Industry Canada Industrie Canada

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Spectrum Management and Telecommunications

Framework for the Use of Certain Non-broadcasting Applications in the Television Broadcasting Bands Below 698 MHz

Aussi disponible en français

Canada

Contents

1. Intent

Through the release of this paper, Industry Canada hereby announces the decisions resulting from the consultation process undertaken in *Canada Gazette* notice SMSE-012-11 — *Consultation on a Policy and Technical Framework for the Use of Non-Broadcasting Applications in the Television Broadcasting Bands Below 698 MHz*.

These decisions, announced in *Canada Gazette* notice SMSE-012-12, address the introduction of certain non-broadcasting applications in the television broadcasting bands below 698 MHz, specifically in the bands 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz.

2. Policy Objectives

The Minister of Industry, through the *Department of Industry Act*, the *Radiocommunication Act* and the *Radiocommunication Regulations*, with due regard to the objectives of the *Telecommunications Act*, is responsible for spectrum management in Canada. This responsibility includes developing national policies and goals for spectrum utilization, and ensuring effective management of the radio frequency spectrum resource.

In developing a framework to make additional spectrum available for increased use, Industry Canada takes into consideration the need to provide spectrum access for new services and technologies, including broadband, the impact of such a framework on all stakeholders and the *Spectrum Policy Framework for Canada* (SPFC). The SPFC objective is to maximize the economic and social benefits that Canadians derive from the use of the radio frequency spectrum.

In the 2010 Consultation Paper on a Digital Economy Strategy for Canada, entitled *Improving Canada's Digital Advantage: Strategies for Sustainable Prosperity*, under the pillar of "Building a World-Class Digital Infrastructure," access to spectrum was identified as one of the challenges facing Canada. By issuing this decision, Industry Canada is, in part, delivering on this commitment.

3. Abbreviations

The following abbreviations are used in this document.

BAS	broadcast auxiliary services
CPC	Client Procedures Circulars
CRTC	Canadian Radio-television and Telecommunications Commission
CTFA	*Canadian Table of Frequency Allocations*
DRAO	The Dominion Radio Astrophysical Observatory, located in Penticton, British Columbia
DTV	digital television
FCC	U.S. Federal Communications Commission
GHz	gigahertz (1 GHz = 10^9 hertz or a frequency of one billion cycles per second)

LPA	low-power apparatus (e.g. wireless microphones)
MHz	megahertz (1 MHz = 10^6 hertz or a frequency of one million cycles per second)
RABC	Radio Advisory Board of Canada
RRBS	remote rural broadband systems
RSS	Radio Standards Specifications
SRSP	Standard Radio System Plans
TV	television
TVWS	television white space(s)
Wi-Fi	Wireless Fidelity, an industry technical standard for wireless networking

4. Background

On August 27, 2011, Industry Canada released SMSE-012-11 — *Consultation on a Policy and Technical Framework for the Use of Non-Broadcasting Applications in the Television Broadcasting Bands Below 698 MHz*. In the consultation, Industry Canada sought comments on general considerations related to the use of non-broadcasting applications in the bands 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz.

The issues consulted upon include the introduction of licence-exempt TV white space (TVWS) devices; the regulatory framework for licensed remote rural broadband systems (RRBS); and the regulatory framework for licensed low-power apparatus (LPA), such as wireless microphones.

TVWS devices are designed to operate using unassigned TV channels without interfering with licensed broadcasters or other authorized wireless telecommunications licensees. These devices would operate on a no-protection, no-interference basis.

It is anticipated that these devices would be initially targeted toward consumers, as they could benefit from the availability of home wireless networks similar to Wi-Fi and also to service providers to offer access to Internet service by making use of wireless broadband equipment with improved range. In the longer term, white space technology also shows promise for machine-to-machine communications and has the potential to facilitate innovative products and services.

Comments were received[1] from 27 parties representing various industries, including TV broadcasters, TVWS proponents, cellular service providers, wireless device manufacturers, the Radio Advisory Board of Canada (RABC), research and development groups, wireless microphone industry and rural broadband service providers.

[1] Comments received can be found on Industry Canada's website.

5. Introduction of Television White Space Devices in Canada

In the consultation, Industry Canada proposed to allow TVWS devices in Canada. In response to the consultation paper, several general comments were received regarding their use. These comments primarily highlighted potential benefits of the introduction of this technology and some potential challenges.

5.1 Summary of Comments

- *Support for the use of TVWS devices.* All respondents, including broadcasters, support allowing the use of TVWS devices and a majority believes that the potential benefits are considerable. Broadcasters urge Industry Canada to adopt strong rules for prevention of interference.

- *Facilitating an economic and competitive environment*. Many respondents believe that TVWS devices would facilitate the introduction of improved, more economical wireless broadband and Internet services to consumers in areas that are currently unserved or underserved. This could foster a competitive market environment that would encourage further experimentation and innovation. This, in turn, could help to minimize deployment costs and enhance the provision of broadband services, which should lead to better Internet access and the availability of innovative consumer products and services.

- *Use for rural/sensor networks.* Respondents envisage the use of TVWS for applications such as rural broadband, wide-coverage hotspots, bridging between small networks, sensor networks and cellular off-loading, all of which would take advantage of these bands' superior propagation characteristics. The RABC believes that allowing TVWS use is an opportunity for Canada to expand wireless broadband services as a complement to RRBS.

- *Benefits to many sectors*. Many respondents note that the potential benefits of the various TVWS applications could apply to all levels of governmental organizations, education facilities, libraries, transportation services, local business enterprises and critical infrastructure entities.

- *Additional spectrum/Wi-Fi gap.* Some respondents believe that TVWS use will help to address the capacity and spectrum shortage challenges facing the wireless communications industry, and that using TVWS spectrum may help to off-load some traffic from the main mobile networks. According to these respondents, the world is facing an impending spectrum shortage of mobile broadband services, arising from the explosive growth in mobile communication. Some respondents believe that the use of TVWS will offer additional spectrum in the lower frequency bands and that its use may provide connectivity where off-loading using other bands, e.g. Wi-Fi at 2.4 GHz and 5.8 GHz, falls short.

- *Rapid proliferation/ensure protection.* Some respondents argue that the expected low cost of TVWS devices, which would be typical of mass-market licence-exempt devices, could facilitate rapid proliferation; therefore, compliance with protection limits for incumbent radio services will be essential.

- *Apprehension of moving too quickly/premature rules.* Not all respondents are convinced that Canada needs to move quickly on allowing TVWS for licence-exempt use. One respondent notes that using TVWS spectrum is not the same as using spectrum set aside for dedicated use for licence-exempt devices. Some respondents think that Industry Canada should closely monitor developments within the United States, especially when considering technical and standards harmonization, and that Industry Canada should only consider the introduction of TVWS devices after the technology has proven itself. In a similar vein, the RABC believes that Industry Canada should strive to preserve a variety of options for creating mobility in TVWS and that the Department should work closely with TVWS database administrators, devices manufacturers and incumbents to establish standards to ensure that harmful interference will not be caused to existing users. In particular Rogers believes that a conservative approach must be used when establishing such limits.

- *Mobile broadband transition anxiety.* Ericsson warns that if up to 120 MHz of spectrum is repurposed for mobile broadband spectrum in Canada, as is currently legislated in the United States, this spectrum would no longer be available for TVWS devices. As well, the remaining TV channels would be packed more closely together in the remaining broadcast spectrum and fewer geographical spots would be available for TVWS devices.

5.2 Discussion

The management of the radio frequency spectrum has traditionally been a centralized process, with the access to spectrum overseen by a regulatory body. However, as technology has progressed, methods allowing dynamic spectrum access have begun to be developed to improve spectrum efficiency. A shift away from conventional licensing approaches could lead to a more flexible, adaptive administrative environment by enabling opportunistic use of the radio frequency spectrum. Such techniques for the use of TVWS have the potential to improve spectrum efficiency while facilitating the introduction of new wireless communications applications in Canada.

Some respondents express some apprehension about the introduction of TVWS devices due to the potential for rapid proliferation, especially in the context of licence-exempt operation among licensed systems. On the other hand, appropriate technical requirements and the ability of these devices to adapt their operation in real time should ensure that incumbent users do not suffer harmful interference. Industry Canada believes that the regulatory approach described in this document will provide the necessary measures to address these concerns.

Industry Canada will also closely monitor international regulatory developments, and will make appropriate regulatory changes as further experience is gained. It is noted that TVWS rules in the United States have been finalized and remaining legal obstacles to related TVWS deployment have been resolved. The development of rules and regulations for TVWS use are also moving quickly in many other countries, including in the United Kingdom, where rules development is particularly advanced.

Despite the potential that repurposing of some TV spectrum below 698 MHz in the United States might lead to calls for similar action in Canada, Industry Canada does not see this as a reason to delay the introduction of TVWS devices. If Canada were to follow the United States, available spectrum would be reduced and fewer geographical areas would be available for the operation of TVWS devices. However, proponents have indicated their belief in the ongoing viability of TVWS use regardless of whether such changes take place.

It is expected that the introduction of the use of TVWS devices will enable the development of new techniques for managing the radio frequency spectrum while easing spectrum shortages and enabling more options for wireless broadband and Internet services for consumers.

Decision related to the introduction of TVWS devices:

Industry Canada will establish procedures and technical rules to permit the introduction of TVWS devices in Canada. These devices will be exempt from licensing and will operate on a no-interference, no-protection basis.

6. Television White Space Interference Prevention

The following sections discuss the approach that will apply to TVWS use to prevent interference to other spectrum users.

6.1 Use of Spectrum Sensing vs. Databases

Industry Canada consulted on approaches to provide interference protection for licensees in the TV bands where TVWS devices are used. These included the use of spectrum sensing and/or the use of geographic TV band databases.

Spectrum sensing is the capability to detect and prevent interference to received signals from other users sharing the spectrum above a determined threshold. An alternative approach uses a list of protected spectrum users, which is maintained in one or more central databases, combined with geo-location of the TVWS devices. The TVWS devices would automatically access these databases to determine what spectrum, if any, is available at its locations.

The consultation paper proposed that Industry Canada focus initially on the development of rules for the use of databases to ensure interference protection from TVWS devices.

6.1.1 Summary of Comments

Spectrum Sensing

- Most respondents believe that spectrum sensing technologies require further development. They are not convinced that spectrum sensing by itself is currently technically viable. For example, Shure is concerned that sensing techniques have not overcome problems associated with detecting receive-only stations and, although sensing has promise, an effective approach for detecting LPA has yet to be developed.

- Some respondents argue that spectrum sensing should be included in the proposal to allow better TVWS utility, especially in urban areas. They believe that spectrum sensing can improve indoor usage of TVWS whereas the use of a database may be challenging in an indoor environment.

Databases

- Many respondents support the proposal for databases.

- Some respondents, including wireless device manufacturers and the members of the RABC, suggest introducing interference management functionalities, through the use of databases, to provide protection between TVWS devices.

6.1.2 Discussion

Consistent with comments received, Industry Canada recognizes that the potential for spectrum sensing technology, either alone or used in conjunction with a geo-location licence information database, is quite promising. However, as most respondents mention, this technology is still in the developmental phase and key obstacles have not yet been resolved, including the inability to detect receive-only stations and to adequately protect LPA.

All respondents agree that the use of databases can provide effective interference protection to licensed incumbents within the same frequency band. Unlike sensing, the use of databases may allow the capability (i.e. through software changes to the databases) to respond to problems with equipment in the field without the need for a consumer recall. In the future, databases may add functionality, including the capability to manage interference between TVWS devices, but this would be outside the scope of Industry Canada's regulations.

Industry Canada is of the view that the use of databases will allow an immediate means to implement TVWS while addressing sharing and interference issues. Spectrum sensing or hybrid approaches using elements of both sensing and geo-location databases show promise for the future.

Decision related to databases and spectrum sensing:

Industry Canada will develop initial rules and regulations for TVWS devices based on the use of geo-location and a registration database system to manage harmful interference.

As spectrum sensing matures, Industry Canada will consider additional regulatory provisions for sensing technology through the technical rule development process under this decision.

6.2 Policies for the Establishment of Databases of Protected Canadian Systems

During the consultation, Industry Canada invited comments on provisions related to database performance and operation, including the development and operation of Canadian TVWS databases by the private sector.

6.2.1 Selection Process and Criteria

6.2.1.1 Summary of Comments

- Most respondents agree that databases should be developed and managed by third party private sector database administrators.

- Most respondents believe that third party database administrators should be selected based upon a competitive process. The RABC urges Industry Canada to consider authorizing multiple database administrators and to allow competition among administrators to ensure that the cost to access white space spectrum is reasonable and affordable.

- Axia NetMedia believes that it is important to ensure that there is no conflict of interest between the database administrators and the broadband service providers.

6.2.1.2 Discussion

Most respondents agree that databases should be developed and that they should be managed by third party private sector administrators.

Although most respondents believe that third party database administrators should be selected based upon a competitive process, this appears to be based on the assumption that Industry Canada would place limits on the number of possible administrators. However, experience in other countries has shown that multiple database administrators can operate at the same time without conflict and that the resulting increase in technical complexity would be minor. In addition, open entry of database administrators will foster the development of a competitive market for database services, which will mitigate many of the concerns that were expressed by respondents, including concerns about the potential for conflicts of interest or monopoly pricing. Such an approach would eliminate the need for Industry Canada to select winners and would allow for innovation among competing database administrators with alternative business models and added services. Evaluation of applicants against a common set of technical requirements will ensure protection of existing spectrum users. Consequently, Industry Canada will authorize any database administrators provided that they meet the appropriate regulatory requirements set out in this decision and the related technical rules.

Decision related to the criteria and selection process for database administrators:

Industry Canada will authorize the establishment of all TVWS database administrators that meet technical requirements. There will be no limit on the number of database administrators that can be authorized to provide service in Canada.

6.2.2 Regulatory Oversight

6.2.2.1 Summary of Comments

- Most respondents want Industry Canada to have strong regulatory oversight of the TVWS databases and believe that Industry Canada should maintain its equipment compliance role. Although respondents generally agree that technical certification of TVWS devices is necessary for their introduction into Canada, respondents do not believe that certification alone will provide sufficient regulatory oversight to control the operation of TVWS devices.

- The RABC supposes that leaving the management and operation of database services entirely to the private sector would create potential problems and believes that oversight by Industry Canada is therefore required.

- Shure believes that Industry Canada must play an active role in the oversight of TVWS databases, especially regarding information security, system reliability and regulatory compliance issues.

- Broadcasters urge Industry Canada to put effective regulatory measures in place prior to authorizing TVWS services in order to protect users and licensed services against excessive cost levies by database administrators.

- The RABC comments that the database administrators should be required to make appropriate updates to the databases in the event that interference is caused by TVWS devices.

- The Whitespace Regional Area Network Alliance (WRAN Alliance) believes that the databases should reside within Canada in order to ensure that regulatory requirements can be enforced.

6.2.2.2 Discussion

The clear majority of comments support Industry Canada maintaining strong regulatory oversight rather than indirectly regulating TVWS databases via the device certification process alone. The respondents have made a strong case and Industry Canada sees the benefit of such an approach. For this reason, the Department will approve TVWS database administrators for operation in Canada and will not rely solely on the certification process to ensure compliance with Industry Canada's rules. That said, as part of the certification process for TVWS devices, they will be required to demonstrate that, when operating in Canada, they communicate with databases that are approved by Industry Canada.

In order to be approved, TVWS database administrators will be required to sign an agreement with Industry Canada, which will list the regulatory requirements with which they must comply. These requirements will include provisions related to database administrator eligibility, security, reliability, authentication, synchronization, interface between database administrators and privacy. Database administrators will be required to demonstrate their compliance with these conditions in order to receive departmental approval. Industry Canada will develop these requirements and criteria in consultation with stakeholders.

Furthermore, in order to provide effective mechanisms to deal with potential interference, database administrators will be required to update their information system algorithms to account for any changes

to these criteria, and may be required to take action at Industry Canada's direction in cases of harmful radio interference. If a database administrator fails to comply with the terms of its agreement, Industry Canada may take measures up to and including revocation of the database administrator's approval until such time that the situation has been rectified to the satisfaction of the Department. Industry Canada believes that requiring databases to be hosted within Canada will help to ensure that these regulatory requirements can be enforced without limiting database administrators to Canadian companies. Database administrators indicate that this will not impose a burden on them.

Some respondents suggest that regulatory measures are needed to protect users and licensed services against excessive cost levies by database administrators. The protection of all licensed services, including collection of associated information, will be a fundamental requirement for a database administrator to receive approval. This would preclude charging a fee for a protected user to be listed in the database, but this would not rule out charging consumers for value-added services.

The existence of multiple database administrators will ensure that the cost to access the databases by TVWS devices is subject to competition. For this reason, Industry Canada has decided not to regulate fees set by database administrators to access their databases by TVWS devices.

Decision related to the regulatory oversight:

Industry Canada will develop requirements for TVWS databases through consultation with stakeholders.

Database administrators will be required to host the TVWS databases in Canada.

6.2.3 Security and Privacy

6.2.3.1 Summary of Comments

- Respondents see the need for reliable security measures, including authentication procedures between TVWS devices and databases, to minimize harmful or unauthorized intrusion or manipulation.

- Axia NetMedia urges strong measures to protect the security of information and the privacy of users. Axia NetMedia believes that, as a minimum, all transactions should be conducted through Secure Socket Layers or other means of authentication/encryption.

- Rogers supports stringent security regarding the contents and communications between the database and TVWS devices.

- All respondents agree that the databases will need to be developed in close cooperation with Industry Canada and that security, reliability and privacy issues will need to be addressed, especially as individual devices and their locations are registered.

- The Institute of Electrical and Electronics Engineers 802 Local Area Network / Metropolitan Area Network Standards Committee comments that security related issues be considered in the database implementation, including ensuring database availability, authorization to access, authentication, encryption, data integrity, non-repudiation, confidentiality and privacy. In addition, the committee believes that TVWS devices should be required to supply a certification of identity in order to be granted operational access by the certified database. This will ensure mutual authentication to avoid spoofing or denial of service attacks.

- The RABC believes that Industry Canada should require all information in the TVWS databases to be made publicly available by the database administrators.

6.2.3.2 Discussion

Industry Canada agrees with the comments received regarding the importance of adequate security measures to protect data and ensure reliable operation. Appropriate measures will be developed in consultation with stakeholders. Industry Canada also agrees with the RABC on the need to make publicly available the information of the stations to be protected.

Information regarding protected stations, including TV stations, cable TV head-ends, RRBS stations and licensed LPA requiring interference protection, will therefore be required to be made publicly available by the database administrators. This does not apply to information regarding TVWS devices or their locations.

Decision related to security and privacy:

Industry Canada will develop measures relating to security and privacy through its established processes, including consulting with stakeholders.

7. Television White Space Implementation

Comments were sought on several proposals regarding the technical provisions for TVWS devices in Canada, which included defining TVWS categories, identifying operating channels, protecting other services and developing general technical provisions for the operation of TVWS devices near the Canada-United States border.

7.1 Television White Space Categories

The consultation proposed the following definitions for TVWS service categories:

Fixed white space device: A white space device that transmits and/or receives radiocommunication signals at a specified fixed location. The fixed device selects radio frequency channels for operation from a list of available channels provided by a TV band database.

Mobile white space device: A white space device that transmits and/or receives radiocommunication signals while in motion or at unspecified fixed points.

- **Mode I mobile white space device:** A mobile white space device that does not use an internal geo-location capability and does not directly access a TV band database to obtain a list of available radio frequency channels. Mode I mobile devices may also be referred to as "slave" devices. A Mode I device must obtain a list of available channels on which it may operate from either a fixed device or a Mode II mobile device. A Mode I device does not initiate a network of white space devices or provide a list of available radio frequency channels to another Mode I device for use by such a device.

- **Mode II mobile white space device:** A mobile white space device that uses an internal geo-location capability and accesses a TV band database for a list of available radio frequency channels. Mode II devices may also be referred to as "master" devices. Access to the database may be through a direct connection to the Internet or through an indirect connection via another fixed or Mode II white space device. A Mode II device may provide its list of available radio frequency channels to another mobile device for use by that device.

7.1.1 Summary of Comments

- Not all respondents comment on the TVWS categories. Of those who do, most respondents suggest harmonization with the U.S. definitions.

- Nokia does not believe that device implementation or innovation should be bound or restricted by predefined device categories.

- Neul does not see a need to distinguish between fixed and mobile devices, but prefers the convention used in the United Kingdom of having two classes: a "master" and a "slave."

- Some respondents are not clear on the use of the term "mobile" in the proposed definitions and sought clarification regarding its meaning. Shure and the WRAN Alliance recommend that Industry Canada use the term "personal/portable" rather than mobile, as it may allude to a TVWS device moving at vehicular speeds. Devices moving at high speeds would not be able to update through databases quickly enough to avoid interfering with other users. Also, high-speed mobile operations are particularly problematic for wireless microphones that may be operating in/near mobile TVWS devices.

7.1.2 Discussion

Industry Canada agrees with the majority of respondents that the definitions of the categories of TVWS devices should be generally harmonized with those in the United States. Although this terminology would be different from that used in the United Kingdom, the proposed definitions make an explicit link to the "master" and "slave" nomenclature.

In response to concerns about the use of the term "mobile" in the proposed definitions, it should be noted that this term does not imply that vehicular operation will be permitted. Vehicular operation would be precluded in practice by the need to reconfirm available channels when a device is moved regardless

of whether the term "mobile" is used in these definitions. Nomadic and transportable operations are permitted under this definition of mobile TVWS devices.

The final wording of these category definitions will be determined following the release of this decision during the development of the technical standard. This will allow for an opportunity for improvements to the originally proposed wording. In addition, this will ease future updates if required, and will ensure that these category definitions do not restrict the potential for future innovation.

Decision related to TVWS categories:

Industry Canada will generally harmonize with the U.S. definitions of TVWS categories, with the exact wording to be determined by Industry Canada through its established processes, including consultation with stakeholders.

7.2 Operating Channels

With some restrictions, the consultation proposed that TVWS devices be permitted to operate on available channels throughout the TV broadcasting bands below 698 MHz. In order to prevent harmful interference, TVWS devices would not be permitted to operate on TV channel 37, which is used by medical telemetry devices and radio astronomy operations at the Dominion Radio Astrophysical Observatory (DRAO) in Penticton, British Columbia.

The consultation also noted that TVWS devices in the United States are subject to additional restrictions on operating channels, depending on whether a fixed or mobile TVWS device is being used.[2]

7.2.1 Summary of Comments

- Respondents generally agree with the proposal to broadly harmonize available operating channels for fixed and mobile TVWS devices with the United States, as well as the proposed operating channel restrictions.

- Some RABC members suggest that Industry Canada consider allowing the operation of mobile TVWS devices on any available channels, including below TV channel 21. In their opinion, the geo-location and database query approach will provide adequate interference protection without the need for additional restrictions. Other RABC members believe that mobile devices should not be permitted below channel 21.

- Motorola also requests that Industry Canada not restrict the use of mobile TVWS devices below TV channel 21. This rule was developed to protect public safety and commercial land mobile radio systems on TV channels 14 to 20, which only exist in the United States.

[2] For instance, in the United States, mobile white space devices are limited to operating only on available channels above 512 MHz (i.e. TV channels 21-36 and 38-51) and operation of fixed white space devices may not be permitted on TV channels 3 and 4 (band 60-72 MHz) given that those channels are heavily used by consumer electronic devices.

- The RABC and broadcasters recommend that channels 3 and 4 in which consumer electronic devices operate, along with channel 37 in which medical telemetry and radio astronomy operate, be explicitly identified in any future documents as prohibited channels for any form of TVWS devices in Canada due to significant risk of interference.

- Rogers comments that TVWS devices should not be permitted to operate on TV channels 2 to 20, 37 or 51. TVWS devices should be prohibited in channels 2 to 13 in particular because VHF TV receivers are more susceptible to interference from electronic devices than UHF TV receivers.

- Neul does not see a need to restrict access to channels according to device type and prefers the approach taken in the United Kingdom to allow use on output power levels, both in-band and out-of-band, to be determined dynamically on a case-by-case basis, rather than in a static manner through predefined channel restrictions.

- Shure feels that mobile TVWS devices should not be permitted to operate below channel 21, that there should be no fixed operation on channels adjacent to broadcast stations and that no operation of TVWS devices should be permitted on channel 37. Allowing only fixed TVWS operation on certain channels would ease sharing with LPA such as wireless microphones, as it would be easier to plan around the relatively static environment associated with fixed TVWS operation.

- Ericsson recommends that Industry Canada consider possible ways to mitigate or minimize the potential interference on channel 51 to avoid adjacent channel interference. Rogers proposes that licensed commercial mobile above TV channel 51 be protected from TVWS devices by limiting the power in channel 51 and adopting rules for minimum distances from commercial mobile base stations.

7.2.2 Discussion

A majority of respondents support harmonization with U.S. rules, including a restriction that mobile TVWS devices only be allowed to operate on TV channel 21 and above. Although there are some comments that propose either greater or lesser restrictions, Industry Canada believes that the advantages of such harmonization by providing a common market for equipment with its resulting benefits for equipment cost and availability outweigh the stated concerns.

Industry Canada agrees with respondents that the heavy use of TV channels 3 and 4 by consumer electronic devices and the risk of harmful interference to those devices from TVWS devices warrant a restriction from operation on these channels, as the United States has also concluded. Radio astronomy observations on TV channel 37 are limited to a single location in Canada and could be protected through the TVWS databases. However, licence-exempt wireless medical telemetry operating on TV channel 37 is used throughout Canada and therefore also warrants a restriction on TVWS operation on this channel, similar to the restriction in the United States.

As the proposed transmitted power for TVWS will be much lower compared to that of the commercial mobile service, the likelihood of adjacent channel interference from TVWS devices will also be lower than the likelihood of interference from adjacent mobile systems. As such, Industry Canada will not restrict TVWS devices from using TV channel 51; however, technical measures for mitigation of adjacent band interference may be considered during the development of technical rules if sufficient technical justification is provided.

Decision to set operating channels:

Industry Canada will broadly harmonize with the U.S. rules regarding channels available to fixed and mobile TVWS devices. Detailed rules will be developed regarding available operating channels for different categories of TVWS devices using Industry Canada's established processes, including consultation with stakeholders.

7.3 Protection of TV Broadcasting

TV broadcasting in Canada has transitioned from an analog to a digital signal format in CRTC-defined mandatory markets; however, there may be continued analog TV broadcasting operations outside these areas. For this reason, protection criteria for both analog and digital TV broadcasting were proposed.

The consultation paper noted that the United Kingdom has proposed a different approach for interference protection from that used in the United States. Rather than specify minimum separation distances as the U.S. has done, the United Kingdom has proposed that TVWS devices in the United Kingdom continuously adjust their transmitter power levels under database control to ensure that TV broadcast interference protection requirements are met. This approach allows for TVWS devices to access additional spectrum at the cost of a significant increase in computational and regulatory complexity.

Comments were sought on the interference protection criteria proposed for TV broadcasting operations to ensure the protection of over-the-air TV broadcasting services. Comments were also sought on whether provisions should be made for TVWS devices using power control to have additional flexibility in selecting frequencies, as in the United Kingdom.

7.3.1 Summary of Comments

Protection Criteria for TV Broadcasting

- All respondents agree with the need to protect broadcasting reception and that the proposed criteria would be adequate. The RABC notes that protection is needed for the full range of broadcasting system types, including full power stations, low-power stations, very low-power stations and receive stations (i.e. cable TV head-ends and TV translator receive sites).

- Rogers is also of the view that certain TV receivers, such as cable television head-ends, could be protected beyond the edge of a TV service contour by registering those receivers in the databases.

Power Control vs. Separation Distance

- Some respondents believe that the U.K. approach should be considered, as it could enable the development of a wider range of devices and applications. They also believe that the U.K. approach will enable access to more white space than the U.S. approach without increasing the risk of interference to broadcasting reception, and that the U.S. approach is too restrictive.

- Nokia notes that flexible power control will benefit TVWS devices in that it will allow operation in additional areas where reduced transmit power is required in order to prevent interference.

- Other respondents prefer the U.S. approach. For example, the RABC prefers commonality with the United States, even though power control may prove useful in the United Kingdom, where TV transmitters are much more tightly packed in order to serve a denser population. In their view, the currently wider geographic TV spacings employed in Canada may not require such measures. Some wireless manufacturers and research and development entities also recommend the harmonization of TVWS technical rules with the United States.

7.3.2 Discussion

Although there is agreement on the need to protect TV broadcasting reception, opinions are divided on whether the U.S. or U.K. approach would be best. More respondents prefer the U.S. approach for reasons of harmonization and all agree that it would provide sufficient protection for TV broadcasting reception. However, there is agreement that flexible power control as in the U.K. approach has significant potential to improve spectral efficiency.

Industry Canada notes that, because of differences in TV broadcasting regulation, the United Kingdom's flexible power control approach would require extensive technical work to be adapted for use in North America. For instance, North American TV coverage areas are specified based on a particular broadcast signal strength whereas in the United Kingdom, TV broadcast coverage areas are specified on a statistical basis taking into account the fact that the locations of all TV sets in the United Kingdom are known due to a legal requirement in these for TV sets to have a licence. For these reasons, the adoption of this approach in Canada would require extensive technical reworking that would likely result in significant delays in the availability of TVWS devices in this country.

Industry Canada will adopt protection criteria to protect the full range of broadcasting systems from harmful interference from TVWS devices as part of its technical rule development. This will include consideration of the possibility to register certain TV receiver stations, such as cable television head-ends, outside of the TV service contour.

In general, for reasons of harmonization and timing, the initial protection criteria will be based on broadcasting service coverage contours and defined separation distances that are harmonized with the United States. That said, Industry Canada will monitor developments in the United Kingdom and will consider updates to its technical rules once experience is gained with the United Kingdom's flexible power control approach. In any case, North American harmonization will remain an important goal.

Decision related to the interference protection criteria for TV broadcasting operations:

Detailed interference protection criteria, based on the full range of analog and digital TV transmitters, will be developed in accordance with Industry Canada's established processes, including consultation with stakeholders.

7.4 Protection of Radio Astronomy

In the consultation paper, Industry Canada proposes to adopt provisions to protect radio astronomy operations from the potential for interference from TVWS devices. In Canada, the only location at which radio astronomy observations are made is the DRAO in Penticton, British Columbia.

7.4.1 Summary of Comments

The comments received unanimously agree that the radio astronomy service should be protected from harmful interference caused by TVWS devices.

7.4.2 Discussion

Industry Canada agrees with the need to protect radio astronomy observations at DRAO, which provide an important contribution to scientific research in Canada. Although TVWS devices will be restricted from operating on TV channel 37, on which most of these observations are made, the high level of sensitivity of the receivers used at DRAO makes them extremely sensitive to radio emissions throughout the TV bands, and not just on TV channel 37. Therefore, in line with past decisions, Industry Canada will adopt provisions through its technical rules for the protection of observations at the DRAO site from TVWS devices operating in nearby channels.

Decision related to the protection of radio astronomy:

Detailed provisions to protect radio astronomy observations made by the DRAO in Penticton, British Columbia, will be developed in accordance with Industry Canada's established process, including consultation with stakeholders.

7.5 Technical Parameters

Industry Canada sought comments on the technical parameters for TVWS devices, noting that these parameters would be developed in more detail following future decisions.

7.5.1 Summary of Comments

- Most respondents believe that technical parameters should generally be harmonized with those in the United States; however, some respondents suggest that harmonization with the United Kingdom would be preferable. Some additional TVWS proponents suggest that Industry Canada should be technology neutral.

- Broadcasters propose that TVWS fixed device transmitter power output should be limited to 1 watt maximum.

- The Institute of Electrical and Electronics Engineers 802 Local Area Network / Metropolitan Area Network Standards Committee believes that the location accuracy should be verified during certification of a TVWS device.

7.5.2 Discussion

Harmonizing technical parameters with those of the United States will promote a common market for TVWS equipment, with resulting benefits for equipment cost and availability. For this reason, Industry Canada will broadly harmonize its technical rules for TVWS devices with those of the United States, including areas such as transmitter power limits, location accuracy, minimum frequency of database checks and cessation of operation rules if a TVWS device cannot make contact with an approved database. As part of the technical rule development process, Industry Canada will consider proposals for technical variations should sufficient justification be provided and on the condition that broad harmonization is maintained. As is normal practice, any technical provisions that are specified in Industry Canada's rules will be subject to testing and certification.

It is expected that TVWS device technology will continue to improve. As such, Industry Canada expects to revisit and update the technical rules for TVWS devices as needed to reflect these improvements.

Decision related to technical parameters:

Detailed technical rules will be established using Industry Canada's established processes, including consultation with stakeholders.

7.6 Out-of-Band Emissions

Comments were sought on appropriate limits for out-of-band radio emissions of TVWS devices. This included comments on whether Industry Canada should include the use of flexible out-of-band emission masks similar to those expected to be implemented in the United Kingdom, or if it would be better for Canada to harmonize with the U.S. approach by specifying a fixed emission mask.

7.6.1 Summary of Comments

- Opinions are divided with regard to the approach on the out-of-band emissions. Some respondents prefer the United Kingdom's adaptable approach and others prefer the U.S. approach. Most TVWS proponents and Axia NetMedia note that the United Kingdom's approach provides additional flexibility; however, they acknowledge that the registration databases could support either type of approach.

- Shure comments that wireless microphones have proved to be more susceptible than TV receivers to the out-of-band emissions generated by first adjacent channel TVWS devices, and relaxing the mask would therefore be unacceptable. Along with Shure, Rogers and Motorola believe that deviating from the U.S. approach would stymie the development of TVWS devices and recommended harmonization of the TVWS technical rules with the United States.

7.6.2 Discussion

Comments are evenly split between the U.S. and U.K. approaches as to which would be best in terms of harmonization, interference protection and cost implications. All respondents agree that the U.S.

approach could be implemented and would provide adequate interference protection for other radio services. However, many respondents also believe that this mask might be unduly restrictive and that more flexibility could be permitted without an undue increase in interference risk through the inclusion of compensatory measures in the database protection algorithms.

Industry Canada notes that concerns have been expressed on whether the United Kingdom's approach could be implemented without increasing the risk of interference to adjacent channel systems.

Industry Canada will specify criteria for out-of-band emissions as part of its development of technical rules. For reasons of harmonization and interference risk, the initial emission masks will be harmonized with U.S. rules. Once again, Industry Canada will continue to monitor developments in the United Kingdom and elsewhere, and may consider updates to its technical rules once experience is gained showing that there is no increased interference risk due to the United Kingdom's use of multiple emission masks. In any case, North American harmonization will remain an important goal.

Decision related to the out-of-band emissions:

Industry Canada will initially harmonize its out-of-band emission masks and adjacent frequency protection criteria with the United States. The detailed technical standards will be developed in accordance with Industry Canada's established processes, including consulting with stakeholders.

7.7 Cross-border Protection

The use of the broadcasting spectrum is covered by the *Agreement Between the Government of Canada and the Government of the United States of America Relating to the TV Broadcasting Service and the Associated Working Arrangement*, the *Letter of Understanding*, which covers the areas within 400 km of the border, and the *Interim Agreement Between Canada and the United States Concerning Digital Television (DTV)*. The Letter of Understanding does not deal with non-broadcasting system use of the broadcast spectrum. Regardless, non-broadcasting use within 400 km of the Canada-United States border must be on a no-protection, no-interference basis with respect to broadcast services in both Canada and the United States. As well, Industry Canada currently enforces a mandatory 121 km border distance within which RRBS stations are not permitted to operate until such time as a new bilateral agreement is reached.

Comments were sought on Industry Canada's proposal to protect U.S. stations operating near the Canada-United States border by including these stations in the Canadian TVWS databases, thereby ensuring the protection of these stations to the same level as stations in Canada.

7.7.1 Summary of Comments

- Comments received support Industry Canada's proposal to use the same protection criteria that will be applied in Canada, which will require Canadian TVWS devices to protect active U.S. broadcasting stations within the United States.

- Shure and RIM both recommend that Industry Canada work with the United States to ensure that TVWS devices near the Canada-United States border are coordinated with LPA and other incumbent services requiring appropriate protection from interference from TVWS devices radiating across the border.

- Some broadcasters agree that the bilateral protection measures mentioned in the consultation should suffice until such time as there is a need to reopen existing agreements or create new ones covering specific unlicensed uses in both countries, as TVWS users will receive equal treatment on both sides of the border.

- Rogers notes that if Canadian TVWS device rules are more stringent than the U.S. rules and the databases are interconnected, then U.S. licensees will be protected adequately.

7.7.2 Discussion

There were no objections to Industry Canada's proposal for the protection of U.S. TV broadcasting reception in the vicinity of the Canada-United States border. The proposed measures mirror current provisions in the United States for the protection of Canadian TV reception near the border. There is no need to provide protection to TV allotments that are not currently in use in the other country, as the database update process will automatically provide this protection as new stations are brought on the air in the other country.

As per its normal practice, Industry Canada will continue to work with the U.S. Federal Communications Commission (FCC) to implement cross-border protection measures for TV broadcasting reception, LPA and RRBS stations. To the extent possible, Industry Canada will work with the FCC and stakeholders to encourage the development of measures to simplify operation of all services using TV broadcasting spectrum in the border area, for example, through the development of common registration processes.

Decision related to cross-border protection:

Industry Canada will require Canadian TVWS devices to protect active U.S. broadcasting operations based on the same protection criteria as will be applied to broadcasting operations within Canada.

8. Remote Rural Broadband Systems

Remote rural broadband systems (RRBS) provide wireless service in remote rural communities in Canada, using TV channels that are unallotted and unassigned. Unlike TVWS devices, these systems are technically evaluated by Industry Canada before they can receive a licence, in order to prevent harmful interference to other spectrum users, in particular, TV broadcasters. RRBS are licensed on a no-protection, no-interference basis in relation to the TV broadcasting service, and must not constrain the provision of existing or future broadcasting services.

The technical rules for RRBS equipment provide for higher transmitter power levels than for TVWS devices. In addition, no spectrum sensing or database access is required. Protection to other radio services from harmful interference is provided through departmental evaluation during the licensing process. Because of the constraints of the evaluation process, RRBS are limited to fixed station operation only.

Comments were sought on the potential for improvements to the framework for RRBS, including the possibility of phasing out licensed RRBS in favour of licence-exempt TVWS devices, with existing deployed RRBS being grandfathered. The consultation proposed that if this phasing out were to occur, TVWS devices could be permitted under database control to use higher power levels when in remote rural areas in order to prevent a gap in capability between the new licence-exempt TVWS devices and the currently licensed RRBS in those locations.

8.1 Summary of Comments

- TVWS proponents have no concerns about including RRBS in their databases so that they can be protected from harmful interference.

- The WRAN Alliance agrees with Industry Canada's proposal to phase out RRBS.

- TELUS believes that RRBS seem to already address the needs that TVWS devices are proposing, and therefore encourages Industry Canada to take a "wait-and-see" approach with respect to the introduction of TVWS devices until a proof of concept is demonstrated and there is a viable commercial rollout, while continuing to license RRBS in the meantime.

- Shure is concerned that if higher powered TVWS devices are permitted as an alternative to RRBS, they may interfere with wireless microphones at a range of many kilometres. Shure comments that if higher power levels are needed in rural areas, it would be preferable that this be done in a licensed manner as currently done with RRBS.

- No comments were received from RRBS operators; however, Axia NetMedia believes that the status of RRBS should not change and that Industry Canada should continue to issue and renew RRBS licences under the current rules.

8.2 Discussion

The consultation paper proposed to gradually phase out RRBS in the belief that TVWS devices, which are expected to be built for a mass market, would become a less expensive alternative for providing broadband connectivity in remote rural areas and that this would make up for the loss of certainty associated with the current licensing process for RRBS.

Many respondents to the consultation do not agree with this conclusion and argue persuasively regarding the continued importance of RRBS and that RRBS could successfully operate in parallel with TVWS devices. Industry Canada will therefore continue to issue and renew licences for RRBS for the time being. Industry Canada may revisit this decision if there are changes in the future to available TV broadcast spectrum below 698 MHz.

Incumbent licensees of RRBS will be protected from harmful interference caused by TVWS devices, and Industry Canada will adopt protection criteria for RRBS from TVWS devices by using existing RRBS-to-RRBS protection criteria as a starting point for discussion.

Decision related to the potential improvements to the framework for RRBS:

Industry Canada will continue to license RRBS.

Protection criteria will be determined through Industry Canada's established processes, including consultation with stakeholders.

9. Low-Power Apparatus, Including Wireless Microphones

Industry Canada consulted on the use of LPA, including wireless microphones. More specifically, it consulted on:

- the appropriate authorization mechanism, including options related to licensed or licence-exempt use;
- whether Industry Canada should identify specific spectrum for use by LPA; if so, how much should be identified; and if the operation of licence-exempt LPA should be restricted to this spectrum;
- the proposal to collect specific "time and location of use" data based on voluntary registration in order to obtain the necessary level of detail of information to provide protection from TVWS devices and on the proposal that eligibility to register for such protection be open to all users of LPA rather than to certain user communities only; and
- the appropriate protection criteria to protect LPA from interference from TVWS devices.

9.1 Summary of Comments

- Almost all respondents support allowing licence-exempt operation of LPA on a no-protection, no-interference basis, but with the option for users to apply for a licence in exchange for interference protection from TVWS devices.
- Neul would prefer that separate rules for LPA be phased out, noting that TVWS devices can provide the same functionality currently provided by LPA. The RABC comments that the status quo, where all LPA users require licences, is untenable because most users do not apply for licences and Industry Canada has had no effective way of policing compliance. Shure urges Industry Canada to implement LPA reforms with a view to developing a licence framework for LPA that would streamline the licensing process.
- Most respondents support exclusively allocating two TV broadcast channels in each market as "safe haven" channels for LPA in which no TVWS device operation is permitted.

- Most TVWS proponents believe that the registration database could accommodate all options for LPA under discussion.

- Axia NetMedia believes that the cost of collecting time and location of use data will be far more than the value of the data collected, and thus does not believe that it is required. RIM suggests that the time and location of use would need to be defined as part of the LPA operation registration and that devices operating outside the "safe haven" channels should be registered for the times and locations that will actually be used. RIM suggests that the registration be subject to a daily renewal.

9.2 Discussion

Respondents generally agree on the need for a change to the current situation in which a licence is required for use of any LPA. Almost all respondents prefer the option to allow LPA on a licence-exempt basis, but with the option to apply for a licence in cases where the operator determines that enhanced communication reliability is required (e.g. when recording TV programs). This would provide protection from harmful interference from TVWS devices by including such licensed LPA in the TVWS databases.

Although some comments suggest that LPA become TVWS devices themselves, the TVWS technology would not allow for cases where reliable LPA operation is needed.

Therefore, based on the comments received, Industry Canada will implement provisions for licence-exemption of LPA while continuing to allow LPA operators to apply for a licence under the existing process where the operator determines that enhanced reliability is required.

Licence-exempt use of LPA will not be included in the TVWS database and will not receive protection from TVWS devices. This approach will introduce a small risk of interference; however, this risk will be compensated by the lack of fees and administrative process. Industry Canada anticipates that this option will be the favoured one for most of the LPA operators who are currently operating without a licence.

Industry Canada anticipates that most current LPA licensees will desire enhanced reliability and will therefore retain their licences. However, given that some LPA licensees receive broad geographic authority, or may only operate intermittently, more data than is currently collected during radio licensing may be needed in order to be able to protect these systems from TVWS device interference at the correct time and location. Therefore, licensed LPA operators will be asked to provide information on the exact timing and location of their operations with the TVWS databases. The details of how this will be done will be the subject of detailed rule development through Industry Canada's established processes following the publication of this decision.

Database administrators will not be permitted to charge fees for registration of licensed LPA, and they will be required to share data on protected LPA to ensure interference protection from any TVWS devices, regardless of the TVWS database with which they are registering.

TVWS devices are not protected from LPA interference regardless of whether or not the LPA is licensed.

The consultation also suggested setting aside up to two TV channels in each market in order to provide a "safe haven" from TVWS devices for LPA operation. The set-aside approach, which was supported by almost all respondents, would have been harmonized with the United States. However, Industry Canada notes that legislation has since been passed in the United States mandating an incentive auction process for the possible repurposing of some of the UHF TV broadcast spectrum for mobile broadband systems.

Until such time that the spectrum environment within the United States in the frequency ranges below 698 MHz has stabilized, it would be premature to set aside channels for LPA in Canada, knowing that it may be necessary to make changes. In addition, Industry Canada notes that there is no eligibility restriction on the licensing of LPA in Canada, unlike in the United States. As a result of the easier availability of licensing as a protective measure from TVWS, there is not the same need in Canada to designate "safe haven" channels for LPA. Therefore, Industry Canada will not designate any "safe haven" channels for LPA at this time.

Decision related to the licensing option for LPA:

Industry Canada will allow LPA on both a voluntary licensed and licence-exempt basis. Operators of licensed LPA will be asked to register their operation with the TVWS databases in order to receive protection from harmful interference from TVWS devices.

Industry Canada will update its detailed rules for LPA through its established processes, including consulting with stakeholders.

10. Changes to the Canadian Table of Frequency Allocations

Allocating frequencies is an important step in developing spectrum utilization policies that foster the implementation of new radiocommunication services. Modifications to the *Canadian Table of Frequency Allocations* (CTFA) are intended to reflect the public interest by introducing new wireless services that benefit Canadians and that respond to marketplace demands.

In previous sections of this document, several decisions are presented in regard to the licensing of LPA, the introduction of licence-exempt TVWS devices and the continued use of RRBS.

Comments were sought on proposed changes to the CTFA to reflect the licensed use of RRBS and LPA.

10.1 Summary of Comments

- Few respondents commented on the proposed allocation changes, but of those respondents who did so, most are comfortable with the proposed changes to the CTFA.

- Some respondents suggest creating a mobile co-primary allocation in the band 470-698 MHz in order to lay the groundwork for possible future uses of this spectrum.

- RIM suggests that the RRBS footnote be revised to indicate that only existing RRBS in operation will be protected and to specify that as of a certain date, no new RRBS will be authorized based upon the possibility of grandfathering RRBS.

10.2 Discussion

There is no need for an allocation in the CTFA to reflect the introduction of TVWS devices or to reflect any licence-exempt use, including licence-exempt LPA. Industry Canada also notes that footnotes 5.293 and 5.297 introduce primary allocations to both the mobile and fixed services in the bands 470-608 MHz and 614-698 MHz in Canada.

Because footnotes 5.293 and 5.297 already provide a fixed allocation for the spectrum used by RRBS, Industry Canada concludes that no changes are needed to the CFTA to reflect the existing use of RRBS.

In the case of LPA, Industry Canada notes that licensed LPA has been in operation under the existing allocations to the broadcasting service. Industry Canada therefore also concludes that no changes are needed to reflect the use of this spectrum by licensed LPA.

Decision related to the changes to the CTFA:

Industry Canada will not make any changes to the CTFA.

11. Next Steps

As a minimum, the following regulatory and technical documents will need to be developed or revised in light of the decisions:

TVWS devices and databases:

- a new Radio Standard Specification (RSS) for certification of TVWS devices;
- TVWS database requirements document; and
- a procedure document for becoming a TVWS database administrator, including the associated agreement.

LPA:

- Revisions to RSS-123, *Licensed Low-Power Radio Apparatus*, and a new RSS for licence-exempt LPA; and
- CPC-2-1-11, *Low-power Licensed Apparatus*

Ongoing review and revisions are also planned for any related documents as experience is gained in Canada and in other countries. Industry Canada may relax or tighten the technical requirements based on this experience.

These documents will be developed or revised using Industry Canada's established processes, including consultation with stakeholders, which typically takes place via the RABC.

The decisions in this paper authorizing the use of TVWS will not go into effect until the above steps are completed.[3]

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Marc Dupuis
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[3] Developmental licences are available in the interim; if interested, please contact Industry Canada. For contact information, see RIC-66, *Addresses and Telephone Numbers of Regional and District Offices* (http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01742.html).