Model Rules for License-Exempt White Space Devices

§ 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 is determined based on the geolocation and database method described in § 3. In addition, availability of frequencies for use by WSDs operating in the broadcast television frequency bands may be determined based on the spectrum sensing method described in § 6.

§ 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 an incorporated geolocation capability 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 the device's incorporated geolocation capability or through the services of a professional installer.

(2) A personal/portable master WSD shall incorporate a geolocation capability to determine its geographic coordinates to an accuracy of ± 50 meters from the transmission. 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 available at the device's geographic coordinates. Master devices must provide the database with the device's geographic coordinates in WGS84 format, 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 AMSL or AGL.

   (2) 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.

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

   (4) A personal/portable master device must access a geolocaton 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.

   (5) 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 (NAD 83) accurate to ± 50 meters);

(iv) Device's antenna height above ground 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, 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 an algorithm provided by [Regulator] or another algorithm that provides equivalent protection to incumbent licensees.

(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 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 the IP addresses and URLs used to access the database and 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 interfering with incumbent services.

(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) Minimum Power levels.

(1) WSDs relying on the geolocation and database method of determining channel availability may transmit at up to the following baseline power levels, which may be increased by the database pursuant to § 3.

(i) Fixed WSDs may transmit at 1 watt conducted power per [television channel size]. Antennas with directional gain of up to 6 dBi (equivalent to 4W EIRP) may be used.

(ii) Personal/portable WSDs that do not operate directly adjacent to an occupied TV channel may transmit at 100 mW EIRP per [television channel size].

(iii) Personal/portable WSDs that operate directly adjacent to an occupied TV channel may transmit at 40 mW EIRP per [television channel size].

(iv) Fixed WSDs communicating with a master WSD for the purpose of establishing initial contact with a geolocation database pursuant to § 3 (g) shall transmit using the 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].

(b) Maximum Emissions limit restrictions.

(1) In the television channels immediately adjacent to the channel in which the WSD is operating, emissions from WSDs relying on the geolocation and database method of determining channel availability shall comply with the following emissions limits. Alternatively, these WSDs may provide less stringent emissions limits to the database, which the database may take into account when determining channel availability and maximum transmit power under § 3.

(i) Fixed devices: -42.8 dBm conducted power per 100 kHz.

(ii) Personal/portable device operating adjacent to occupied TV channels: -56.8 dBm EIRP per 100 kHz.

(iii) All other personal/portable devices: -52.8 dBm EIRP per 100 kHz.

(2) In the television channels immediately adjacent to the channel in which the WSD is operating, emissions from WSDs relying on the spectrum sensing method of determining channel availability shall not exceed -55.8 dBm EIRP per 100 kHz.

§ 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.

(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 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 within the level of accuracy specified in § 3. 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].