White Space Regulatory Domains

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Summary

This document provides summary of regulations for White Space communication in different regulatory domains:

- USA TV Band
- CANADA TV Band
- UK TV Band
- CEPT

Background

TV White Spaces (USA): White spaces refer to frequencies allocated to a broadcasting service but not used locally.

Digital Dividend(Uk): The digital dividend refers to the spectrum which is released in the process of digital television transition. It may include TV White Spaces.

USA TV BAND

Status

- Radio regulations: published
- Database: trials started
- Device certification: do not know

Documents

- FCC 08-260 2nd Report and Order and Memorandum Opinion and Order
  - http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-260A1.pdf
- FCC DA-09-20 Erratum
  - http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-287799A1.pdf
- FCC 10-174 2nd Memorandum Opinion and Order
  - http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-10-174A1.pdf
- FCC Doc 302279 Erratum
  - http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-302279A1.pdf

USA TV BAND

- White space channelization
  - 6 MHz
- Device classes
  - Fixed
  - Personal/Portable
    - Mode 1
    - Mode 2
    - Sensing only
- Primary user protection
  - TV bands database
    - Shall be accessed by Fixed and Personal/Portable Mode 2 devices before starting communication

TV Channel No	Freq. band (MHz)	TV Channel No	Freq. band (MHz)	TV Channel No	Freq. band (MHz)
2	54-60	19	500-506	36	602-608
3	60-66	20	506-512	37	608-614
4	66-72	21	512-518	38	614-620
5	76-82	22	518-524	39	620-626
6	82-88	23	524-530	40	626-632
7	174-180	24	530-536	41	632-638
8	180-186	25	536-542	42	638-644
9	186-192	26	542-548	43	644-650
10	192-198	27	548-554	44	650-656
11	198-204	28	554-560	45	656-662
12	204-210	29	560-566	46	662-668
13	210-216	30	566-572	47	668-674
14	470-476	31	572-578	48	674-680
15	476-482	32	578-584	49	680-686
16	482-488	33	584-590	50	686-692
17	488-494	34	590-596	51	692-698
18	494-500	35	596-602	52	698-704

Red: No TVWS

Green: May be allocated toWireless Microphones

Blue: All Devices

Black: Personal/Portable Devices

Fixed Devices

A TVBD that transmits and/or receives radio communication signals at a specified fixed location.

- Allowed to communicate with other fixed devices and with personal/portable devices
- Allowed to operate on TV channels 2 -51, excluding 3,4,37 and the first channel above and the first channel below TV channel 37 (608-614 MHz) that are available. If a channel is not available both above and below channel 37, operation is prohibited on the first two channels nearest to channel 37. These channels are allocated to microphones.
- Shall not operate on adjacent TV channels.
- Shall have geolocation capability
- Shall access database to determine available channels
- Shall be registered to database
- Allowed to use outdoor antenna
- Allowed up to 1W transmit output power per 6 MHz (6dBi antenna gain is allowed), resulting EIRP 4 Watt
- Maximum transmit power 12.2 dBm (16.6mW) per 100 kHz

Personal/Portable Devices

A TVBD that transmits and/or receives radiocommunication signals at unspecified locations that may change.

➡Allowed to communicate with fixed devices and with other personal/portable devices

➡Allowed to operate on TV channels 21-51, excluding channel 37 and channels allocated to microphones.

➡Three modes

- Mode I device
  - A personal/portable TVBD that does not use an internal geo-location capability and access to a TV bands database to obtain a list of available channels. A Mode I device must obtain a list of available channels on which it may operate from either a fixed TVBD or Mode II personal/portable TVBD.
- Mode II device
  - A personal/portable TVBD that uses an internal geolocation capability and access to a TV bands database, either through a direct connection to the Internet or through an indirect connection to the Internet by way of fixed TVBD or another Mode II TVBD, to obtain a list of available channels.
- Sensing only device
  - A personal/portable TVBD that uses spectrum sensing to determine a list of available channels.

Mode 1/Mode2 Personal/Portable Devices

- 100mW EIRP (limited to 40mW when operating adjacent to occupied channel)

- Maximum 2.2 dBm (1.66mW) per 100 kHz (limited to -1.8Bm (0.66 mW) when operating adjacent to a occupied channel) with 0 dBi antenna gain.

- TVBDs shall incorporate transmit power control to limit their operating power to the minimum necessary for successful communication. Applicants for equipment certification shall include a description of a device's transmit power control feature mechanism.

- In the television channels immediately adjacent to the channel in which a TVBD is operating emissions from the TVBD shall be at least 72.8 dB below the highest average power in the TV channel in which the device is operating.

Sensing only devices

- **Requirements for sensing only devices**
  - 50mW EIRP (limited to 40mW when operating adjacent to occupied channel)
  - The required detection thresholds are:
    - (A) ATSC digital TV signals: -114 dBm, averaged over a 6 MHz bandwidth;
    - (B) NTSC analog TV signals: -114 dBm, averaged over a 100 kHz bandwidth;
    - (C) Low power auxiliary, including wireless microphone, signals: -107 dBm, averaged over a 200 kHz bandwidth.
- **Each device should be tested by FCC in laboratory and field tests for authorization.**
- **Current sensing limits combined with low allowed transmit power gives database approach a priority.**

Database Access

- **Must be supported in both Fixed and Portable Mode 2 devices**
- **Geolocation**
  - **Each device shall know its geolocation with the accuracy of ±50 meters**
  - **Personal/Portable devices should check their geolocation every 60 seconds while in operation**
- **Database access**
  - **Once daily access and each activation,**
  - **Portable devices for each 100 meter movement,**
  - **Portable devices may load information for different locations**

Communication Procedure for Fixed and Mode II TVBDs

(1) Fixed and Mode II TVBDs shall provide their location and required identifying information to the TV bands database

(2) Fixed and Mode II TVBDs shall not transmit unless they receive, from the TV bands database, a list of available channels and are only allowed to transmit on the available channels on the list provided by the database.

(3) Fixed TVBDs register and receive a list of available channels from the database by connecting to the Internet, either directly or through another fixed TVBD that has a direct connection to the Internet.

(4) Mode II TVBDs receive a list of available channels from the database by connecting to the Internet, either directly or through a fixed or Mode II TVBD that has a direct connection to the Internet.

(5) A fixed or Mode II TVBD that provides a list of available channels to a Mode I device shall notify the database of the FCC identifier of such Mode I device and receive verification that that FCC identifier is valid before providing the list of available channels to the Mode I device.

(6) A fixed device located at a site where the ground level height above average terrain (HAAT) is greater than 76 meters shall not be provided a list of available channels

Communication Procedure for Mode I TVBDs

- To initiate contact with a fixed or Mode II device, a Mode I device may transmit on an available channel used by the fixed or Mode II TVBD or on a channel the fixed or Mode II TVBD indicates is available for use by a Mode I device on a signal seeking such contacts
- A fixed or Mode II device may provide a Mode I device with a list of available channels only after it contacts its database, provides the database the FCC Identifier (FCC ID) of the Mode I device requesting available channels, and receives verification that the FCC ID is valid for operation.
- At least once every 60 seconds a Mode I device must either receive a contact verification signal from the Mode II or fixed device that provided its current list of available channels or contact a Mode II or fixed device to re-verify/re-establish channel availability

CANADA TV BAND

- Status
  - Radio regulations: will not be available before 2012
  - Database: not available at the moment
  - Device certification: not available at the moment
- Documents
  - **Consultation on a Policy and Technical Framework for the Use of Non-Broadcasting Applications in the Television Broadcasting Bands Below 698 MHz**
    - http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/consultation-smse012e.pdf/$FILE/consultation-smse012e.pdf

Considered CANADA TV BAND

- White Space Channelization
  - 6 MHz
- Device classes
  - Fixed
  - Mobile
    - Mode 1
    - Mode 2
- Primary service protection
  - Geolocation Database: Initial focus
  - Sensing: Spectrum sensing is expected to continue to develop and would therefore be permitted once this technology has matured sufficiently

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15	476-482	32	578-584	49	680-686
16	482-488	33	584-590	50	686-692
17	488-494	34	590-596	51	692-698
18	494-500	35	596-602		

Red: No Consideration astronomy medical telemetry

Black: Considered

UK TV BAND

- Status
  - Radio regulations: will not be available before 2012
  - Database: not available at the moment
  - Device certification: not available at the moment
- Documents
  - A statement on our approach to awarding the digital dividend, Dec. 2007.
    - http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement/statement.pdf
  - Consultation on licence-exempting cognitive devices using interleaved spectrum, Feb. 2009.
    - http://stakeholders.ofcom.org.uk/binaries/consultations/cognitive/summary/cognitive.pdf
  - Statement on licence-exempting cognitive devices using interleaved spectrum, July 2009.
    - http://stakeholders.ofcom.org.uk/binaries/consultations/cognitive/statement/statement.pdf
  - Geolocation for Cognitive access: A discussion on using geolocation to enable licence-exempt access to the interleaved spectrum, Nov. 2009.
    - http://stakeholders.ofcom.org.uk/binaries/consultations/cogaccess/summary/cogaccess.pdf
  - Implementing Geolocation Nov. 2010.
    - http://stakeholders.ofcom.org.uk/binaries/consultations/geolocation/summary/geolocation.pdf
  - Implementing Geolocation, Summary of consultation responses and next steps Sept. 2011.
    - http://stakeholders.ofcom.org.uk/binaries/consultations/geolocation/statement/statement.pdf

UK TV BAND

- White Space Channelization
  - 8 MHz
- Device classes
  - Master
  - Slave
- Primary Service Protection:
  - Geolocation database
  - The maximum transmit power is determined based on DTT protection levels ie the cognitive signal should be at least 33dB below the received DTT signal and -17 dB n +/-1, -34dB on n+/-2, -36dB on n+/-3, -52dB on N+/-4 through N+/-8 and -30dB on n+/-9. If PMSE (Microphones) 38dB co-channel and -55dB on n+/-1 adjacent channels

TV Channel No.	Frequency band (MHz)	TV Channel No.	Frequency band (MHz)	TV Channel No.	Frequency band (MHz)
21	470-478	37	598-606	53	726-734
22	478-486	38	606-614	54	734-742
23	486-494	39	614-622	55	742-750
24	494-502	40	622-630	56	750-758
25	502-510	41	630-638	57	758-766
26	510-518	42	638-646	58	766-774
27	518-526	43	646-654	59	774-782
28	526-534	44	654-662	60	782-790
29	534-542	45	662-670	61	790-798
30	542-550	46	670-678	62	798-806
31	550-558	47	678-686	63	806-814
32	558-566	48	686-694	64	814-822
33	566-574	49	694-720	65	822-830
34	574-582	50	702-710	66	830-838
35	582-590	51	710-718	67	838-846
36	590-598	52	718-726	68	846-854
				69	854-862

Red: Cleared channel, reserved for other services.

Green: Wireless microphone only

Blue: TVWS devices

Note: that this is the plan as of November 2010.

Types of Devices

- *Master devices* that contact a database to obtain a set of available frequencies in their area;
  - Device model number tells whether it has antennas mounted outdoor.
  - The master device will manage slave devices, maintain record of slave devices.
    - Manage by signalling to them the parameters by which they may communicate with the master device.

- *Slave devices* which obtain the relevant information from master devices but do not contact the database themselves
  - Obtain the list from the master device
  - Slave device transmits only to master devices
  - Ceasing transmission immediately when instructed by the master device or within 5 seconds of not receiving a response from the master device to a transmission

Communication Procedure

- The master device consult a list of databases.
- The master device then decides which database to use
- The master device provides the following information:
  - Location, locational accuracy, device type, antenna height, and other data
- The database returns the following information:
  - The frequencies of allowed operation, associated power levels, time validity of operation and other parameters (geographic validity of operation, requirement of sensing)
- The master device can then signal allowed frequencies and power levels to any slave device on its selected channels and the slave can respond with confirmation or data.

CEPT

- Status
  - Radio regulations: Technical and operational requirements published
  - Database: not available at the moment
  - Device certification: not available at the moment
- Documents
  - EUROPEAN COMMISSION: Mandate to CEPT on technical considerations regarding harmonization options for the digital dividend, 30 Jan 2007
  - CEPT Report 24: "Technical considerations regarding harmonization options for the Digital Dividend". A preliminary assessment of the feasibility of fitting new/future applications/services into non-harmonized spectrum of the digital dividend (namely the so-called "white spaces“ between allotments), 1 July 2008
  - ECC Report 159: “Technical and Operational Requirements for the Possible Operation of Cognitive Radio Systems in the White Spaces of the Frequency band 470-790 MHz, Jan 2011

CEPT TV BAND

- White Space Channelization
  - 470 MHz to 790 MHz
- Device classes
  - Master
  - Slave
- Primary Service Protection:
  - Geolocation
  - Sensing
    - Sensing only will not provide adequate protection to the broadcasting service, taking into account current technologies.

Types of Devices

- *Master devices*
  - Communicating with the associated slave devices.
  - Derive the location, with associated accuracy, of a slave device.
  - Act as a proxy for geolocation database queries towards the slave devices.
  - Control the operation of the slave devices in terms of which channels, bandwidths and what maximum transmit power they are allowed to use.
- *Slave devices*
  - Receiving, at a minimum, instructions on frequency allocation and the allowed maximum transmit power for each allocated frequency from the master device.
  - A slave device shall optionally also be able to communicate to the master devices, information on its location, its location accuracy, device type (including device identifier), etc.
  - A slave device unit shall not transmit within the 470-790 MHz band unless instructed to do so by the master device.

Communication Procedure

- General requirements for devices
  - Communicating its geographical location
  - Receiving from the database, at a minimum, information on frequencies that could be used by the device in its location.
  - Cease operation, if
    - it can not reconsult the database by the end of the validity period of the received frequency information,
    - it fails to monitor its location with the required accuracy,
    - it moves outside the determined area, for which the frequency information received from the database is valid.
- In the case of a master/slave device configuration, Master device should be capable of
  - Communicating with the associated slave devices.
  - Derive the location, with associated accuracy, of a slave devices
  - Act as a proxy for geo-location database queries towards the slave devices.
  - Control the operation of the slave devices in terms of which channels, bandwidths and what maximum transmit power they are allowed to use.

Summary

This document summarized status of USA, Canada, and UK regulatory domains in terms of allowing unlicensed TVWS usage

The frequency range is between 54 MHz to 782 MHz, and 470 MHz to 698 MHz is expected to be available in all three domains

All domains are expected to be focused on database access to allow TVWS usage supported by devices with geolocation capability

TVWS related studies are ongoing in Singapore, Japan, and ITU-R but current directions in these regulatory domains are not clear