the most benefit from the coordination of information. This would appear to be the device manufacturers or service providers, who will gain access to spectrum, otherwise free of charge.

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

The capability to manage cognitive devices' use of spectrum should be retained and would benefit both the devices themselves and licensed users. A geolocation database would enable local populations of devices to be managed to work in the most efficient manner, whilst maintaining protection of DTT and PMSE. In addition to frequency management it should also include power control, varying the permissible transmit power of individual cognitive devices. There would also be a means of modifying the use of the spectrum to incorporate new devices and technologies as they become available.

It may be appropriate to instruct cognitive devices to avoid specific frequency ranges around significant programme making events and locations, either temporarily or on an ongoing basis. Conversely there could also be occasions when the size or shape of areas requiring protection could be relaxed. It may be that it favours spectrum availability for cognitive devices in certain circumstances rather than always applying a cautious set of protection conditions for PMSE and DTT reception.

Spectrum management capability would also allow devices to be effectively switched-off should interference be suffered by licensed users and would provide Ofcom with a way of stopping operation should the system prove unsuccessful either technically or commercially.

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

No comment

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

A dedicated widespread network of beacons occupying its own spectrum would be expensive with high initial costs. Geolocation offers a more reliable solution without the high costs of beacon infrastructure. It is also unlikely that an internationally harmonised beacon frequency could be identified in the short term, reducing the potential for economies of scale in production of cognitive device hardware.

The costs of facilitating a beacon frequency should be shouldered by those who stand to gain the most benefit from its provision. This would appear to be the device manufacturers or service providers, who will gain access to spectrum, otherwise free of charge.

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

A beacon solution would require a high availability for all locations if cognitive devices fail to operate without a valid beacon signal.

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

We are currently uncomfortable with the prospect of detection-only devices being enabled and would prefer for all approaches to include a geolocation facility as standard. This would ensure protection for licensed PMSE and DTT within the spectrum. However we believe devices that contain a combination of both approaches may be the optimum solution. The ability to refer to a database in

the first instance and then use detection to identify other cognitive devices and newly operational PMSE use would ensure even greater protection from interference for both PMSE and DTT.

It would appear that detection-only devices are some years away to being developed to the appropriate standard and the use of geolocation in the first instance could give manufacturers an opportunity to test the market and the spectrum for use by such devices.

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

Protecting licensed services adjacent to the interleaved spectrum would require inefficient universal guard bands across the whole of the UK for the sensing solution. Alternatively, with geolocation as the primary means of controlling cognitive devices, spectrum restrictions need only be applied where necessary to protect genuine adjacent channel use and can adapt dynamically as required.

***Question 24)**: Do you agree that there should be no limits on band width?*

Provided that PMSE, DTT and other licensed services can rely on protection from cognitive device interference there should be no restrictions on the bandwidth of these systems.

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

The time between checks for channel availability needs to be related to the speed of movement of the cognitive device. Every second may be excessive for a stationary device but may be entirely appropriate if the device is travelling at speed in a train or car. Also the frequency of channel availability checks depends upon whether sensing or geolocation is employed. It would therefore seem reasonable to employ a rescan time of 1s for the cognitive device employing sensing and geolocation.

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

It is a reasonable starting figure based on the assumptions in the ERA report but needs to be considered again when the supporting parameters are further investigated.

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

No comment.

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

Provided the slave device is within a known distance of the master device it would be reasonable to permit the master device to control the slave with respect to spectrum availability. The key point is to know the position of the slave with respect to the master.