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22 January 2015

Mr. Manyaapelo Richard Makgotlho
The Independent Communications Authority of South Africa (ICASA)
Block A, B, C and D
Pinmill Farm
164 Katherine Street
Sandton

Per email: rmakgotlho@icasa.org.za

Dear Mr. Makgotlho:

The Dynamic Spectrum Alliance (DSA) has noted the publication by ICASA of the Discussion Paper on the Framework for Dynamic and Opportunistic Spectrum Management 2015 for consultation in terms of sections 2 (c) (d), (e), (i) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act and section 4B of the Independent Communications Authority of South Africa.

In response to ICASA's invitation to comment, please find attached DSA's submission.

Sincerely Yours,

Prof. H Sama Nwana
Executive Director
Dynamic Spectrum Alliance

Dynamic Spectrum Alliance Limited
21 St Thomas Street
Bristol BS1 6JS
United Kingdom
http://www.dynamicspectrumalliance.org

3855 SW 153rd Drive
Beaverton, OR 97003
United States

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ICASA Consultation: Discussion Paper on the Framework for Dynamic and Opportunistic Spectrum Management 2015

Comments of Dynamic Spectrum Alliance

The Dynamic Spectrum Alliance (DSA) supports ICASA's recent proposal to allow wireless devices to use vacant channels in the television broadcast bands.[1] In order to maximize use of those bands, ICASA's rules for this spectrum should (1) authorize license-exempt use of vacant channels, also known as television white spaces or TVWS; (2) establish technical rules that enable a wide variety of uses, including last-mile access, improved Wi-Fi connectivity, and machine-to-machine communications, while protecting incumbent users; and (3) move forward without delay.

1. ICASA should authorize use of vacant channels in the broadcast bands on a license-exempt, managed access basis.

In its Discussion Paper, ICASA recognizes that allowing dynamic access to the broadcast bands would make "significant amounts of otherwise underutilized spectrum available for broadband use."[2] The DSA agrees. The propagation characteristics of spectrum under 1 GHz make it ideal for deploying wireless broadband and other innovative applications, and technology now allows wireless devices to operate without causing harmful interference to incumbent services. Establishing a license-exempt, managed access framework for use of this spectrum will foster economic growth, complement licensed uses, and enable innovation.

The spectrum in the UHF bands is both underused and well-suited for delivering wireless broadband. As set forth in the Discussion Paper, there are only 189 digital terrestrial television (DTT) broadcast locations in South Africa, and the UHF bands contain "an unusually large amount of 'white space.'"[3] Moreover, the bands' propagation characteristics "enabl[e] signals to travel further and penetrate walls and irregular terrain," making them "uniquely well-suited for non-line-of-sight broadband communication."[4] In addition to wireless broadband, the spectrum can also be used for a variety of other applications, including machine-to-machine or Internet of

[1] ICASA, Discussion Paper on the Framework for Dynamic and Opportunistic Spectrum Management 2015, Government Gazette, General Notice No. 1001 (2015) (Discussion Paper).
[2] *Id.* at 6.
[3] *Id.* at 7.
[4] *Id.* at 33-34.

Things communications, in-building media distribution, and government, public safety, educational, and healthcare applications.[5]

Equally importantly, technological developments now allow new products and services to make use of this valuable spectrum while protecting incumbent users. For example, devices can rely on databases to provide a list of available channels based on a device's location. In such situations, databases calculate channel availability based on information regarding protected operations (e.g., location, frequency, and transmitter power) as well as characteristics of the wireless device itself (e.g., location, transmit power capabilities, and out-of-band emissions characteristics). Within South Africa, demonstrations of TVWS technology in Cape Town and in Limpopo province have delivered high-speed broadband to end users, and no incidents of harmful interference have been reported.[6]

In order to maximize the benefits of access to underused spectrum in the TV bands, ICASA should pursue a license-exempt, managed access approach to authorization. As recognized by ICASA, "licence-exempt wireless technologies currently contribute significantly to the economy by expanding network reach and improving network management."[7] According to Richard Thanki at the University of Southampton, licence-exempt Wi-Fi offload alone is predicted to generate $250 billion in economic value globally over the years 2012 through 2016.[8] A recent paper by Thanki calculates that making TVWS spectrum available for use on a license-exempt basis could generate over $100 billion in value to the South African economy over the next ten years by making broadband more affordable, increasing adoption of broadband connectivity, and driving economic growth from increased use of the Internet.[9]

Moreover, a licence-exempt approach will complement licensed networks and foster innovation. A balance of licensed spectrum, which has enabled traditional macrocell mobile networks, and licence-exempt spectrum, which has been used by low-power technologies such as Wi-Fi, cordless phones, and baby monitors, has fueled the wireless connectivity revolution. While access to licensed spectrum provides large operators a level of certainty need to deploy capital-intensive networks, licence-exempt access can accelerate innovation, because

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[5] Many of these use cases have been demonstrated in trials and commercial deployments throughout the globe. For additional details, see Worldwide Commercial Deployments, Pilots, and Trials, http://www.dynamicspectrumalliance.org/pilots/ (last visited Nov. 18, 2015). *See also* Discussion Paper at 33-34.

[6] *See id.*; Discussion Paper at 19; The Cape Town TV White Spaces Trial, http://www.tenet.ac.za/tvws (last visited Nov. 18, 2015). The role of databases in interference protection is discussed in further detail in section 2, *infra*.

[7] Discussion Paper at 33.

[8] Richard Thanki, *The Role of TV White Space Technology in Achieving Universal Broadband Connectivity in South Africa* 16 (Nov. 2015), *available at* https://lastingparties.wordpress.com/2015/12/11/tv-white-spaces-in-south-africa/.

[9] *Id.* at 47.

entrepreneurs can introduce products and services rapidly, without going through a time-consuming licensing process. In the future, demand for machine-to-machine applications, as well as for broadband connectivity, will drive demand for license-exempt access to low-frequency spectrum.[10] By making more license-exempt spectrum available below 1 GHz, ICASA can create another important tool to improve connectivity, and drive economic growth throughout the country.[11]

Finally, a license-exempt, managed access approach is consistent with approaches taken in other jurisdictions that have adopted rules for the use of TVWS. Canada, Singapore, the United Kingdom, and the United States have all adopted rules for the licence-exempt use of the broadcast bands, and all rely on databases to protect higher priority users from harmful interference.[12]

2. ICASA's technical rules for the use of TVWS should maximize meaningful opportunities for use while protecting incumbents.

In elaborating its framework for the use of TVWS, ICASA should adopt rules that protect incumbents while maximizing opportunities for secondary use by wireless devices. If ICASA establishes a licence-exempt managed access framework, as proposed above, it "can allow considerably more flexibility when developing technical rules applicable to TVWS devices, as compared to unmanaged services."[13] Below, the DSA makes several specific recommendations

[10] According to Yochai Benkler at Harvard's Berkman Center for Internet and Society, companies have invested significantly or even primarily in licence-exempt technologies across a variety of sectors, including wireless healthcare, smart grid communications, inventory management, access control, mobile payments, and fleet management. *See* Yochai Benkler, *Open Wireless vs. Licensed Spectrum: Evidence from Market Adoption* 1, 4 (Working Paper), *available at* http://www.benkler.org/Open_Wireless_V_Licensed_Spectrum_Market_Adoption_current.pdf.
[11] *See generally* Thanki, *supra* note 8.
[12] *See Unlicensed Operation in the TV Broadcast Bands*, ET Docket No. 04-186; *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, Second Memorandum Opinion and Order, 25 FCC Rcd 18661 (2010); Industry Canada, *Framework for the Use of Certain Non-Broadcasting Applications in the Television Broadcasting Bands Below 698 MHz* (2012), *available at* http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10493.html; Press Release, Industry Canada, Enhancing Wi-Fi Services in Rural Communities (Feb. 15, 2015), *available at* http://news.gc.ca/web/article-en.do?nid=928659; Infocomm Development Authority of Singapore*, Regulatory Framework For TV White Space Operations In The VHF/UHF Bands* (2014), *available at* *http://www.ida.gov.sg/~/media/Files/PCDG/Consultations/20130617_whitespace/ExplanatoryMemo.pdf*; Ofcom, *Implementing TV White Spaces* (2015), *available at* http://stakeholders.ofcom.org.uk/binaries/consultations/white-space-coexistence/statement/tvws-statement.pdf.
[13] Discussion Paper at 35.

regarding elements of the rules. The DSA also attaches its model regulations for the use of TVWS—which track the recommendations set forth below—as an Appendix to this submission.[14]

ICASA should permit the use of either databases or sensing to protect incumbent users. In addition to providing devices a list of available channels for use, databases offer two advantages in ensuring protection against harmful interference. First, the database allows operating parameters to be changed—for example, to accommodate changes in incumbent operations—without upgrading devices in the field. Second, because devices report their location to the database, "[n]on-functioning or interference-causing devices [can be] quickly be located and isolated, allowing speedy resolution of interference complaints."[15] Both of these features make databases an attractive option for managing access to TVWS spectrum.

In refining its framework, ICASA should clarify its proposal to define two types of geolocation databases.[16] Absent further clarification, the DSA suggests that ICASA should establish one set of baseline requirements for all databases and allow database providers to innovate in provisioning value-added services, rather than establishing two classes of databases.

In addition to allowing database-enabled access to TVWS, ICASA should permit the use of sensing as an additional method of interference protection, both used alone and as an enhancement to database-enabled sharing.[17] Although sensing has not been widely used in the TV bands, some companies are exploring stand-alone sensing solutions.[18] Others have expressed an interest in using sensing combined with databases to expand spectrum availability in the broadcast bands[19] because, as ICASA notes in its Discussion Paper, "spectrum sensing techniques can be used to enhance the accuracy in the detection of incumbent services performed by spectrum databases."[20]

The DSA agrees that ICASA should allow commercial entities to offer database services. As ICASA has recognized, "[c]ompetition among databases will encourage innovation and improvement in this sector, helping to develop the expertise and

[14] *See* Appendix A.
[15] *Id.*
[16] *Id.* at 13 (defining "reference geolocation white space database" and "secondary geolocation white space database").
[17] *See, e.g.*, 47 C.F.R. § 15.717 (authorizing the use of devices that rely on sensing for interference protection).
[18] *See, e.g.*, SHARED SPECTRUM COMPANY, http://www.sharedspectrum.com/ (last visited Apr. 19, 2015).
[19] Letter from Paul Margie, Counsel to Google Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket 12-268, Sept. 17, 2014, at 1.
[20] Discussion Paper at 35.

infrastructure necessary to offer a managed assignment service. In particular, allowing multiple databases will take advantage of expertise in developing and maintaining resilient infrastructure, managing device queries, providing customer service, and developing value-added services."[21] By contrast, a single provider approach would provide limited incentives to innovate and improve database technology.

ICASA should require databases to use a point-to-point propagation model that takes into account terrain effects. The propagation model used to calculate the presence of incumbent broadcast signals dramatically affects the amount of spectrum authorized for use by TVWS devices. It is a given that incumbents must be protected effectively. Within that parameter, in order to maximize spectrum use and effectively protect incumbents, ICASA should require database providers to use propagation models that rely on point-to-point modeling and take into account the variability in terrain when calculating propagation and spectrum availability.[22] In 2013, a trial conducted in Cape Town, South Africa used terrain-based, point-to-point modeling to protect incumbent broadcasters, and no interference was detected.[23] Indeed, terrain-based, point-to-point models like the Longley-Rice propagation model or the ITU-R Recommendation P. 1812-3 model are often used to calculate broadcaster-to-broadcaster interference protection.[24]

An approach such as the one relied on by the U.S. Federal Communications Commission (FCC) is not preferred. The FCC has chosen to rely on the F(50,50) curves propagation model to protect incumbents from interference from white space devices.[25] This model calculates a circular contour around each incumbent installation, regardless of the terrain in and around the transmitter location. Because it fails take terrain into account, it can both over- and under-protect incumbent users, unnecessarily limiting spectrum availability in some areas while risking potential interference to protected entities in others.

ICASA should establish different classes of devices, including fixed, portable, master, and client. Recognizing fixed and portable devices as distinct categories will give ICASA the flexibility to establish different rules for each class if it decides such an approach

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[21] *Id.* at 36.
[22] *Cf.* DSA, *Suggested Technical Rules and Regulations for the Use of Television White Spaces* § 4(a) & n.3, *available at* http://www.dynamicspectrumalliance.org/regulations/.
[23] James Carlson et al., *Studies on the Use of Television White Spaces in South Africa: Recommendations and Learnings from the Cape Town Television White Spaces Trial* 40 (Cape Town Trial Recommendations), *available at* http://www.tenet.ac.za/tvws/recommendations-and-learnings-from-the-cape-town-tv-white-spaces-trial.
[24] *See Office of Engineering and Technology Releases and Seeks Comment on Updated OET-69 Software,* Public Notice, ET Docket No. 13-26; GN Docket No. 12-268, 28 FCC Rcd 950 (2013); ITU-R Recommendation P.1812-3 (2013), *available at* http://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.1812-3-201309-I!!PDF-E.pdf.
[25] 47 C.F.R. § 15.712.

would be beneficial. For example, a number of regulators have permitted fixed devices to rely on the services of a professional installer to provide their location information or operate at higher power levels.[26] At the same time, ICASA should permit devices to operate in either master or client mode. Master devices use an automated geolocation capability or the coordinates provided by a professional installer to access a database either directly or through another master device. Client devices do not use an automated geolocation capability and do not directly access a white space database to obtain a list of available white space channels. Instead, they rely on master devices to provide them with an approved list of channels for use. Both modes of operation promote incumbents effectively because a client device can only operate if it establishes a connection with a master device and the master device authorizes operation on channels in the client device's vicinity. Equally importantly, allowing both modes will promote innovation and diversity in TVWS devices: for example, client devices can use a variety of form factors if they do not need to accommodate geolocation capability. Accordingly, both modes of operation should be permitted.

ICASA should permit devices with power levels up to 10 watts and allow adjacent channel operation. In its Discussion Paper, ICASA states that it is "of the view that in order to increase the potential range and utility of TVWS devices, transmitter power levels should be determined and limited by the database."[27] The DSA agrees. In establishing maximum power levels for devices, ICASA should authorize a continuous range of TVWS device transmitter power levels and rely on databases to provide maximum power levels by location and frequency.[28] This approach is preferable to a static approach where a regulator predetermines the maximum power for fixed and mobile devices because it maximizes spectrum utilization. Indeed, for exactly this reason, the FCC has adopted changes this year to make its approach to TVWS power-level approvals more graduated than before.[29] In addition, ICASA should allow white spaces to operate adjacent to broadcast operations. The ICASA-sponsored trial in Cape Town demonstrated that adjacent channel operation at a power of 4 Watts EIRP

[26] 47 C.F.R. § 15.711(b)(1) (allowing professional installation of fixed devices); Singapore Explanatory Statement at 20 (allowing professional installation of fixed devices); Ofcom, *Licensing Manually Configurable White Space Devices* 13-14 (2015) (allowing professional installation of fixed and nomadic devices, but not mobile devices) , *available at* http://stakeholders.ofcom.org.uk/binaries/consultations/manually-configurable-wsds/statement/Licensing_manually_configurable_white_space_devices.pdf; Singapore Explanatory Statement at 11 (allowing fixed devices to operate at higher power levels than portable devices); 47 C.F.R. § 15.709 (allowing fixed devices to operate at higher power levels than portable devices).

[27] Discussion Paper at 38.

[28] *Id.*

[29] *Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37*, Report and Order, 30 FCC Rcd 9551, ¶¶ 40-45 (2015).

did not cause harmful interference to incumbent users.[30] Accordingly, there is no reason to limit adjacent channel operation to very low power levels or ban it altogether.

ICASA should permit devices to comply with either FCC or ETSI out-of-band emissions limitations. If ICASA establishes standards for out-of-band emissions by TVWS devices that recognize both the FCC rules and the ETSI standard for such emissions, then South African users of TVWS will be able to take full advantage of devices being developed for the global market. The ETSI rules permit devices meeting less stringent emissions standards to operate, but they are granted access to spectrum in fewer areas to ensure protection of primary users. Regulatory frameworks and TV white space databases can accommodate both the FCC and Ofcom approaches, and allowing both approaches provides operators and users with additional flexibility. Indeed, the TVWS rules adopted by the Government of Singapore earlier this year allow for either approach.[31] ICASA should follow the same course.

The proposed rules should allow license-exempt managed use of the VHF bands. ICASA's Discussion Paper proposes to adopt rules for licence-exempt use of the frequencies between 470 and 694 MHz.[32] In its final rules, ICASA should extend its framework to allow licence-exempt use of VHF spectrum as well. The same methods used to protect broadcasters in the UHF band can also protect VHF spectrum users. As a result, implementing this addition should be straightforward and could free up significant additional spectrum contiguous to the UHF band.

3. ICASA should move forward without delay.

Finally, ICASA should move forward expeditiously with its rulemaking. Trials in this country have demonstrated that use of TVWS can bring significant benefits to South African citizens without causing harmful interference to existing users.[33] And there are no substantial impediments to moving forward. The International Telecommunication Union (ITU) has made clear that no further international action is required for individual regulators to move forward with TVWS regulations; rather, as explained by François Rancy, Director of the ITU's Radiocommunication Bureau, "The ITU World Radiocommunication Conference of 2012 concluded that the current international regulatory framework can accommodate software defined radio and cognitive radio systems, hence dynamic spectrum access, without being changed. The development of systems implementing this concept, such as TV white spaces, is

[30] Discussion Paper at 38; Carlson et al., *supra* note 23, at 38.
[31] IDA Singapore, Telecommunications Standards Advisory Committee, *Technical Specifications: Television White Spaces* § 5.3, Issue 1 (March 2015).
[32] Discussion Paper at 7, 19, 34.
[33] *See* Worldwide Commercial Deployments, Pilots, and Trials, *supra* note 5; Carlson et al., *supra* note 23.

therefore essentially in the hands of national regulators in each country."[34] TVWS technology, moreover, can be utilized both during and after the digital switchover.[35] Thus, as ICASA itself has recognized, enabling dynamic spectrum sharing would make this spectrum available to users quickly, "as opposed to waiting for the conclusion of analogue to digital migration and the subsequent clearing of TV operations in these bands."[36] For all these reasons, ICASA should act now to unlock the potential of these vacant frequencies.

Respectfully submitted,

Prof. H. Nwana
Executive Director
Dynamic Spectrum Alliance

[34] François Rancy, Director, ITU Radiocommunication Bureau, Remarks at ITU Radiocommunication Seminar for Arab Countries (Dec. 13, 2013).
[35] *See* Discussion Paper at 27 (raising this question). Relatedly, at the 2015 World Radio Conference 2015 (WRC-15), the ITU agreed to maintain its primary allocation of the lower UHF spectrum from 470 MHz to 694 MHz to terrestrial broadcasting (TV) services until at least 2023 in ITU Region 1 (including Europe, the Middle East, and Africa).
[36] *Id.* at 7.

Dynamic Spectrum Alliance Limited
21 St Thomas Street
Bristol BS1 6JS
United Kingdom
http://www.dynamicspectrumalliance.org

3855 SW 153rd Drive
Beaverton, OR 97006
United States

Appendix A

Suggested Technical Rules and Regulations

for the Use of Television White Spaces

Dynamic Spectrum Alliance

§ 1 Permissible Frequencies of Operation

a) White space devices ("WSDs") are permitted to operate on a license-exempt basis subject to the interference protection requirements set forth in these rules.
b) WSDs may operate in the broadcast television frequency bands, as well as any other frequency bands designated by [Regulator].
c) WSDs shall only operate on available frequencies determined in accordance with the interference avoidance mechanisms set forth in § 2.
d) Client WSDs shall only operate on available frequencies determined by the database and provided via a master white space device in accordance with § 3(f).

§ 2 Protection of Licensed Incumbent Services

Availability of frequencies for use by WSDs may be determined based on the geolocation and database method described in § 3 or based on the spectrum sensing method described in § 6.1.

§ 3 Geolocation and Database Access

(a) A WSD may rely on the geolocation and database access mechanism described in this section to identify available frequencies.

(b) WSD geolocation determination.

(1) The geographic coordinates of a fixed WSD shall be determined to an accuracy of ± 50 meters by either automated geolocation or a professional installer. The geographic coordinates of a fixed WSD shall be determined at the time of installation and first activation from a power-off condition, and this information shall be stored by the device. If the fixed WSD is moved to another location or if its stored coordinates become altered, the operator shall re-establish the device's geographic location either by means of automated geolocation or through the services of a professional installer.

(2) A personal/portable master WSD shall use automated geolocation to determine its location. The device shall report its geographic coordinates as well as the accuracy of its geolocation capability (e.g., +/- 50 meters, +/- 100 meters) to the database. A personal/portable master device must also re-establish its position each time it is activated from a power-off condition and use its geolocation capability to check its location at least once every 60 seconds while in operation, except while in sleep mode, i.e., a mode in which the device is inactive but not powered down.

(c) Determination of available frequencies and maximum transmit power.

(1) Master WSDs shall access a geolocation database designated by [Regulator] over the Internet to determine the frequencies and maximum transmit power

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available at the device's geographic coordinates. A database will determine available frequencies and maximum transmit power based on the algorithm described in § 4. However, in no case shall the maximum transmit power exceed the values provided in § 7.

(2) Master devices must provide the database with the device's geographic coordinates in WGS84 format, a unique alphanumeric code supplied by the manufacturer that identifies the make and model of the device model number, and unique device identifier such as a serial number. Fixed master devices must also provide the database with the antenna height of the transmitting antenna specified in meters above ground level or above mean sea level.

(3) When determining frequencies of operation and maximum transmit power, the geolocation database may also take into account additional information voluntarily provided by a master WSD about its operating parameters and indicate to the WSD that different frequencies and/or higher maximum transmit power are available based on this additional information.

(4) WSD operation in a frequency range must cease transmitting immediately if the database indicates that the frequencies are no longer available.

(5) A personal/portable master device must access a geolocation database as described in paragraph (c)(1) to re-check the database for available frequencies and maximum operating power when (1) the device changes location by more than 100 meters from the location at which it last accessed the database or (2) the device is activated from a power-off condition.

(6) A personal/portable master WSD may load frequency availability information for multiple locations around, i.e., in the vicinity of, its current location and use that information in its operation. A personal/portable master WSD may use such available frequency information to define a geographic area within which it can operate on the same available frequencies at all locations; for example, a master WSD could calculate a bounded area in which frequencies are available at all locations within the area and operate on a mobile basis within that area. A master WSD using such frequency availability information for multiple locations must contact the database again if/when it moves beyond the boundary of the area where the frequency availability data is valid, and must access the database daily even if it has not moved beyond that range to verify that the operating frequencies continue to be available. Operation must cease immediately if the database indicates that the frequencies are no longer available.

(d) Time validity and database re-check requirements. A geolocation database shall provide master devices with a time period of validity for the frequencies of operation and maximum transmit power values described in paragraph (c).

(e) Fixed device registration.

(1) Prior to operating for the first time or after changing location, a fixed WSD must register with a database by providing the information listed in paragraph (e)(3) of this section.

(2) The party responsible for a fixed WSD must ensure that a database has the most current, up-to-date information for that device.

(3) The database shall contain the following information for fixed WSDs:

(i) A unique alphanumeric code supplied by the manufacturer that identifies the make and model of the device [in jurisdictions that require a certification ID number this ID number may be used];

(ii) Manufacturer's serial number of the device;

(iii) Device's geographic coordinates (latitude and longitude (WSG84)

(iv) Device's antenna height above ground level or above mean sea level (meters);

(v) Name of the individual or business that owns the device;

(vi) Name of a contact person responsible for the device's operation;

(vii) Address for the contact person;

(viii) Email address for the contact person;

(ix) Phone number for the contact person.

(f) Client device operation.

(1) A client WSD may only transmit upon receiving a list of available frequencies and power limits from a master WSD that has contacted a database. To initiate contact with a master device, a client device may transmit on available frequencies used by the master WSD or on frequencies that the master WSD indicates are available for use by a client device on a signal seeking such contacts. A client WSD may optionally provide additional information about its operating parameters to a master device that may be taken into account by the database when determining available frequencies and/or maximum transmit power for the client device. The client device must also provide the master device with a unique alphanumeric code supplied by the manufacturer that identifies the make and model of the client device, which will be supplied to a geolocation database.

(2) At least once every 60 seconds, except when in sleep mode, i.e., a mode in which the device is inactive but is not powered-down, a client device must communicate with a master device, which may include contacting the master device to re-verify/re-establish frequency availability or receiving a contact verification signal from the master device that provided its current list of available frequencies. A client device must cease operation immediately if it has not communicated with the master device as described above after more than 60 seconds. In addition, a client device must re-check/reestablish contact with a master device to obtain a list of available frequencies if the client device resumes operation from a powered-down state. If a master device loses power and obtains a new frequency list, it must signal all client devices it is serving to acquire a new frequency list.

(g) Fixed devices without a direct connection to the Internet. If a fixed WSD does not have a direct connection to the Internet and has not yet been initialized and communicated with a geolocation database consistent with this section, but can receive the transmissions of a master WSD, the fixed WSD needing initialization may transmit to the master WSD on either a frequency band on which the master WSD has transmitted or on a frequency band which the master WSD indicates is available for use to access the geolocation database to receive a list of frequencies and power levels that are available for the fixed WSD to use. Fixed devices needing initialization must transmit at the power levels specified under the technical requirements in these rules for the applicable frequency bands. After communicating with the database, the fixed WSD must then only use the frequencies and power levels that the database indicates are available for it to use.

(h) Security.

(1) For purposes of obtaining a list of available frequencies and related matters, master WSDs shall be capable of contacting only those geolocation databases operated by administrators authorized by [Regulator].

(2) Communications between WSDs and geolocation databases are to be transmitted using secure methods that ensure against corruption or unauthorized modification of the data; this requirement also applies to communications of frequency availability and other spectrum access information between master devices.

(3) Communications between a client device and a master device for purposes of obtaining a list of available frequencies shall employ secure methods that ensure against corruption or unauthorized modification of the data. Contact verification signals transmitted for client devices are to be encoded with encryption to secure the identity of the transmitting device. Client devices using contact verification signals shall accept as valid for authorization only the signals of the device from which they obtained their list of available frequencies.

(4) Geolocation database(s) shall be protected from unauthorized data input or alteration of stored data. To provide this protection, a database administrator shall establish communications authentication procedures that allow master devices to be assured that the data they receive is from an authorized source.

§ 4 Database Algorithm

(a) The input to a geolocation database will be positional information from a master WSD, a classification code or other information characterizing a device's emissions performance,[2] the height of the transmitting antenna for fixed master devices and use by licensed incumbents in or near the geographic area of operation of the WSD. The database may, at its discretion, accept additional information about WSD operating parameters. The database will supply a list of available frequencies and associated radiated powers to WSDs pursuant to either

[2] The European Telecommunications Standards Institute (ETSI) defines five different classes of emissions masks. If available, this information should be supplied to the database. If not, the device can provide its emissions performance to the database in another form. If a device is sophisticated enough to modify its emissions profile dynamically, then regulators can consider an approach in which the database provides a maximum power level per channel and then the device ensures – based on its emissions profile – that it falls below the ceiling provided by the database.

(1) the algorithm provided in Annexes A and B or (2) the algorithm provided in Annex D. Annex C provides guidance for implementing either algorithm.[3]

(b) Information about incumbent licensed usage typically will be provided from information contained in [Regulator's] databases.

(c) Any facilities that [Regulator] determines are entitled to protection but not contained in [Regulator's] databases shall be permitted to register with a geolocation database pursuant to § 5.

§ 5 Database Administrator

(a) Database administrator responsibilities. [Regulator] will designate one public entity or multiple private entities to administer geolocation database(s). Each geolocation database administrator designated by [Regulator] shall:

(1) Maintain a database that contains information about incumbent licensees to be protected.

(2) Implement propagation algorithms and interference parameters issued by [Regulator] pursuant to § 4 to calculate operating parameters for WSDs at a given location. Alternatively, a database operator may implement other algorithms and interference parameters that can be shown to return results that provide at least the same protection to licensed incumbents as those supplied by [Regulator]. Database operators will update the algorithms or parameter values that have been supplied by [Regulator] after receiving notification from [Regulator] that they are to do so.

(3) Establish a process for acquiring and storing in the database necessary and appropriate information from the [Regulator's] databases and synchronizing the database with current [Regulator] databases at least once a week to include newly licensed facilities or any changes to licensed facilities.

(4) Establish a process for the database administrator to register fixed WSDs.

(5) Establish a process for the database administrator to include in the geolocation database any facilities that [Regulator] determines are entitled to protection but not contained in a database maintained by [Regulator].

(6) Provide accurate information regarding permissible frequencies of operation and maximum transmit power available at a master WSD's geographic coordinates based on the information provided by the device pursuant to § 3(c). Database operators may allow prospective operators of WSDs to query

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[3] The DSA supports models that protect incumbents but maximize spectrum utility. To that end, they support models that use point-to-point modeling. In addition, they support models that take into account the variability in terrain in calculating propagation and spectrum availability. Annexes A and B describe the model, which meets these criteria. It is based on the Longley-Rice propagation model. However, the DSA believes that ITU-R. P-1812 is also an acceptable propagation model for this purpose. Details regarding ITU-R. P-1812 are set forth in Annex D. Other models may also be appropriate, provided that they use point-to-point calculations and take into account terrain variability.

the database and determine whether there are vacant frequencies at a particular location.

(7) Establish protocols and procedures to ensure that all communications and interactions between the database and WSDs are accurate and secure and that unauthorized parties cannot access or alter the database or the list of available frequencies sent to a WSD.

(8) Respond in a timely manner to verify, correct and/or remove, as appropriate, data in the event that [Regulator] or a party brings a claim of inaccuracies in the database to its attention. This requirement applies only to information that [Regulator] requires to be stored in the database.

(9) Transfer its database, along with a list of registered fixed WSDs, to another designated entity in the event it does not continue as the database administrator at the end of its term. It may charge a reasonable price for such conveyance.

(10) The database must have functionality such that upon request from [Regulator] it can indicate that no frequencies are available when queried by a specific WSD or model of WSDs.

(11) If more than one database is developed for a particular frequency band, the database administrators for that band shall cooperate to develop a standardized process for providing on a daily basis or more often, as appropriate, the data collected for the facilities listed in subparagraph (5) to all other WSD databases to ensure consistency in the records of protected facilities.

(b) Non-discrimination and administration fees.

(1) Geolocation databases must not discriminate between devices in providing the minimum information levels. However, they may provide additional information to certain classes of devices.

(2) A database administrator may charge a fee for provision of lists of available frequencies to fixed and personal/portable WSDs [and for registering fixed WSDs].

(3) [Regulator], upon request, will review the fees and can require changes in those fees if they are found to be excessive.

§ 6 Spectrum Sensing in the Broadcast Television Frequency Bands

(a) Parties may submit applications for authorization of WSDs that rely on spectrum sensing to identify available frequencies in the television broadcast bands. WSDs authorized under this section must demonstrate that they will not cause harmful interference to incumbent licensees in those bands.

(b) Applications shall submit a pre-production WSD that is electrically identical to the WSD expected to be marketed, along with a full explanation of how the WSD will protect incumbent licensees against harmful interference. Applicants may request that commercially sensitive portions of an application be treated as confidential.

(c) Application process and determination of operating parameters.

(1) Upon receipt of an application submitted under this section, [Regulator] will develop proposed test procedures and methodologies for the pre-production WSD. [Regulator] will make the application and proposed test plan available for public review, and afford the public an opportunity to comment.

(2) [Regulator] will conduct laboratory and field tests of the pre-production WSD. This testing will be conducted to evaluate proof of performance of the WSD, including characterization of its sensing capability and its interference potential. The testing will be open to the public.

(3) Subsequent to the completion of testing, [Regulator] will issue a test report, including recommendations for operating parameters described in subparagraph (c)(4), and afford the public an opportunity to comment.

(4) After completion of testing and a reasonable period for public comment, [Regulator] shall determine operating parameters for the production WSD, including maximum transmit power and minimum sensing detection thresholds, that are sufficient to enable the WSD to reliably avoid harmfully interfering with incumbent services.[4]

(d) Other sensing requirements. All WSDs that rely on spectrum sensing must implement the following additional requirements:

(1) Frequency availability check time. A WSD may start operating on a frequency band if no incumbent licensee device signals above the detection threshold determined in subparagraph (c) are detected within a minimum time interval of 30 seconds.

(2) In-service monitoring. A WSD must perform in-service monitoring of the frequencies used by the WSD at least once every 60 seconds. There is no minimum frequency availability check time for in-service monitoring.

(3) Frequency move time. After an incumbent licensee device signal is detected on a frequency range used by the WSD, all transmissions by the WSD must cease within two seconds.

§ 7 Technical Requirements for WSDs Operating in the Television Broadcast Bands

(a) Maximum power levels.

(1) WSDs relying on the geolocation and database method of determining channel availability may transmit using the power levels provided by the database pursuant to § 4. However, the maximum conducted power delivered to the antenna system for WSDs shall never exceed the following values:

[4] In the context of television broadcast services, the Partners suggest that harmfully interfering with an *otherwise viewable* television signal would not be permitted under these guidelines.

(i) The maximum conducted power delivered to the antenna system shall not exceed 16.2 dBm/100 kHz[5].[6] If transmitting antennas of directional gain of greater than 6 dBi are used, this conducted power level shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Personal/portable WSDs devices shall be treated the same as fixed devices, except[7]:

a. If the personal/portable WSD does not report its height information, it will be treated like a fixed devices operating at 1.5 meters above ground.

b. If the personal/portable WSD does report its height information, and that height is more than 2 meters above ground, an additional 7 dB of power may be permitted beyond what is allowed for fixed devices.

(iii)Fixed WSDs communicating with a master WSD for the purpose of establishing initial contact with a geolocation database pursuant to § 3 (g) may transmit using the maximum power levels in this paragraph applicable to personal/portable WSDs.

(2) WSDs relying on the spectrum sensing method of determining channel availability may transmit at 50 mW per [television channel size] and -0.4 dBm/100KHz effective isotropic radiated power (EIRP).

§ 8 Definitions.

(a) *Available frequency*. A frequency range that is not being used by an authorized incumbent service at or near the same geographic location as the WSD and is acceptable for use by a license exempt device under the provisions of this subpart. Such frequencies are also known as White Space Frequencies (WSFs).

(b) *Client device*. A personal/portable WSD that does not use an automatic geolocation capability and access to a geolocation database to obtain a list of available frequencies. A client device must obtain a list of available frequencies on which it may operate from a master device. A client device may not initiate a

[5] A trial in Cape Town, South Africa, in which several DSA members participated, operated at 4W immediately adjacent to broadcast operations, and no interference was detected. The power level recommended in these rules corresponds to a maximum of 10 W effective isotropic radiated power (EIRP) in a 6 MHz channel. In actual deployments, the power is likely to be limited further by incumbent operation and the device's emissions profile.
[6] The calculation of maximum conducted power under this rule should take into account the transmit power of the radio as well the loss from cable and connectors.
[7] According to Ofcom's proposed technical rules, portable devices located more than 2 meters above ground are presumed to be indoor. The additional power adjustment accounts for building loss.

network of fixed and/or personal/portable WSDs nor may it provide a list of available frequencies to another client device for operation by such device.

(c) *Contact verification signal*. An encoded signal broadcast by a master device for reception by client devices to which the master device has provided a list of available frequencies for operation. Such signal is for the purpose of establishing that the client device is still within the reception range of the master device for purposes of validating the list of available frequencies used by the client device and shall be encoded to ensure that the signal originates from the device that provided the list of available frequencies. A client device may respond only to a contact verification signal from the master device that provided the list of available frequencies on which it operates. A master device shall provide the information needed by a client device to decode the contact verification signal at the same time it provides the list of available frequencies.

(d) *Fixed device*. A WSD that transmits and/or receives radiocommunication signals at a specified fixed location. A fixed WSD may select frequencies for operation itself from a list of available frequencies provided by a geolocation database and initiate and operate a network by sending enabling signals to one or more fixed WSD and/or personal/portable WSDs.

(e) *Geolocation capability*. The capability of a WSD to determine its geographic coordinates in WGS84 format. This capability is used with a geolocation database approved by the [Regulator] to determine the availability of frequencies at a WSD's location.

(f) *Master device*. A fixed or personal/portable WSD that uses a geolocation capability and access to a geolocation database, either through a direct connection to the Internet or through an indirect connection to the Internet by connecting to another master device, to obtain a list of available frequencies. A master device may select a frequency range from the list of available frequencies and initiate and operate as part of a network of WSDs, transmitting to and receiving from one or more WSD. A master device may also enable client devices to access available frequencies by (1) querying a database to obtain relevant information and then serving as a database proxy for the client devices with which it communicates; or (2) relaying information between a client device and a database to provide a list of available frequencies to the client device.

(g) *Network initiation*. The process by which a master device sends control signals to one or more WSDs and allows them to begin communications.

(h) *Operating frequency*. An available frequency used by a WSD for transmission and/or reception.

(i) *Personal/portable device*. A WSD that transmits and/or receives radiocommunication signals at unspecified locations that may change.

(j) *Sensing only device*. A WSD that uses spectrum sensing to determine a list of available frequencies.

(k) *Spectrum sensing*. A process whereby a WSD monitors a frequency range to detect whether frequencies are occupied by a radio signal or signals from authorized services.

(l) *White space device (WSD).* An intentional radiator that operates on a license exempt basis on available frequencies.

(m) *Geolocation database*. A database system that maintains records of all authorized services in the frequency bands approved for WSD use, is capable of determining available frequencies at a specific geographic location, and provides lists of available frequencies to WSDs. Geolocation databases that provide lists of available frequencies to WSDs must be authorized by [Regulator].

A full copy of this document, including Annexes A-D, can be found on the Dynamic Spectrum Alliance public website here:
http://www.dynamicspectrumalliance.org/assets/submissions/Suggested%20Technical%20Rules%20and%20Regulations%20for%20the%20use%20of%20TVWS.pdf