TV white spaces

A consultation on white space device requirements

Consultation

Publication date: 22 November 2012

Closing Date for Responses: 10 January 2013

Contents

Section 1

Executive Summary

1.1 The term "white space spectrum" refers to frequencies that are *not* being used by existing licensees at all times or at all locations. A white space device can make use of these frequencies provided that the risk of harmful interference to the licensed users of the spectrum can be appropriately managed.

1.2 Location-aware wireless devices, assisted by databases which provide information on white space availability taking into account existing licensed use, offer the promise of opportunistic access to under-utilised frequency bands around the United Kingdom for innovative and useful services. We believe that such database-assisted operation can also be a key enabling technology for the efficient and dynamic sharing of spectrum in a variety of frequency bands.

1.3 We have been investigating the prospects of access to white spaces in the UHF TV band[1] (also known as TV white spaces) since 2007. Following a series of consultations, in 2011 we issued a statement *Implementing Geolocation: Summary of consultation responses and next steps*[2] ("2011 Statement") which set out our approach for authorising the use of TV white spaces[3]. We concluded that licence exempt devices could be authorised to use TV white spaces, so long as they radiated in specific frequencies and at specific powers communicated to them by TV white space databases that had met Ofcom's requirements. Under these conditions, we believed that it would be achievable to ensure that such devices would not cause harmful interference to the existing licensed services.

1.4 In paragraph 4.2 of the 2011 Statement we noted that we would:

> *"…work with stakeholders to finalise the critical activities that are necessary for setting up a suitable regulatory framework to manage and update the flow of information to and from a geolocation database. Ofcom intends to set up further workshops and direct engagement with those interested parties to facilitate definition of the key areas of detail.*"

1.5 Furthermore in paragraph 1.20 we noted that:

> *"...there are a number of issues that remain where further detail is required, and there may be need for more decisions on behalf of the regulator which could require consultation.*"

1.6 In paragraph 1.18, we also set out that one of our next steps would be to:

> *"…prepare and consult on a draft IR and VNS[4] as the basis for licence exemption of white space devices in the UK.*"

---

[1] The UHF TV band extends from 470 MHz to 790 MHz.
[2] http://stakeholders.ofcom.org.uk/consultations/geolocation/statement/.
[3] The use of the "600 MHz" cleared spectrum (550–606 MHz) by white space devices has been addressed as part of Ofcom's UHF Strategy consultation.
See: http://stakeholders.ofcom.org.uk/consultations/uhf-strategy/statement/.
[4] IR: Interface Requirement. VNS: Voluntary National Specification.

1.7 We have now developed a framework for the overall operation of white space devices in the UK that is designed to ensure that we can manage the risks of harmful interference to the existing users of the UHF TV band, which are Digital Terrestrial Television (DTT) and Programme making and special events (PMSE). In this document we consult on the various elements that comprise that framework, including the proposed regulatory requirements and technical specifications for white space devices that we believe are necessary to avoid harmful interference . Specifically, we present our proposals with regards to the following:

1.7.1 Operation of white space devices – These relate to the different categories of white space device, the sequence of operations that such devices will need to perform, and their interactions with each other and with qualifying databases[5].

1.7.2 Parameters – These relate to the parameters that will need to be exchanged between white space devices, and between white space devices and databases.

1.8 We recognise that the detailed technical specification of the wireless communication protocols between the devices, and the communications protocols between the devices and databases, is a matter for industry. For this reason, our proposals are technology neutral and apply only to those functionalities of the devices which have a bearing on managing the impact of harmful interference.

1.9 Our proposed framework for the operation of white space devices in the UK would be implemented through a package of different instruments which collectively set out the regulatory requirements and technical specifications for such devices. This proposed package of instruments includes an example of what the statutory instrument (SI) setting out the terms of the licence exemption might look like, a draft interface requirement (IR) document, and a draft voluntary national specification (VNS). These documents are published alongside this consultation.

1.10 Finally, we note that this is a consultation on device requirements. Nevertheless, some of the functionalities of qualifying white space databases are also described here, in so far as these relate to the databases' interactions with the devices. The full requirements for the operation of the databases are outside the scope of this consultation and will be the subject of future engagement with stakeholders.

Next steps

1.11 This consultation, published on 22 November 2012, lasts for seven weeks. The closing date for responses is 10 January 2013.

1.12 We welcome stakeholder comments on the proposals presented in this document. We recognise the technical complexity and importance of the issues, and we will

[5] We anticipate setting out in a database contract the various qualifications which a database must meet before it can be included in Ofcom's list of qualifying white space databases. This is necessary since, as explained in this document, white space devices cannot operate in TV white spaces unless they do so in accordance with the frequency/power parameters that they must obtain from a qualifying white space database.

conduct a stakeholder workshop[6] on 3 December 2012 to allow stakeholders to express their views on the proposals we have put forward.

1.13 Following this consultation, we will amend, where appropriate, the example SI and draft IR, and VNS to take account of stakeholder responses. As soon as possible once this exercise is complete, we intend to notify the European Commission of our draft regulations and device specifications as collated in the three documents above. This process is in accordance with the European Union rules on national technical regulations. In parallel, we will also publish a statement on the outcome of the present consultation. We hope to be able to do these in the first quarter of 2013.

1.14 Following the notification[7] to the European Commission and expiry of the three month European standstill period, and subject to no detailed opinions being received from the European Commission or any Member State, we will be in a position to undertake the one month statutory UK consultation on the draft SI. We intend to do this once the first databases have successfully undergone Ofcom's qualification process. This will be followed by a statement on the adoption of the SI.

1.15 See Section 8 for further details of our stakeholder engagement plans with regards to other aspects relating to the authorisation of the use of white spaces in the UHF TV band.

[6] Please email TV.WhiteSpaces@ofcom.org.uk by 29 November 2012 if you are interested in attending the workshop.

[7] The process for notifying the European Commission of our draft regulations and device specifications is described in more detail in Section 8 of this document.

Section 2

What are the TV white spaces?

2.1 The *Digital Switchover* (DSO) – namely the transition from analogue to digital terrestrial television (DTT) – has freed up a significant amount of spectrum in the UHF band for new uses. This is illustrated in Figure 1 below. Digital TV can be transmitted more efficiently than analogue TV, using less spectrum to carry more TV channels than were previously available. Our statement on the Digital Dividend Review ("DDR statement")[8] addressed the question of what would be the best use for the frequencies that become available UK-wide – through clearance – after the transition to DTT. It also considered the availability of spectrum within the frequency channels that carry DTT after DSO. This is known as "interleaved spectrum", and it is available because at any particular location, only a subset of the channels reserved for DTT are actually used.

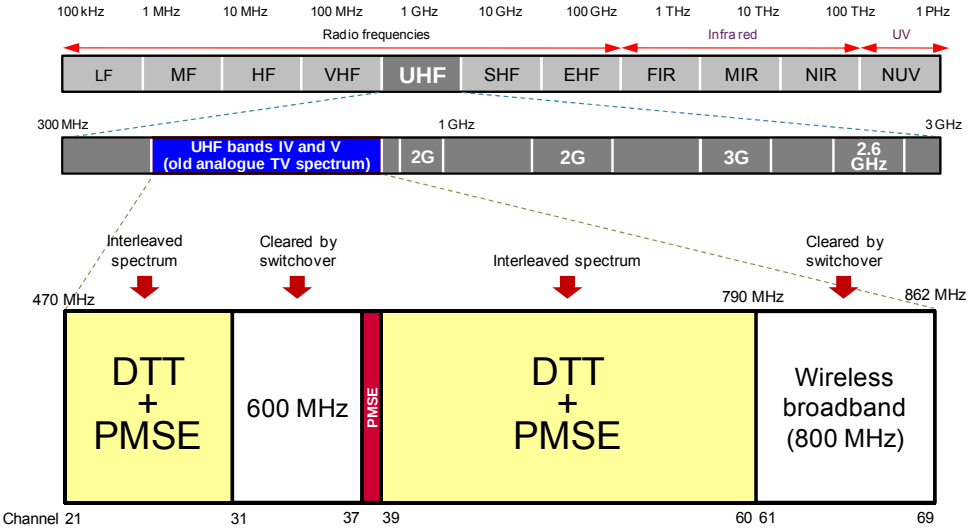

Figure 1. The UHF TV band and released spectrum due to digital switchover.

2.2 Currently, Freeview TV channels are broadcast using up to six multiplexes[9]. Each multiplex requires an 8 MHz channel. Multiplexes are transmitted at different frequency channels across the country in the frequency range 470 MHz to 790 MHz. Whilst a total of 32 channels each 8 MHz wide are reserved for DTT in the UK, only six of these channels are required to receive the 6 multiplexes at any given location. In other words, the vast majority of channels are unused for DTT transmission at any given location. This is required because high-power TV broadcasts using the same frequency need geographic separation between their coverage areas to avoid interference. This is illustrated in Figure 2 below.

2.3 However, the channels that are not used by DTT at any given location can be used by lower-power devices on an opportunistic basis. This opportunistic access to interleaved spectrum is not new. Programme making and special events (PMSE)

[8] *"Digital dividend review: A statement on our approach to awarding the digital dividend"*, http://stakeholders.ofcom.org.uk/consultations/ddr/statement/

[9] A multiplex is a group of TV channels that are combined into a single signal for transmission.

equipment such as radio microphones and audio devices have been exploiting the interleaved spectrum for a number of years, and JFMG[10] issues more than 50,000 licences annually for this type of use.

2.4 In addition, and following the Government's policy on local TV, we have started in May this year[11] the process of licensing local TV channels that will be broadcast on a new multiplex. These broadcasts will initially be from 21 locations, and will take advantage of frequencies that are not used by the six national multiplexes.

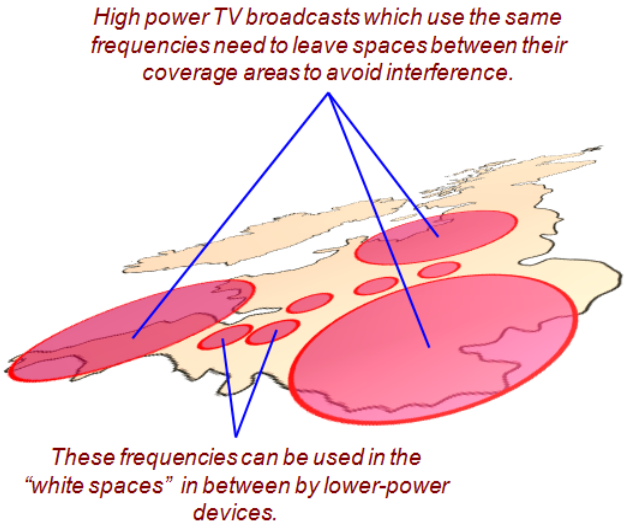

Figure 2. Interleaved spectrum and TV white spaces.

2.5 We have proposed opening interleaved spectrum not only to PMSE and local TV services which use the spectrum on a licensed basis, but also to devices that will operate on a licence exempt basis. We refer to the spectrum that is left over by DTT (including local TV) and PMSE use as TV white spaces (TVWSs). By this we mean the combination of locations and frequencies in the 470 MHz to 790 MHz[12] band that can be used by new users without causing harmful interfering to DTT reception or PMSE usage.

2.6 It should be noted that the UK is not the only country looking at making more efficient use of UHF spectrum. In fact, the US have already put in place the regulatory regime to enable licence exempt use in the UHF frequencies allocated to DTT (which were already shared by PMSE use, as in the UK). White space databases (WSDBs) are already operating in the US. We understand that these databases have begun to provide services to communications providers willing to supply broadband access to remote areas over TV white spaces.

---

[10] http://www.jfmg.co.uk/.
[11] http://media.ofcom.org.uk/2012/05/10/ofcom-invites-applications-for-first-21-local-tv-channels/.
[12] Note that Ofcom's UHF Strategy consultation has considered the potential change in use of the "700 MHz" band (694-790 MHz) from DTT use to mobile use. This would have an effect on the amount of spectrum available for white space devices. Ofcom's UHF strategy consultation has also addressed the potential interim use of the "600 MHz" cleared spectrum (550–606 MHz), and concluded on an approach that will enable shared use by DTT, PMSE and white space devices. See: http://stakeholders.ofcom.org.uk/consultations/uhf-strategy/statement/. We finally note that channel 38 (606-614 MHz) is used exclusively by radio microphones under specific licensing.

2.7 At this stage, it is too early to predict accurately how citizens and consumers will be able to benefit from this. Suggested applications include rural broadband, WiFi-like access (both in hotspots and in the home) with extended range, and machine to machine communications (e.g., for purposes of remote sensing, control and telemetry). We briefly describe some of these use cases below.

Use cases

2.8 Here we describe a number of use cases for access to the TVWS spectrum. We present these only for the purpose of illustrating the nature of the white space devices (WSDs) which might emerge within the next few years. It should be noted that our policies with regards to authorising the use of TVWSs are both application-neutral and service-neutral, and as such, support all envisaged use cases.

2.9 Stakeholders have identified the following main use cases for access to the TVWS spectrum:

2.9.1 Rural broadband – This involves the use of TVWSs to provide fixed wireless broadband communications to rural communities. In this application a communications provider would deliver radio coverage by deploying so called "master"[13] WSDs in the form of base stations. The communications provider would also provide so called "slave"[13] WSDs in the form of consumer premises equipment (CPE) which would connect to the master WSDs over the UHF TV band. The communications provider would have the option of developing its own WSDB to qualify for inclusion in Ofcom list of qualifying WSDBs or it might enter into a commercial agreement with a third party WSDB provider.

2.9.2 Hot-spot coverage – This involves the use of TVWSs to provide fixed or mobile indoor/outdoor communications in hot-spots. This is very much similar to the way WiFi technology is used today for the same purpose in coffee shops and public areas. In this application a communications provider would install master WSDs in the form of small base stations or wireless routers in the hotspots. The slave WSDs would then be in the form of modem cards or dongles in laptops or mobile phones. As with the rural broadband case, the master WSDs might be supported by the communication provider's own WSDB, or by a third party WSDB.

2.9.3 In-home broadband – This involves the use of TVWSs to provide in-home wireless communications, in the same way that WiFi technology and mobile network femto-cells are used today. In this application both the master and slave WSD would be consumer equipment. The master would be in the form of a wireless router similar to today's broadband routers, and the slave in the form of a wireless card or dongle in a PC, laptop, mobile phone, or other consumer device. In this application the master WSDs would most likely be supported by a commercial WSDB provider.

2.9.4 In-home multi-media distribution – This is not too different from the in-home broadband application, except that the TVWSs would be used to transfer multi-media content or other data from one device to another, i.e., as a form of cable replacement.

[13] A master WSD connects directly to a database. A slave WSD connects to a master WSD.

2.9.5 Machine-to-machine communications – This typically refers to low data-rate connections between sensors and devices used for purposes of control, telemetry, or remote monitoring. The applications might include the control of consumer equipment and devices in the home, control and monitoring of equipment in factories, remote reading of utility meters and remote sensing of the environment. Depending on the precise application, the WSDs could take the form of a base station, or a small and low-power radio device.

2.10 In all the above cases, the main driver for the use of the TVWS frequencies is the favourable propagation characteristics of radio waves in the UHF TV band, and their ability to penetrate deep inside buildings. Figures 3 and 4 depict example of WSD deployments for some of the above use cases.

2.11

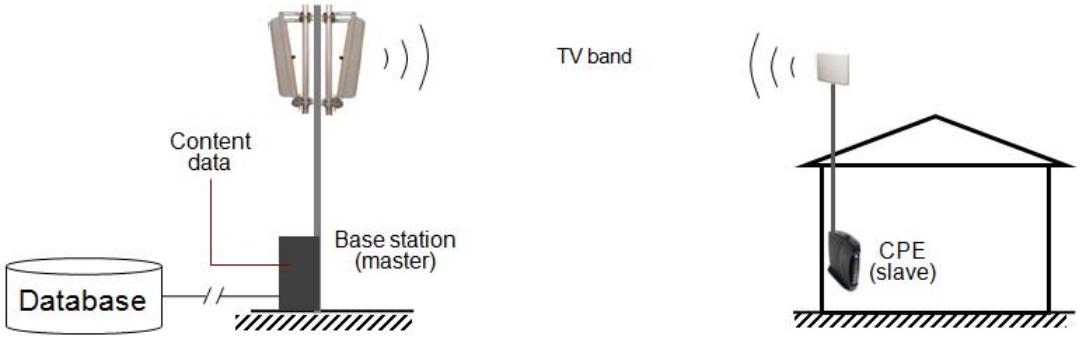

Figure 3. Use cases: rural broadband or utility meter reading (machine-to-machine).

2.12

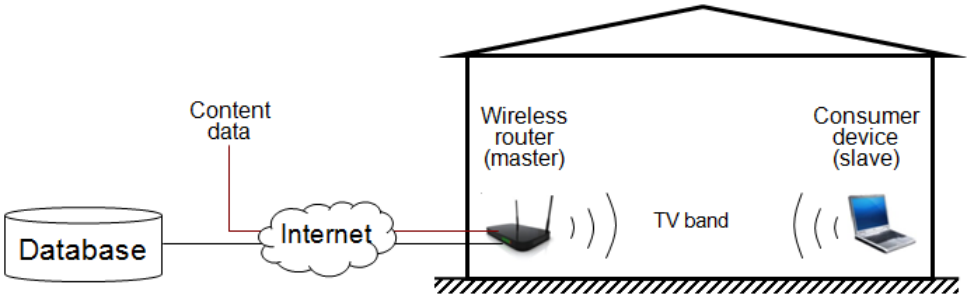

Figure 4. Use cases: in-home broadband, in-home multi-media distribution, or indoor public hot-spot coverage.

2.13 In summary, we expect that the availability of TV white spaces will spawn a host of new applications and services from which consumers and citizens will benefit.

Section 3

Introduction

3.1 This introduction is structured into five subsections. In the first subsection we present a summary of our past work on defining our approach for the use of TVWSs. As a result of this work we have made a number of implementation decisions that we present in the second subsection, which is the overview of the adopted framework. The key elements of this framework are as follows:

- Licence exempt access to the TVWSs, on the basis of a number of terms and conditions designed to minimise the risk of interference to primary users, i.e. DTT and PMSE.

- In order to be licence exempt, devices must receive from a qualifying database information on the available frequency channels and the power levels that they can use.

3.2 The next subsection explains the work that we have carried out over the last year on the details of implementing the framework that we are adopting. We then present the scope of this consultation, and the reasons why we are consulting now. We conclude the introduction with an outline of the rest of this document.

Background

3.3 Our activities in the area of TVWS date back to December 2007, when we issued the DDR statement that presented our approach to awarding the digital dividend. Among a number of proposals to secure optional use of the band, we considered allowing access to the interleaved spectrum in the UHF TV band by devices that would be exempt from the requirement to be licensed under the Wireless Telegraphy Act 2006 (WT Act). We concluded that we should allow this, as long as we were satisfied that it would not cause harmful interference to existing licensed uses, including DTT and PMSE, and that such devices could potentially bring substantial benefits to citizens and consumers.

3.4 In February 2009 we published a consultation entitled "*Digital dividend: Cognitive access; A consultation on licence exempting cognitive devices using interleaved spectrum*"[14]. Here we introduced the three mechanisms that could be used by a device operating in the UHF TV band to determine which frequencies it could use. These were sensing[15], geo-location[16], and beacon transmissions[17].

3.5 In the subsequent statement entitled "*Digital dividend: Cognitive access; A statement on licence exempting cognitive devices using interleaved spectrum*"[18] published in July 2009, we determined that beacon transmissions were inferior to the other two

[14] http://stakeholders.ofcom.org.uk/consultations/cognitive/summary.
[15] Whereby devices monitor frequencies for any radio transmissions, and if they do not detect any, assume that the channel is free and can be used.
[16] Whereby devices determine their geographic location and query a "geo-location" database which responds with the frequencies they can use at their current location.
[17] Whereby a network of fixed transmitters or base stations are established around the country and broadcast signals informing devices as to which channels are free in their vicinity.
[18] http://stakeholders.ofcom.org.uk/binaries/consultations/cognitive/statement/statement.pdf.

approaches, and that we would not consider it further. We provisionally concluded on the parameters needed for sensing, and noted that further discussion would be needed as to how a geo-location database might operate. We also concluded that it was appropriate to proceed with developing a regulatory framework enabling both sensing and geo-location mechanisms, and to let industry choose its preferred approach.

3.6 In November 2009, we published a discussion document entitled "*Digital Dividend: Geolocation for cognitive access; A discussion on using geolocation to enable licence-exempt access to the interleaved spectrum*"[19]. This document elaborated on our views on geo-location and the mechanisms required to make it work. The responses were predominantly supportive of our proposed way ahead, with some useful suggestions for improvement or for additional flexibility. Based on the responses we received to the November 2009 document, on workshops held with key stakeholders and on further analysis, we concluded that:

- The devices would be licence exempt.
- A device would be required initially to consult an Ofcom list of qualifying databases and select from this a preferred database.
- The device would then be required to contact this preferred database and provide information about its location and technical characteristics. The database would subsequently respond with the available frequencies, permitted powers and the time validity of these parameters.
- Many different database ownership models might emerge, and we should be as flexible as possible in allowing one or more databases and providing mechanisms for future changes.

3.7 We presented these conclusions in our consultation entitled "*Implementing geolocation*"[20] published in November 2010 ("2010 Consultation"). This consultation provided further details of our views on how geo-location would work in practice, the requirements that devices would have to fulfil in order to be licence exempt and the requirements for geo-location databases.

3.8 Stakeholders responded to this consultation highlighting a number of concerns about the risk of harmful interference to incumbents and the lack of harmonised standards. They also made suggestions on the conditions for licence exemption of devices, and the database requirements and responsibilities. Our ensuing statement, "*Implementing geolocation: Summary of consultation responses and next steps*"[21], published in September 2011 ("2011 Statement"), summarised the responses and our views on them. We also said in that statement that we would:

> "*…work with stakeholders to finalise the critical activities that are necessary for setting up a suitable regulatory framework to manage and update the flow of information to and from a geolocation database.*"

3.9 In addition, we stated that:

[19] http://stakeholders.ofcom.org.uk/consultations/cogaccess/summary.
[20] http://stakeholders.ofcom.org.uk/consultations/geolocation/summary.
[21] http://stakeholders.ofcom.org.uk/consultations/geolocation/statement/.

> "*...there are a number of issues that remain where further detail is required, and there may be need for more decisions on behalf of the regulator which could require consultation.*"

3.10 The following section summarises our decisions from the 2011 Statement and previous activities. It presents the framework that has underpinned our work, internally and with stakeholders, since the 2011 Statement.

Overview of adopted framework

3.11 WSDs operating in the UHF TV band will be licence exempt equipment that share spectrum with the DTT and PMSE services. These two licensed services are the primary users of the band, and as such, WSDs must not cause harmful interference to these services[22].

3.12 By itself, a WSD does not have access to the requisite information about DTT and PMSE usage of the band to be able to transmit without there being a substantial risk of causing undue interference to these users. Therefore, it must contact an appropriate repository – a WSDB – and communicate information about itself and its geographic location.

3.13 The WSDB will respond to the WSD with a set of parameters indicating the frequencies[23] and maximum powers at which the WSD can transmit without causing harmful interference to the primary users.

3.14 The following are the key elements of the regulatory framework that we have developed:

- WSDs will be permitted to transmit in the UHF TV band provided that they do not cause undue interference to incumbent licensed users within the band, namely DTT and PMSE, or outside the band.
- WSDs will be exempt from the requirement for a licence under the WT Act provided that they comply with a set of requirements captured in a statutory instrument.
- Compliance with the licence exemption regulations will require that WSDs operate according to the frequency/power parameters that they receive from a WSDB. They will be required to obtain such parameters from a qualifying WSDB. The qualifying WSDB will generate the frequency/power parameters for WSDs on the basis of information relating to the protection of incumbent users that Ofcom will regularly make available.
- WSDs will be able to identify qualifying WSDBs by consulting a list on a website maintained by Ofcom, and select a preferred WSDB from that list. The choice of preferred WSDB will be for the master WSD to determine itself.
- In order to be included on this list, WSDB providers will have to satisfy Ofcom that they are qualified to provide WSDB services. Ofcom and each WSDB

[22] Or indeed, to licensed services outside the UHF TV band.
[23] It is possible that there are not any frequencies available, in which case the instruction would be not to transmit at all.

provider will enter into arrangements that specify the obligations applying to the provision of qualified WSDB services.

- There are two categories of device: master WSDs and slave WSDs. A master WSD is required to have:

  i) a communications link to access Ofcom's list of qualifying WSDBs, and

  ii) a communications link to query one of the qualifying WSDBs.

- A slave WSD, on the other hand, does not have a direct connection to Ofcom or a WSDB; it will obtain its frequency/power parameters from a WSDB through a master WSD.

- A WSDB may be "open" or "closed". An open database provides services to any WSD, whereas a closed database only serves a closed group of WSDs. It will be for the WSDB operator to determine the nature of its commercial arrangements with WSDs.

- A WSDB must provide frequency/power parameters to WSDs on a non-discriminatory basis. This means that a WSDB must provide the same frequency/power parameters to all WSDs which have the same device characteristics and are in the same geographic location.

- The number of qualifying WSDBs will not be capped.

- A WSDB may provide supplementary "value-added" services to devices. An example of this could be a classification of the available channels according to their quality.

3.15 The interactions between the entities involved in our adopted framework are shown in Figure 5.

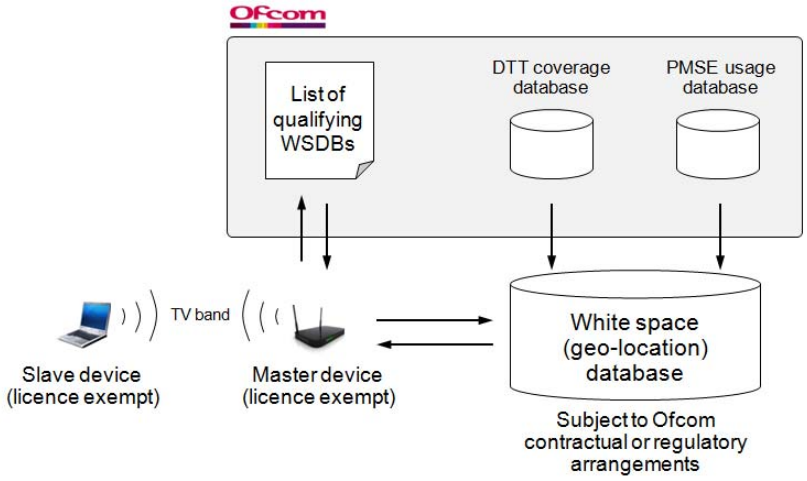

Figure 5. Adopted framework for authorising the use of TV white spaces.

3.16 Finally, as explained further below, we are currently examining the nature of the information to be provided by Ofcom to the WSDBs. Our proposed approach will be presented in future stakeholder engagement.

Current work on TV white spaces policy

3.17 In this sub-section we present an overview of our activities since the 2011 Statement as well as Ofcom's next steps on white spaces. The developments in this past year and the status of our implementation under the broad umbrella of TV white spaces are as follows:

- **Device requirements and licence exemption**. We laid out the basic principles of our approach to licence exemption of WSDs in the 2010 Consultation and the 2011 Statement. We have also engaged extensively with the technical working group to discuss the requirements relevant to the regulation and technical specification of the devices. Based on the proposals in the 2011 Statement and on the results of the stakeholder engagement, we have produced a package of documents that collectively set out how we propose to implement our framework for the operation of WSDs. This package includes an example of what the statutory instrument setting out the terms of the licence exemption might look like, a draft interface requirement document that presents a technical description of the provisions in the SI, and a voluntary national specification showing how the requirements could be tested. The outcome of this work is this consultation, where we present our proposed regulatory requirements and technical specifications in detail in conjunction with drafts of these three documents.

- **Co-existence with incumbent services**. Over the course of the past six months we have engaged closely with stakeholders, primarily via the technical working group, to discuss the technical parameters for co-existence between WSDs and incumbent users of the TV band, namely DTT and PMSE. These discussions have been informed by various measurements of protection ratios for DTT receivers when subjected to interference from WSDs and stakeholder contributions relating to the modelling of interferer-victim geometries. These discussions are on-going, but are expected to be completed in early 2013. We intend subsequently to consult on our proposals.

- **Database requirements and qualification**. Our approach for WSDBs involves Ofcom entering into arrangements with database providers, who have demonstrated that their databases meet certain requirements and are able to provide the TVWS availability information to the individual WSDs. This qualification process is necessary since WSDs will only be permitted to operate in TV white spaces if they have consulted a qualifying WSDB and operate in accordance with the parameters provided by that WSDB. We are working to develop the details of the WSDB requirements and to translate these requirements into contractual terms, and we expect to engage with stakeholders to discuss the substance of the requirements and the contract. We are also considering holding an end to end trial to test the interoperation of Ofcom's systems, with WSDBs and devices. In addition, we are evaluating the impact of the database approach on Ofcom's operations, which fall broadly in three areas:

i) Provision of the TVWS availability data to the WSDBs[24]. Some of the options that we are considering for this present significant requirements for us in terms of information systems and data communications.

ii) Enforcement. WSDs present a risk to the operation of the incumbent services in this band. Although the database model has been developed to ensure that cases of undue interference are rare, we need to understand how rare these will be, and how Ofcom and the WSDBs might deal with these when they occur.

iii) The qualification process for databases and our day to day management of the database contracts.

- **Making information on DTT and PMSE available to databases**. Our proposal in the 2011 Statement was that the databases would calculate TVWS availability, using the DTT and PMSE data as input. We are considering whether this should be the case or whether Ofcom should instead calculate TVWS availability in-house and then pass it on to the databases. The main reason for the latter alternative is the complexity of the calculations and the need to ensure a consistent output from all databases. We will address this issue in the co-existence consultation mentioned above.

- **Baseline and enhanced modes.** Our *baseline* framework for the operation of WSDs, as set out in our 2011 Statement, involves the automatic reporting of device parameters from WSDs to WSDBs. Our discussions with stakeholders have indicated that fixed WSDs may benefit from *enhanced* TVWS availability if specific parameters pertaining to these devices (e.g., distance to nearest victim, antenna characteristics, etc.) are reported by the user of the device and accounted for by the WSDBs. However, this so-called "enhanced mode" does raise new questions with respect to our approach to the authorisation of the WSDs, and the arrangements between Ofcom, the WSDBs and the organisations putting the devices into operation. These are complex issues that in our view will be better addressed once the framework for the baseline mode is in place. We aim to return to the enhanced mode once the details of the baseline mode have been finalised. We intend to do this by publishing a consultation document once the framework for the baseline mode is sufficiently advanced.

- **Engagement with the Government's Communications Review[25]**. The Government's review asks for views on how to reduce regulatory burdens and future-proof for the digital age. One of the key elements of this review is spectrum. The Department for Culture, Media and Sport held a seminar on 12 July 2012 to gather views on specific changes to the regulatory framework that would result in more efficient spectrum management and published a discussion paper alongside[26]. Ofcom participated in that seminar and formally responded to the discussion paper. One of the points we raised in our response[27] was related to the power to authorise spectrum management

[24] By TVWS availability we mean the frequencies and transmission power levels that can be used by WSDs at a given location without affecting DTT receivers and PMSE users.
[25] http://dcmscommsreview.readandcomment.com/.
[26] http://dcmscommsreview.readandcomment.com/spectrum/.
[27] http://stakeholders.ofcom.org.uk/binaries/consultations/ofcomresponses/Ofcom_DCMSspectrum.pdf.

databases. In particular, we suggested that there were potential benefits, in terms of securing optimal use of spectrum, from having a clear framework for the provision, management and regulation of databases (and their providers) that perform the function or have the effect of managing access to spectrum. We also noted that we should have the ability to the recover the costs (whether ours or those of a third party) involved in this way of managing spectrum.

- **International activities. In** parallel with our internal studies and discussions with stakeholders, we have contributed to a number of key European activities. Notably, these include the work of ECC SE43[28] in defining the technical requirements for the operation of WSDs and of ETSI BRAN[29] in defining a European harmonised standard which is a route for manufacturers to demonstrate presumption of conformity with the essential requirements of the Radio and Telecommunications Terminal Equipment (R&TTE) Directive[30].

Why we are consulting now and what we are consulting on

3.18 Our 2011 Statement set out our approach to authorising the use of white spaces in the UHF TV band, based on a model which involves Ofcom granting licence exemption for the use of WSDs. Compliance with the licence exemption regulations would require that WSDs operate according to the operational parameters that they receive from a qualifying WSDB.

3.19 As explained above, over the course of the first half of 2012 we engaged extensively with stakeholders, notably via the technical working group, to derive appropriate technical requirements and a model for how WSDs might operate and interact with WSDBs. We have since built on this work to create a framework for the operation of WSDs that is implemented through a suite of three draft documents setting out the proposed regulatory requirements for WSDs and their technical specifications. These three documents are:

a) An example statutory instrument (SI) – This draft provides an indication of how we might describe the terms and conditions with which WSDs must comply in order to be exempted from the requirement for a licence under the WT Act.

b) The interface requirement (IR) – This is a technical description of the provisions in the SI and is used for the purpose of the notification to the European Commission of the technical regulations we are proposing to adopt. The IR also identifies requirements which are contained in the VNS and which Ofcom considers to be key features of the device to achieve compliance with the essential requirements of the R&TTE Directive, specifically to avoid harmful interference..

---

[28] European Communications Committee (ECC), Working Group Spectrum Engineering 43 (WG SE 43) is the European group that defines technical and operational requirements for cognitive radio systems in the TV white spaces. http://www.cept.org/ecc.

[29] European Telecommunications Standards Institute (ETSI) committee Broadband Radio Access Networks (BRAN) produces technical standards for broadband radio access networks. http://portal.etsi.org.

[30] Directive 99/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity http://ec.europa.eu/enterprise/sectors/rtte/index_en.htm.

c) The voluntary national specification (VNS) – This provides guidance to manufacturers – in the absence of European harmonised standards – on suitable tests for WSD manufacturers to demonstrate compliance with the requirements of the R&TTE Directive. The VNS will be suppressed when a stable draft of the ETSI BRAN harmonised standard is available.

3.20 We consider it appropriate to carry out a UK consultation now on our proposed regulatory requirements and technical specifications for WSDs in the UHF TV band, and on how we have reflected these requirements and specifications in the example SI and draft IR and VNS.

3.21 Following this consultation and in accordance with European Union rules[31] on national technical regulations, we need to notify the European Commission of our draft technical regulations, the grounds for them and, where necessary, the main basic legislative and regulatory provisions of the draft regulation.

3.22 It should be noted that some of the functionalities of WSDBs are described in this document. This is only in so far as they relate to their interactions with the WSDs. The full requirements for the operation of the WSDBs are outside the scope of this consultation, but will be published once they have been defined (see Section 8).

Structure of this document

3.23 In Section 4 we describe the legal framework which sets out our duties in relation to authorising the use of WSDs in the UHF TV band.

3.24 In Sections 5 and 6 we describe the details of our proposed requirements and a model of operation for WSDs. This is followed in Section 7 with a description of how our proposals have been translated into the example SI and draft IR and VNS.

3.25 Finally, in Section 8 we outline our next steps in relation to the proposals presented in this document, as well as our future plans to engage with stakeholders on other issues relating to the authorisation of databases and co-existence with existing users.

[31] Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards (as amended).

Section 4

Legal framework

4.1 This section describes our functions and duties in assessing how best to define the requirements for WSDs in relation to their use of white spaces in the UHF TV band and considers how they apply to achieving our objectives with regards to TV white spaces. Set out below are our general duties that apply across all our functions, together with a number of specific duties.

Our general duties

4.2 Section 3(1) of the Communications Act 2003 (the Communications Act) provides that our principal duties in carrying out our functions are:

- to further the interests of citizens in relation to communications matters; and
- to further the interests of consumers in relevant markets, where appropriate by promoting competition.

4.3 In carrying out these duties, we are required, among other things, to secure a number of objectives such as the desirability of promoting competition, investment, and innovation.

Our spectrum duties

4.4 In carrying out our general duties, we are required under the Communications Act to secure, in particular, the optimal use of the electromagnetic spectrum for wireless telegraphy, and to have regard to the different needs and interests of all persons who may wish to make use of the spectrum for wireless telegraphy.

4.5 In addition, in carrying out our spectrum functions under section 3 of the WT Act, we are required to have regard in particular to:

- the extent to which the spectrum is available for use or further use for wireless telegraphy;
- the demand for use of that spectrum for wireless telegraphy; and
- the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy;

4.6 In carrying out our functions, we are also required to have particular regard to the desirability of promoting:

- the efficient management and use of the spectrum for wireless telegraphy;
- the economic and other benefits that may arise from the use of wireless telegraphy;
- the development of innovative services; and
- competition in the provision of electronic communications services.

Application of our duties in relation to TV white spaces

4.7 Our policies with regards to TV white spaces are determined by observance of our general and specific duties above. We have interpreted these duties are requiring us to:

4.7.1 Facilitate access to TV white spaces. We believe that there are significant benefits to consumers in making TV white spaces available for use, such as efficient use of spectrum, the emergence of innovative services, and increased competition. We consider that licence exempt access to these bands is the best approach to facilitate these benefits. We set out why we believe this to be the case in detail in the November 2010 Consultation.

4.7.2 Protect the incumbent users, namely DTT and PMSE. DTT is the main platform for provision of TV services and, as such, delivers significant value for consumers. In addition, it performs a very important public policy role in providing universal low cost access to public service broadcasting content, whilst also providing a wide consumer choice of channels. PMSE applications in the band include wireless microphones, in-ear-monitors, talkback and audio links. These services support a wide range of activities from programme making, theatres, concerts, sports event coverage and smaller scale users including churches and schools.
We consider that a wide scale deployment of licence exempt WSDs presents a risk of increased interference to DTT and PMSE users. As a result, we are determined to put in place a regulatory framework that ensures co-existence between the primary and the secondary services, and one that minimises the risk of undue interference.

4.7.3 Minimise the regulatory burden. A certain amount of regulation is necessary to authorise access to TV white spaces and to protect the incumbents, but we have tried to keep this as light as possible, consistent with the need to prevent undue interference, in order to maintain flexibility. We are at the very early days of white space development and, although some business models and use cases have already been put forward (see Section 2), it is difficult to predict which models, applications and technologies will succeed. In order to facilitate the emergence of innovative services, we consider we should put in place a framework that is flexible to accommodate different approaches.

4.8 Our decisions in the past, and the proposals in this document with regards to the requirements of WSDs, are aimed at fulfilling the above objectives.

Section 5

Requirements for white space devices

5.1 We have developed a detailed framework for the operation of WSDs in the UK. In this section we present the details of the proposed regulatory requirements and technical specifications for WSDs that we consider are necessary in order to implement our overall framework. We consider that the various proposed requirements that we have outlined in this section and in Section 6 will collectively play an important role in ensuring that WSDs can operate without causing harmful interference to the primary licensed users of the UHF TV band.

5.2 These proposed requirements broadly translate into the requirements in the SI and IR and the technical specifications in the VNS. Section 7 explains in more detail the relationship between the requirements set out both in this section and in Section 6, and the example SI and draft IR and VNS.

5.3 We first describe a number of WSD categories. We then set out the proposed sequence of operations that WSDs will need to perform, followed by a number of additional operational features.

5.4 Our proposals are presented with reference to "device parameters", "operational parameters" and "channel usage parameters". These are defined as follows:

- Device parameters are the parameters that WSDs will communicate to a qualifying WSDB in order to provide the WSDB with relevant information about the device. These parameters include various characteristics of the device as well as its geographic location.

- Operational parameters are the parameters that the WSDB provides to a WSD in order to ensure that the WSD can transmit without causing undue interference to the primary uses of the UHF TV band. These operational parameters include notably the frequencies and power levels that the device can use at its location, and are generated by the WSDB taking into account DTT and PMSE use. There are two types of operational parameters:

  a) Specific operational parameters – The WSDB derives these for a particular WSD, on the basis of the WSD's specific device parameters.

  b) Generic operational parameters – The WSDB derives these for all slave WSDs operating in the coverage area of a master WSD. These are derived on the basis of assumed *default* (cautious) slave device parameters.

- Channel usage parameters refer to the actual frequencies and powers at which a WSD intends to transmit over the UHF TV band.

5.5 The above parameters are described in more detail in Section 6.

Framework re-visited

5.6 Figure 6 illustrates the way in which WSDs interact with WSDBs and Ofcom, as defined in our framework for authorisation of the use of TVWSs (see Section 3).

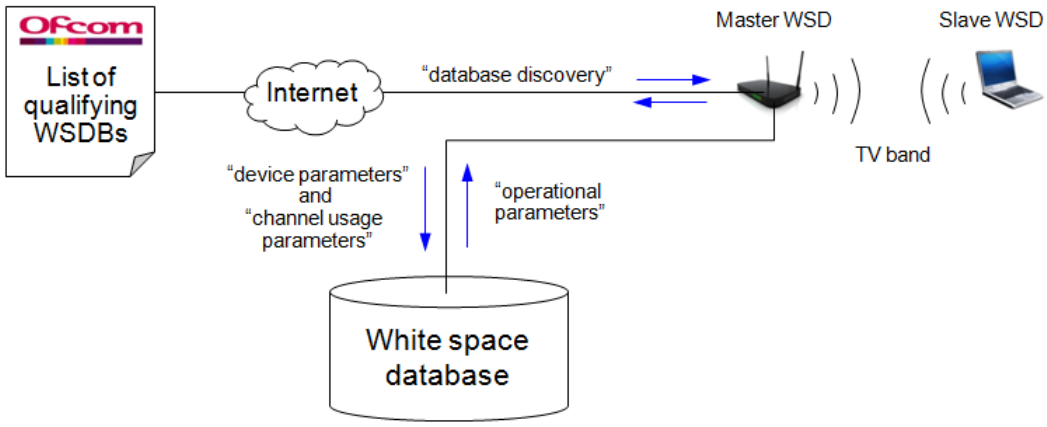

Figure 6. Interactions among various entities.

5.7 As described above, a WSD may or may not directly communicate with a WSDB. A WSD that directly communicates with a WSDB in order to receive its operational parameters is called a master WSD. A WSD that does not directly communicate with a WSDB is called a slave WSD. A slave WSD receives its operational parameters indirectly from a WSDB via a master WSD. Slave WSDs can therefore have reduced functionality and complexity.

5.8 The discovery by a master WSD of Ofcom's list of qualifying WSDBs will take place via an internet connection. Depending on the use case, the communications between a master WSD and a WSDB may be via an internet connection, or via a proprietary connection[32]. A master WSD will not be permitted to perform the above communications via the UHF TV band, unless it has already received appropriate operational parameters from a qualifying WSDB.

5.9 The communications between a master WSD and a slave WSD will normally[33] occur over the UHF TV band.

5.10 A master WSD must have horizontal geo-location capability, i.e., it must have the ability to determine and report its latitude and longitude coordinates. This is necessary so that it is able to receive location-specific operational parameters from a WSDB.

5.11 Horizontal geo-location capability is optional for slave WSDs. Where a slave WSD does not have horizontal geo-location capability, a WSDB will infer the location of the slave WSD based on the coverage area of the serving master WSD. Where a slave WSD does have horizontal geo-location capability, it can report its coordinates to a serving master WSD, and subsequently a WSDB.

5.12 Vertical geo-location capability is optional for both master and slave WSDs. This is the ability of the device to determine and report its altitude coordinate (height above

[32] This might be the case where the master WSD and WSDB are operated by the same entity, e.g., a communications provider in a rural broadband use case.

[33] In some special use cases, a TV white space communications system might be designed such that the association between a slave WSD and a master WSD, and the communication of "special operational parameters" from a master WSD to a slave WSD, do not occur over the UHF TV band. This might be via wireless communications in another frequency band or via wire-line communications. Such functionality is permitted so long as the WSDs comply with the appropriate "operational parameters" when transmitting over the UHF TV band.

sea level). Where a device does not have vertical geo-location capability, a WSDB will assume a default (cautious) value for the device height based on the device type reported by the WSD. Where a slave or master WSD does have vertical geo-location capability, it can report its height to a serving master WSD or directly to a WSDB, as appropriate.

Device categories

5.13 A wide range of WSDs are likely to appear in the future to satisfy the requirements of different use cases. They are also likely to be installed and deployed in a number of diverse ways for different use cases. In some use cases, the low cost of the device is a priority, and this might imply poorer spectral emission masks. In other use cases, WSDs might require specific wireless technologies to meet the required quality of service.

5.14 Efficient use of the TVWS spectrum dictates that WSDBs treat different categories of WSDs differently, so that the higher propensity of one WSD category to cause harmful interference does not constrain the use of spectrum for other WSD categories. For this reason, we propose to categorise WSDs according to the characteristics described below. Accordingly, WSDs must report their category to a WSDB as part of their device parameters. See also Section 6.

Device Type

5.15 The “device type” describes the expected deployment of the WSD. We currently envisage two types of WSD, which we refer to as type A and type B. A type A device is one whose antennas are permanently mounted on a non-moving outdoor platform. A type B device is one whose antennas are not permanently mounted on a non-moving outdoor platform. A type B WSD must have an integral antenna.

5.16 We have introduced the two distinct device types so that a WSDB can make different assumptions in generating operational parameters for each type. This will enable the WSDB to manage more efficiently (in terms of TVWS use) the likelihood of interference to the incumbent licensed services. This is on the basis that the WSDB will allow those devices with a lower propensity to cause interference to transmit with more relaxed constraints, and therefore achieve a more efficient use of spectrum.

5.17 For example, type A devices are likely to have their antennas located at height, and this presents an increased risk of interference to the incumbent services. For this reason, we will need to take a more conservative approach in generating operational parameters for type A devices. On the other hand, type B devices will either be indoor or outdoor portable/mobile devices. Consequently the operational parameters for type B devices might be more relaxed as compared to those for type A devices.

5.18 The device type must be declared by the manufacturer, as proposed in the draft voluntary national specification (VNS). We are proposing a similar requirement in the harmonised standard being developed by ETSI BRAN.

5.19 Additional device types might be introduced in the future as the nature of TVWS use cases becomes clearer. The definitions of these additional types would have to be included in the VNS and harmonised standard.

Emission class

5.20 The “emission class” identifies the spectrum emission mask (spectral leakage) of the WSD, which itself influences the propensity of a WSD to cause harmful interference to the incumbent licensed services. We propose four classes of emission mask, as described in Tables 1 and 2 later in this section. This allows device manufacturers the flexibility to produce equipment which radiates with different levels of spectral purity, and hence have different costs of manufacture.

5.21 That is not to say that a cheaper device with a poorer spectral purity will cause greater harmful interference. A WSDB will take into account the reported emission class of a WSD when it generates the operational parameters for the device.

5.22 The WSD emission class must be declared by the manufacturer, and the spectrum emission mask must be tested as specified in the draft VNS. We are proposing a similar requirement in the harmonised standard being developed by ETSI BRAN.

Radio technology

5.23 Measurements indicate that the in-block time-frequency structure of the signals emitted by a WSD can have a substantial impact on the propensity of the WSD to cause harmful interference to DTT reception. That is to say, WSDs with different wireless technologies could cause widely differing levels of harmful interference, even if the WSDs complied with the same out-of-block emission mask (i.e., had the same emission class).

5.24 Rather than assuming the worst case technology, a WSDB may account for the reported technology of a WSD, and can generate specific operational parameters such that WSDs with more benign technologies can be permitted to transmit subject to more relaxed constraints.

5.25 The WSD technology must be declared by the manufacturer, as proposed in the draft VNS. We envisage this technology information to be captured as a simple look up. We are proposing a similar requirement in the harmonised standard being developed by ETSI BRAN.

Rationale for our proposals

5.26 The categories identify WSDs with different deployment and performance characteristics. These allow manufacturers the flexibility to create WSDs at a range of cost points, and for the industry to match these to different use cases and business propositions. At the same time, the reporting of the WSD categories to WSDBs ensures that WSDs that are less likely to cause interference to incumbent licensed users are allowed to transmit with more relaxed constraints.

5.27 The associated costs are related to a) the requirement for WSDs to communicate their categories to WSDBs, and b) the added complexity required in the WSDBs to deal with different WSD categories. We believe that these costs are minimal. The signalling overhead for communicating the WSD categories to WSDBs is a small fraction of the signalling capabilities of a modern wireless device. Furthermore, the requirement for WSDBs to select category-specific operational parameters is readily manageable given the state-of-the art in computing technology. In conclusion, we believe that the benefits of introducing the above WSD categories outweigh the costs.

Question 1: Do you agree with our approach to defining the various categories of WSDs?

Sequence of operations

5.28 In this sub-section we set out the sequence of procedures for the exchange of information between WSDBs, master WSDs, and slave WSDs. These procedures reflect the following high level operational requirements:

- A qualifying WSDB must receive information from a WSD about the characteristics of that WSD in order to generate operational parameters for that WSD.

- A qualifying WSDB must maintain a record of the actual usage of the TV white spaces. This means that each device must report back to the WSDB the actual frequencies and powers that it uses. We believe this is important for the purpose of spectrum management for two reasons:

  i) To enable offending WSDs to be readily identified if interference occurs.

  ii) To allow the WSDBs to know the extent to which available white spaces are being used.

5.29 We acknowledge that a range of WSD wireless technologies are likely to emerge, therefore we have defined the requirements to be technology-neutral. In addition, we have specified the sequence of operations at a high level, with only enough detail to ensure that the necessary information is exchanged between WSDs and WSDBs.

5.30 We do not believe that our requirements impose any constraints on industry-led innovation in this field, or the emergence of international technology standards which specify the details of the communications protocols among WSDs, and between WSDs and WSDBs.

5.31 We recognise that the requirement to report back to the WSDB the actual usage parameters is an additional communications burden, which is not present in other licence exempt use. However, we believe that the circumstances of licence exemption in the UHF TV band – widespread primary use, allocation of radio resources by databases – make it important to keep track of actual use, in particular since the reporting of actual use is relatively easy to implement once the database and the communications infrastructure are in place.

5.32 The proposed sequence of events in the interactions between master WSDs, slave WSDs and WSDBs is described below in the context of the following four separate phases:

a) Generation and communication of specific operational parameters for individual master WSDs.

b) Generation and communication of generic operational parameters for all slave WSDs in the coverage area of a particular master WSD.

c) Association of a slave WSD with a master WSD.

d) Generation and communication of specific operational parameters for individual slave WSDs.

5.33 These phases are illustrated in Figure 7 below, along with the corresponding sequence of parameter exchanges illustrated in Figure 8.

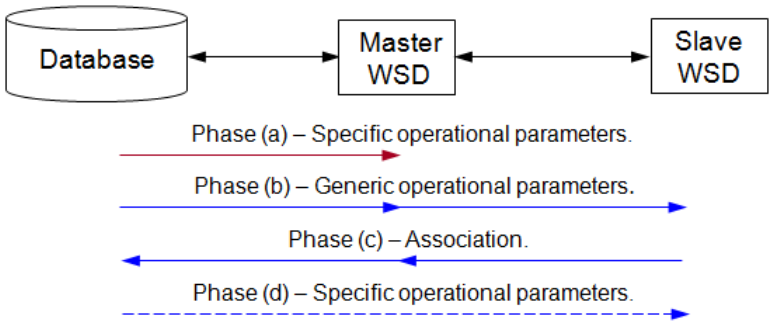

Figure 7. Illustration of operational phases.

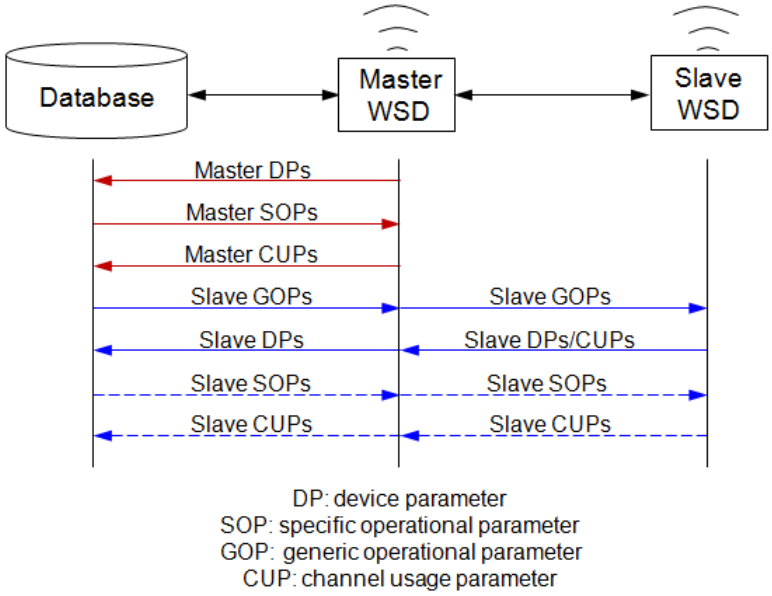

Figure 8. Sequence of data exchange.

5.34 We recognise that the requirements set out here relating to the interactions between master and slave WSDs may be implemented in a variety of ways in industry-defined wireless technologies. However, it is important to note that, while the details of implementation may diverge from the sequence of events outlined here, this must not in any way alter a) the information exchange between the master WSDs and WSDBs or b) the operational parameters of the master and slave WSDs, all as set out in this document.

Phase (a) – Specific operational parameters for a master WSD

5.35 This phase relates to the generation and communication of specific operational parameters for master WSDs. Any master WSD wishing to transmit in the UHF TV band must undertake the steps described below:

5.35.1 A master WSD wishing to transmit in the UHF TV band must first obtain a list of qualifying WSDBs from Ofcom's website.

5.35.2 The master WSD must contact one of the WSDBs in the list and request specific operational parameters for its own transmissions. As part of this process, the master WSD must communicate its device parameters (including its horizontal location) to the WSDB.

5.35.3 The WSDB will then generate the specific operational parameters that the master WSD must comply with for its transmissions in the UHF TV band. For this, the WSDB will use the "TVWS availability data"[34] obtained from Ofcom, and the device parameters provided by the master WSD.

5.35.4 The WSDB will communicate the specific operational parameters to the master WSD.

5.35.5 The master WSD must respond to the WSDB with its channel usage parameters, i.e., the channel(s) and radiated power(s) that it intends to use. The channels used will be a subset of those included in the specific operational parameters that the master WSD received from the WSDB.

5.35.6 The master WSD can only then start transmissions in the UHF TV band according to its reported channel usage parameters.

Phase (b) – Generic operational parameters for slave WSDs

5.36 This phase relates to the generation and communication of generic operational parameters for slave WSDs in the coverage area of a particular master WSD. Any master WSD seeking to support the association of slave WSDs over the UHF TV band must undertake the steps described in paragraph 5.38 below. We use the term "association" to refer to the process whereby a slave WSD initially identifies itself to its serving master WSD.

5.37 We recognise that there may be circumstances where the WSD wireless technology supports the association of slave WSDs via media other than the UHF TV band, e.g., via wireless access in other frequency bands, or wire-line access. As will become evident, in such cases "specific" (Phase d) rather than "generic" (Phase b) operational parameters apply.

5.38 The sequence of events in this phase is as described below:

5.38.1 The master WSD must contact a qualifying WSDB, and request generic operational parameters for the transmissions of those slave WSDs within its coverage area.

5.38.2 The WSDB will generate the generic operational parameters that slave WSDs must comply with for their transmissions in the UHF TV band for the purpose of association with a master WSD. For this, the WSDB will use the "TVWS availability data" obtained from Ofcom and the channel usage parameters received from the master WSD (see 5.35.5) to calculate the coverage area in which slave WSDs are likely to operate. It will then calculate the generic operational parameters that apply within the coverage area based on a number of *default* (conservative) device parameters. Note that at this stage no slave device parameters will be available at the master

[34] This data indicates the maximum power that a WSD is permitted to radiate within each DTT channel, when the device is located in a particular geographic pixel.

WSD or at the WSDB. This is because the slave WSDs will not have yet associated with the master WSD, and will not have had the opportunity to communicate their device parameters to the master WSD

5.38.3 The WSDB will communicate the generic operational parameters to the master WSD.

5.38.4 The master WSD must then *broadcast*[35] the generic operational parameters to slave WSDs within its coverage area. The broadcast parameters will correspond to the full set (or a subset) of the channels identified and communicated by the WSDB[36] (see 5.38.3).

5.38.5 Slave WSDs must comply with the broadcast parameters when they transmit in the UHF TV band for purposes of association with the master WSD.

5.39 Slave WSDs which have already associated with a master WSD may continue to comply with the broadcast parameters for all subsequent transmissions, or alternatively, may request specific operational parameters in order to benefit from increased TVWS availability (see Phase (d)). The choice here is a matter for the device manufacturers.

Phase (c) – Association of a slave WSD with a serving master WSD

5.40 This phase relates to the association of slave WSDs with master WSDs. Any slave WSD wishing to transmit in the UHF TV band, irrespective of whether association is performed over the UHF TV band or not, must undertake the steps described below:

5.40.1 A slave WSD must associate with a master WSD by submitting its device parameters to the serving master WSD. Where association is performed over the UHF TV band, a slave WSD must also submit its channel usage parameters[37] to the serving master WSD. The channels used will correspond to the full set (or a subset) of those included in the generic operational parameters broadcast by the master WSD (see 5.38.4).

5.40.2 Where association is performed over the UHF TV band, the slave WSD can submit its device parameters and channel usage parameters by transmitting in the UHF TV band according to its reported channel usage parameters.

5.40.3 The master WSD must forward the device parameters and (where association is performed over the UHF TV band) the channel usage parameters of its associated slave WSDs to the WSDB.

---

[35] The broadcast may be explicit or implicit. By explicit, we mean that the relevant information is explicitly signalled to the slave WSDs via a broadcast channel. By implicit, we mean that the relevant information is inferred by the slave WSDs by monitoring the master WSD transmissions.

[36] The master may not be able to, or may not be willing to, receive transmissions from slave WSDs in the whole raster of channels provided by the WSDB.

[37] Note that the submission of "channel usage parameters" only applies if association is performed over the UHF TV band, where the slave WSD is aware of "generic operational parameters" broadcast by the serving master WSD.

Phase (d) – Specific operational parameters for a slave WSD

5.41 This phase relates to the generation and communication of specific operational parameters for individual slave WSDs.

5.42 A slave WSD which associates with a master WSD over the UHF TV band need not undertake the steps described in 5.44 below unless it wishes to obtain specific operational parameters. This is because a slave WSD will have the option to continue using the generic operational parameters for its transmissions following association. Note that a slave WSD which complies with specific operational parameters is likely to benefit from increased TVWS availability, as compared to the case where it complies with generic operational parameters.

5.43 However, a slave WSD which associates with a master WSD over a medium other than the UHF TV band must undertake the steps described in 5.44 below. This is because generic operational parameters do not apply in such circumstances, and special operational parameters are necessary.

5.44 The sequence of events in this phase is as described below:

5.44.1 A slave WSD may contact its serving master WSD and request specific operational parameters for its transmissions. In such a case, the master WSD must forward this request to the WSDB. Alternatively, a master WSD may itself request specific operational parameters from the WSDB for the transmissions of the slave WSD. Whether the request for specific operational parameters is directly from the slave WSD or the master WSD, is a matter for the device manufacturer.

5.44.2 The WSDB will[38] generate specific operational parameters that the associated slave WSD must comply with for its transmissions in the UHF TV band. For this, the WSDB must use the "TVWS availability data" obtained from Ofcom, and the slave device parameters provided previously by the master WSD (see 5.40.3).

5.44.3 The WSDB will communicate the specific operational parameters for a slave WSD to the master WSD.

5.44.4 The master WSD must then communicate the specific operational parameters to the associated slave WSD. The communicated parameters will correspond to the full set (or a subset[39]) of the channels identified and communicated by the WSDB.

5.44.5 The slave WSD must respond to the master WSDB with its channel usage parameters, i.e., the channel(s) and radiated power(s) that it intends to use. The channels used will be the full set (or a subset[40]) of those included in the specific operational parameters that the slave WSD has received from the master WSD.

---

[38] Note that the WSDB is not obliged to generate "specific operational parameters". This is a commercial matter for the WSDB provider.
[39] It may be that the master WSD does not support some of the channels that the WSDB has identified as suitable for the slave WSD, or that its own resource management function limits the channels it can receive transmissions on.
[40] It may be that the slave WSD cannot use all the channels indicated by the master WSD.

5.44.6 The slave WSD can submit its channel usage parameters by transmitting in the UHF TV band according to its reported channel usage parameters.

5.44.7 The master WSD must forward the channel usage information to the WSDB.

Rationale for our proposals

5.45 Our proposals have been developed with the objective of managing the risk of harmful interference to existing licensed users, as expressed in the high level requirements in 5.28. We believe our proposals achieve that objective by ensuring that:

- the information obtained by WSDs on the available DTT channels and maximum permitted powers is provided by an approved source, i.e., a qualifying WSDB.
- a WSDB holds a minimum set of information in order to generate the operational parameters. This minimum information consists of:

  i) the device parameters of a particular WSD, which allow the WSDB to generate specific operational parameters, or

  ii) the device parameters (including location) and the channel usage characteristics of a master WSD, which allow the WSDB to generate generic operational parameters for all slave WSDs in the coverage area of that master WSD.
- WSDs only transmit in the 470 – 790 MHz band once they have received appropriate operational parameters from a qualifying WSDB.
- WSDs report back to WSDBs their actual/intended usage of the TVWSs, so that in the event of harmful interference to existing services, the cause of interference can be identified.

5.46 We consider that the proposed elements in phases (a) to (d) will enable us to achieve our stated objectives. We do not consider that – in the context of the overall functionality of modern wireless devices – our proposals impose a significant communications burden or a substantive increase in the complexity of WSDs.

Question 2: Do you agree with our proposed sequence of operations for WSDs?

Additional operational requirements: master WSD

5.47 In this section we present a number of operational requirements for master WSDs. These are in addition to the requirements in the four phases outlined earlier.

Discovery of qualifying databases

5.48 When operating in the territories of the UK[41], a master WSD must *discover* qualifying WSDBs by consulting a device-readable list of qualifying WSDBs provided at a website[42] maintained by Ofcom. That list will be based on the list of qualifying databases that will be set out in a schedule to the SI.

5.49 However, the list will be updated regularly to reflect which of the qualifying WSDBs are currently in operation. This is because Ofcom may from time to time require qualifying WSDBs to suspend the provision of white space services for a period of time. This may occur for a variety of reasons (for example, to carry out routine maintenance or in order to investigate the source of reported interference). As a result, WSDs will be required to check the device-readable list of qualifying WSDBs on a regular basis to make sure that the WSDB from which it is seeking to obtain services remains a qualifying WSDB and is currently in operation.

5.50 While a WSDB that has been suspended under the terms of the arrangements with Ofcom should cease to communicate with WSDs until that suspension has been lifted, we consider that the requirement for WSDs to check the Ofcom device-readable list regularly provides an important additional safeguard to ensure that WSDs do not communicate with any qualifying WSDBs that continue to operate contrary to instructions from Ofcom.

5.51 The requirement therefore is that a master WSD must cease communications within the UHF TV band if more than N minutes have elapsed since it previously successfully discovered a qualifying WSDB as defined on Ofcom's device-readable list. In this way, WSBDs that no longer qualify, or qualifying WSDBs whose operations have been suspended, can be removed from the device-readable list, and no WSD will contact a removed WSDB after N minutes have elapsed.

5.52 In our 2011 Statement we had suggested that a value of N corresponding to 24 hours would be appropriate. We still believe this to be the case. However, we believe that there is benefit in allowing different national regulatory authorities to adjust the value of N according to their national circumstances, thereby removing the need for a harmonised value. For this reason we propose that the value of N itself be also listed on the Ofcom website and downloaded by master WSDs along with the list of qualifying WSDBs.

Device parameters must not be accessible to the user

5.53 Device parameters must be determined automatically by the master WSD. In other words, master WSDs must be designed such that the device parameters cannot be

[41] This does not prejudge whether the regulations would include the UK Crown dependencies which would be subject to discussions with the relevant authorities.

[42] Our current thinking is to make the list of qualifying WSDBs available at a website (accessible via the HTTPS protocol). We are proposing to specify the file format in xml with UTF-8 encoding. This proposal is currently under review by Ofcom and third parties, and is subject to change. Whilst Ofcom would endeavour to ensure the website has sufficiently high availability, there would be circumstances where this is not possible. For this reason, we propose that if a device failed to obtain the list of qualifying databases from the Ofcom website, it should continue to use its previous list and reconsult the website every hour thereafter until such time when the list can be accessed.

input into the device by the user of the device. The rationale for this requirement is to reduce the risk of tampering and false reporting by the users of WSDs.

Cease transmissions when instructed by the database

5.54 A master WSD (and its served slave WSDs) must cease transmission within 60 seconds of receiving instructions to do so by the WSDB. This implements a so-called WSDB "kill switch" to rapidly disable individual WSDs. The "kill switch" will be applied by the WSDB in appropriate circumstances, such as for example, in the event of interference to the DTT and PMSE services.

5.55 We believe that a value of 60 seconds is small enough to facilitate real time diagnosis (switching off devices and observing the impact) in the event that harmful interference to the existing licensed services is reported, and yet is considerably larger than the signalling times of modern wireless devices and so does not impose a substantial burden on the WSDs.

5.56 The time validity parameter described later is an alternative tool for disabling individual WSDs following a pre-defined time interval.

Time and geographic validity

5.57 A master WSD will be permitted to transmit in the UHF TV band only in accordance with the received specific operational parameters for a time period which does not exceed the time validity of those parameters and in a geographic area which does not exceed the geographic validity of those parameters. The geographic validity of specific operational parameters for a master WSD will be the geographic area wherein the horizontal position of the WSD differs by no more than 50 metres from its position determined at the time when the WSD last reported its location to a WSDB.

5.58 This means that a master WSD can move up to 50 metres in any (horizontal) direction without needing an update to its specific operational parameters. Conversely, if a master WSD moves more than 50 metres in any (horizontal) direction, then it must request an update to its specific operational parameters and the generic operational parameters of the slaves in its coverage area.

5.59 The value of 50 metres for the geographical validity of the operational parameters is a consequence of the fact that DTT networks are typically planned based on a grid of 100 metre by 100 metre pixels. This in turn means that the TVWS availability (and hence all operational parameters) will themselves be derived based on a similar grid.

5.60 The time validity is itself included in the specific operational parameters and is necessary to ensure that master WSDs re-consult WSDBs with sufficient frequency to keep up to date with the dynamic nature of spectrum use by the PMSE service.

Multi-channel operation

5.61 A master WSD which wishes to transmit simultaneously over multiple DTT channels must

a) comply with the maximum permitted in-block EIRP spectral densities in each of the DTT channels to be used; and

b) radiate with a total in-block EIRP (measured over the total number of DTT channels to be used) which does not exceed the smallest of the maximum permitted in-block EIRPs specified over each of the DTT channels to be used.

5.62 In the current framework, TV white space availability is calculated based on the assumption of a WSD radiating in a single DTT channel and subject to constraints relating to harmful interference to the DTT and PMSE services. Clearly, if a WSD were to be allowed to radiate proportionally greater powers with increasing bandwidths, there would be a significant risk of interference. This has implications both in terms of harmful interference to the DTT and PMSE services, as well as interference among WSDs (issues of politeness). For this reason, additional rules are necessary for dealing with cases of multi-channel WSD radiation.

5.63 It can be readily shown (see Appendix 6) that, in the absence of information at the WSD relating to the incumbent services and the relevant protection ratios, the imposition of the rules proposed in 5.61 is the only viable approach.

Out-of-block emissions

5.64 The out-of-block EIRP spectral density, P_{OOB}, of a master WSD must satisfy that:

$$P_{OOB(\mathrm{dBm/(100\,kHz)})} \leq \max\left(P_{IB(\mathrm{dBm/(8\,MHz)})} - AFLR(\mathrm{dB}), -84\right)$$

where P_{IB} is the WSD's in-block EIRP spectral density, and $AFLR$ is the WSD's adjacent frequency leakage ratio outlined in the table below for different device emission classes.

Table 1. Master WSD adjacent frequency leakage ratios for different device emissions class.

Where P_{OOB} falls within the n^{th} adjacent DTT channel	AFLR (dB)			
	Class 1	Class 2	Class 3	Class 4
n = ±1	74	74	64	54
n = ±2	79	74	74	64
|n| ≥ 3	84	74	84	74

5.65 The above values were proposed following discussions with a number of stakeholders, including device manufacturers. Note that class 1 devices produce the cleanest signals in terms of spectral leakage, i.e., have the greatest AFLR. The out-of-block emissions are defined with a spectral resolution of 100 kHz in light of the narrowband nature of the PMSE signals (typical bandwidth of 200 kHz).

5.66 We propose to specify the out-of-block limits in relative terms, so that the resulting protection ratios do not change as a function of the WSD in-block EIRP itself. This considerably reduces the complexity of co-existence rules. The absolute value of –84 dBm/(100 kHz) is specified to account for the difficulty in maintaining a high leakage ratio at very low in-block EIRPs.

5.67 The class 1 leakage ratio of 74 dB in the first adjacent channel is consistent with the value[43] specified by the FCC for a WSD transmitting at maximum in-block EIRP.

Security

5.68 Communications between a master WSD and the website which contains Ofcom's list of qualifying WSDBs should be performed using secure protocols that avoid malicious corruption and unauthorised modification of data, and ensure that WSDs communicate with the correct website. For that reason, we propose that that the website be accessed using the HTTPS[44] protocol.

5.69 Communications between a master WSD and a WSDB must be performed using secure protocols that avoid malicious corruption or unauthorised modification of the data. We expect these security protocols to be addressed by technology standardisation organisations.

5.70 Communications between a master WSD and a slave WSD for purposes of relaying WSDB-related instructions and parameters must be performed using secure protocols that avoid malicious corruption or unauthorised modification of the data. We expect these security protocols to be specified within wireless technology standards.

Question 3: Do you agree with our proposed additional operational requirements for master WSDs?

Additional operational features: slave WSD

5.71 In this section we present a number of proposed operational features for slave WSDs. These are in addition to the requirements in the four phases outlined earlier.

Device parameters must not be accessible by the user

5.72 Device parameters must be determined automatically by a slave WSD. In other words, slave WSDs must be designed such that the device parameters cannot be input into the slave WSD by the user of the device. The rationale for this requirement is to reduce the risk of tampering and false reporting by the users of WSDs.

Cease transmissions when instructed by the master

5.73 A slave WSD must cease transmission within one second when instructed to do so by its serving master WSD. This implements a so-called WSDB "kill switch" to disable individual WSDs in the event of interference to licensees.

5.74 We believe that a value of one second is small enough to facilitate real time diagnosis (switching off devices and observing the impact) in the event that harmful interference to the existing services is reported, and yet is still larger than the signalling times of modern wireless devices and so does not impose a substantial burden on the WSD air interface.

[43] The FCC out-of-block specifications are given in absolute terms.
[44] HTTPS stands for the hypertext transfer protocol secure. HTTPS is a widely used communications protocol for secure communication over a computer network, with especially wide deployment on the internet.

5.75 The time validity parameter described later is an alternative tool for disabling individual WSDs following a pre-defined time interval.

Cease transmissions if communications with the master WSD is lost

5.76 A slave WSD must cease transmissions if it loses communications for more than five seconds with the master WSD from which it has received its slave operational parameters. This requirement addresses the risk that the slave WSD moves outside the coverage area of its associated master WSD, and continues to transmit at frequencies and powers that are no longer permitted. This also indirectly implements a geographic validity constraint for the generic operational parameters of non-geolocated slave WSDs. We believe that a five second interval is sufficiently long that the loss in communication is unlikely to be a temporary outage caused by the dynamic nature of the wireless channel.

Direct slave to slave WSD communications

5.77 A slave WSD may communicate with another slave WSD provided that it maintains communication over the UHF TV band with its serving master WSD and remains under the control of the said master WSD. This is to ensure that slave WSDs do not operate autonomously and that they continue to transmit subject to the operational parameters received from their respective master WSDs.

Time and geographic validity

5.78 A slave WSD will be permitted to transmit in the UHF TV band only in accordance with the received “generic” or “specific” operational parameters for a time period which does not exceed the time validity of those parameters, and in a geographic area which does not exceed the geographic validity of those parameters. The geographic validity of generic operational parameters will be the coverage area of the serving master WSD. The geographic validity of specific operational parameters for geo-located slave WSDs will be the geographic area wherein the horizontal position of the WSD differs by no more than 50 metres from its position determined at the time when the slave WSD last reported its location to a master. This means that a slave WSD can move up to 50 metres in any (horizontal) direction without needing an update to its specific operational parameters. Conversely, if a slave WSD moves more than 50 metres in any (horizontal) direction, then it must request an update to its specific operational parameters.

5.79 The value of 50 metres for the geographical validity of operational parameters is a consequence of the fact that DTT networks are typically planned based on a grid of 100 metre by 100 metre pixels.

5.80 The time validity is itself included in the “generic” and “specific” operational parameters and is necessary to ensure that slave WSDs receive operational parameters with a sufficient frequency to keep up to date with the dynamic nature of spectrum use by the PMSE service.

Multi-channel operation

5.81 A slave WSD which wishes to transmit simultaneously over multiple DTT channels must:

a) comply with the maximum permitted in-block EIRP spectral densities in each of the DTT channels to be used; and

b) radiate with a total in-block EIRP (measured over the total number of DTT channels to be used) which does not exceed the smallest of the maximum permitted in-block EIRPs specified over each of the DTT channels to be used.

5.82 The above requirements are identical to those for master WSDs, and are proposed based on the same rationale.

Out-of-block emissions

5.83 The out-of-block EIRP spectral density, P_{OOB}, of a slave WSD must satisfy that:

$$P_{OOB(dBm/(100\,kHz))} \leq \max\left(P_{IB(dBm/(8\,MHz))} - AFLR(dB), -84\right)$$

where P_{IB} is the WSD's in-block EIRP spectral density, and $AFLR$ is the WSD's adjacent frequency leakage ratio outlined in the table below for different device emission classes.

Table 2. Slave WSD adjacent frequency leakage ratios for different device emissions class.

Where P_{OOB} falls within the n^{th} adjacent DTT channel	AFLR (dB)			
	Class 1	Class 2	Class 3	Class 4
n = ±1	74	74	64	54
n = ±2	79	74	74	64
|n| ≥ 3	84	74	84	74

5.84 The above requirements are identical to those for master WSDs, and are proposed based on the same rationale.

Antenna gain

5.85 The antenna gain of slave WSDs is an important parameter. This is because when calculating generic operational parameters, a WSDB needs to estimate the possible locations of slave WSDs based on the expected coverage area of their serving master WSD. To do so, the WSDB will need to assume a specific value for the slave WSD receiver antenna gain. We are considering whether to specify a limit on the maximum receiver antenna gain of slave WSDs.

Question 4: Do you agree with our proposed additional operational requirements for slave WSDs?

Summary

5.86 We have presented in this section our proposed framework for the operation of WSDs. We believe that this framework provides a minimum set of requirements for achieving our objectives of allowing WSDs to operate under a licence exempt regime on the basis that the risk of harmful interference to existing licensed users can be managed.

5.87 The proposed requirements ensure that WSDs operate according to constraints specified by qualifying WSDBs, and that the WSDs report back their actual/intended transmission frequencies and powers to the WSDBs for purposes of spectrum management and diagnosis in the event of harmful interference.

5.88 We note that the detailed interactions between master and slave WSDs may be implemented by the industry in ways that may differ from those set out in this document. However, it should be noted that any divergence must not alter a) the nature and sequence of information exchange between the master WSDs and WSDBs, or b) the operational parameters of the master and slave WSDs, all as set out in this document.

5.89 The steps in Phase (a), regarding specific operational parameters for master WSDs, must be undertaken by all master WSDs wishing to transmit in the UHF TV band.

5.90 The steps in Phase (b), regarding generic operational parameters for slave WSDs, must be undertaken only when a slave WSD does not have a means of association with a master WSD other than via the UHF TV band[45]. Here, we require that a master WSD broadcasts generic operational parameters, and that slave WSDs receive these parameters, and commence association with the master WSD by transmitting over the UHF TV band in compliance with these parameters.

5.91 Following association, a slave WSD (or its serving master WSD) may request specific operational parameters for its transmissions (Phase d). As compared to generic operational parameters these will represent more relaxed constraints and provide better TVWS availability, since they account for the device parameters received from the slave WSD during association.

5.92 Alternatively, a slave WSD may continue transmitting in compliance with the generic operational parameters. This may be the case for applications where slave WSDs require limited data rates or transmission powers, in which case specific operational parameters will not bring additional benefits to the end user.

5.93 The purpose of Phase (c), association of a slave WSD with a serving master WSD, is to ensure that the supporting WSDB holds information about every slave WSD transmitting in the UHF TV band. We recognise that slave WSDs (or their serving master WSDs), may also wish to request specific operational parameters as outlined in Phase (d). In this case, the association step and the request for specific operational parameters could be implemented together. The high-level requirement is that the device parameters and the actual/intended channel usage parameters are made available to the WSDB.

[45] In cases where association occurs via media other than the UHF TV band, “generic” rather than “specific” operational parameters apply.

Section 6

Parameters

6.1 In Section 5, we presented a framework for the operation of master and slave WSDs which involves “device parameters”, “operational parameters”, and “channel usage parameters”. In this section we describe these parameters in more detail.

6.2 All device parameters must be determined automatically by a WSD as required in sections 5.53 and 5.72. In other words, device parameters shall not be determined or input into a WSD by the user of the device. This is to reduce the risk of tampering and false reporting by the users of WSDs.

6.3 It should be noted that at this point in time we have concluded that a sensing functionality in WSDs is not required for the protection of primary users in the UK from harmful interference. However, we do recognise that sensing would enable devices to operate more efficiently by learning about the interference environment in their local geographic area and to select the best channels from those authorised by the WSDB. Nevertheless, we think that such sensing functionality would best be defined by the industry as technical specifications within wireless technology standards. We note that if sensing were to be introduced at a future date for purposes of protecting the primary users, then such sensing functionality would need to be reflected in the relevant European harmonised standard.

Device parameters

Master WSD parameters

6.4 The device parameters attributed to a master WSD are described in this section. These parameters will be communicated by a master WSD to a WSDB. This is for the purposes of generating specific operational parameters for master WSDs and spectrum management.

6.5 Where a parameter is labelled as “mandatory”, this means that, if the said parameter is not communicated to a WSDB, then that WSDB will not generate specific operational parameters for the master WSD and, therefore, the WSD will be unable to transmit in the UHF TV band.

6.6 Where a parameter is labelled as “optional”, this means that, if the said parameter is not communicated to a WSDB, then that WSDB will assume a cautious default value for that parameter in generating specific operational parameters for the master WSD.

6.7 The device parameters that the master WSD must communicate to the WSDB are as follows:

6.7.1 Unique device identifier (mandatory) – This will be used by a WSDB to identify an *individual* master WSDs. The unique device identifier is specified in the VNS and will need to be internationally harmonised. This is being addressed in the European harmonised standard under development by ETSI BRAN.

6.7.2 Emission class (mandatory) – This identifies the emission mask of the master WSD, and allows a WSDB to generate specific operational parameters based on emission class-specific protection ratios. Table 1

describes our proposed emission classes. Emission classes are specified in the VNS and will also be specified in the European harmonised standard under development by ETSI BRAN. As additional classes emerge over time, these can be incorporated into the standards.

6.7.3 Technology identifier (mandatory) – This enables a WSDB to generate specific operational parameters based on technology-specific protection ratios, and will also be helpful in informing the WSDB about the broad time-frequency structure of the WSD signal, e.g., the extent to which the signal is bursty in time, and/or occupies its in-block bandwidth. This information will be useful in combination with the feedback of channel usage parameters from WSDs to WSDBs in better understanding the use of the radio resource. The technology identifier is specified in the VNS and will need to be internationally harmonised. This is being addressed in the European harmonised standard under development by ETSI BRAN. As additional technologies emerge over time, their identifiers can be incorporated into the standards.

6.7.4 Device type (mandatory) – This identifies a master WSD as type A or type B, and will enable a WSDB to make different assumptions in generating specific operational parameters based on the device type. The device types are specified in the VNS and will also be specified in the European harmonised standard being developed by ETSI BRAN. As additional types emerge over time, these can be incorporated into the harmonised standard.

6.7.5 Device model identifier (mandatory) – This describes the manufacturer's identity and the device's model number or some other identifier of the product family. This is specified in the VNS and is being addressed in the European harmonised standard under development by ETSI BRAN.

6.7.6 Device master/slave category (mandatory) – This identifies the device as either a master or slave WSD.

6.7.7 Antenna latitude/longitude coordinates and accuracy (mandatory) – These will enable a WSDB to generate specific operational parameters based on the geographic location of the master WSD. The coordinates will have to be specified in the WGS84 format. The accuracy of the antenna latitude/longitude coordinates will have to be specified as $\pm\Delta x$ and $\pm\Delta y$ metres respectively, corresponding to a 95% level of confidence.

6.7.8 Antenna height (altitude) above sea level and accuracy (optional)[46] – This will enable a WSDB to generate specific operational parameters based on the height of the master WSD. The accuracy of the antenna altitude will have to be specified as $\pm\Delta z$ metres respectively, corresponding to a 95% level of confidence.

6.8 The need for the device type, emission class and technology identifiers were described in Section 5. The unique device identifier is needed to allow a WSDB to address individual devices, while the device model identifier is useful for purposes of spectrum management and identifying the source in the event of harmful interference. A WSDB would also need to know whether a WSD is a master or a

[46] Antenna altitude is optional because vertical geo-location is considered to be more challenging than horizontal geo-location, and fewer positioning systems support the former.

slave, hence the need for the master/slave category. Therefore, we believe that the above parameters are justified in the context of spectrum management, and that they only introduce a minimal overhead for their signalling to a WSDB.

Slave WSD parameters

6.9 The device parameters attributed to a slave WSD are described in this section. These parameters will be communicated from a slave WSD to a serving master WSD, and will subsequently be communicated to a WSDB. This is for the purposes of generation of specific operational parameters for the slave WSD and spectrum management.

6.10 Where a parameter is labelled as “mandatory”, this means that if the said parameter is not communicated to a WSDB, then the database will not generate specific operational parameters for the slave WSD.

6.11 Where a parameter is labelled as “optional” this means that if the said parameter is not communicated to a WSDB, then the database will assume a cautious default value for that parameter in generating specific operational parameters for the slave WSD.

6.12 The device parameters that the slave WSD must communicate to a master WSD are as follows:

6.12.1 Unique device identifier (mandatory) – This will be used by a WSDB to identify *individual* slave WSDs. The unique device identifier is specified in the VNS and will need to be internationally harmonised. This is being addressed in the European harmonised standard under development by ETSI BRAN.

6.12.2 Emission class (mandatory) – This identifies the emission mask of the slave WSD, and allows a WSDB to generate specific operational parameters based on emission class-specific protection ratios. Table 2 describes our proposed emission classes. Emission classes are specified in the VNS and will also be specified in the European harmonised standard under development by ETSI BRAN. As additional classes emerge over time, these can be incorporated into the standards.

6.12.3 Technology identifier (mandatory) – This enables a WSDB to generate specific operational parameters based on technology-specific protection ratios, and will also be helpful in informing the WSDB about the broad time-frequency structure of the WSD signal, e.g., the extent to which the signal is bursty in time and/or occupies its in-block bandwidth. This information will be useful in combination with the feedback of channel usage information from WSDs, to WSDBs in better understanding the use of the radio resource. The technology identifier is specified in the VNS and will need to be internationally harmonised. This is being addressed in the European harmonised standard under development by ETSI BRAN. As additional technologies emerge over time, their identifiers can be incorporated into the standards.

6.12.4 Device type (mandatory) – This identifies a slave WSD as type A or type B, and will enable a WSDB to make different assumptions in generating specific operational parameters based on the device type. The device types are specified in the VNS and will also be specified in the European

harmonised standard being developed by ETSI BRAN. As additional types emerge over time, these can be incorporated into the harmonised standard.

6.12.5 Device model identifier (mandatory) – This describes the manufacturer's identity and the device's model number or some other identifier of the product family. This is specified in the VNS and is being addressed in the European harmonised standard under development by ETSI BRAN.

6.12.6 Device master/slave category (mandatory) – This identifies the device as either a master or slave WSD.

6.12.7 Antenna latitude/longitude coordinates and accuracy (optional) – These will enable a WSDB to generate specific operational parameters based on the geographic location of the slave WSD. These coordinates will have to be specified in the WGS84 format. The accuracy of the antenna latitude/ longitude coordinates will have to be specified as $\pm\Delta x$ and $\pm\Delta y$ metres respectively, corresponding to a 95% level of confidence.

6.12.8 Antenna height (altitude) above sea level and accuracy (optional) – This will enable a WSDB to generate specific operational parameters based on the height of the slave WSD. The accuracy of the antenna altitude will have to be specified as $\pm\Delta z$ metres respectively, corresponding to a 95% level of confidence.

6.13 Regarding the need for the above parameters, the same arguments apply here as for the case of master WSDs. We consider that the parameters are justified in the context of spectrum management, and that they only introduce a minimal overhead for their signalling to a WSDB.

6.14 It should be noted that antenna location is optional because slave WSDs are not required to have geo-location capability, and can transmit using generic operational parameters derived based on the coverage area of their serving master WSD.

Operational parameters

Master WSD specific operational parameters

6.15 The specific operational parameters for a master WSD are described in this section. These parameters will be generated by a WSDB for each master WSD based on the device parameters of the master WSD. These parameters will then be communicated by the WSDB to the master WSD.

6.16 The specific operational parameters are as follows:

6.16.1 Lists of lower and upper frequency boundaries[47] within which a master WSD will be authorised to operate. A lower frequency boundary will be specified as (470 + 8k) MHz, with the corresponding upper frequency boundary specified as (470 + 8k + 8) MHz, where $0 \leq k \leq 39$.

6.16.2 A maximum permitted master WSD in-block EIRP, P_0, specified in dBm over a bandwidth of 0.1 MHz, and a maximum permitted master WSD in-

[47] The upper and lower frequencies of a boundary pair correspond to the edges of a DTT channel. A WSD may transmit over multiple DTT channels or fractions of DTT channels.

block EIRP, P_1, specified in dBm over a bandwidth of 8 MHz, between each lower frequency boundary and its corresponding upper frequency boundary.

6.16.3 Limits on the maximum *total* number of DTT channels that may be used at any given time, and the maximum number of *contiguous* DTT channels that may be used at any given time.

6.16.4 A single time validity defined as the instant in time beyond which the specific operational parameters communicated by the WSDB cease to be valid. This parameter will be specified as an absolute time in a 24 hour clock format (hour:min) with reference to GMT.

6.17 The maximum permitted in-block EIRPs are specified with resolutions of 100 kHz and 8 MHz. This is for the following two reasons:

- The co-channel victims are the PMSE and DTT services, and the respective protection ratios[48] are typically measured with the interferer defined over bandwidths of 200 kHz[49] and 8 MHz, respectively.

- By specifying the relationship between the values P_0 and P_1 (as communicated from the WSDB to the WSDs) the regulator can decide the TVWS availability for narrowband WSDs. For example, if the value of P_0 is chosen to be $1/80^{th}$ (in the linear domain) of the value of P_1, then a WSD must radiate with proportionally lower powers as its in-block bandwidth reduces.

6.18 The limits on the maximum in-block bandwidths are an important tool for mitigating spectrum hoarding and managing interference among WSDs in cases where congestion might arise.

6.19 The time validity ensures that master WSDs re-consult WSDBs with sufficient frequency to keep up with the dynamic nature of spectrum use by the PMSE service. The value of the time validity will be set by the WSDBs on the basis of the frequency of update of the PMSE information by Ofcom. This frequency of update is likely to be once every few hours in the UK.

Slave WSD operational parameters

6.20 The operational parameters for a slave WSD are described in this section. Generic operational parameters will be generated by a WSDB for all slave WSDs in the coverage area of a serving master WSD. Specific operational parameters will be generated by a WSDB for each slave WSD based on the device parameters of the slave WSD. These operational parameters will then be communicated by the WSDB to a master WSD, which will subsequently forward these to the relevant slave WSDs.

6.21 The specific operational parameters and the generic operational parameters are as follows:

[48] Protection ratio is the ratio of wanted signal power over unwanted signal power at the point of failure of the receiver.

[49] The typical in-block bandwidth of PMSE equipment is 200 kHz, however, lower bandwidths are occasionally encountered. We believe that a 100 kHz resolution is an adequate trade-off.

6.21.1 Lists of lower and upper frequency boundaries[47] within which a slave WSD will be authorised to operate. A lower frequency will be specified as (470 + 8k) MHz, with the corresponding upper frequency specified as (470 + 8k + 8) MHz, where $0 \leq k \leq 39$.

6.21.2 A maximum permitted slave WSD in-block EIRP, P_0, specified in dBm over a bandwidth of 0.1 MHz, and a maximum permitted slave WSD in-block EIRP, P_1, specified in dBm over a bandwidth of 8 MHz, between each lower frequency boundary and its corresponding upper frequency boundary.

6.21.3 Limits on the maximum *total* number of DTT channels that may be used at any given time, and the maximum number of *contiguous* DTT channels that may be used at any given time.

6.21.4 A single time validity defined as the instant in time beyond which the specific operational parameters communicated by the serving master WSD cease to be valid. This parameter will be specified as an absolute time in a 24 hour clock format (hour:min) with reference to GMT, or as relative time with respect to the time the operational parameters are received by the slave WSD.

6.22 The same rationale apply here as for the case of master WSD operational parameters.

Channel usage parameters

Master WSD channel usage parameters

6.23 The channel usage parameters for a master WSD are described in this section. These parameters shall be communicated by a master WSD to a WSDB. This is for the purposes of generating generic operational parameters for slave WSDs and spectrum management.

6.24 The channel usage parameters are as follows:

6.24.1 The intended lower and upper frequency boundaries[47] of the in-block emissions of the master WSD. A lower frequency will be specified as (470 + 8k) MHz, with the corresponding upper frequency specified as (470 + 8k + 8) MHz, where $0 \leq k \leq 39$,

6.24.2 The maximum in-block EIRP spectral densities specified in dBm over bandwidths of 0.1 MHz and 8 MHz, that the master WSD intends to radiate between each reported lower frequency boundary and its corresponding upper frequency boundary.

6.25 We believe that the above is adequate to capture with sufficient granularity the actual/intended in-block bandwidth(s) of the signal.

Slave WSD channel usage parameters

6.26 The channel usage parameters for a slave WSD are described in this section. These parameters shall be communicated by a slave WSD to a master WSD, and will subsequently be forwarded to a WSDB. We are considering the alternative whereby the channel usage parameters of a slave WSD are inferred by a master WSD and subsequently forwarded to a WSDB (i.e., these parameters are not explicitly

communicated from a slave to a master). This is for purposes of spectrum management.

6.27 The channel usage parameters are as follows:

6.27.1 The intended lower and upper frequency boundaries[47] of the in-block emissions of the slave WSD. A lower frequency will be specified as (470 + 8k) MHz, with the corresponding upper frequency specified as (470 + 8k + 8) MHz, where $0 \leq k \leq 39$.

6.27.2 The maximum in-block EIRP, specified in dBm over bandwidths of 0.1 MHz and 8 MHz, that the slave WSD intends to radiate between each reported lower frequency boundary and its corresponding upper frequency boundary.

6.28 We believe that the above is adequate to capture with sufficient granularity the actual/intended in-block emissions of the signal.

Question 5: Do you agree with the proposed device parameters, operational parameters and channel usage parameters?

Section 7

Draft regulatory and technical deliverables

7.1 In Sections 5 and 6 we presented the regulatory requirements and technical specifications for WSDs and their interactions with WSDBs that together represent the overall framework for the operation of WSDs.

7.2 In this section, therefore we describe how the overall framework is translated into the suite of documents published in draft form alongside this consultation document. These documents explain how we consider that the various regulatory requirements and technical specifications will be implemented in practice. These documents consist of the following:

a) An example statutory instrument (SI) – This describes how we might set out the terms and conditions with which WSDs must comply in order to benefit from an exemption from the requirement for a licence under the WT Act.

b) A draft interface requirement (IR) document 2088 – This document is a technical description of the provisions in the SI and is used for the purpose of the notification to the European Commission of the technical regulations we are proposing to adopt. The IR also identifies requirements which are contained in the VNS and which Ofcom considers to be key features of the device to achieve compliance with the essential requirements of the R&TTE Directive, specifically to avoid harmful interference.

c) A draft voluntary national specification (VNS) – This provides guidance to manufacturers pending publication of the European harmonised standard which is currently being developed in ETSI BRAN. The VNS will be superseded by the ETSI harmonised standard when the latter becomes available. This document sets out the technical specifications that we consider WSDs should comply with in order to operate without causing harmful interference.

7.3 The rest of this section introduces the above three draft documents as published alongside this consultation document.

Example statutory instrument

7.4 The SI provides an example of what the regulations might look like for the exemption of WSDs. The proposed regulations are to be made under Section 8(3) of the WT Act. Section 8(1) of that Act makes it unlawful to establish or use a wireless telegraphy station, or to install or use wireless telegraphy apparatus except under and in accordance with a licence granted by Ofcom. However, under Section 8(3), Ofcom may by regulations exempt from Section 8(1) the establishment, installation or use of certain equipment.

7.5 Regulation 3 in the example SI provides that wireless telegraphy equipment used for the purposes of accessing TV white spaces will be exempt from the provisions of Section 8(1) of the WT Act, provided that the requirements in Regulations 4, 5 and 6 are met.

7.6 Regulation 4 lays out the terms of the exemption that apply to all WSDs. It provides that WSDs must be used in the frequency range 470 MHz to 790 MHz and must not

be used airborne.. It refers to the VNS and requires that WSDs achieve a similar level of protection from undue interference to other users of the electromagnetic spectrum that is provided for in the VNS. Regulation 4 sets out the distinction between master and slave WSDs. It also identifies what operational parameters a WSDB will provide to a master WSD specifying the operational conditions under which a master WSD, or any slave WSD that that master WSD may serve, may transmit. Finally, it sets out a general requirement that WSDs must not cause or contribute to undue interference.

7.7 Regulation 5 sets out the various terms of the exemption that apply to master WSDs. In particular, a master WSD must:

- not request operational parameters from anyone other than a qualifying WSDB (such qualifying WSDBs being listed in a schedule to the SI);
- transmit only in accordance with the operational parameters received from a qualifying WSDB and only within the geographical area in which the parameters are valid.

7.8 Regulation 5 specifies the device parameters (i.e. the information about its device characteristics and geographic location) that a master WSD must provide to a qualifying WSDB for the purposes of its own transmissions. It also specifies the information that a master WSD must provide to a qualifying WSDB about its intended transmissions following receipt of operational parameters from that WSDB and it sets out a requirement for master WSDs to cease transmissions in the UHF TV band within 60 seconds of receiving an instruction to do so.

7.9 In addition, Regulation 5 sets out various requirements for master WSDs when serving slave WSDs. A master WSD must:

- only communicate operational parameters to slave WSDs where those operational parameters have been communicated to the master WSD by a qualifying WSDB; and
- a master WSD must communicate various specified information that it receives from a slave WSD to a qualifying WSDB.

7.10 Regulation 6 sets out the terms of exemption for a slave WSD. In particular, a slave WSD must transmit only in accordance with the operational parameters it has received from a master WSD and, if the slave WSD is a geo-located slave, only within the geographical area in which the parameters are valid.

7.11 Regulation 6 also specifies that slave WSDBs must transmit in accordance with either generic operational parameters or specific operational parameters. It sets out the various information that the slave WSD must provide to its serving master WSD on receipt of a set of generic operational parameters and on receipt of a set of specific operational parameters. Finally, it sets out a requirement for slave WSDs to cease transmissions in the UHF TV band:

- within one second of receiving instructions from a master WSD to do so; or
- if the slave WSD loses communications with its serving master WSD for more than five seconds.

7.12 These provisions are necessary to address the risk that WSDs will cause undue interference and to provide Ofcom with appropriate tools to carry out our enforcement duties effectively.

Draft interface requirement document 2088

7.13 The IR is the template agreed by Member States and the European Commission for the purpose of member states' notification of technical regulations to the European Commission.

7.14 The proposed IR contains a technical description of the provisions in the SI. These are essentially the minimum requirements with which devices must comply. Together with the "essential requirements" detailed in Article 3.2 of the R&TTE Directive, these requirements constitute the minimum requirements for WSDs in the UHF TV band in the UK.

7.15 In addition, the provisions in the informative part of the proposed IR, identify a number of requirements which are contained in the VNS and which Ofcom considers to be key features of the device to achieve compliance with the essential requirements of the R&TTE Directive, specifically to avoid harmful interference.

Draft voluntary national specification

7.16 The R&TTE Directive removes the need for national type approval regimes. Under the R&TTE Directive regime, manufacturers self declare conformance to the requirements of the Directive via a number of possible routes. Once a declaration of conformance has been made, and notification procedures with the relevant spectrum management authorities have been completed, the apparatus may be placed on the market in all states in the European Economic Area.

7.17 In order to declare conformance with the R&TTE Directive, the manufacturers must satisfy the "essential requirements" that the Directive lays out. The European Telecommunication Standards Institute (ETSI) has the mandate to develop harmonised standards. Compliance with these harmonised standards is not mandatory, but it is a route to show presumption of conformity with the "essential requirements" of the Directive.

7.18 ETSI is currently developing a draft harmonised standard for white space devices operating in the UHF TV band. Whilst awaiting publication of the standard, Ofcom has produced, in discussion with industry experts, a VNS. This VNS will be superseded when the ETSI standard is available. We are actively contributing to the work being undertaken within ETSI to ensure that the ETSI standard contains all the requirements that we consider necessary to demonstrate presumption of conformity with the essential requirements of the R&TTE Directive.

7.19 The VNS contains the technical specifications that have been described in Sections 5 and 6 of this consultation, in addition to a number of further radio frequency (RF) requirements. The VNS also contains the test procedures for compliance with the above technical specifications. Specifically, the VNS addresses the following items:

- Nominal and occupied channel bandwidths. These requirements and tests ensure that the device does not transmit outside of the frequency limits communicated by the WSDB.

- In-block EIRP/EIRP spectral density. These requirements and tests ensure that the device does not radiate at a power that is greater than the limits communicated by the WSDB, and include the multi-channel operation requirements of Section 5.

- Transmitter unwanted emissions. This suite of requirements and tests ensure that the out of block emissions of the device comply with the stated limits.

- Receiver spurious emissions. These requirements and tests ensure that device emissions when in receive mode comply with the stated limits.

- WSDB discovery. These requirements and tests ensure that a master WSD regularly obtains a list of qualifying WSDBs from a website provided by Ofcom, and then proceeds to contact a WSDB on that list to receive operational parameters before starting radio transmissions in the UHF TV band.

- Communication of device parameters, operational parameters and channel usage parameters. This suite of requirements and tests ensure that devices submit to the WSDB, and receive from the WSDB, the parameters as specified in Section 6 and according to the sequence of operations in Section 5 of this consultation.

- Time validity of parameters. This requirement and test ensure that the device does not continue to transmit once the time validity of the operational parameters it has received from the WSDB has expired.

- Device shutdown. This requirement and test ensure that a device shuts down when instructed to do so by the WSDB.

- Slave to slave WSD communication. This requirement ensures that slave WSDs remain under the control of a serving master WSD when engaging in direct slave to slave communication.

- Geo-location and geo-location validity. These requirements and tests ensure that, where relevant, the device reports its geo-location and geo-location uncertainty, and that it does not continue to transmit once the geo-location validity of the operational parameters it has received from the WSDB has expired.

- User access restrictions. This requirement ensures that the parameters that the device communicates to the WSDB are not accessible by the user.

- Integral antenna. This requirement specifies that Type B devices must have an integral antenna.

Summary

7.19.1 In this section we have described the way in which the regulatory requirements and technical specifications of Sections 5 and 6 have been translated into the example SI, draft IR and draft VNS published alongside this consultation. Together, these documents form our proposal for an overall regulatory and technical framework allowing the use of WSDs in the UK.

7.19.2 A number of the requirements that we propose to be included in the SI and IR reflect the fact that the appropriate operation of WSDs depends partly on the control of the devices through an entity (a WSDB) which is geographically separated from the devices at the point that the latter are put into service. Given the novelty of this approach, the fact that it is not possible to specify certain parameters (e.g., frequency and power) of the WSD air-interface in advance (as these parameters have dynamic values to be defined by the WSDB), and the absence of harmonised standards, we consider it appropriate to take the proposed approach to the specification of the SI, IR and VNS

Question 6: Do you agree with our approach of implementing the requirements in the example SI and the draft IR and VNS?

Section 8

Next Steps: our plans for stakeholder engagement

8.1 In this section we describe our plans for engagement with stakeholders in relation to four areas. These are WSD requirements (the subject of this consultation), WSDB requirements, issues of co-existence with incumbent services and a so-called "enhanced mode" specific to fixed WSDs.

Device requirements

8.2 The present consultation document sets out our proposals for a set of regulatory requirements and technical specifications for WSDs. These proposals have been translated into an example statutory instrument (SI), a draft interface requirement (IR) document, and a draft voluntary national specification (VNS). These three documents are published alongside this consultation.

8.3 This consultation, published on 22 November 2012, will last seven weeks. The closing date for responses is 10 January 2013.

8.4 We welcome stakeholder comments on the proposals presented in this document. We recognise the technical complexity and importance of the issues, and we will conduct a stakeholder workshop on 3 December to allow stakeholders to express their views on the proposals we have put forward. Following closure of the consultation, we will review and consider the points raised in the responses and will, where appropriate, amend the example SI and draft IR, and VNS. As soon as possible once this exercise is complete, we intend to notify the European Commission of these documents. In parallel, we will also publish a statement on the outcome of the present consultation. We hope to be able to do these in the first quarter of 2013.

8.5 The notification process is in accordance with European Union rules[50] on national technical regulations, under which we need to notify the European Commission of our draft technical regulations, the grounds for them and, where necessary, the main basic legislative and regulatory provisions of the draft regulation.

8.6 As part of this procedure, the European Commission will inform all the other Member States of the drafts we have notified, to allow opportunity for Member States to comment. To allow time for this process we are required to refrain from adopting the draft technical regulations for three months from the date of receipt by the Commission; this is known as the "standstill period". If our draft regulations are deemed to present an impediment to the free movement of products in the EU, then a "detailed opinion" may be issued by the European Commission or another Member State. This has the effect of extending the standstill period by a further three months.

8.7 Following the notification to the European Commission and expiry of the three month standstill period, and on the basis that no detailed opinions have been received, we will be in a position to undertake the one month statutory UK consultation on the draft

[50] Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards (as amended).

SI. We intend to do this once the first WSDBs have successfully undergone Ofcom's qualification process. This will be followed by a statement on the adoption of the SI.

Database requirements and qualification

8.8 As explained in Section 3, at this stage we are still developing the details of the WSDB requirements and translating these requirements into a draft database contract for WSDBs and Ofcom. In addition to the policy considerations, there are a number of operational aspects arising out of the proposed approach that are being addressed within Ofcom.

8.9 Once we have sufficiently progressed the work on the WSDB requirements and contract, we will publish the WSDB requirements and a draft contract. We expect this to happen in the first half of 2013. We will then discuss the proposed WSDB requirements and draft contract with stakeholders through a series of workshops.

8.10 We are also considering holding an end to end trial to test the interoperability of Ofcom systems, WSDBs and devices. This trial will help us fine tune the details of the contract.

8.11 Once we are confident that the draft contract addresses all the required aspects of the relationship, in particular when it comes to dealing with interference, we expect to start the process of entering into contracts with WSDB providers and carrying out the assessment of the WSDBs' compliance with the qualification requirements to be included in that contract.

Co-existence with incumbent services

8.12 As explained in Section 3, we have engaged with stakeholders to discuss the technical parameters for co-existence between WSDs and incumbent users. We intend to publish a consultation document to summarise our proposals regarding the co-existence of WSDs with incumbent services which operate in (and immediately adjacent to) the UHF TV band. We will also include in that consultation the proposed role of Ofcom in quantifying the TVWS availability across the UK subject to the defined co-existence criteria. We expect this publication to take place in the first half of 2013.

8.13 The co-existence criteria that will be presented in the above consultation document will not impact the requirements for WSDs (SI/VNS/IR), but may have some impact on the database operational requirements. For this reason, the timing of this consultation will be managed in conjunction with our stakeholder engagement on the database requirements.

Enhanced mode

8.14 Our *baseline* framework for the operation of WSDs, as set out in our statement of 2011, involves the automatic reporting of device parameters from WSDs to WSDBs.

8.15 Our discussions with stakeholders have indicated that fixed WSDs may benefit from *enhanced* TVWS availability, if specific parameters pertaining to these devices (e.g., distance to nearest victim, antenna characteristics, etc.) are reported by the user of the device and accounted for by the WSDBs.

8.16 This "enhanced mode" of operation for fixed devices raises questions regarding the authorisation of devices and the arrangements between Ofcom, the WSDBs and the

organisations putting the devices into operation. Addressing these questions now would inevitably result in delays in the project timelines for the finalisation of the WSD regulatory framework. For this reason, we have decided to proceed, in the first instance, with specifying the WSD and WSDB framework for the baseline mode only.

8.17 We aim to return to the “enhanced mode” once the details of the “baseline mode” have been finalised. We intend to do this by publishing a consultation document once the regulations for the baseline framework are sufficiently advanced.

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 10 January 2013**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at https://stakeholders.ofcom.org.uk/consultations/whitespaces/howtorespond/form, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email TV.WhiteSpaces@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Siew Yoon Tan
Floor 3
Spectrum Policy Group
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 7981 3770

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Reza Karimi on 020 7981 3567.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your

response should be kept confidential, can you please specify what part or whether all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.11 Following the end of the consultation period, Ofcom intends to publish a statement in 2013.

A1.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

A1.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Graham Howell, Secretary to the Corporation, who is Ofcom's consultation champion:

Graham Howell
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email Graham.Howell@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

If you want part of your response, your name or your organisation not to be published, 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

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name

Signed (if hard copy)

Annex 4

Consultation questions

A4.1 The following is a list of consultations questions raised in this document:

Question 1: Do you agree with our approach to defining the various categories of WSDs?

Question 2: Do you agree with our proposed sequence of operations for WSDs?

Question 3: Do you agree with our proposed additional operational requirements for master WSDs?

Question 4: Do you agree with our proposed additional operational requirements for slave WSDs?

Question 5: Do you agree with the proposed device parameters, operational parameters and channel usage parameters?

Question 6: Do you agree with our approach of implementing the requirements in the example SI and the draft IR and VNS?

Annex 5

Impact assessment

Introduction

A5.1 The analysis presented in this section, together with our analysis on technical and functional issues in Section 5 and Section 6, is an impact assessment of the proposals relating to WDSs presented in Section 5 and Section 6. Our intention is to implement these proposals, and previous policy decisions in this area, in a suite of three documents that we have published in draft form alongside this document: an example statutory instrument, a draft interface requirement document and a draft voluntary national specification.

A5.2 Impact assessments are defined in Section 7 of the Communications Act 2003. They provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best-practice policy-making. This is reflected in Section 7 of the Communications Act, which means that generally we have to carry out impact assessments where our proposals would be likely to have a significant effect on businesses or the general public or when there is a major change in our activities. However, as a matter of policy, we are committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. For further information about our approach to impact assessments, see the guidelines "Better policy-making: Ofcom's approach to impact assessment," which are on our website at www.ofcom.org.uk/consult/policy_making/guidelines.pdf.

A5.3 You should send any comments on this impact assessment to us by the closing date for this consultation. We will consider all comments before moving to our next step, which would be the notification to the European Commission of this suite of three documents.

The citizen and/or consumer interest

A5.4 Assuming that access to TV white spaces is allowed, we expect there to be citizen and consumer benefits. White space access might be used, for example, to facilitate wireless distribution around the home, local- or personal-area networks, wireless systems within public spaces and many other applications not yet envisaged.

A5.5 We considered in detail the citizen and consumer benefits of allowing licence exempt access to the TV white spaces in our November 2010 consultation. We do not consider that there have been any major events or developments that could change our assessment of the benefits and costs to citizens and consumers, so we only summarise here the main points of that assessment.

A5.6 The use of WSDs might enable new applications or make existing applications less expensive, which could bring significant benefits to consumers. However, estimating the value that these applications might bring in practice is very difficult because, at present, it is unclear what their scope, function and take-up might be. In

the DDR statement[51], we estimated that the direct benefits of licence exempt use of cleared spectrum in the UHF band, plus the broader social value such as increasing access to digital services by specific stakeholder groups, could be up to in the range of £200-320m net present value over 20 years. White space access as proposed will have less value, because of the restrictions imposed by coexistence with incumbent services.

A5.7 Use of white spaces may have negative impacts on citizens and consumers. We identified the following two main effects in the November 2010 consultation:

- increased risk of harmful interference to existing licensed uses; and
- constraints to the future development of more valuable licensed uses of the spectrum.

A5.8 We argued in November 2010 that the risks of these impacts materialising is low. The regime based on geo-location and databases goes a long way in mitigating the interference risk. Furthermore, one of the main objectives of our work in the last year has been to put in place the mechanisms and requirements that ensure that incumbent users will not be unduly affected by licence exempt use. Section 5 and section 6 in this document contain proposed requirements and technical specifications for the WSDs that in our view achieve this.

A5.9 With regards to future developments of valuable uses, we continue to believe that the database approach is appropriate to enable Ofcom to ensure that new, higher value use can be introduced with the assurance that it will be protected from interference from licence exempt users.

Policy objective

A5.10 Section 5 and Section 6 of this document present our proposals for the requirements of licence exempt devices operating in the TV white spaces. These requirements arise from our understanding of how our duties, in particular our spectrum management duties, are relevant to the regulation of the TV white spaces. Specifically, we believe that we should:

- Facilitate access to TV white spaces. As explained above, there are significant benefits to citizens and consumers in making TV white spaces available on a licence exempt basis.
- Protect incumbent users. DTT and PMSE generate significant economic benefit, and in addition DTT plays a key public policy role in providing universal low cost public service broadcast. In consequence, we must ensure that any new use co-existing in the same frequency band does not cause harmful interference to these services.
- Minimise the regulatory burden. A certain amount of regulation is necessary to authorise access to TV white spaces and to protect the incumbents, but we have tried to keep this as light as possible to ensure flexibility.

[51] "Digital dividend review: A statement on our approach", http://stakeholders.ofcom.org.uk/consultations/ddr/statement/ .

A5.11 We consider that the proposals in Section 5 and Section 6, and the regulatory framework that we have already consulted on, achieve these policy objectives because:

- They put in place the legal instruments that enable access to TV white spaces without the need for a licence under the WT Act.
- They enable arrangements whereby the qualifying WSDB will have appropriate information from devices in order to determine the frequencies and powers that devices may use, and require that devices only transmit according to the information received from the qualifying WSDB.
- They ensure that the WSDB receives the information about the actual radio resource (i.e. frequencies and power levels) that devices employ.
- They include only the requirements that, in our view, are essential to put in place a regime that protects incumbents from undue interference.

A5.12 We explain in the relevant paragraphs of Sections 5 and 6 how each proposed requirement supports these high level requirements, and what alternatives may have been available.

Costs and benefits

A5.13 We consider that the benefits of the proposed device requirements are clear: they provide the necessary safeguards to protect incumbent uses from undue interference, whilst enabling the introduction of new, innovative uses.

A5.14 The main cost of our proposals is that they might impose complexity and require exchange of information (communications overheads) between the entities (the database, the master WSD and the slave WSD). In certain cases, these might be seen as restricting the flexibility afforded by innovative technology solutions.

A5.15 We consider that the complexity and overheads of our requirements are minor and well within what current wireless technologies can manage. We have made every effort to limit any restrictions on flexibility and have defined the requirements to be technology neutral. We consider that if we were to remove any of the proposed requirements, then the protection of incumbents from interference might be compromised. Therefore, we believe that our proposals present the right compromise between enabling the benefits whilst mitigating the costs.

Conclusion on the proposed requirements

A5.16 As we have explained in the relevant sections of this document, we consider that the options chosen provide the best compromise in observing our duties – manifested in the high level requirements above – and mitigating complexity, overheads and rigidity for the new users.

Equality Impact Assessment

A5.17 Following an initial analysis undertaken in relation to this project we are not aware that the issues being considered here are intended to (or would, in practice,) have a significant differential impact on different racial groups, on disabled citizens or consumers or other minority groups compared with citizens and consumers in

general. Similarly, the proposed policies do not make distinctions between consumers or citizens in different parts of the UK or between consumers and citizens on low incomes. We do not believe that the proposed policies will have a particular effect on one group of consumers over another.

Annex 6

Constraints for multi-channel WSD transmissions

Summary

A6.1 A multi-channel white space device (WSD) is one which radiates simultaneously in multiple (contiguous or otherwise) 8 MHz DTT channels.

A6.2 In the current framework, TV white space availability is calculated by a database based on the assumption of a WSD radiating in a single DTT channel and subject to constraints relating to the harmful interference to the DTT and PMSE services.

A6.3 Clearly, it is inconceivable that a WSD could be allowed to radiate proportionally greater powers with increasing bandwidth. This has implications both in terms of harmful interference to the DTT and PMSE services, as well as interference among WSDs (issues of politeness).

A6.4 For this reason, additional rules are necessary for dealing with cases of multi-channel WSD radiation. In this brief analysis we present just such a rule[52], and explain why – in the absence of relevant information at the WSD regarding the interference environment – there are few (if any) viable alternatives to the derived rule.

Problem formulation

A6.5 Consider the following toy scenario: There exists a single 8 MHz victim DTT channel, and two 8 MHz interferer WSD adjacent channels (we shall call the latter channels 1 and 2).

A6.6 According to the current framework for access to TVWSs, a database will have pre-established that a WSD can radiate power Π_1 in channel 1 or power Π_2 in channel 2. By definition,

$$r_1\Pi_1 = r_2\Pi_2 = K = \text{Constant} \qquad (1)$$

where r_1 and r_2 are protection coefficients (products of protection ratios and coupling gains) from interferer channels 1 and 2 to the victim channel.

A6.7 Question – If a WSD wishes to radiate over both channels 1 and 2, what powers P_1 and P_2 can it radiate within channels 1 and 2, respectively?

[52] This was originally suggested at Ofcom's TVWS technical working group: Ron Porat, Vinko Erceg, "Multi-channel support," Broadcom, 24, May 2012.

Solution

A6.8 Strictly speaking, the correct answer to the formulated question is that the WSD can radiate at P_1 and P_2 so long as:

$$r_1 P_1 + r_2 P_2 \leq K\,, \tag{2}$$

or stated differently, so long as:

$$P_2 \leq \frac{K}{r_2} - \frac{r_1}{r_2} P_1\,. \tag{3}$$

A6.9 This is illustrated in the figure A1 below:

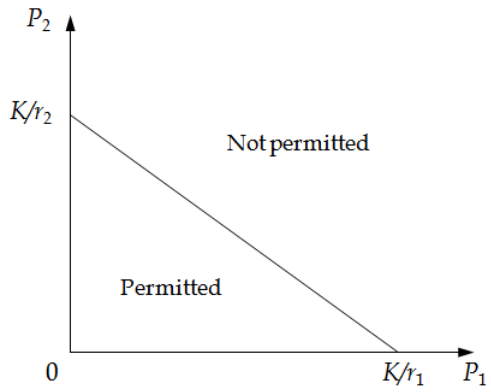

Figure A1. Locus of possible radiated powers.

A6.10 In short, the device should be allowed to radiate according to an infinite number of combinations of (P_1, P_2) pairs, so long as the relationship between P_1 and P_2 stated in Equation (3) is satisfied. However, in order to know this relationship, the device needs to know the values of r_1, r_2 and K.

A6.11 A highly advanced database of the future might be sophisticated enough to report r_1, r_2, and K to the device. However, this is highly complicated and not possible in our current framework, i.e., we have to live in a world of incomplete information. Whatever strategy we adopt, we need to assume that the WSD has no knowledge of r_1, r_2 and K.

A6.12 Absent any information on r_1, r_2 and K, we can identify an upper bound on P_1 and P_2 as follows. Consider the upper bound

$$P_1 + P_2 \leq \min(\Pi_1, \Pi_2)\,. \tag{4}$$

A6.13 Then, if follows that:

$$\begin{aligned} K &= \max(r_1, r_2)\min(\Pi_1, \Pi_2) \\ &\geq \max(r_1, r_2)(P_1 + P_2) \geq r_1 P_1 + r_2 P_2\,. \end{aligned} \tag{5}$$

A6.14 In other words, the upper bound of Equation (4) satisfies our requirement of Equation (2). The bound is not very tight, but, absent additional information, it is the best we can manage.

A6.15 So, given maximum permitted power levels Π_1 in channel 1 and Π_2 in channel 2, the constraints on a 2-channel WSD's EIRPs in each channel can be written as:

$$\boxed{P_1 + P_2 \leq \min(\Pi_1, \Pi_2).} \quad (6)$$

A6.16 In other words, the total EIRP must not exceed the smallest maximum permitted EIRP specified over each of the two DTT channels. This readily generalises to requirement (b) for WSD multi-channel transmissions described in Section 5 of this document.

A6.17 In addition, without loss of generality, assume that $\Pi_1 < \Pi_2$. The implication is that:

$$\begin{aligned} &P_1 + P_2 \leq \min(\Pi_1, \Pi_2), \\ &P_1 + P_2 \leq \Pi_1, \end{aligned}$$

$$\begin{aligned} &\Rightarrow P_1 \leq \Pi_1, \\ &\Rightarrow P_2 \leq \Pi_1 \leq \Pi_2. \end{aligned}$$

In other words, the EIRPs in each channel also comply with the maximum permitted values in each channel.

■

Annex 7

Glossary

A7.1 Altitude – Height above sea level.

A7.2 Association – The process whereby a slave WSD initially identifies itself to its serving master WSD (typically, but not necessarily, via transmissions in the TV white spaces).

A7.3 Channel usage parameters – These are parameters that are reported by a WSD to inform a WSDB of the actual radio resources that it intends to use.

A7.4 Device parameters – These are parameters that relate to a specific WSD. They can be either master device parameters or slave device parameters;

A7.5 Digital terrestrial television (DTT) – Terrestrial platform for the delivery of TV content via broadcasting in the UHF band.

A7.6 Generic operational parameters – The technical parameters received by a master WSD from the WSDB (or by a slave WSD from the WSDB through its serving master WSD) for the slave WSD's transmissions in the TV white spaces, but not specific to the slave's device parameters. Generic operational parameters apply, for instance, to a slave WSD's initial transmissions for purposes of association with its serving master WSD.

A7.7 Geographic validity – This is the geographic area within which the operational parameters for a geo-located white space device are valid. That geographic area is the area within a 50 metre radius of the latitude and longitude coordinates of the geo-located white space device determined at the time at which that geo-located white space device last reported its latitude and longitude coordinates to a qualifying white space database.

A7.8 Geo-location capability – This is the ability of a WSD to determine and report its latitude and longitude coordinates. Some WSDs may also have the ability to determine and report their altitude which is the height of their antenna above sea level.

A7.9 Horizontal geo-location capability – Capability of a WSD to determine its geographic latitude and longitude coordinates.

A7.10 In-block emissions – These are emissions that fall within a DTT channel that is used by a WSD for purposes of transmitting information to a receiver. For a WSD which transmits simultaneously in k DTT channels, the in-block emissions fall within k segments of the signal's frequency spectrum, each 8 MHz wide. Emissions are specified here as equivalent isotropic radiated power (EIRP).

A7.11 Master operational parameters – These are the technical parameters which a master WSD receives from a WSDB for the purposes of the master WSD's transmissions in the frequency band 470 – 790 MHz;

A7.12 Master WSD – This is geo-located WSD that obtains master operational parameters for its own transmissions and slave operational parameters for the transmissions of

any slave WSDs that it may serve, both specific to its geographic location. Master WSDs must have horizontal geo-location capability.

A7.13 Out-of-block emissions – These are emissions that fall outside the in-block segments of a radiated signal's frequency spectrum. These correspond to unintended radiations. Emissions are specified here as equivalent isotropic radiated power (EIRP).

A7.14 PMSE – Programme making and special events.

A7.15 Qualifying white space database – A white space database which has qualified to communicate with WSDs and to provide operational parameters to those WSDs under the terms of a contract between Ofcom and the person providing the white space database and which white space database is listed in Schedule 1 to the SI.

A7.16 Sensing level – the level of the signal, from an incumbent user, at the WSD receiver that indicates the WSD that the incumbent is close enough to require protection, i.e. that the frequency used by the incumbent cannot be used by the WSD.

A7.17 Slave operational parameters – These are the technical parameters which a master WSD receives from a WSDB and then communicates to a slave WSD for the purposes of the slave WSD's transmissions in the frequency band 470 – 790 MHz.

A7.18 Slave WSD – This is a WSD that obtains slave operational parameters directly from a master WSD. The slave WSD is then a served device. The master WSD is then a serving device.

A7.19 Time validity – The time prior to which the operational parameters returned from the WSDB are valid.

A7.20 TV white spaces – Frequencies within the band 470 MHz to 790 MHz which have been identified by a WSDB for use by a WSD under the operational conditions specified by the WSDB.

A7.21 TV white space database (WSDB) – A database system which can communicate with WSDs and provide information on TV white space availability.

A7.22 Type A WSD – A WSD whose antennas are permanently mounted on a non-moving outdoor platform.

A7.23 Type B WSD – A WSD whose antennas are not permanently mounted on a non-moving outdoor platform. A type B WSD must have an integral antenna

A7.24 UHF TV band – This is defined as the frequency band 470 – 790 MHz (DTT channels 21-60).

A7.25 Vertical geo-location capability – Capability of a WSD to determine its geographic altitude.

A7.26 White space device (WSD) – A wireless telegraphy equipment which operates in TV white spaces.