

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of

Unlicensed Operation in the TV Broadcast
Bands

ET Docket No. 04-186

Additional Spectrum for Unlicensed
Devices Below 900 MHz and in the 3 GHz
Band

ET Docket No. 02-380

COMMENTS OF MOTOROLA, INC.

Steve B. Sharkey
Director, Spectrum and Standards
Strategy

Robert D. Kubik
Director, Telecom Relations Global

Motorola, Inc.
1455 Pennsylvania Avenue, NW
Suite 900
Washington, DC 20004
TEL: 202.371.6900

January 31, 2007

Table of Contents

Summary	i
I. Background and summary	2
II. TV White Space FOR Public Safety AND Other critical Operations.	8
A. TV Channels 14-20	9
B. Public Safety Priority Access.....	13
III. Spectrum Access Methods.....	16
IV. Operation of personal/portable devices	22
V. Conclusion.....	24
Appendix.....	A-1

Summary

Motorola supports the FCC's general approach to promote use of the TV broadcast bands by unlicensed devices on most of the spectrum occupied by channels below TV channel 52 because it believes that reasonable technical rules can be developed to minimize interference to incumbent operations. The spectrum made available as a result of the Commission's action will be beneficial for a variety of commercial and non-commercial broadband services and is uniquely appropriate for service in rural areas. Motorola believes, however, that the FCC should adopt policies that will enhance the usefulness and availability of this spectrum for devices and applications that meet the needs of public safety agencies and other critical uses. Such applications will serve as a useful supplement for mission critical systems operated in dedicated licensed spectrum allocations.

Motorola appreciates and supports the Commission's decision to prohibit portable unlicensed devices on TV channels 14-20 in order to protect public safety operations that share this spectrum in 13 markets across the country. Because the interference impact to emergency responders could have disastrous consequences, Motorola agrees with the Commission's fundamental view that unlicensed use of the 470-512 MHz band should not be allowed until the technology to ensure proper protection of incumbent public safety licensees has been fully developed, tested and proven.

Motorola recommends, however, that the Commission consider allowing some limited and controlled use of the 470-512 MHz band by low powered devices in order for public safety and other critical users (and the industry that serves them) to gain more experience and understanding of the application of cognitive radio equipment in that environment. More specifically, Motorola recommends that the Commission allow public safety agencies and other critical users to deploy fixed and personal/portable low power devices within the 470-512 MHz band that are consistent with the technical standards established in this proceeding on a nationwide basis. As further experience with the technology is applied, the Commission can review whether these eligibility restrictions continue to be warranted.

Such use of the 470-512 MHz band should be controlled and monitored. Operations would not be unlicensed but would be authorized “by rule” in the same manner that the FCC authorizes police departments to use radiolocation speed determining devices (“radar guns”) without having to apply for a new license. In order to protect incumbent land mobile uses in the 470-512 MHz band, Motorola recommends the establishment of 145 kilometer exclusion zones around the 13 markets that use these frequencies for land mobile services. This is only a modest expansion of the FCC’s initial proposal to adopt exclusion zones of 134 kilometers.

In addition to establishing 470-512 MHz for public safety low powered devices, the Commission should also consider adopting priority access requirements for devices that operate in other portions of the TV spectrum to help ensure that public safety and other critical users have adequate spectrum capacity. More specifically, Motorola recommends that public safety

and other critical users be provided unconditional priority access to two VHF and two UHF channels from TV channels 7-25. In addition, during emergency situations, public safety and other critical users should have the ability to preempt users on other channels with this range if necessary to meet critical communications requirements.

Motorola previously stated that it is premature to rely on spectrum sensing as a spectrum access method because of the difficulties involved in implementing sensing technology in this environment and continues to recommend that database and location information should be the final source for determination on whether or not to transmit. While Motorola believes that cognitive radios will inherently have sensing capabilities for determining which candidate channels provide the best communications opportunities, it is not clear at this time whether those capabilities can be used for independent identification and protection of licensed incumbents.

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of

Unlicensed Operation in the TV Broadcast
Bands

ET Docket No. 04-186

Additional Spectrum for Unlicensed
Devices Below 900 MHz and in the 3 GHz
Band

ET Docket No. 02-380

COMMENTS OF MOTOROLA, INC.

On October 18, 2006, the Federal Communications Commission (“Commission” or “FCC”) released a First Report and Order and Further Notice of Proposed Rule Making in the above-captioned proceeding that addresses the use of low-powered unlicensed devices to operate on vacant channels in the spectrum allocated for television broadcast service.¹ Motorola, Inc. (“Motorola”) respectfully submits these comments in response to the issues raised in the Further Notice.

In general, Motorola supports the Commission’s approach to promote use of the TV broadcast bands by unlicensed devices on most of the spectrum occupied by channels below channel 52 because of its belief that reasonable technical rules can be developed to minimize interference to incumbent operations. The spectrum made available as a result of the Commission’s action will be beneficial for a variety of commercial and non-commercial

¹ See FCC 06-156, rel. October 18, 2006, (“Further Notice” or “First R&O”).

broadband services and is uniquely appropriate for service in rural areas. Motorola believes, however, that the FCC should adopt policies that will enhance the usefulness and availability of this spectrum for devices and applications that meet the needs of public safety agencies and other critical uses. Such applications will serve as a useful supplement for mission critical systems operated in dedicated licensed spectrum allocations.²

I. BACKGROUND AND SUMMARY.

This proceeding was initiated to promote more efficient and effective use of the spectrum allocated for television broadcast service by allowing for the development and deployment of new types of unlicensed broadband devices and services for businesses and consumers.³ In developing its initial proposals, the Commission noted that there is significant bandwidth available in the TV bands because multiple 6 MHz wide channels are generally vacant or unused in any particular area.⁴ To ensure that no harmful interference to authorized users of the spectrum will occur, the Commission proposed to require that unlicensed devices operating on these vacant channels comply with significant restrictions and technical protections, including the incorporation of any number of a variety of “smart radio” or cognitive features to identify the vacant spectrum in the area where the unlicensed devices are located on a dynamic basis.⁵ With

² Motorola emphasizes that although TV white space spectrum offers the potential to serve a variety of public safety and other critical use applications, its availability will not lessen the need for adequate spectrum allocations for licensed mission critical operations.

³ See FCC 04-133, rel. May 25, 2004, (“Notice”) at ¶ 1.

⁴ *Id.* at ¶ 6. Unused spectrum in the TV broadcast service is commonly referred to as “TV white space”.

⁵ *Id.* at ¶ 2.

such protections, the Commission stated that unlicensed use of this spectrum could result in significant benefits for consumers and economic development for businesses by providing additional competition in the broadband market.⁶

In its comments submitted in response to the initial Notice, Motorola agreed that it would be technically feasible to have low-power unlicensed devices share spectrum with incumbent broadcasters without causing harmful interference to TV reception.⁷ However, Motorola expressed concern about unlicensed operation in TV spectrum that is currently shared by commercial and public safety land mobile operations. Motorola argued against unlicensed use of this shared spectrum until protection mechanisms that ensure interference-free unlicensed transmissions to mobile facilities are proven reliable.⁸ Specifically, Motorola recommended against permitting unlicensed operations on TV channels 14-20 (470-512 MHz) that are already available for shared use by public safety and other critical land mobile services and TV channels 52-69 (698-806 MHz) that have been reallocated to public safety, commercial wireless and band manager services.

The First R&O adopted in October of 2006 focused on the larger policy issues addressed by the original Notice. It adopted the general policy to allow the operation of fixed low power devices on most TV channels beginning on February 18, 2009, in areas where those frequencies

⁶ *Id.* at ¶ 1.

⁷ *See* Comments of Motorola, Inc., ET Docket No. 04-186, filed Nov. 30, 2004, at 2.

⁸ *Id.* at 5, 6.

are not being used for TV or other incumbent licensed services.⁹ Exempted from this general decision were TV channel 37, which is used by radio astronomy and wireless medical telemetry devices, and the reallocated TV channels 52-69. The First R&O did not allow any unlicensed operations (fixed or personal/portable) on these channels. Further, consistent with Motorola's recommendations, the First R&O prohibited the use of unlicensed personal/portable devices on TV channels 14-20 due to the difficulties of coordinating unlicensed use with mobile services.¹⁰

The Further Notice was adopted concurrently with the First R&O. In this phase of this proceeding, the Commission seeks additional technical analyses to determine the answers to the following fundamental questions:

- 1) Can personal/portable devices operate in the TV broadcast band without causing harmful interference?¹¹
- 2) Should fixed unlicensed devices be permitted to operate on TV Channels 14-20 in the 13 cities where these channels are used by public safety and other mobile services?¹²
- 3) Should low power devices authorized to operate in the TV band be permitted only on a licensed, rather than an unlicensed, basis or should there be a hybrid licensing scheme?¹³

The Further Notice also requests further comment on the methods that low power devices may use to determine whether a portion of the TV band is unused at a specific time and location.

Specifically, the Commission seeks additional comment on the technical viability of the

⁹ First R&O at ¶ 2.

¹⁰ *Id.* at ¶ 21.

¹¹ Further Notice at ¶ 3.

¹² *Id.* at ¶ 56.

¹³ *Id.* at ¶ 26.

following three methods while offering specific technical proposals to implement these techniques:

Spectrum Sensing Approach: An unlicensed device could have sensing capabilities incorporated into its equipment to detect whether other transmitters are operating in an area.¹⁴

Geo-location/Database Approach: The location of an unlicensed device is established by a professional installer or by the device itself using geo-location technology such as GPS incorporated within the device. It could then be determined from either a local internal or remote external database whether the unlicensed device is located far enough outside the protected service contours of licensed television stations to avoid causing harmful interference.¹⁵

Control Signal Approach: An unlicensed device could receive information transmitted from an external source such as a broadcast station or another unlicensed transmitter indicating which channels are available at its geographic location.¹⁶

Motorola supports the Commission's efforts to expand the effective use of the TV broadcast spectrum by promoting the deployment of unlicensed and/or registered devices that are capable of operating on a non-interfering basis. The success of this policy, however, is dependent on the development and performance of spectrum access methods that help ensure that unlicensed devices operate only where protected incumbent facilities are not located. In this regard, Motorola has been actively participating in the leading IEEE cognitive radio and coexistence standardization venues including IEEE 802.22, IEEE P1900 and the SDR Forum.¹⁷

¹⁴ *Id.* at ¶ 33.

¹⁵ *Id.* at ¶ 49.

¹⁶ *Id.* at ¶ 52.

¹⁷ The IEEE 802.22 working group of the IEEE 802 LAN/MAN standards committee is formally developing "Standard for Wireless Regional Area Networks (WRAN) - Specific requirements - Part 22: Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Policies and procedures for operation in the TV Bands" and focuses on constructing a consistent, national fixed point-to-multipoint WRAN that will utilize

In IEEE 802.22, Motorola has been instrumental in the drafting of the 802.22 baseline standard for fixed point to multipoint wireless broadband access in the TV white space. Motorola is also taking a leading role in the discussions in IEEE 802.22.1, a Task Group of IEEE 802.22, to draft a disabling beacon standard that offers enhanced protection to licensed and protected devices and services. To proactively address the critical need for proper, professional installation of fixed access base stations, Motorola participates as the vice-chair of Task Group IEEE 802.22.2, established to create a Recommended Practice for installation of TV white space devices. In IEEE P1900, Motorola chairs the Task Group work that is developing methods and standards for the use of cognitive radio technology to select from among many standards available on a multi frequency, multimode wireless network. In the SDR Forum, Motorola holds leadership positions in the development of software defined radio technologies for advanced radio technologies. Motorola believes that the diverse standards venues are needed to solve the myriad of complex technological issues to make innovative services in the TV white space a reality.

(Continued)

UHF/VHF TV bands. The IEEE P1900 Standards Group was established in the first quarter 2005 jointly by the IEEE Communications Society and the IEEE Electromagnetic Compatibility Society. The objective is to develop supporting standards dealing with new technologies and techniques being developed for next generation radio and advanced spectrum management. The Software Defined Radio (SDR) Forum is a non-profit organization comprised of approximately 100 corporations from around the globe dedicated to promoting the development, deployment and use of software defined radio technologies for advanced wireless systems.

In these comments, Motorola augments its previously filed comments in this proceeding including updated analysis and recommendations on each of the spectrum access methods discussed in the Further Notice. Motorola intends to provide additional information to the FCC as work in the various IEEE forums described above progresses.

Motorola believes that the TV white space spectrum will be valuable for a variety of both commercial and non-commercial uses and that the ability to use this spectrum for unlicensed and registered devices while fully protecting services with higher regulatory priority will advance and improve over time. At this nascent stage of development, however, Motorola believes that it is appropriate for the Commission to proceed with some caution so that future opportunities are not diminished by haphazard early deployments.

Motorola recommends that the Commission adopt special provisions that would enhance the utility of TV white space spectrum for use by public safety and other critical users. For example, until the capabilities of spectrum access methods are fully proven, the Commission should limit the availability of TV white space on channels 14-20 to public safety and other critical user organizations. Such low-powered use should be coordinated and authorized “by rule” as opposed to individually licensing users or allowing for Part 15 unlicensed uses. This approach would be consistent with the First R&O’s decision to prohibit unlicensed use of these channels. In addition, the Commission should consider adopting rules for pre-emptive access for public safety and other critical users over some portion of the TV band to ensure adequate

spectrum capabilities during emergency response situations. These issues are more fully discussed below.

II. TV WHITE SPACE FOR PUBLIC SAFETY AND OTHER CRITICAL OPERATIONS.

Motorola believes that this proceeding offers opportunities for the development of technologies that can support and augment existing licensed public safety operations in the VHF and UHF portions of the spectrum. While unlicensed devices are not suitable substitutes for mission critical licensed systems, the TV white space spectrum will likely serve as a useful supplement for public safety and other critical users, particularly for data transmissions, as cognitive technology develops and matures. Such data operations could complement existing VHF or UHF voice systems at an incident scene, a nuclear power plant, a water treatment plant, a petroleum refinery or a transportation depot facility, which are all high risk targets for breaches of homeland security.¹⁸

The unique nature of broadcast television as a one-way service with a relatively stable environment allows for shared use in ways that fully protect the priority users of the spectrum by using properly designed cognitive equipment. These same conditions or opportunities do not necessarily apply, however, in bands that are widely used for mobile services. Accordingly, it should not be assumed that sharing techniques used in the TV band can be easily imported into

¹⁸ While not all of the communications at these facilities are officially defined as public safety under the Commission's rules, Motorola believes they are nonetheless critical, especially given potential manmade or natural disasters and possible terrorist attacks. Disruption of the nation's or even a region's power, water supply, source of petroleum or transportation/delivery could potentially cripple the economy and have devastating effects on the public.

other bands for sharing with other services.¹⁹ Motorola believes, however, that sharing can be successful in the TV white space and that the Commission should consider policies that would further promote the development and deployment of these technologies for public safety and other critical users within the TV white space spectrum. To this end, Motorola offers the following two recommendations.

A. TV Channels 14-20.

In general, public safety and other critical users are wary about using unlicensed devices for mission critical applications in a band that is also available to commercial and consumer users because of the potential for unintended interference especially during times of emergency. This concern was the principal reason behind the FCC's allocation of spectrum in the 4.9 GHz band for public safety uses despite the commercial availability of similar spectrum bands at 2.4 GHz and 5 GHz bands.²⁰ Motorola believes that the Commission has a similar opportunity to satisfy some of the requirements of public safety and other critical users in the TV white space without adversely affecting the commercial and consumer markets.

¹⁹ Also, the nature of the primary use of the band must be considered. For example, the impact of interference would be significantly more devastating if it occurs to public safety communications as opposed to bands used for non-safety of life applications. Accordingly, proposals to allow cognitive radio devices to operate in dedicated public safety spectrum as proposed in other Commission proceedings should be approached with extreme caution. *See* FCC No. 06-181, rel. December 22, 2006 (“9th NPRM in WT No. Docket 96-86”).

²⁰ *See* FCC 02-47, rel. February 27, 2002 (“4.9 GHz Allocation Order”).

In the First R&O, the Commission disallowed use of unlicensed personal/portable devices on TV channels 14-20 principally to protect two-way communications systems operating in 13 markets across the county. The Further Notice seeks comment on whether this spectrum should be opened to unlicensed fixed use.

Motorola appreciates and supports the Commission's decision to prohibit portable devices in the 470-512 MHz band in order to protect public safety operations. To date, much of the discussion and focus of the technical work in this proceeding has been directed at protecting broadcast operations and little, if any, work has been done to ensure that public safety, business, industrial and commercial mobile operations on channels 14-20 will be protected from potential interference. Because the interference impact to emergency responders could have disastrous consequences, Motorola agrees with the Commission's fundamental view that unlicensed use of the 470-512 MHz band should not be allowed until the technology to ensure proper protection of incumbent public safety licensees has been fully developed, tested and proven.

Motorola believes, however, that this decision presents an opportunity for public safety and other critical users. Motorola recommends that the Commission consider allowing some limited and controlled use of the 470-512 MHz band by low powered devices to help meet the needs of public safety and other critical uses. This would also allow public safety and other critical users, and the industry that serves them, to gain experience and understanding of the application of cognitive radio equipment in that environment. More specifically, Motorola recommends that the Commission allow public safety agencies and other critical users to deploy

fixed and personal/portable low power devices within the 470-512 MHz band that are consistent with the technical standards established in this proceeding on a nationwide basis. Such devices will be required to rely on appropriate mechanisms that ensure interference protection to incumbent broadcast and land mobile services. This will contribute valuable information on the capabilities and requirements of spectrum access methods, such as control signal beacons. As further experience with the technology is applied, the Commission can review whether these eligibility restrictions continue to be warranted.²¹

Use of the 470-512 MHz band by public safety and other critical users should be controlled and monitored. While Motorola does not recommend individually licensing users and agencies for these devices given the relatively low power allowed, users should be required to register and coordinate unlicensed use with an appropriate Commission frequency coordinating committee. Also, similar to the authorization “by rule” of radiolocation speed determining devices (“radar guns”), authority to operate these low-powered devices can be provided through the entity’s general land mobile license.²² This approach would be consistent with the

²¹ Motorola notes that out-of-band emissions from low-power devices operating on channel 14 could interfere with incumbent land mobile base receivers operating immediately below 470 MHz. For low power/unlicensed devices operating within 100 meters of a land mobile base receiver, the radiated emission limits of 47 C.F.R. § 15.209 exceed the current protection levels described in 47 C.F.R. § 73.687(e) that are applicable to a TV transmitter operating on TV channel 14. Based on typical performance parameters of land mobile systems operating below 470 MHz, the received level of Part 15 emissions could exceed land mobile base receiver noise floor and degrade performance up to 0.5 km for conventional land mobile operations and 1.5 km for trunked land mobile operations. There is similar interference potential into Federal land mobile operations below TV channel 7 (174 MHz). The FCC should consider ways to protect these adjacent band land mobile systems from such interference.

²² See 47 C.F.R. § 90.20(f)(4) of the FCC’s Rules.

Commissions decision in the First Report and Order to prohibit unlicensed portable use on these channels.

Allowing even limited use of 470-512 MHz for low-power devices requires the establishment of exclusion zones around public safety and other mobile system operations similar to Commission provisions for protecting TV operations. Developing the appropriate zones for the 13 affected markets²³ requires certain assumptions about the maximum technical parameters (*e.g.*, power spectral density and antenna heights) that would be applicable to the low-powered/unlicensed transmitters. More specifically, this task requires that the Commission: 1) define a power spectral density limit relevant to narrow band victim receivers, 2) consider antenna height and terrain variations, and 3) consider an interference level of 21 dBu/25 kHz. As shown in the attached appendix, Motorola recommends that the Commission proscribe in its rules a power spectral density of 8 dBm/3 kHz bandwidth, which is consistent with existing Part 15 rules.²⁴ This yields an exclusion zone of approximately 15 kilometers beyond the 130 km land mobile operational zone.²⁵ Motorola therefore recommends that the FCC adopt a 145 kilometer

²³ See 47 C.F.R. § 90.303 of the FCC's Rules.

²⁴ See 47 C.F.R. §§ 15.247(a)(2), 15.247(a)(3) and 15.247(e) of the FCC's Rules.

²⁵ Under Section 90.305 of the FCC's Rules, land mobile base stations operating on TV channels 14-20 may not be located more than 50 miles from the cities' specified geographic coordinates, and mobile stations must be within 30 miles of their associated base station yielding an effective 80 mile (approximately 130 km) operational area for land mobile systems.

exclusion zone around the 13 markets where land mobile services are able to access frequencies in the 470-512 MHz band on a licensed basis.²⁶

B. Public Safety and Critical User Priority Access.

In addition to establishing 470-512 MHz for public safety low powered devices, the Commission should also consider adopting priority access requirements for devices that operate in other portions of the TV spectrum to help ensure that public safety and other critical users have adequate spectrum capacity. As explained in more detail below, public safety and other critical users should be provided unconditional priority access to two VHF and two UHF channels in TV channels 7-25. In addition, during emergency situations, public safety and other critical users should have the ability to preempt users on other channels with this range if necessary to meet critical communications requirements.

Aside from channels 14-20, most of this TV band spectrum should be available with the least amount of constraints possible to encourage rapid deployment of lower priced applications and provide adequate protection of incumbents.²⁷ Though cognitive techniques offer flexibility, there are significant advantages to allowing public safety and other critical uses unconditional preemption for some channels. Providing public safety and other critical users with priority

²⁶ Systems that have been authorized by waiver to operate beyond the normal 80 mile limit would also need to be protected with incrementally larger protection zones.

²⁷ Beyond the obvious issues of protecting the authorized incumbents, it will be important to manage the co-existence of multiple users in the same channels. Given the propagation characteristics and large coverage areas of UHF signals, the potential for multiple applications simultaneously using the same white space in the same area requires some contention management techniques.

access to two VHF and two UHF channels on a routine basis when channels 14-20 are not available would help ensure reliable access to spectrum. When not needed by priority users, these four channels would be available for use by other commercial or consumer uses.

In emergencies, public safety and other critical users should also have priority access to additional channels below TV channel 26 to meet requirements in time of crisis. Examination of spectrum availability in a post-DTV transition environment shows that there are a number of places in the country where only minimal channels within 14-20 would be accessible by public safety and other critical users. Therefore, Motorola believes that priority access to two additional VHF and two additional UHF channels below Channel 26 and, where not used for full power digital TV would be critical to serving these needs, with expanded priority to channels below TV channel 26 during emergencies.

Access to additional channels in this range will integrate well with existing public safety and other critical uses of spectrum. Typically, VHF and UHF spectrum is used by smaller public safety agencies and other critical operations for its large coverage area and its ability to support unit to unit voice communications over significant distances and through many obstructions such as buildings and dense trees. Large cities, such as New York, LA and Chicago depend on UHF for enhanced in-building penetration and States such as Virginia, Alaska, and Vermont depend on VHF for coverage over wide areas of rugged terrain. Other public safety and other critical users also deploy systems on VHF and UHF spectrum to the extent that any capacity is available. Unfortunately all too often there is insufficient spectrum to fully meet the communications needs

of these entities. TV white space spectrum would provide these public safety and critical users supplemental options for data at VHF and UHF and would be complementary to actions to deploy data systems in 700 MHz and above.

Cognitive equipment designed for public safety and other critical uses should be capable of operating on any channel within TV channels 7-25. This will assist public safety and other critical users in deploying products capable of utilizing any of the channels that might be available in a given area without the need for multiple radios. To this end, Motorola recommends that devices operating in the TV white space support the ability for public safety and other critical users to pre-empt non-critical users, when necessary, on channels 7-25. Devices operating on TV channels 26-51 would not have this restraint, but devices that work below channel 26 should be required to support the monitoring necessary to be pre-empted.²⁸

In summary, Motorola believes that Public Safety and other critical users should have exclusive access to TV channels 14-20 for low powered devices and priority access to two additional VHF and two additional UHF channels from channels 7-25. Given the flexibility of the technology necessary to make effective use of TV white space spectrum, we believe this is a workable approach for public safety and other critical users as well as commercial/consumer operations. As experience is gained and products improved, it may be desirable to redefine these proposed preemption requirements in the future. Given the flexibility of cognitive radios,

²⁸ Motorola supports the use of disabling beacons to implement this recommendation. See pages 18-19, *infra*.

redefining established pre-emption priorities should not require equipment modifications or trade-out.²⁹

III. SPECTRUM ACCESS METHODS.

The Further Notice seeks additional comment on three methods for enabling interference free operation in the TV white space spectrum: geolocation and database lookup, beacons or control signals, and spectrum sensing. With regard to the use of geolocation and database lookup approaches, the Further Notice seeks specific comment on the development, maintenance, and availability of a comprehensive database of all TV and other incumbent stations. The Commission asks whether third-party providers are willing and able to maintain such a database and also on the parameters that should be included in the database. The Commission also seeks comment on the technical requirements for relying on the geolocation/database approach, including the appropriate method of geo-location (GPS, professional installation, or other method) and for determining the required separation from authorized users in the TV bands.

As for the use of control signals to regulate device transmissions, the Further Notice notes that many of the same issues surrounding the development of a database for geolocation techniques also apply to use of the control signals. However, the Further Notice also seeks comment on the format and content of the control signal and asks how beacons can protect other

²⁹ The FCC could require devices operating in channels 7-25 to have over-the-air programming technology to enable this flexibility although it is possible that market forces might obviate the need for regulation.

authorized services, such as wireless microphones, whose location may not be included in the databases.

In previously filed comments, Motorola supported the use of beacons and geolocation database lookup techniques to avoid interference to incumbent users and offered specific recommendations for the implementation of these techniques.³⁰ Motorola recommended that the Commission specify location accuracy rather than mandate use of a particular location technology such as GPS to encourage innovation in the field of location technology. In addition, channel availability information sent by control signals to fixed and handheld units must be in a standard format and include a validity period for which the channel is available. The device must also include fail-safe methods to cease operation if the control signal or database information cannot be updated or accessed. Finally, Motorola noted that third party providers of vacant channel information (e.g., a frequency coordinator, industry association, local broadcast group) should be held liable for the accuracy of location data.

With regard to spectrum sensing, the Commission has stated that its experience with Dynamic Frequency Selection (DFS) implemented in the 5 GHz U-NII rules leads it to believe that similar spectrum sensing rules can be applied to TV band devices. The Further Notice provides extensive discussion and numerous proposals for appropriate spectrum sensing rules for TV band devices including proposed rules for the appropriate detection threshold, channel

³⁰ *See*, n. 6 *supra*.

availability check time, move time and non-occupancy period, bandwidth and antenna considerations and other issues.

Motorola previously stated that it is premature to rely on such methods because of the difficulties involved in implementing sensing technology in this environment and continues to recommend that database and location information should be the final source for determination on whether or not to transmit. While Motorola believes that cognitive radios will inherently have sensing capabilities for determining which candidate channels provide the best communications opportunities, it is not clear at this time whether those capabilities can be used for independent identification and protection of licensed incumbents.

As the Commission moves forward in its studies and evaluation of techniques to open the TV white space it must consider the interaction between sensing techniques and how it corresponds to information contained in their database. Issues include defining which information source may have precedence, what measures to take if a TV signal is sensed and is not part of the database, how frequently the database needs to be accessed if sensing is employed, and measures to take if the database could not be accessed. Particularly in the early stages of this effort, the Commission should proceed conservatively to ensure protection of incumbent services and users.

For some licensed or other protected users, a static database is not practical. For example, some wireless microphone usage can be predictable and hence protected via the database (*e.g.*, studios, sporting events, political conventions). Some uses such as news gathering are not as predictable and difficult to protect via a static database. For this problem, Motorola sees three possible solutions:

Sensing the licensed or otherwise protected user. Sensing alone can be difficult. When considering lower power operations, identification of that signal is even more difficult. For a wireless microphone, any detection from a discrete spectral line (dead-air mike) to nearly 200 kHz bandwidth may be considered a microphone. Even if a microphone could be positively identified by observing changes in spectral patterns, it could not be determined with certainty whether it was a legitimate and protected Part 74 usage.

A dynamic database. This must be updated by the license holder and checked by the unlicensed operator on a regular basis.

A disabling beacon. This signal would need to be demodulated by the TV band device and not simply sensed in order to maximize spectrum availability for unlicensed use. This beacon should contain pertinent database information, have recourse from interference, and have the authority to serve as a proxy for the license holder. Thus, it should be licensed and authenticable.

For protection of wireless microphones and other transient protected devices, Motorola recommends the use of a disabling beacon. The beacon should be licensed in the same class as the protected deployment, and should have information pertaining to the protected deployment, including deployment location coordinates, an identification (MAC address or call-sign), frequency/time usage information, and protected contour size. The control signal could originate either from the protected deployment location or a nearby location that would still enclose the deployment within the announced protected contour. Motorola recommends that this beacon be required for TV band devices in a limited number of channels, in addition to those required to

enable public safety and other critical users, to protect these operations and codified in Commission rules.³¹

While the Commission is the regulatory authority for maintaining accurate and timely information on licensed television transmitters, distribution of database information can be done through a third party. Necessary database information includes complete information on TV transmitter location ERP, HAAT, RCAGL, FCC service code, license status, and call sign. The current format available on the FCC's web site (at <http://www.fcc.gov/mb/audio/tvq.html>) is appropriate, but is lacking in completeness of the data (*e.g.*, some ERP, HAAT, RCAGL and license status values are missing or otherwise inaccurate). Accordingly, the Commission's database records would either need to be updated or some other means for providing reliable and accurate information would need to be established.

Rules should be codified as to which licenses to consider (*e.g.*, licensed, construction permit, etc.) for interference calculations, and officially accepted contour levels for the multiple FCC service codes should be centralized to ensure that consistent calculations are performed by various equipment providers. In order to maintain consistent radio operation across various equipment providers, mutually agreed upon propagation formulas, similar to the FCC CURVES program, should be utilized.³² Optionally, a universally accepted format, machine readable

³¹ Motorola notes that manufacturers of wireless audio microphones and in-ear monitoring systems like Shure, Inc. have participated in this proceeding and we look forward to further comments as how their use of the band can continue as TV white space is opened.

³² *Available at* <http://www.fcc.gov/mb/audio/bickel/curves.html>.

database of official contour maps should be maintained by the Commission or an entity designated by the Commission. Such requirements will help ensure consistency in defining service contours and provide a high level of certainty about where radios are permitted to operate in the TV white space.

As previously discussed, Motorola notes that this spectrum offers additional options for first and second responders in large, widespread emergencies/disasters. The cognitive technology to be used in this spectrum can have the ability to take advantage of spectrum as it becomes available, provided that the database information is updated in a timely fashion. For example, if a catastrophic event disables television broadcast facilities in an area, similar to what happened in Louisiana after Hurricane Katrina, the database should be updated to reflect this and allow the cognitive radios to access this spectrum until such time as the broadcast facility is repaired. Having public safety use these devices as part of their normal communications equipment will help ensure that they are well positioned to maximize the potential benefits in times of wide-spread emergency or disaster. Applications such as unit-to-unit (without infrastructure) streaming video can be very useful in analyzing an incident scene, yet requires significant bandwidth which could be made available in this spectrum. The significantly larger coverage area of VHF and UHF spectrum compared to higher frequencies increases the utility of these devices in devastated areas where fixed infrastructure may be sporadic or damaged.

IV. OPERATION OF PERSONAL/PORTABLE DEVICES

The Further Notice seeks additional comment on whether usage of personal/portable devices should be allowed in the TV bands and the means by which personal/portable devices can operate without causing interference to authorized users.

Motorola, in general, supports the use of personal/portable devices in the TV bands. Use of personal/portable devices in the TV bands offers an opportunity to support and augment existing public safety services. For example, it would be possible to use unused TV channels to create a video link between a police cruiser and an officer in a building or other location remote to the police cruiser and obstructed from line-of-sight operation. Another example where public safety could benefit would be at a disaster site, where a site-wide broadband system could be installed more simply and with better coverage than could be achieved with existing technologies at higher frequencies. In both of these examples, the propagation and penetration of TV band signals acts to enable new services.³³

Motorola believes that significant commercial applications could also be enabled by operation of personal/portable devices in the TV white space. In addition to the benefits noted above for public safety and other critical users the consumer market applications include streaming of multimedia signals in the home and on-site video for security in home and

³³ Because of favorable propagation characteristics, one example is the use of vacant TV channels to provide precise personnel positioning in a portable device for First Responders and Public safety.

commercial venues. In these applications, the propagation and penetration properties of TV band signals acts to enable and simplify services.³⁴

The Commission requested comment on means by which personal/portable devices could detect protected users in the TV bands. Motorola believes that spectral sensing, while promising, has not yet been demonstrated to be sufficiently robust to be used as an exclusive means of recognizing and avoiding interference with protected incumbents in the TV band.³⁵ A system employing spectral sensing in combination with some form of geolocation or database look-up appears to be necessary to insure protection of authorized licensed users. Rules regarding spectral sensing could be relaxed at a later date as the technology becomes more proven.

For the special case of networks of personal portable devices connected to outlets of a commercial cable TV system for the purpose of multimedia streaming in the home, Motorola believes that it may be practical to infer location and TV channel availability from control information provided on the cable TV feed. Motorola suggests that the FCC consider this as an alternative to other, more general schemes for interference avoidance.

³⁴ As previously discussed, Motorola believes that TV channels 14-20 should be limited to public safety use rather than general unlicensed devices.

³⁵ As the Commission evaluates how best to enable spectrum sensing some pertinent documents for consideration include the “802.22 Key Sensing Task Checklist” *available at* http://grouper.ieee.org/groups/802/22/Meeting_documents/2006_Oct/22-06-0183-01-0000-Key-Spectrum-Sensing-Tasks.doc and the “802.22 Sensing Test Plan” *available at* http://grouper.ieee.org/groups/802/22/Meeting_documents/2007_Jan/22-06-0202-01-0000_Sensing_Test_Plan.doc.

V. CONCLUSION.

Use of the TV white space spectrum for low powered devices will provide the opportunity to serve a variety of commercial and public safety related communications requirements. However, the FCC should proceed in a cautious manner at this point in time given the nascent state of spectrum sensing techniques and other spectrum access methods that must be refined to ensure interference protection to incumbent and protected facilities. As products are improved and new cognitive techniques are developed, the FCC can possibly expand its policies to make even more effective use of spectrum allocated to the TV broadcast services. For now, the Commission should focus on policies that enhance the usability of this spectrum for public safety and other critical use applications consistent with the recommendations contained herein.

Respectfully Submitted,

Respectfully submitted,

By: /s/ Steve B. Sharkey

Steve B. Sharkey

Director, Spectrum and Standards Strategy

Robert D. Kubik

Director, Telecom Relations Global

Motorola, Inc.

1455 Pennsylvania Avenue, NW

Suite 900

Washington, DC 20004

TEL: 202.371.6953

January 31, 2007

Appendix

Operation of low power data devices on TV channels 14-20 requires the protection of licensed land mobile radio (“LMR”) facilities that are operational in 13 markets across the country. Such protection should be established through “exclusion zones” surrounding the relevant cities where use of low power devices would not be permitted. The derivation of exclusion zones necessary to protect public safety and other LMR narrowband receivers requires that one consider the undesired signal’s power spectral density, antenna heights and terrain in the path loss estimation.

The size of the exclusion zone depends upon the power falling within the bandwidth of the victim receiver and on the power spectral density of the interferer. While maximum transmit power output and EIRP have been defined (1 watt and 4 watts, respectively), the bandwidth over which the unlicensed signal is spread is not clearly defined.

The exclusion zone size can be calculated for different power spectral densities. Figure 1 plots the required exclusion zone beyond the nominal 130 km radius for 4 W EIRP over bandwidths of 25 kHz, 250 kHz, 1.25 MHz, 2.5 MHz, and 5 MHz for 10 m antenna height consumer premises equipment and 2 m height narrowband LMR receivers. An omni-directional unlicensed transmitter antenna pattern was assumed. These results were generated using the NTIA irregular terrain propagation model (*available at* <http://ntiacsd.ntia.doc.gov/msam/ITM/itm.htm>). The parameters that were used to calculate these results are shown in Table I.

Tx antenna height	10 m	Rx antenna height	2 m
Frequency	500 MHz	Polarization	Vertical
Tx site criteria	Very careful	Rx site criteria	Random
Delta H	0, 30, 60, or 90 m	Surface refract.	301 N-units
Dielectric const.	15	Ground conduct.	.005 S/m
Radio Climate	Continental Temp.	% Confidence	50
% Time	10	% Location	50
Distance	[variable]	Mode	Broadcast

Table I. Parameters used for calculation of exclusion zones for various power spectral densities. ‘Very careful’ Tx antenna siting was used to give more conservative results.

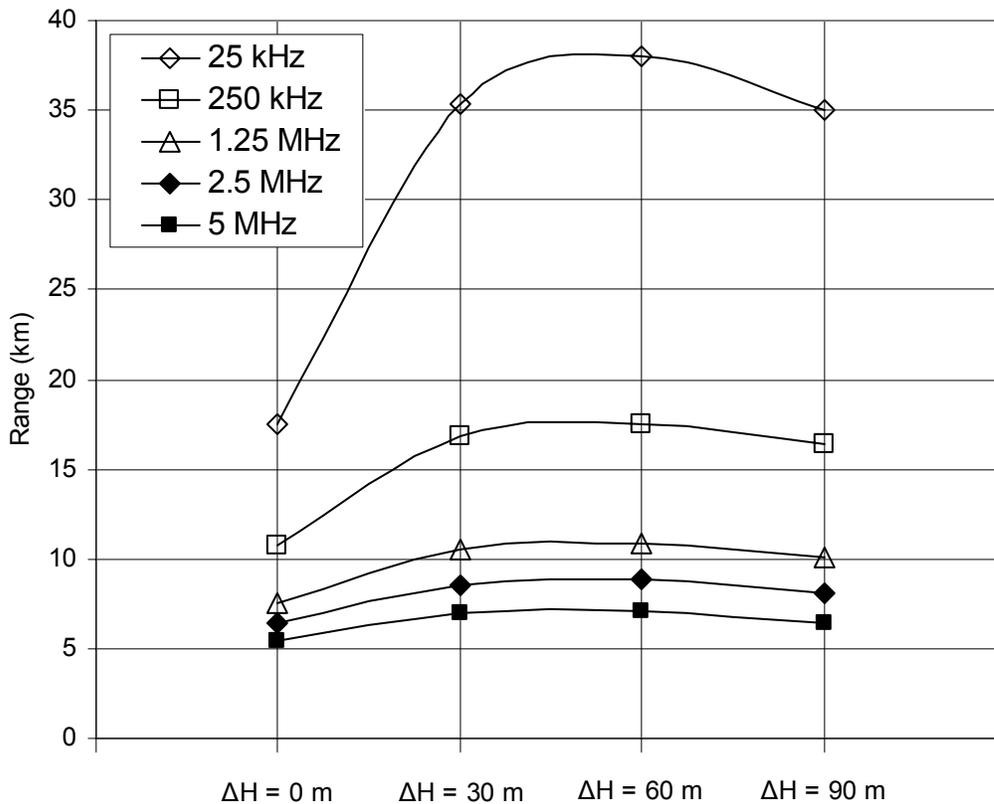


Figure 1. Graph of required exclusion zone beyond nominal 130 km radius for 4 W EIRP over various modulation bandwidths and terrain variations.

As shown, modulation bandwidth or power spectral density has a significant impact on the required exclusion zone. If unlicensed fixed access were allowed to transmit at 4 watts EIRP in a 25 kHz bandwidth, exclusion zone beyond 130 km protection zone is approximately 40 km. Terrain variation has a significant impact at narrower bandwidths with higher power density.

Occupied bandwidth is not necessarily the same as modulation bandwidth. For example, a 1700-subcarrier OFDMA with 3 kHz sub-carrier spacing would occupy 5.1 MHz if all sub-carriers were assigned. Power spectral density would be about -2 dBm/3 kHz bandwidth for 1 watt power output. Additional exclusion zone for protection from interference into 25 kHz bandwidth would follow the 5 MHz curve above, or about 7 km. However, a single user may only be allocated a fraction of those carriers, *e.g.*, if 85 sub-carriers were allocated to a single user, this would correspond to a 255 kHz modulation bandwidth for power spectral density calculation. These sub-carriers do not have to be assigned adjacent to each other, they could occupy the entire TV channel bandwidth. If entire power output could be applied to that single user's signal, and equally to each sub-carrier, power spectral density would be about 11 dBm/3 kHz bandwidth. Additional exclusion zone into 25 kHz bandwidth would be approximately 17 km.

If maximum conducted power spectral density of 8 dBm/3 kHz bandwidth is mandated by the FCC, as defined in Section 15.247(e) for unlicensed digital modulation, the exclusion zone required beyond the 130 km Land Mobile protection zone is approximately 15 km, which yields a total exclusion zone of 145 kilometers from the center city coordinates. This is only somewhat greater than the 134 kilometer exclusion zones proposed in the original Notice of Proposed Rule Making in this proceeding.¹

Use of contour analysis for nearby interferers tends to underestimate interference potential into LMR. LMR systems are normally designed for better than 90% reliability in a faded environment at edge of service area, which requires > 30 dB C/I between median signal levels. Typical LMR contour analysis uses 39 dBu F(50,50) service area contour versus 21 dBu F(50,10) interference contour at 2 m victim receiver antenna height, for a D/U of 18 dB. For distant interferers, delta between F(50,50) and equivalent F(50,10) contours is 10-14 dB. Therefore delta between median signal levels is 18 dB D/U + 10 to 14 dB delta = 28 to 32 dB C/I. As distance between interferer and victim decreases, delta between F(50,50) and F(50,10) contours declines, until at about 15 km they are the same. C/I based upon contour analysis declines from 30 dB for distant interferers to only 18 dB for nearby interferers, resulting in less protection than is actually required. If original 21 dBu F(50,10) interference contour were converted to a median signal, about 9 dBu F(50,50), the 30 dB C/I would be maintained for both distant and nearby interferers.

In conclusion, Motorola recommends that for protection of co-channel operation on channels 14 – 20 in the vicinity of the affected metropolitan areas that the FCC limit the power spectral density and establish both co-channel and adjacent channel exclusion zones. Specifically, all devices should have power spectral density conducted from the intentional radiator to the antenna to be no greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. With this limitation established, it is then appropriate to adopt 145 kilometer exclusion zones around the center city coordinates of the cities that share TV channels 14-20 for land mobile services.

With regard to operation on TV channels that are adjacent to land mobile use of TV channels 14-20, Motorola's analysis agrees with the FCC's original proposal to adopt 131 kilometer exclusion zones from the center city coordinates.² These same exclusion zones will need to be applied to areas where the FCC has agreed to allow land mobile use on TV channels 14-20 beyond the 13 specified markets in Section 90.303 of its rules.³

¹ See Notice (n. 2 supra) at ¶ 36.

² *Id.*

³ See, e.g., Goosetown Enterprises Inc., 16 FCC Rcd 12792 (2001).