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 Before the
 Federal Communications Commission
 Washington, D.C. 20554

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In the Matter of)
)
 Unlicensed Operation in the TV Broadcast Bands) ET Docket No. 04-186
)
 Additional Spectrum for Unlicensed Devices) ET Docket No. 02-380
 Below 900 MHz and in the 3 GHz Band)

SECOND MEMORANDUM OPINION AND ORDER

Adopted: September 23, 2010

Released: September 23, 2010

By the Commission: Chairman Genachowski; Commissioners Copps, McDowell, Clyburn and Baker
 issuing separate statements.

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I. INTRODUCTION

1. By this action, we are finalizing rules to make the unused spectrum in the TV bands available for unlicensed broadband wireless devices. This particular spectrum has excellent propagation characteristics that allow signals to reach farther and penetrate walls and other structures. Access to this spectrum could enable more powerful public Internet connections - - super Wi-Fi hot spots - - with extended range, fewer dead spots, and improved individual speeds as a result of reduced congestion on existing networks. Many other applications are possible, such as broadband access to schools particularly in rural areas, campus networks that are better able to keep pace with user's increasing demands for bandwidth, home networks that are better able to support real time streaming video applications, remote sensing of water supplies by municipalities and support for the smart grid. The potential uses of this spectrum are limited only by the imagination. Although the particular unused TV channels vary from location to location, the devices will have the flexibility and agility to locate and operate on the unused channels, no matter where the devices are located. The devices will use geo-location technology to determine their location and a database look-up that identifies the unused channels that are available at their location. This type of "opportunistic use" of spectrum has great potential for enabling access to other spectrum bands and improving spectrum efficiency. Our actions here are expected to spur investment and innovation in applications and devices that will be used not only in the TV band but eventually in other frequency bands as well.

2. Specifically, we are resolving on reconsideration certain legal and technical issues in order to provide certainty concerning the rules for operation of unlicensed transmitting devices in the television broadcast frequency bands (unlicensed TV bands devices, or "TVBDs"). Resolution of these issues will allow manufacturers to begin marketing unlicensed communications devices and systems that operate on frequencies in the TV bands in areas where they are not used by licensed services ("TV white spaces"). The opening of these bands for unlicensed use, which represents the first significant increase in unlicensed spectrum below 5 GHz in over 20 years, will have significant benefits for both businesses and consumers and will promote more efficient spectrum use.

3. We are responding to seventeen petitions for reconsideration that were filed in response to the *Second Report and Order and Memorandum Opinion and Order* ("*Second Report and Order*") in this proceeding.¹ These petitions collectively request numerous changes in the rules for TV bands devices. We are upholding the majority of the Commission's prior decisions on the issues raised therein. In this regard, we continue to believe that the approach the Commission followed in the *Second Report and Order* is desirable and appropriate for this first step in allowing unlicensed operations in the TV bands. We do, however, find merit in a number of the requests for changes to the rules for TVBDs and are granting those requests by modifying and clarifying the rules in four areas. Specifically, we are taking the following actions:

- Protection Criteria for Incumbent Services

¹ We are addressing seventeen petitions for reconsideration that were filed in response to the *Second Report and Order and Memorandum Opinion and Order* ("*Second Report and Order*") in this proceeding. See *Second Report and Order and Memorandum Opinion and Order* in ET Docket Nos. 02-380 and 04-186, 23 FCC Rcd 16807 (2008).

- Modifying the protection criteria for low power auxiliary stations such as wireless microphones to reduce the required separation between such devices and unlicensed personal/portable devices operating in Mode II.
- Modifying the definition of the receive sites entitled to protection outside of a television station's service area to include all multi-channel video programming distributors as defined by our rules.
- Reserving two vacant UHF channels for wireless microphones and other low power auxiliary service devices in all areas of the country.
- Allowing operators of event and production/show venues that use large numbers of wireless microphones on an unlicensed basis that cannot be accommodated in the two reserved channels and any others available at that location to register the sites of those venues on TV bands databases to receive the same geographic spacing protections afforded licensed wireless microphones.
- Restricting fixed TV bands devices from operating on locations where the ground level is more than 76 meters above the average terrain level in the area.
- TV Bands Devices
 - Eliminating the requirement that TV bands devices that incorporate geo-location and database access must also listen (sense) to detect the signals of TV stations and low power auxiliary service stations (wireless microphones). As part of that change we are also revising and amending the rules in several aspects to reflect use of that method as the only means for determining channel availability. While we are eliminating the sensing requirement for TVBDs, we are encouraging continued development of this capability because we believe it holds promise to further improvements in spectrum efficiency in the TV spectrum in the future and will be a vital tool for providing opportunistic access to other spectrum bands..
 - Adopting power spectral density limits for unlicensed TV bands devices.
 - Modifying the rules governing measurement of adjacent channel emissions.
 - Restricting fixed TV bands devices from operating at locations where the height above average terrain of the ground level is greater than 76 meters.
- TV Bands Database
 - Requiring that communications between TV bands devices and TV bands databases, and between multiple databases, are secure.
 - Requiring that all information that is required by the Commission's rules to be in the TV bands databases be publicly available.
- Use of TV Channels
 - Amending the rules to protect Canadian and Mexican stations in the border areas by including those stations in the TV bands database as protected services.
 - Changing the protection zone for the radio astronomy facility near Socorro, New Mexico to a rectangular area.
 - Declining to grant a request by FiberTower to set aside TV channels for fixed licensed backhaul use.

4. We are also making other minor changes and refinements to our rules for TV bands devices which are discussed below. With these changes and clarifications, our rules will better ensure that licensed services are protected from interference while retaining flexibility for unlicensed devices to share the TV bands with them.

II. BACKGROUND

5. The Commission provides for the operation of unlicensed radio transmitters in Part 15 of

its rules.² Under these rules, unlicensed devices are allowed to operate on frequencies shared with authorized services at relatively low power, *i.e.*, at output power levels of 1 watt (W) or less. Operation under Part 15 is subject to the condition that a device does not cause harmful interference to authorized services, and that it must accept any interference received.³ The rules adopted in the *Second Report and Order* permit unlicensed devices to operate on TV channels that are not in use in their vicinity, subject to specific technical requirements that are intended to prevent interference to TV broadcasting and other authorized users of the TV bands.

6. The broadcast television service operates under Part 73 of the Commission's rules. Full service TV stations operate on six-megahertz channels designated 2 to 51 in four bands of frequencies in the VHF and UHF regions of the radio spectrum (54-72 MHz, 76-88 MHz, 174-216 MHz and 470-698 MHz).⁴ To avoid interference between TV stations, stations on the same and adjacent channels must comply with a number of technical provisions that effectively require that significant distances be maintained between co-channel and adjacent channel stations.⁵ The service range of a TV station is shorter than its interference range, so there are areas between stations that are outside of TV station service areas where channels are unused. In addition, television stations operate with relatively high antennas and high power so that their signals can propagate to, and serve viewers at, significant distances. Such propagation distances also extend the range at which TV signals can cause interference and increase the area between them where channels are not used. There are typically a number of TV channels in a given area that are not being used by full service digital TV stations in order to avoid interference to co-channel or adjacent channel stations. A transmitter operating at a low antenna height and a low power level, *e.g.*, an unlicensed device, will have a much shorter service and interference range and can operate in these areas between TV station service areas without causing interference to TV services. There are also some areas where channels that could be used by a full service television station that are not being used for economic or other reasons. These channels can also be used by unlicensed devices without causing interference.

7. In addition to full service TV stations operating under Part 73 of the rules, certain other licensed services are permitted to operate on TV channels. Class A television stations operate under Subpart J of Part 73 of the rules.⁶ Low power TV, TV translator and TV booster stations are permitted to operate under Part 74 of the rules on a secondary basis to full service TV stations and on an equal basis with Class A TV stations, provided they meet technical rules to prevent interference to reception of full service and Class A stations.⁷ Class A and low power TV stations are permitted to broadcast in either analog or digital, and are permitted to operate on channels 2-51 and also on channels 52-69 (698-806 MHz), provided they will not cause interference to other licensed services on those channels. Part 74 also permits certain broadcast auxiliary operations on TV channels 14-69 on a secondary basis.⁸ In addition, Part 74 permits certain entities to operate wireless microphones and other low power auxiliary station

² See 47 C.F.R. Part 15.

³ See 47 C.F.R. § 15.5.

⁴ See 47 C.F.R. § 73.603(a).

⁵ See 47 C.F.R. §§ 73.616, .622, .623, and .699.

⁶ See 47 C.F.R. Part 73 Subpart J. Class A TV stations operate at the power levels permitted for low power television stations under Part 74 of the rules, but have certain protection rights with respect to full service analog and digital TV stations that are not available to TV translator and low power stations.

⁷ See 47 C.F.R. Part 74 Subpart G.

⁸ See 47 C.F.R. § 74.602(h). This rule section permits TV studio-transmitter links, TV relay stations, and TV translator relay stations to be authorized to operate fixed point-to-point service on UHF TV channels 14-69 on a secondary basis, subject to the provisions in Part 74, subpart G.

transmitters on vacant TV channels on a non-interference basis.⁹

8. Further, in 13 metropolitan areas, one to three channels in the range of channels 14-20 are used by licensees in the Private Land Mobile Radio Service (PLMRS) under Part 90 of the rules and the Commercial Mobile Radio Service (CMRS) under Part 22 of the rules.¹⁰ In addition, medical telemetry equipment is permitted to operate on an unlicensed basis on any vacant TV channel in the range of channels 7-46, and unlicensed remote control devices are allowed to operate on any TV channel above 70 MHz (*i.e.*, above channel 4), except for channel 37.¹¹ TV channel 37 (608-614 MHz) is allocated for radio astronomy and the wireless medical telemetry service (WMTS) and is not used for TV broadcasting. The Offshore Radiotelephone Service uses channels 15-17 in certain regions along the Gulf of Mexico.¹² In Hawaii, channel 17 is reserved for inter-island communications but, no active licensees currently use this channel in Hawaii.¹³ Unlicensed TV bands devices also need to protect these licensed uses.

9. On November 4, 2008, the Commission adopted a *Second Report and Order* in this proceeding in which it allowed unlicensed operation in the TV bands at locations where frequencies are not in use by licensed services. The Commission permitted both fixed and personal/portable unlicensed devices to operate in the TV bands. Fixed devices may operate at up to 4 Watts EIRP (effective isotropic radiated power). The Commission permitted fixed devices to operate on any channel between 2 and 51, except channels 3, 4 and 37, and subject to a number of other conditions such as a restriction against operation on the same channel (co-channel) as a TV station or on the first channel adjacent (adjacent channel) to such a station pending consideration of further information that may be submitted into the record in this proceeding. Personal/portable devices may operate either as Mode I devices (operates only on channels identified by either a fixed or Mode II personal/portable device) or as Mode II devices (relies on geo-location and database access to determine available channels at its location). Personal portable devices may operate on any unoccupied channel between 21 and 51, except channel 37, and may use up to 100 milliwatts EIRP, except that operation on the first adjacent channels to TV stations are limited to 40 milliwatts EIRP. All devices (fixed and personal/portable) must include adaptive power control so that they use the minimum power necessary to accomplish communications. Because channels in the range 2 and 5-20 will be restricted to fixed devices, many of these channels will remain available for wireless microphones that operate on an itinerant basis. In addition, in 13 major markets where certain channels between 14 and 20 are used for land mobile operations, two channels between 21 and 51 are being kept free of unlicensed devices and thus available for wireless microphones.

10. The Commission required that fixed and personal/portable devices must also have a capability to sense TV broadcast and low power auxiliary service station signals, *i.e.*, wireless microphones, as a means to minimize potential interference. The Commission also established additional

⁹ See 47 C.F.R. § 74.861.

¹⁰ See 47 C.F.R. Part 90 Subpart L and 47 C.F.R. Part 22 Subpart E.

¹¹ See 47 C.F.R. §§ 15.231, 15.241 and 15.242. Effective October 16, 2002, the Commission ceased granting certifications for new medical telemetry equipment that operates on TV channels, but there is no cutoff on the sale or use of equipment that was certified before that date, *see* 47 C.F.R. § 15.37(i). To provide spectrum for wireless medical telemetry equipment, the Commission established the Wireless Medical Telemetry Service to operate on a primary basis in 13.5 megahertz of spectrum in three spectrum blocks at 608-614 MHz (TV channel 37, which the WMTS now shares with radio astronomy), 1395-1400 MHz, and 1427-1429.5 MHz. *See* Amendment of Parts 2 and 95 of the Commission's Rules to Create A Wireless Medical Telemetry Service, *Report and Order*, ET Docket No. 99-255, 15 FCC Rcd 11206 (2000). *See also*, Amendments to Parts 1, 2, 27, and 90 of the Commission's Rules to License Services in the 216-220 MHz, 1390-1395 MHz, 1427-1429 MHz, 1429-1432 MHz, 1432-1435 MHz, 1670-1675 MHz, and 2385-2390 MHz Government Transfer Bands, WT Docket No. 02-8, *Memorandum Opinion and Order*, 18 FCC Rcd 16920 (2003).

¹² See 47 C.F.R. § 2.106 NG66(b) and 47 C.F.R. § 22.1007.

¹³ See 47 C.F.R. § 22.591.

requirements to further mitigate the potential for interference and to help remedy any interference that might occur. To prevent interference to authorized services in the TV bands, all unlicensed devices, except personal/portable devices operating in Mode I, must include a geo-location capability and provisions to access through the Internet a database containing information on protected radio services (e.g., location and operating channels) and capable of providing the channels that may be used by an unlicensed device at its location. All fixed devices must register their locations in the database and must transmit identifying information to make it easier to identify them if they are found to interfere. Furthermore, fixed and personal/portable devices operating independently must provide identifying information to the TV bands database. The unlicensed devices must first access the database to obtain a list of the permitted channels before operating and re-check the database at least once daily. This database will be established and administered by a third party, or parties, to be selected through a public notice process to solicit interested entities. The Commission released a Public Notice on November 25, 2009 inviting proposals from entities wishing to be designated as a TV bands device database manager.¹⁴ Nine parties filed proposals in response to this notice.

11. In the *Second Report and Order*, the Commission also required all TV bands devices to be certified by the FCC Laboratory. The Laboratory will request samples of the devices for testing to ensure that they meet all the applicable requirements. The Commission also made provisions for the certification of devices that do not include the geo-location and database access capabilities, and instead rely on spectrum sensing to avoid causing harmful interference, subject to a much more rigorous set of tests by our Laboratory in a process that will be open to the public. These tests will include both laboratory and field tests to fully ensure that such devices meet a "Proof of Performance" standard that they will not cause harmful interference. Under this procedure the Commission will issue a Public Notice seeking comment on the application, as well as test procedures and methodologies. The Commission will also issue a Public Notice seeking comment on its recommendations. The decision to grant such an application will then be made at the Commission level.

12. Seventeen parties filed petitions for reconsideration of requirements adopted in the *Second Report and Order*. Twenty parties filed oppositions to one or more of these petitions, and eleven parties filed replies to oppositions. A list of parties filing petitions is in Appendix A. Equipment authorization for the marketing of unlicensed TV bands devices has been held in abeyance pending the Commission's action on the petitions for reconsideration and its selection of one or more database managers.

13. On January 14, 2010, the Commission adopted a *Report and Order and Further Notice of Proposed Rule Making (Wireless Microphone R&O/FNPRM)* addressing the rules for wireless microphones and other low power auxiliary devices that operate in the TV bands.¹⁵ In that action, the Commission prohibited the manufacture, import, sale, lease, offer for sale or lease, or shipment of wireless microphones and other low power auxiliary stations intended for use in the 700 MHz Band (TV channels 52-69) in the United States. The Commission also required that all low power auxiliary stations, including wireless microphones,¹⁶ cease operations in the 700 MHz Band no later than June 12, 2010. In

¹⁴ See "Office of Engineering and Technology Invites Proposals from Entities Seeking to be Designated TV Band Device Database Managers," Public Notice, DA 09-2497, ET Docket No. 04-186, rel. Nov. 25, 2009.

¹⁵ See *Report and Order and Further Notice of Proposed Rule Making* in WT Docket Nos. 08-166 and 08-167 and ET Docket No. 10-24, 25 FCC Rcd 643 (2010).

¹⁶ Low power auxiliary stations are intended to transmit over distances of approximately 100 meters for uses such as wireless microphones, cue and control communications, and synchronization of TV camera signals. 47 C.F.R. § 74.801. As a general matter, in this item the term "low power auxiliary station" is intended to include devices authorized under Part 74, Subpart H of our rules as well as devices operated on an unlicensed basis pursuant to the waiver in the Wireless Microphone R&O/FNPRM. See *Wireless Microphone R&O/FNPRM*, 25 FCC Rcd at 682-87 ¶¶ 81-90."

recognition of the fact that wireless microphones are used for important functions, but that many were being operated by parties ineligible for the required Part 74 license, the Commission waived the Part 15 rules for a limited period to permit unauthorized users of wireless microphones and other low power auxiliary stations to operate on an unlicensed basis under Part 15 pursuant to certain specified technical requirements -- in the 700 MHz Band until June 12, 2010, and in the core "TV bands" until the effective date of the Commission's actions in response to the Further Notice.¹⁷

14. A number of TV band device applications are already operating on an experimental basis. The city of Wilmington North Carolina is trialing "Smart City" applications, including public "hot spots," low-cost broadband to a low-income housing development, and water level and water purity sensors for compliance with Environmental Protection Agency requirements and flood controls. In addition, a demonstration project in Claudville Virginia is bringing broadband access to a rural elementary school, as well as to consumers in their homes, and newly established public hot spots in the community. Plumas County California has undertaken a "Smart Grid" trial for electricity networks, which allows the electric cooperative to manage the electrical system, obtain data from substations, and manage power flow. The network in that trial also enables free energy monitoring tools that allow consumers to save energy and money, for example, by identifying appliances that are always on and using energy.

III. DISCUSSION

15. In this Second Memorandum Opinion and Order, we address on reconsideration a wide variety of issues relating to unlicensed use of the TV bands. These issues include protection criteria for incumbent authorized services, technical rules for TV bands devices, TV bands database requirements, the channels that can be used by TV bands devices, and several miscellaneous issues. We are generally upholding the decisions the Commission made in the *Second Report and Order* with some specific revisions and clarifications. As indicated above, in this regard the actions we take here are consistent with and continue the approach towards authorization of unlicensed devices in the TV bands we enunciated in the *Second Report and Order* – our actions in this proceeding are to be a conservative first step that includes many safeguards to prevent harmful interference to incumbent communications services.¹⁸ We do, however, agree with petitioners with regard to a number of the requested changes to the rules and are modifying and clarifying our rules as appropriate in granting those requests. We believe these changes and clarifications will provide for improved protection of licensed services in the TV bands, resolve certain uncertainties in the rules and provide manufacturers with greater flexibility in designing products to meet market demands. Our decisions denying and granting the various requests for changes to our rules for TV bands devices are discussed below.

16. With the issuance of this decision and the forthcoming decision by our Office of Engineering and Technology on selection of one or more database managers, manufacturers will be able to begin to make unlicensed TV bands devices and systems available to consumers, business and government users for general use.¹⁹ We intend to closely oversee the introduction of these devices to the market and will take whatever actions may be necessary to avoid, and if necessary correct, any harmful interference that may occur. Further, we will consider in the future any changes to the rules that may be appropriate to provide greater flexibility for development of this technology and protect against harmful interference to incumbent communications services.

A. Protection Criteria for Incumbent Services

1. TV Stations

17. In the *Second Report and Order*, the Commission adopted technical criteria for

¹⁷ The "core TV bands" consist of TV channels 2-51, excluding channel 37.

¹⁸ *Second Report and Order*, 23 FCC Rcd 16808 (2008), ¶ 1.

¹⁹ *Id.* at 16817, ¶10.

determining when a TV channel is considered vacant for the purpose of allowing operation of an unlicensed device on that channel. It protected full service TV stations and Class A TV, low power TV, TV translator and TV booster stations from interference within defined signal contours.²⁰ The signal level defining a television station's protected contour varies depending on the type of station, e.g., analog or digital TV, and the band in which a TV station operates, e.g., VHF or UHF. The protected contours for analog TV stations are calculated in accordance with the F(50,50) curves specified in the Commission's rules, and the protected contours for digital TV stations are calculated in accordance with the F(50,90) curves. While Part 74 of the rules protects low power stations to a higher signal strength contour, and therefore to a shorter distance, than full service TV stations, the Commission decided to require TV bands devices to protect low power stations to the same contour as full service TV stations.²¹

18. To prevent interference to TV reception within these protected contours, the Commission required TV bands devices to comply with the same desired-to-undesired (D/U) signal ratios as digital TV stations.²² Fixed TV bands devices and Mode II personal/portable TV bands devices operating with power levels greater than 40 milliwatts must operate outside the protected contours of both co-channel and adjacent channel TV stations at a sufficient separation distance to ensure that the D/U ratios are met within those TV stations' protected contours. Personal/portable devices operating with power levels of 40 milliwatts or less are permitted to operate within the protected contours of adjacent channel TV stations due to the lower risk of causing harmful interference at that power level.²³ The Commission adopted a table of minimum distance separations from the contours of co-channel and adjacent channel TV stations that fixed and Mode II personal/portable must meet.²⁴ The Commission determined these separation distances based on the power and antenna height of the TV bands device, the TV station protected contour, and the D/U ratio required to prevent interference. When a fixed or a Mode II personal/portable TV bands device contacts a TV bands device database and provides its geographic coordinates, the database will calculate which TV channels are vacant based upon the above criteria and provide a list of those vacant channels to the TV bands device.²⁵ The Commission also required that all TV bands devices include the ability to listen to the airwaves to sense analog and digital television stations as an additional measure of protection.²⁶

19. *Petitions and Replies.* Adaptrum argues that the Commission should permit the use of more accurate TV propagation models than the FCC curves, and that if TV bands devices have both sensing and geo-location capabilities, the database administrator should be permitted to use this information to improve the coverage predictions.²⁷ It states that the criteria described in the rules is a 1966 state of the art calculation appropriate for manual calculations and it is not clear whether terrain can be considered in predicting TV station coverage.²⁸ NCTA states that it does not oppose redefining the protected contours of TV stations to take local terrain features into account more precisely, but these

²⁰ *Id.* at 16865, ¶165.

²¹ *Id.*

²² *Id.* at 16866, ¶167.

²³ *Id.* at 16868, ¶176.

²⁴ *Id.* at 16871, ¶181.

²⁵ *Id.* at 16841, ¶85

²⁶ *Id.* at 16844, ¶95.

²⁷ See Adaptrum petition at 7.

²⁸ See Adaptrum petition at 6. Motorola agrees with Adaptrum that other radio propagation software should be used in place of the R-6602 curves when calculating interference protection inside adjacent channel contours. See Motorola opposition at 13.

measures are not yet ready to be deemed reliable.²⁹

20. PISC argues that low power TV stations should not be protected to the same service contours as full power stations because this would preclude the use of valuable spectrum for expanding broadband access for the benefit of a very small minority of over-the-air viewers capable of receiving low power signals outside their limited service contours.³⁰ SBE and Community Broadcasters Association argue that the Commission failed to protect low power TV and TV translator operations because its analysis focused exclusively on digital operations while many low power TV stations will continue to operate in analog.³¹ Community Broadcasters Association argues that the Commission should reduce the maximum power level of TV bands devices by 9 dB on upper adjacent channels, 14 dB on lower adjacent channels, and make any other appropriate adjustments to take into account the characteristics of analog TV receivers.³² Rudman/Ericksen argue that use of the horizontal plane transmit antenna pattern in the Commission's database for calculating TV station protected contours will give incorrect results for stations employing antennas with mechanical beam tilt.³³ Cohen, Dippell and Everist state that the Commission should consider the interference problem that can result when a consumer uses a TV bands device in close proximity to an indoor TV antenna with amplification.³⁴

21. *Decision.* We affirm our decisions regarding the protection contours for TV stations. First, we decline to change the method that must be used to calculate TV station protected contours. No party has described an alternative model that will provide more accurate calculations of TV station contours than the Commission's current method. The current method of calculating TV station contours in Section 73.684 of the rules using the FCC curves in Section 73.699 of the rules is straight forward, well understood and has proven sufficiently accurate over time. Given the lack of compelling information to the contrary, we believe that calculations of channel availability relying on that methodology will provide satisfactory protection of TV services. Further, with respect to Adaptrum's request that TV signal information be incorporated into the TV bands databases, as discussed below, we are removing the requirement that TV bands devices that include a geo-location capability and access to a database must sense television and low power auxiliary stations. Thus, sensing information on the location of TV signals would not be available to incorporate into the database. We agree with Rudman/Ericksen that the TV bands device database should include information on transmit antenna beam tilt to permit TV contour calculations to be made consistent with Part 73 of the rules and are modifying Section 15.713(h) the rules accordingly.³⁵

22. We also affirm our decision to protect low power television stations to the same signal contour as full service TV stations. Low power stations may provide the only over-the-air broadcast services in rural areas, and we disagree that viewers of those stations should receive less protection than

²⁹ See NCTA opposition at 13.

³⁰ See PISC petition at 24. PISC suggests that low power stations receive expanded protection in the database by demonstrating the number of viewers outside the protected contours that would be harmed by interference from TV bands devices. *Id.* at 25. Community Broadcasters questions whether low power TV stations would have the resources to prove where their viewers reside. See Community Broadcasters opposition at 2.

³¹ See SBE petition at 11-12; Community Broadcasters petition at 2.

³² See Community Broadcasters petition at 3.

³³ See Rudman/Ericksen petition at 11.

³⁴ See Cohen, Dippell and Everist petition at 4.

³⁵ The Commission's TV station database specifies the amount of electrical and mechanical beam tilt in degrees, as well as the orientation of any mechanical beam tilt. The Commission's database does not contain vertical pattern information for stations employing beam tilt, so the Commission uses the assumed vertical transmit antenna patterns in Table 8 of OET Bulletin 69 in calculating TV station contours.

viewers of full service stations. Further, low power stations by their nature cover only a relatively small area, so a modest increase in the protected area beyond the defined Part 74 contour for these stations will not significantly impact the deployment of TV bands devices.

23. We disagree with SBE and Community Broadcasters that the rules fail to protect analog TV stations. While the D/U protection ratios for analog TV stations are higher than for digital stations, the protected service contours for analog stations are also higher than for digital stations. The net result is that the level of an undesired signal from a TVBD that will cause interference to an analog station is higher than the level that will cause interference to a digital station. Thus, the Commission's standards for protection of digital TV stations from interference caused by TVBDs when applied for protection of analog TV stations provide somewhat greater protection of analog TV stations than would standards produced from a similar analysis that specifically considered protection of analog TV stations. We also find that an analysis focusing on digital operation is appropriate for low power television stations because these stations will eventually convert to digital operation.

24. We decline to adopt any new requirements related to the use of TV bands devices in close proximity to amplified indoor antennas. A TV bands device and a TV receiver in close proximity would be under the control of the same party who could take steps to eliminate interference. The Commission previously adopted a requirement in the *Second Report and Order* requiring manufacturers to provide information to consumers on possible methods to resolve interference to television in the event it occurs, so we find no need to adopt any additional requirements.³⁶

2. Wireless Microphones and other Low Power Auxiliary Stations

25. In the *Second Report and Order*, the Commission decided that the locations where licensed Part 74 low power auxiliary stations, including wireless microphones, are used can be registered in the TV bands device database and will be protected from interference from TV bands devices.³⁷ TV bands devices may not operate co-channel to a registered low power auxiliary station within a distance of 1 kilometer of the registered coordinates.³⁸

26. *Petitions and Replies.* Adaptrum and Dell/Microsoft believe that only licensed wireless microphones should be entitled to interference protection.³⁹ Dell/Microsoft argue that parties that do not have a Part 74 license should not be permitted to register wireless microphones in the database, because allowing them to register could block white space access in many metropolitan areas.⁴⁰ Carlson Wireless suggests that unlicensed wireless microphones be required to access the spectrum on the same terms as white space devices and be allowed to register in the database.⁴¹ Shure, Sennheiser and CWMU argue that all wireless microphone users should be able to register in the database and be afforded interference protection from TV bands devices.⁴² However, Motorola, the Wi-Fi Alliance and PISC oppose this request.⁴³ In statements representative of the positions of these parties, the Wi-Fi Alliance argues that affording protection for all wireless microphones, including those operating without a license, undermines

³⁶ See 47 C.F.R. § 15.706.

³⁷ See *Second Report and Order*, 23 FCC Rcd 16876 (2008) at ¶198.

³⁸ *Id.* at 16876, ¶199.

³⁹ See Adaptrum petition at 2 and Dell/Microsoft opposition at 7.

⁴⁰ See Dell/Microsoft opposition at 7.

⁴¹ See Carlson Wireless opposition at 6.

⁴² See Shure petition at 16, Sennheiser opposition at 4 and CWMU opposition at 6.

⁴³ See Motorola opposition at 20, Wi-Fi Alliance opposition at 2 and PISC opposition at 8.

the Commission's attempts to establish a controlled environment for the white spaces.⁴⁴ It believes that non-licensed wireless microphones that do not operate under the appropriate operational restrictions in the TV bands device rules pose a serious interference threat to TV bands devices and that all unlicensed wireless microphone usage should fall under the same rules as TV bands devices.⁴⁵ CWMU requests that the Commission expand eligibility for wireless microphone licenses.⁴⁶ Carlson Wireless, Motorola and WISPA ask that two channels in each market be designated for non-exclusive use by wireless microphones that are not currently licensed.⁴⁷ Rudman/Ericksen argue that it is not necessary to reserve the first vacant channel above and below channel 37 for wireless microphones because the Commission can simply protect a point/radius for each wireless microphone in the ULS database.⁴⁸

27. Several parties argue that wireless microphones should be protected at a distance greater than one kilometer. CWMU believes that if a table specifying protection distances for wireless microphones as a function of power and antenna height can not be added to Section 15.712(f)(1), then the protection distances specified in this section should be increased to 2 km for personal/portable devices and 4 km for fixed devices.⁴⁹ Shure argues that a two kilometer protective zone for fixed devices is required to offer meaningful protection, since the interference range of a four watt TV bands device is hugely disproportional to a wireless microphone's one kilometer protection zone and an increase to two kilometers will restore a reasonable level of proportionality.⁵⁰ SBE believes wireless microphones are entitled to protection anywhere within their operational area shown in the Commission's database, not just within a one or two kilometer radius.⁵¹

28. Other parties argue that the current protection radius should be maintained or even reduced. WISPA, Carlson Wireless, and Wi-Fi Alliance support maintaining the current one kilometer protection radius for wireless microphones.⁵² PISC contends that extending interference protection zones for registered wireless microphone venues to 2 km is excessive and an inefficient use of spectrum.⁵³ Dell/Microsoft argue that a one kilometer distance should apply only to 4 watt fixed devices, while a 160 meter separation distance from 100 mW devices and a 100 meter separation distance from 40 mW devices will provide the same level of protection for wireless microphones as a one kilometer separation distance from 4 watt devices.⁵⁴

29. *Decision.* We continue to recognize that wireless microphones are currently used in many different venues where people gather for events large and small and many consumers and businesses have come to rely on these devices. We have previously limited use of channels 2 and 5-20 to communications between fixed TVBDs and reserved two channels in the range 14-51 in the 13 markets where PLMRS and CMRS systems operate to make sure that frequencies are available for wireless

⁴⁴ See Wi-Fi Alliance opposition at 2.

⁴⁵ See Wi-Fi Alliance opposition at 2.

⁴⁶ See CWMU opposition at 4-5.

⁴⁷ See Carlson Wireless opposition at 10, Motorola petition at 6 and WISPA petition at 6.

⁴⁸ See Rudman/Ericksen petition at 10. The Commission's Universal Licensing System can be accessed at <http://wireless.fcc.gov/uls/index.htm?job=home>.

⁴⁹ See CWMU opposition at 9.

⁵⁰ See Shure petition at 13-14.

⁵¹ See SBE opposition at 7-8.

⁵² See WISPA opposition at 7, Carlson Wireless opposition at 6, and Wi-Fi Alliance opposition at 2.

⁵³ See PISC opposition at 14.

⁵⁴ See Dell/Microsoft opposition at 2.

microphones.⁵⁵ As discussed below, we are herein expanding the reservation of two channels in the range 14-51 to all markets nationwide as suggested by several petitioners. This will provide frequencies where a limited but substantial number of wireless microphones can be operated on any basis without the potential for interference from TV bands devices. It will also ensure that frequencies are available everywhere for licensed wireless microphones used on a roving basis to operate without risk of receiving harmful interference from TVBDs. We have also provided for a nominal separation distance between TVBDs and sites of venues and events where large numbers of unlicensed wireless microphones used by permitting such sites to be registered in the TV bands databases. Further, we note that at any particular location a number of TV channels will not be available for use by TVBDs due to the application of the various interference protection requirements under our rules. Thus, a significant amount of spectrum will be available on which wireless microphones can be operated as they have in the past without concern for interference from TVBDs. We believe that this spectrum will provide sufficient frequencies to support wireless microphone operations at the great majority of events. We disagree with those who argue that more spectrum should be reserved for wireless microphones. We observe that wireless microphones generally have operated very inefficiently, perhaps in part due to the luxury of having access to a wealth of spectrum. While there may be users that believe they need access to more spectrum to accommodate more wireless microphones, we find that any such needs must be accommodated through improvements in spectrum efficiency. The Commission underscored this point in the currently pending wireless microphone proceeding and sought comment on solutions that could enable wireless microphones to operate more efficiently and/or improve their immunity to harmful interference.⁵⁶ We will continue to pursue this issue as the Commission considers possible repurposing of the TV spectrum.

30. We disagree with the petitioners that argue unlicensed wireless microphones should be subject to the same requirements as TVBDs under our rules. There are many important differences that make it impractical to apply the same rules to both types of devices. For example, TVBDs are expected to be data devices that will have access to the Internet. Wireless microphones do not typically include geo-location technology nor do they connect to the Internet, so requiring these devices to check for channel availability through a database would be impractical. Also, TVBDs generally should be able to tolerate some latency, whereas wireless microphones operate in real time and generally cannot tolerate significant latency. Most importantly, unlicensed wireless microphones have been operating for quite some time without causing harmful interference. Accordingly, we conclude that unlicensed wireless microphones should not be subject to the more confined approach we have applied to TVBDs.

31. With regard to registration of unlicensed devices in the TV bands databases, we first observe that unlicensed wireless microphones operate under the same general conditions of operation in Section 15.5 of the rules as TV bands devices, meaning they may not cause interference to authorized services and must accept any interference received, including interference from other non-licensed devices.⁵⁷ As a general matter, we therefore find that it would be inappropriate to protect unlicensed wireless microphones against harmful interference from other unlicensed devices, and in particular TV bands devices. We observe that there are a wide variety of applications for wireless microphones ranging from a single wireless microphone used by a performer or presenter, to small theatrical productions using perhaps 10 - 20 microphones, to large scale productions and events such as professional sports events and Broadway style productions that may use well over 100 wireless microphones. The overwhelming majority of such use does not merit registration in the TV bands database. In cases where the number of

⁵⁵ See *Second Report and Order*, 23 FCC Rcd 16860 (2009) at ¶ 151. With regard to channels 2 and 5-20, the Commission stated that restricting use of channels 2 and 5-20 to communications by fixed devices with other fixed devices would meet the needs of those desiring to provide service at a distance and also limit the number of TVBDs that could potentially conflict with wireless microphone use.

⁵⁶ See *Report and Order and Further Notice of Proposed Rule Making* in WT Docket Nos. 08-166 and 08-167 and ET Docket No. 10-24, 25 FCC Rcd 643, 702 (2010).

⁵⁷ See 47 C.F.R. § 15.5.

wireless microphones needed for an event is relatively low, the operator of unlicensed microphones can avoid receiving harmful interference from TVBDs by simply using the reserved channels or other channels in each market where TVBDs are not allowed to operate. The two reserved TV channels will accommodate a minimum of at least 16 wireless microphones and the additional channels that are not available for TVBDs at most locations will accommodate many additional wireless microphones.⁵⁸ On the other hand, we recognize that certain events, such as major sporting contests or live theatrical productions/shows, may use scores of wireless microphones and therefore may not be able to be accommodated in the two reserved channels and other channels that may be available for wireless microphones at that location.

32. Accordingly, we are addressing unlicensed wireless microphones and low power auxiliary devices in our rules for TV band devices as follows. As the general rule, we are not allowing unlicensed wireless microphones and other low power auxiliary devices operating without a license to be registered in the database; these devices will not be afforded protection from interference from TV bands devices on channels where TV bands devices are allowed to operate.⁵⁹ Entities desiring to operate wireless microphones on an unlicensed basis without potential for interference from TVBDs may use the two channels in each market area where TVBDs are not allowed to operate, as well as other TV channels that will be available in the vast majority of locations. Such entities may consult with a TV bands database to identify the reserved channels at their location, as well as the TV channels that may not be available for TV band devices.⁶⁰ Entities operating or otherwise responsible for the audio systems at major events where large numbers of wireless microphones will be used and cannot be accommodated in the available channels at that location may request registration of the site in the TV bands data bases. The registration requests must be filed with the Commission. Entities filing registration requests will be required to certify that they are using the reserved channels and all other available channels from 7 – 51 (except channel 37) that are not available for use by TV band devices and are practicable for use by wireless microphones.⁶¹ The request to be registered must be filed with the Commission at least 30 days in advance and include the hours, dates or days of the week and specific weeks on which those microphones will be in actual use (on dates where events are not taking place those sites will not be protected) and other identifying information also required of low power auxiliary licensees. Unlicensed microphones at event sites qualifying for registration in TV bands databases will be afforded the same geographic spacing from TVBDs as licensed microphones. We also advise entities responsible for event sites qualifying for registration in TV bands databases that registration does not create or establish any form or right or assurance of continued use of the spectrum in the future.

33. To allow us to better identify registered wireless microphone licensed operations and unlicensed sites, we are adopting the following registration procedures. Operators of licensed wireless microphones may register sites directly with one of the designated database administrators and provide the information required by the rules, which we are amending to include the wireless microphone call

⁵⁸ A 6 megahertz television channel can support the operation of 6-8 wireless microphones that operate with the current 200 kHz analog technology. *See ex parte* submission from Shure dated July 1, 2004 at page 4.

⁵⁹ Entities may, of course, also operate wireless microphones on channels other than those that are reserved but, except in cases where a large number of microphones are needed, will not be afforded protection from TVBDs on those other channels.

⁶⁰ We also anticipate that wireless microphone vendors will know the reserved channels in each area and will be able to assist their customers in selecting equipment that can operate on frequencies on those channels.

⁶¹ Some channels that are not available for TVBDs may not be suitable for use by wireless microphones due to the potential for interference from licensed operations such as television stations or the need to protect public safety operations.

sign.⁶² As indicated above, operators of venues using unlicensed wireless microphones will be required to register their sites with the Commission, which will transmit the information to the TV bands device database administrators. For the purpose of this registration, the Commission will develop a form that will allow the information to be filed through one of the Commission's electronic filing systems, such as the Universal Licensing System (ULS). The applicant will be required to certify that it complies with the requirements for registration of unlicensed wireless microphones, including that it will first make use of all TV channels not available for TV bands devices that are practicable for wireless microphone use, including channels 7-51 (except channel 37), and submit the information specified by the rules, which we are amending to include the name of the venue where the equipment is operated. As a benchmark, at least 6 - 8 wireless microphones must be operating in each channel that is being used for the event.⁶³ Registration requests that do not meet these criteria will not be registered in the TV bands databases. The Commission will take actions against parties that file inaccurate or incomplete information, such as denial of registration in the database, removal of information from the database pursuant to Section 15.713(i), or other sanctions as appropriate to ensure compliance with the rules. The Commission will make requests for registration of sites that use unlicensed wireless microphones public and will provide an opportunity for public comment or objections. We are delegating authority for administering this registration process jointly to our Office of Engineering and Technology and Wireless Telecommunications Bureaus.

34. Turning next to issues concerning the manner in which wireless microphones are protected, we are maintaining the requirement that fixed TV bands devices may not operate co-channel with low power auxiliary stations within 1 km of their coordinates registered in the TV bands databases. We recognize the arguments of Shure and CWMU about the difference in power levels between fixed TV bands devices and wireless microphones. However, whether harmful interference occurs in a particular situation depends on many factors, including the undesired signal power, antenna directivity and separation distance, as well as the level of the desired signal at the receiver, the receive antenna and receiver characteristics, and any intervening structures or terrain that could attenuate the undesired signal. Neither Shure nor CWMU provided an analysis with their petitions demonstrating that the 1 km separation distance adopted in the *Second Report and Order* is inadequate for fixed devices when taking all relevant factors into account. In cases where licensed low power auxiliary stations are being used at large outdoor venues, such as racetracks or golf courses, we will permit the party registering the devices to specify the coordinates of multiple locations within the site to ensure that protection is provided over the entire facility where microphones are being used.⁶⁴

35. However, we agree with petitioners that argue that it is not necessary to provide low power auxiliary stations the same protection from personal/portable TV bands devices because the latter operate with power levels at least forty times lower than the maximum power permitted for fixed TV bands devices. Therefore, we are modifying our rules to require that Mode II (independent)

⁶² Section 74.882 requires that, for transmitters used for voice transmissions and having a transmitter output power exceeding 50 mW, an announcement be made at the beginning and end of each period of operation at a single location identifying the transmitting unit's call sign and other information. 47 C.F.R. § 74.882

⁶³ We will continue to monitor technological progress in improving the spectrum efficiency of wireless microphones and could increase our benchmark for the number of wireless microphones on a channel.

⁶⁴ The coordinates of multiple locations at an event site could be specified in a TV bands database by either designating multiple locations in a single site record or by including a separate record in the database for each of the multiple locations. We allow the TV bands database managers to decide how to handle such cases. However, for purposes of determining the geographic areas around event sites in which TVBDs may not operate, in cases where multiple locations are specified for a site, the TV bands database administrators are to treat each of the multiple locations registered for a large site as a separate location, *i.e.*, each location registered for a site is to be treated as if it were a separately entered record independent of the other locations at the site (even though the geographic areas of the multiple locations overlap, and we expect them to do so in order to achieve contiguous geographic protection of an event site).

personal/portable devices not operate co-channel with low power auxiliary stations within 400 meters (0.4 km) of their coordinates registered in the TV bands device database.⁶⁵ A 100 mW transmitter will produce a lower signal at 400 meters than a 4 watt transmitter at 1 km using a free space calculation, so this shorter distance will provide greater protection for low power auxiliary devices from 100 mW TV bands devices than a 1 km separation from 4 watt devices. We will use this same 400 meters distance for personal/portable devices that operate with less than 100 mW of power.⁶⁶

36. We find that it is not practical to protect wireless microphones using information obtained from the ULS and decline to require that that information be used in defining such protection as suggested by Rudman/Ericksen. Some wireless microphones are licensed using specific coordinates, while others are licensed to a wide area such as the entire service area of a TV station, and a license may specify multiple operating channels. We also observe that wireless microphones can be operated intermittently at discrete locations, rather than continuously over a wide area. Thus, the use of ULS licensing data could preclude TV bands devices from operating on multiple channels and at locations where no wireless microphones are in operation.

3. Translators, Cable Headends and Multichannel Video Program Distributors

37. In the *Second Report and Order*, the Commission adopted rules to protect TV translator receive sites and cable TV headends that are located outside the protected contours of the TV stations being received. TV translator receive sites are often located on high towers or at high elevations and use high gain antennas to receive a full service station's signal well beyond the station's service area. Cable headends are facilities that acquire and distribute video service signals over a cable television system. Broadcast TV signals are often received off-the-air at a cable headend for retransmission over the cable system. In many cases, the cable headend will use an antenna with high gain antenna mounted high on a tower to receive a TV station's signals well beyond the station's service area in a manner similar to that used by TV translators. The Commission found that it is important to avoid disruption of TV service to viewers who are located beyond TV station service areas and able to receive those signals through retransmission on TV translators and cable systems.⁶⁷ While those viewers are in fact located beyond the areas where the Commission normally protects TV services, in these cases TV services have *de facto* been extended and valuable service is being provided to a significant number of households. If a TV bands device were to be located between the TV translator/cable headend and TV station and then operate on one or more of the channels being received by those facilities in a manner that results in harmful interference, TV reception to the households and the cable system services could be disrupted.

38. To protect cable headends and TV translator receive sites which are not listed in Commission databases, the Commission allowed operators of TV translator receive sites and cable headends that are located within 80 km of the service contour of the received TV station to register their location and the channel(s) they receive in the TV bands device database. To prevent unnecessary entries

⁶⁵ Mode I personal/portable devices will use the same set of available channels as the fixed or Mode II device with which they communicate and our presumption under the rules is that the specific geographic location of these devices will not be known. Therefore, the distance between a Mode I device and a protected (registered) wireless microphone site cannot be identified with any more accuracy than the location of the fixed device with which the Mode I device communicates. We will therefore treat Mode I devices the same as fixed devices purposes of protecting wireless microphones – in this respect the list of channels they obtain from their fixed device will reflect at least a 1 km separation from a protected wireless microphone site. However, Mode I devices will in fact as often as not be located closer to a protected site than their fixed device.

⁶⁶ The relative difference in power between a personal/portable device operating at 100 mW and a personal/portable device operating at 40 mW is so small that there would be no significant difference in the separation distance values for these two power levels. We are therefore specifying the same 400 m separation for devices operating with 100 mW or 40 mW.

⁶⁷ See *Second Report and Order* 23 FCC Rcd 16872 (2008) at ¶185.

into the database, the Commission permitted translator receive sites and cable headends to be registered only if they are outside the protected contour of the TV station being received.⁶⁸ The rules limit operation of TV bands devices co-channel and adjacent to the channel(s) being received over an arc of +/- 30 degrees from a line between the receive site and the TV station(s) being received.⁶⁹ Within this arc, TV bands devices operating co-channel to the received station may not operate within 80 km of the receive site, and TV bands devices on channels adjacent to the received station may not operate within 20 km of the receive site. The protection radius extends only as far as the protected contour of the station being received, so the co-channel protection distance would be less than 80 km for receive sites closer than this distance from a protected contour, and both the co-channel and adjacent channel protection distances would be less than 20 km for receive sites closer than this distance from a protected contour. In addition, to prevent interference to TV translators and cable headends from TV bands devices outside the main beam of the receive antenna, the Commission prohibited TV bands devices from operating co-channel to the channel(s) being received by these facilities within 8 kilometers and from operating on adjacent channels within 2 kilometers in all directions off the +/- 30 degree arc.

39. *Petitions and Replies.* SBE and MSTV/NAB requests that satellite receive sites receive the same protection as cable headends. DIRECTV/DISH Network similarly asks that the Commission clarify that the facilities of all multi-channel video programming distributors (MVPDs) receive the same protection as cable headends.⁷⁰ NCTA and DIRECTV request that cable headends more than 80 km outside a station's contour be made eligible for protection, that the protected wedge area be increased to +/- 50 degrees and that operators of fixed TV bands devices be required to coordinate with all operators of cable headends within 100 km who might be affected.⁷¹ NCTA also states that the rules should define a clear process whereby cable operators can receive a greater protection area upon a showing of factors requiring greater protection distances than those provided in the rules.⁷² Motorola supports allowing registration of headends beyond 80 km but opposes increasing the width of the protected arc and the co-channel protection distance in the radius outside the arc, arguing that the current protection specifications are adequate to protect the vast majority of headend receivers.⁷³ Adaptrum submits that the cable headend and translator receive site protection requirements are overly stringent and asks that the protection distance outside the main lobe of the antenna be made 100 meters rather than 2 km for adjacent channels.⁷⁴ Google and Motorola oppose requiring coordination of fixed devices with cable headend operators as an unnecessary burden.⁷⁵ Dell/Microsoft state that the cable headend protection provisions could unnecessarily restrict device operations and should be reduced or eliminated where practicable.⁷⁶

40. DIRECTV/DISH Network, NCTA and SBE ask that the Commission allow the registration of headend facilities located within broadcast TV station protected contours.⁷⁷

⁶⁸ *Id.* at 16872, ¶187.

⁶⁹ *Id.* at 16872, ¶186.

⁷⁰ See SBE petition at 15, MSTV/NAB opposition at 11 and DIRECTV/DISH Network petition at 3.

⁷¹ See NCTA petition at 15-17 and DIRECTV opposition at 7.

⁷² See NCTA petition at 15, 17. It also requests that the Commission correct a conflict between paragraph 186 of the text of the decision and Section 15.712(b) of the rules. Specifically, NCTA notes that paragraph 186 specifies protection distances are to be determined from the protected contour of the TV station being received, while Section 15.712(b) specifies they are to be determined from the receive site.

⁷³ See Motorola opposition at 7-8.

⁷⁴ See Adaptrum petition at 10.

⁷⁵ See Google opposition at 19 and Motorola opposition at 8.

⁷⁶ See Dell/Microsoft petition at 7.

⁷⁷ See DIRECTV/DISH Network petition at 3-4, NCTA petition at 16 and SBE petition at 15.

DIRECTV/DISH Network and NCTA state this option is necessary to provide protection from portable TV bands devices using adjacent channels and because receive facilities located near a station's protected contour boundary could be at risk of interference from TV bands devices outside the contour. Dell/Microsoft oppose permitting such registration, stating that headends inside service contours already receive protection.⁷⁸ Dell/Microsoft, Motorola and PISC request that the Commission clarify that headends are entitled to register channels in the database only in instances where the headend is actually relying on an over-the-air signal, and Dell/Microsoft and PISC believe that channel registration in the TV bands database be limited to local channels, not out-of-market stations.⁷⁹

41. *Decision.* As discussed below, we are modifying our rules to expand and more clearly define the types of receive facilities that may be registered in the TV bands database and are making certain changes to the protection criteria for these receive facilities. The purpose of permitting the registration of receive sites is to protect the reception of over-the-air TV signals that are redistributed through another means. Consistent with this intent, we will permit the registration of TV receive sites for other types of video service providers besides cable systems and will modify the rules in this regard to more clearly and completely define the types of facilities that may be registered. We are therefore specifying that receive sites of all multi-channel video programming distributors (MVPDs) as defined by Section 602(13) of the Communications Act may be voluntarily registered in the database, in addition to TV translator receive sites.⁸⁰

42. We recognize that there are cable headends that receive TV station signals located at distances beyond 80 km from the edge of a television station's protected service contour and understand NCTA's concern for possible disruption service to cable subscribers. These same considerations would apply to other MVPDs and to TV translator, low power TV and Class A TV stations that re-transmit programming from another TV station. We do not believe that the requested change would have significant impact on the availability of TV white space because these facilities are generally in remote areas where many channels will be available for white space devices. However, we also recognize that parties may wish to have an opportunity to review such requests to confirm the assessment. We are therefore providing that current MVPD operators, TV translator, low power TV and Class A TV stations with receive sites located beyond the 80 km co-channel protection distance in the rules may apply for a waiver of that distance during a period that will end 90 days after the effective date of the rules adopted herein. Such waiver requests would also involve shifting the 20 km adjacent channel protection distance so that it is measured from the actual receive site. We will then issue a public notice requesting comment on requests we receive and issue decisions. MVPD operators and TV translator, low power TV and class a TV stations that commence operation in the future with receive sites located beyond the co-channel and adjacent protection distances may apply for a waiver of those distances within 90 days of commencing operation. Following receipt of such request(s), we will then issue a public notice asking for comment on the request(s) and issue decision(s).

43. We decline to increase the width of the +/-30 degree protected arc as requested by NCTA. A receive site located outside the protected contour of a TV station would need to incorporate a high gain receive antenna, which has a narrow beamwidth. While we recognize NCTA's argument that an antenna has side lobes that will allow it to receive signals outside its main beam, this does not in itself demonstrate that the current protection requirement is inadequate or that a wider protected arc is necessary. Adaptrum provides no information to support its argument that the protection distance outside

⁷⁸ See Dell/Microsoft opposition at 13.

⁷⁹ See Dell/Microsoft petition at 8, Motorola opposition at 7 and PISC opposition at 18.

⁸⁰ The term "multichannel video programming distributor" is defined by Section 602(13) of the Communications Act as a person such as, but not limited to, a cable operator, a multichannel multipoint distribution service, a direct broadcast satellite service, or a television receive-only satellite program distributor, who makes available for purchase, by subscribers or customers, multiple channels of video programming. See 47 U.S.C. § 522(13).

of the main lobe of the receive antenna should be significantly reduced and we therefore deny that request. We further decline to require operators of fixed TV bands devices to coordinate with operators of receive sites. The requirements we have adopted are extremely conservative and will adequately protect receive sites, so a coordination requirement is unnecessary and would be cumbersome to implement.

44. We find it unnecessary to provide for registration of receive sites within the protected contour of a TV station being received and thus decline to allow such registrations. Within a station's protected service contour, receive sites are protected from interference by the same provisions that protect reception by consumers. The rules require that TV bands devices be located outside the contour of a co-channel TV station, so a TV bands device located near a contour that is communicating with another TV bands device would not be directing its signal into the contour where the receive site is located. Further, a receive site inside, but near the edge of a protected contour, would have its receive antenna directed toward the TV station and not at the TV bands device outside the contour. Therefore, the orientation of the antennas in this situation makes interference highly unlikely. Additionally, a TV bands device operating on a channel adjacent to an occupied TV channel is permitted to operate within the service contour, but at a lower power level not to exceed 40 mW. This lower power level combined with the fact that a receive site within a contour will receive a higher signal level than a receive site outside the contour makes adjacent channel interference from that source again unlikely. Furthermore, in the event that interference does occur, the operator of the TV bands device is required to cease operation.

45. Finally, we are modifying the text of the rules to clarify that registration for receive sites is limited to channels that are received over-the-air and are used as part of service of the MVPD, TV translator, low power TV station or Class A TV station. We are not, however, limiting registration to local channels so as not to preclude the possibility that an MVPD or TV translator/low power television station may retransmit out-of-market channels if it is authorized to do so.

B. TV Bands Devices

1. Spectrum Sensing

46. In addition to requiring that TV bands devices access a database to determine available channels, the Commission decided in the *Second Report and Order* to require that TV bands devices be capable of sensing analog TV signals, digital TV signals and wireless microphone signals at a level of -114 dBm within defined receiver bandwidths.⁸¹ This level is referenced to an omni-directional receive antenna with a gain of 0 dBi.⁸² If a receive antenna with a minimum directional gain of less than 0 dBi is used, the detection threshold must be reduced by the amount in dB that the minimum directional gain of the antenna is less than 0 dBi.⁸³ Alternative approaches for the sensing antenna are permitted that provide at least the same performance as an omni-directional antenna with 0 dBi gain.⁸⁴ The Commission also required that the receive antenna used by fixed devices be located at least 10 meters above the ground to maximize the likelihood that its reception is not blocked from receiving signals originating from any direction.⁸⁵ It found that receive antenna height requirements are impractical for personal/portable devices and declined to impose such requirements on those devices.⁸⁶

47. Under the rules adopted in the *Second Report and Order*, a TV bands device is permitted

⁸¹ See *Second Report and Order* 23 FCC Rcd 16889, 16890 (2008) at ¶¶237, 240.

⁸² *Id.* at 16890, ¶241.

⁸³ *Id.*

⁸⁴ *Id.*

⁸⁵ *Id.*

⁸⁶ *Id.*

to begin operating on a TV channel if no wireless microphone or other low power auxiliary device signals above the detection threshold are detected within a minimum time interval of 30 seconds.⁸⁷ A TV bands device must also perform in-service monitoring of channels on which it operates a minimum of once every 60 seconds.⁸⁸ There is no minimum channel availability check time for in-service monitoring. If a device detects a wireless microphone or other low power auxiliary device signal on a channel it is using, the device must cease all transmissions on that channel within two seconds.⁸⁹ If a TV signal is detected on a channel indicated as available for use by the database, the TV bands device must provide a notice of that detection to the operator of the device and provide a means for the operator to remove the channel from the device's list of available channels.⁹⁰ However, with respect to TV signals, the database is the controlling factor in determining whether a channel is available, and there is no requirement for a TV bands device to avoid operating on a channel where it detects a TV signal, since it is possible to detect a signal outside a station's protected service contour.

48. A personal/portable device operating in Mode I must identify (report) those TV channels on which it senses a wireless microphone or television signal above the detection threshold to the fixed or Mode II personal/portable device that provides it with a list of available channels. The fixed or Mode II device must respond as if it had detected the signal itself, *i.e.*, it must not use the occupied channel if the Mode I device detects a wireless microphone and must report the TV signal detection to the operator of the device. In addition, TV bands devices communicating either directly with one another or linked through a base station must share information on channel occupancy determined by sensing. If any device in a local area group or network determines that a channel is occupied and notifies other devices with which it is linked, all the other linked devices will be required to respond as if they had detected the signal themselves.⁹¹

49. *Petitions and Replies.* A number of parties argue that there is no need for the spectrum sensing requirements and request that they be eliminated, particularly the requirement to sense wireless microphones. Adaptrum, Dell/Microsoft, PISC, Wi-Fi Alliance and others argue that the combination of the TV bands database and safe harbor channels 2-20, where personal/portable devices cannot operate, will be adequate to protect all wireless microphone use in the TV bands.⁹² PISC and Google also argue that to the extent that the Commission imposes sensing requirements in addition to geo-location and database access, it protects unauthorized microphone users and compromises the underlying concept of the rules to protect authorized licensed use.⁹³ The Wi-Fi Alliance also argues that detecting low power auxiliary signals at extremely weak levels will add substantial TV bands device development time and expense.⁹⁴ Shure, on the other hand, argues that the spectrum sensing requirement should be retained and strengthened because it is necessary to protect those wireless microphones operating in a manner that

⁸⁷ *Id.* at 16891, ¶245.

⁸⁸ *Id.*

⁸⁹ *Id.*

⁹⁰ *Id.* at 16843, 16844, ¶¶92, 96.

⁹¹ *Id.* at 16892, 249.

⁹² See Adaptrum petition at 2; Dell/Microsoft petition at 8; PISC petition at 5-8; Wi-Fi Alliance petition at 4-5; Motorola petition at 8; WISPA petition at 5 (argues that the Commission failed to consider the adverse effect that complying with sensing requirements would have on WISPs); IEEE 802 petition at 3 (argues that sensing to detect broadcast TV signals should be optional when reliable database access exists); Federation of Internet Solution Providers opposition at 2; Google opposition at 7-9.

⁹³ See PISC petition at 8; Google opposition at 7-9. See also Wi-Fi Alliance petition at 5.

⁹⁴ See Wi-Fi Alliance petition at 5. See also Federation of Internet Solution Providers opposition at 2 (also doubts the ability of spectrum sensing technology to perform as intended).

makes registration in the database impractical.⁹⁵ Sennheiser and SBE also oppose the elimination or weakening of the sensing requirement for protecting wireless microphones.⁹⁶

50. Several parties argue that, if the sensing requirement is retained, the -114 dBm detection threshold which applies to all incumbent operations is too low and should be increased. Dell/Microsoft and Google argue that the -114 dBm sensing level was recommended based on the assumption that sensing would be the only method for protecting incumbents, and this low level threshold is not necessary in light of the Commission's decision to require geo-location capability and database access.⁹⁷ Adaptrum contends that it is challenging or impossible to develop a device that can detect signals at a -114 dBm threshold and that such sensitivity can be achieved for wireless microphones only if the signal format and channel plan are known.⁹⁸ Dell/Microsoft, IEEE 802, Wi-Fi Alliance, Motorola and PISC contend that the wireless microphone sensing threshold should be increased to at least -107 dBm, arguing generally that a higher threshold will reduce the chance of false detections due to noise.⁹⁹ Sennheiser and Shure oppose requests to raise the TV bands device sensing threshold for wireless microphones,¹⁰⁰ and other parties argue that the detection threshold should be lowered. MSTV/NAB contends that there is no basis in the record for the -114 dBm sensing level, which would provide inadequate protection to roving wireless microphones that are not in the database.¹⁰¹ SBE, Shure and CWMU argue that the sensing level should be lowered to -126 dBm as is required in the United Kingdom.¹⁰²

51. Petitioners also request that other aspects of the sensing requirements be modified. IEEE 802, Motorola, WISPA, Carlson Wireless, Federation of Internet Solution Providers and Google believe that the 10 meter minimum receive antenna height for fixed stations is not necessary when a database is used.¹⁰³ Motorola, WISPA, Carlson Wireless and Google recommend a 3 meter antenna height as more practical and economically viable.¹⁰⁴ WISPA believes that the requirement that TV bands devices utilize an omnidirectional sensing antenna is overprotective and should be eliminated because it is only necessary for the sensing antenna to detect a protected signal in the path between the base station and the customer's equipment.¹⁰⁵

52. Shure requests that the Commission decrease the channel re-check interval from 60 seconds to ten seconds to prevent prolonged incidents of co-channel interference, and that the Commission establish a non-occupancy period of 60 minutes after a wireless microphone is detected on a

⁹⁵ See Shure opposition at 5-6.

⁹⁶ See Sennheiser opposition at 5; SBE opposition at 6-7, 12.

⁹⁷ See Dell/Microsoft petition at 3 and Google opposition at 11.

⁹⁸ See Adaptrum petition at 2.

⁹⁹ See Dell/Microsoft petition at 4-5, IEEE 802 petition at 5, Wi-Fi Alliance petition at 5, Motorola petition at 12, and PISC opposition at 10.

¹⁰⁰ See Sennheiser opposition at 5; Shure opposition at 7. Shure argues that a 100 mW TV bands device will interfere far beyond its -107 dBm sensing range.

¹⁰¹ See MSTV/NAB opposition at 19.

¹⁰² See SBE petition at 24; Shure opposition at 7-8; CWMU opposition at 9. However Google argues that the tighter sensing requirement in the United Kingdom applies only when geo-location is not used. See Google opposition at 12.

¹⁰³ See IEEE 802 petition at 3, Motorola petition at 8, WISPA petition at 7, Carlson Wireless opposition at 2, Federation of Internet Solution Providers opposition at 3 and Google opposition at 13.

¹⁰⁴ See Motorola petition at 8, WISPA petition at 9, Carlson Wireless opposition at 2 and Google opposition at 13.

¹⁰⁵ See WISPA petition at 9.

channel to prevent spectrum contention battles that result in disruptions of service.¹⁰⁶ SBE argues that the re-check interval should be decreased to once per second to prevent disruption of active newsgathering, live entertainment or sports.¹⁰⁷ Carlson Wireless, Dell/Microsoft, Google, Motorola, PISC and WISPA oppose requests to decrease the channel re-check interval.¹⁰⁸ Google argues that a 10 second interval for occupancy checking would render any use of TV bands devices impractical.¹⁰⁹ Dell/Microsoft argue that microphone users can reserve in advance channels where TV bands devices can not operate,¹¹⁰ and PISC argues that given the specificity of the database, it is unnecessary to require a non-occupancy period for channels being used by wireless microphones.¹¹¹

53. Motorola argues that the requirement to use distributed sensing will result in overly large areas in excess of 5 km where TV bands devices will have to vacate a channel used by a wireless microphone.¹¹² WISPA requests that the Commission eliminate the requirement for all fixed TV bands devices to take remedial action in the event one device in a network senses a protected signal because the detection of one signal by one TV bands device could result in an entire WISP network being shut down.¹¹³ However, Shure contends that distributed sensing is a critical interference protection feature because networked devices will be more likely to identify signals hidden from a single TV bands device.¹¹⁴

54. *Decision.* We are eliminating the requirement for TV bands devices that rely on geo-location and database access to sense analog and digital TV signals and also wireless microphones and other low power auxiliary stations. Much of this proceeding has focused on the central question of whether spectrum sensing is a viable tool for providing access to spectrum. We have noted the benefits and limitations of spectrum sensing through testing conducted by our engineers and extensive discussion in the *Second Report and Order*. We continue to believe that spectrum sensing will continue to develop and improve. We anticipate that some form of spectrum sensing may very well be included in TVBDs on a voluntary basis for purposes such as determining the quality of each channel relative to real and potential interference sources and enhancing spectrum sharing among TVBDs. However, at this juncture, we do not believe that a mandatory spectrum sensing requirement best serves the public interest. As petitioners and responding parties indicate, the geo-location and database access method and other provisions of the rules will provide adequate and reliable protection for television and low power broadcast auxiliary services, so that spectrum sensing is not necessary. With respect to protection of television services, we observe that the geo-location and database method is already the primary means for preventing interference to TV stations.¹¹⁵ The sensing requirement adopted in the *Second Report and Order* only requires that a TV bands device inform the user when a TV signal above a threshold is

¹⁰⁶ See Shure petition at 13.

¹⁰⁷ See SBE petition at 24.

¹⁰⁸ See Carlson Wireless opposition at 7, Dell/Microsoft opposition at 6, Google opposition at 12, Motorola opposition at 20, PISC opposition at 13 and WISPA opposition at 5 (a six-fold increase in the frequency of in-service monitoring and a 60 minute non-occupancy period would lead to more false positive detections and would be regulatory overkill).

¹⁰⁹ See Google opposition at 12.

¹¹⁰ See Dell/Microsoft opposition at 6.

¹¹¹ See PISC opposition at 13.

¹¹² See Motorola petition at 13-14.

¹¹³ See WISPA petition at 11.

¹¹⁴ See Shure opposition at 8-9.

¹¹⁵ *Second Report and Order*, 23 FCC Rcd 16841(2008) at para. 85.

detected and provide an opportunity for the user to change channel, but it does not preclude operation on a channel where a TV signal is detected. That is, the *Second Report and Order* essentially relied on geo-location and the TV bands data bases to protect over-the-air TV broadcasting, not spectrum sensing.

55. We also now conclude that inclusion of a spectrum sensing capability is not necessary to protect wireless microphone operations. Parties operating Part 74 licensed low power auxiliary stations at fixed locations are eligible to register those operations in the TV bands device database to obtain interference protection from TV bands devices. As indicated above, for parties ineligible for Part 74 licensing, the Commission, in its *Wireless Microphone R&O/FNPRM* permitted the operation of low power auxiliary service stations on an unlicensed basis under Part 15 of the rules pending a final decision on its proposals to expand eligibility for Part 74 licensing and to allow a new category of wireless audio devices to operate in the core TV bands under Part 15. Based on our informal observations of the marketing and uses of wireless microphones, it appears that the number of wireless microphones operating under the Part 15 waiver significantly outnumbers those operating as Part 74 licensed devices. As indicated above, unlicensed devices operate on a non-interference basis, meaning they may not cause interference to authorized services, and must accept any interference received, including interference from other un-licensed devices such as TV bands devices. Requiring TV bands devices to sense low power auxiliary stations such as wireless microphones would inappropriately give interference protection to a large number of other unlicensed, unprotected devices because there is no way for the sensing feature of a TV bands device to distinguish licensed from unlicensed devices.¹¹⁶ We recognize that there will be some licensed low power auxiliary stations that can be used roving applications for which the location can not be known in advance and therefore cannot be registered in the TV bands device database. As discussed below, we have reserved two channels at all locations on which unlicensed TV bands devices will not be allowed to operate in order to ensure that there are frequencies on which licensed microphones used in roving applications such as electronic news gathering can operate. The availability of the frequencies in these channels will make it unnecessary to provide special protection from interference for such applications.

56. With the elimination of the spectrum sensing requirement for TV bands devices that use geo-location and database access, there is collaterally no longer a need for a minimum receive antenna height for fixed devices, and we are consequently removing that requirement from the rules. We are also revising and amending certain elements the rules so that they continue to provide comparable assurance of protection against interference in the absence of sensing capabilities and to clarify and simplify the rules as they pertain to interference protection. In addition to revisions of the geo-location and database access rules, the changes include revision of certain terms used in the rules and elimination of the terms "client device," "client mode," "master device," and "master mode."

57. As part of these changes, we are eliminating the requirements for devices operating in Mode I to use distributed sensing. We also observe that some of the comments on this issue appear to reflect an understanding that the rules permit extensive networks of devices that would all be linked together using a commonly identified list of available channels. We wish to correct any misconceptions that, at least at this stage, the rules contemplate or permit such networks and sharing of channel availability information. Rather, as stated in the *Second Report and Order*, we will permit personal/portable TVBDs to be used in the operation of networks only where a means is provided to ensure that each device is operating consistent with the channels available at its particular location.¹¹⁷ The rules do not permit personal/portable devices operating in Mode I to relay channel availability information from one Mode I device to another Mode I device unless some means is used to ensure that each device is operating within the parameters for its particular location.

¹¹⁶ As discussed below, we are, however, extending protection to unlicensed devices used at venues where large numbers of wireless microphones are used.

¹¹⁷ *Id.* at 16854, ¶132.

58. Our elimination of the general requirement that all TV bands devices perform spectrum sensing at least once per minute and report channel availability information to other devices in a network removes the only existing requirement in the rules for a Mode I device to maintain contact with a fixed or Mode II device. In reviewing this provision, we also observe that the rules currently do not require that a Mode I device periodically re-establish its list of available channels through either device that uses geo-location and database access; however, such re-checks for channel availability are necessary to ensure that a Mode I device does not continue to operate on a channel that becomes unavailable. To address these concerns, we are adding a requirement that a device operating in Mode I must either receive a special signal from the Mode II or fixed device that provided its current list of available channels to verify that it is still in reception range of that device or contact a Mode II or fixed device at least once per minute to re-verify/re-establish channel availability. This new requirement, including the special signal for verifying contact with the Mode II or fixed device that provided the Mode I device's list of available channels, is described in more detail in the section below on Re-check Procedures. This requirement is necessary because a Mode I device is not generally expected to be able to determine when it has moved, and it could possibly be moved to a location where the operating channel is occupied. Maintaining regular contact with a Mode II or fixed device will ensure that Mode I devices operate only on channels available at their location and that they cease operation when they move out of range of the device from which they obtained their list of available channels, in which case their list of available channels would not longer be valid. This requirement will also address situations where a Mode I device is no longer able to maintain contact with an operating fixed or Mode II device (for example, if the fixed or Mode II device with which the Mode I device has been communicating ceases operation and the Mode I device is not able to contact a replacement).

59. In reviewing the rules in this context, we also observe that Section 15.711(b)(3)(ii) of the rules requires that a Mode II personal/portable device access the database for a list of available channels each time it is activated from a power-off condition and re-check its location and the database for available channels if it changes location during operation. It is our intent that a Mode II device monitor its location regularly to determine if its location has changed under this requirement. We are therefore amending this section of the rules to clarify that a Mode II device must use its geo-location capability to check its location at least once every 60 seconds, except when in "sleep mode," *i.e.*, in a mode in which the device is inactive but is not powered-down. This clarification will ensure that Mode II devices re-check their list of available channels within a short interval if their location changes. It will also provide clarity with respect the re-check requirements for devices that operate on a mobile basis within a bounded geo-graphic area in which the same channels are available at all locations.

60. While we are eliminating spectrum sensing for TVBDs that use geo-location and database access, we continue to believe that this technology offers significant promise for improving spectrum access and efficiency both in the TV bands and in providing access to other spectrum. Spectrum sensing has come a long way and some have expressed the view that even today it is sufficiently developed that it can be relied upon for determining access to the TV bands and other spectrum. We are therefore leaving open the opportunity to submit applications for certification of sensing-only devices. We acknowledge that the process for approval of such devices is rigorous. However, we continue to believe that an open and transparent review as provided by that process is appropriate for sensing-only devices. Accordingly, we are retaining the provisions in our rules that permit the authorization and operation of personal/portable TV bands devices that rely on sensing alone under a "proof-of-performance" standard. We invite parties that submit such applications when they are ready to do so. We are taking this opportunity to clarify that devices that use sensing alone may initiate and participate in a network of TVBDs and may communicate with fixed, Mode I, Mode II and other sensing-only TVBDs but may not provide a Mode I device with a list of available channels. We are also re-locating the existing spectrum sensing technical provisions that previously applied to all TVBDs into

the rule section on sensing-only devices.¹¹⁸

61. We are also increasing the minimum required detection threshold for wireless microphones and other LPAS stations of sensing-only devices from -114 dBm to -107 dBm. We are making this change for two reasons. First, sensing-only devices must operate with lower power than fixed or other personal/portable devices (except for personal/portable devices operating on channels adjacent to television stations), so a higher detection threshold would provide a level of protection that is approximately comparable to a lower threshold in a higher power device. Second, the rules for such devices specify that although compliance with the detection threshold for spectrum sensing is required, it is not necessarily sufficient for demonstrating reliable interference avoidance.¹¹⁹ Thus, the required detection threshold we are adopting serves as a minimum performance criteria for a device.

62. Authorization of a sensing only TVBD under the proof-of-performance standard also requires that a manufacturer submit a prototype device that will be tested by the Commission to ensure that the device is capable of operating without interference prior to certification. The decision on whether to certify a sensing-only device will be based on its performance, and in particular its ability to reliably detect the presence of authorized transmissions.¹²⁰ If the Commission determines through testing that a lower detection threshold is necessary to prevent interference then we would require the device to meet the lower threshold before it could be certified. We believe that these requirements for sensing-only devices are sufficiently conservative to prevent interference to TV reception and low power auxiliary stations. We see no basis for increasing the threshold for sensing of television signals.

2. Technical Requirements

a. Antenna Height

63. Because the range at which a TV bands device can cause interference increases as the height of the device's antenna increases, the Commission adopted a maximum antenna height limit of 30 meters above ground for fixed devices. This height limit was intended to balance unlicensed fixed TV bands device transmission range with the distance at which those operations could impact licensed services.¹²¹ The Commission did not impose height restrictions on personal/portable devices because it found that it is not practical to administer an antenna height limit for those devices and the lower power and limited antenna gain of personal/portable devices would generally result in propagation over a shorter range than fixed devices.¹²² Further, the Commission observed that personal/portable devices, unlike fixed devices which have gain antennas mounted outdoors to maximize the propagation range of their signals, will likely typically be used indoors where their signals will be attenuated by exterior walls. These factors will significantly reduce the range at which signals from a personal/portable device will be of sufficient field strength to cause interference.

64. *Petitions and Replies.* Several parties request that the Commission permit fixed devices to operate with transmit antenna heights greater than 30 meters to allow greater coverage from a single site, thus allowing the use of fewer towers.¹²³ However, MSTV/NAB and SBE oppose increasing the

¹¹⁸ See 47 C.F.R. § 15.717. The spectrum sensing requirements include detection threshold levels, receive antenna characteristics (e.g., gain and directionality), channel availability check time, in-service monitoring, and channel move time.

¹¹⁹ *Id.*

¹²⁰ See *Second Report and Order* 23 FCC Rcd 16895 at ¶261.

¹²¹ *Id.* at 16886, ¶228.

¹²² *Id.* at 16886, ¶229.

¹²³ See IEEE 802 petition at 3, WISPA petition at 13, Motorola petition at 6 and Federation of Internet Solution Providers opposition at 3. WISPA and Motorola request that the Commission revise the table of minimum required separation distances between TV station protected contours and fixed TV bands devices using antenna heights

(continued....)

maximum allowable antenna height due to concerns about an increased potential for interference.¹²⁴ IEEE 802, SBE, and MSTV/NAB also supports defining the maximum antenna height as the height above average terrain (HAAT), rather the height above ground.¹²⁵ IEEE 802 and SBE believe that the current “height above ground” specification underestimates the protection distances needed from antennas located on a mountain.¹²⁶ However, Google opposes specifying the antenna height as HAAT because the more sophisticated calculations required could impede prompt equipment deployments.¹²⁷ Rudman/Ericksen and SBE argue that the lack of a maximum transmit height for personal/portable devices will result in interference.¹²⁸

65. *Decision.* We decline to increase the maximum permitted transmit antenna height above ground for fixed TV bands devices. As the Commission stated in the *Second Report and Order*, the 30 meters above ground limit was established as a balance between the benefits of increasing TV bands device transmission range and the need to minimize the impact on licensed services.¹²⁹ Consistent with the Commission’s stated approach in the *Second Report and Order* of taking a conservative approach in protecting authorized services, we find the prudent course of action is to maintain the previously adopted height limit. If, in the future, experience with TV bands devices indicates that these devices could operate at higher transmit heights without causing interference, the Commission could revisit the height limit.

66. While we expect that specifying a limit on antenna height above ground rather than above average terrain is satisfactory for controlling interference to authorized services in the majority of cases, we also recognize petitioners’ concerns about the increased potential for interference in instances where a fixed TV bands device antenna is located on a local geographic high point such as a hill or mountain.¹³⁰ In such cases, the distance at which a TV bands device signal could propagate would be significantly increased, thus increasing the potential for interference to authorized operations in the TV bands. We therefore conclude that it is necessary to modify our rules to limit the antenna HAAT of a fixed device as well as its antenna height above ground. In considering a limit for antenna HAAT, we need to balance the concerns for long range propagation from high points against the typical variability of ground height that occurs in areas where there are significant local high points – we do not want to preclude fixed devices from a large number of sites in areas where there are rolling hills or a large number of relatively high points that do not generally provide open, line-of-sight paths for propagation over long distances. We find that limiting the fixed device antenna HAAT to 106 meters (350 feet), as calculated by the TV bands database, provides an appropriate balance of these concerns. We will therefore restrict fixed TV bands devices from operating at locations where the HAAT of the ground is greater than 76 meters; this

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greater than 30 meters. See Motorola petition at 6 and WISPA petition at 14. MSTV/NAB disagrees with these parties’ recommended separation distances, arguing that they are based on faulty assumptions. See MSTV/NAB opposition at 10.

¹²⁴ See MSTV/NAB opposition at 9 and SBE opposition at 7.

¹²⁵ See IEEE 802 petition at 3, SBE petition at 13, and MSTV/NAB opposition at 8. WISPA prefers using above ground measurement, but would not oppose HAAT if it allowed for increased base station height. See WISPA reply to oppositions at 10.

¹²⁶ See IEEE 802 petition at 3-4 and SBE petition at 13.

¹²⁷ See Google opposition at 14.

¹²⁸ See Rudman/Ericksen petition at 13 and SBE opposition at 5.

¹²⁹ See *Second Report and Order* 23 FCC Rcd 16886 (2008), ¶228.

¹³⁰ The antenna height above ground is the distance from the antenna center of radiation to the actual ground directly below the antenna. To calculate the antenna height above average terrain (HAAT), the average elevation of the surrounding terrain above mean sea level must be determined along at least 8 evenly spaced radials at distances from 3 to 16 km from the transmitter site. The HAAT is the difference between the antenna height above mean sea level (the antenna height above ground plus the site elevation) and the average elevation of the surrounding terrain.

will allow use of an antenna at a height of up to 30 meters above ground level to provide an antenna HAAT of 106 meters. Accordingly, we are specifying that a fixed TV bands device antenna may not be located at a site where the ground HAAT is greater than 75 meters (246 feet). The ground HAAT is to be calculated by the TV bands database using computational software employing the methodology in Section 73.684(d) of the rules to ensure that fixed devices comply with this requirement.

67. In reexamining this issue, we also note that the rules currently do not indicate that fixed device antenna heights must be provided to the database for use in determining available channels. It was clearly the Commission's intent that fixed devices include their height when querying the database because the available channels for fixed devices cannot be determined without this information.¹³¹ We are therefore modifying Sections 15.711(b)(3) and 15.713(f)(3) to indicate that fixed devices must submit their antenna height above ground to the database.

68. We continue to decline to establish height limits for personal/portable devices. As the Commission stated in the *Second Report and Order*, there is no practical way to enforce such limits, and such limits are not necessary due to the different technical and operational characteristics of personal/portable devices.

b. Power and Power Spectral Density Limits

69. In the *Second Report and Order*, the Commission allowed fixed TV bands devices to operate with a peak transmitter output power of one watt with a maximum antenna gain of 6 dBi, and to require that the transmitter power be reduced by the same amount in dB that the maximum antenna gain exceeds 6 dBi.¹³² This allows unlicensed TV bands fixed devices to operate with the equivalent of 4 watts EIRP. The Commission found that 4 watts EIRP is sufficient to allow fixed devices to communicate at ranges that will serve community and rural users while minimizing the potential for interference to broadcast television and other authorized services in the TV bands. Fixed TV bands devices were not permitted to operate adjacent to occupied TV channels, although the Commission decided to defer a final decision on this issue and to keep the record open pending the development of additional information demonstrating that a reliable method can be developed to allow adjacent channel operation while protecting authorized services.¹³³

70. The Commission allowed personal/portable TV bands devices to operate with a peak transmitter output power of 100 mW with a maximum antenna gain of 0 dBi, and required that the transmitter power of such devices be reduced by the same amount in dB that the maximum antenna gain exceeds 0 dBi.¹³⁴ This allows personal/portable TV bands devices to operate with an equivalent of 100 mW EIRP. In cases where a personal/portable device is operating adjacent to an occupied TV channel, the maximum permitted EIRP is 40 mW.¹³⁵ Personal/portable devices that rely on spectrum sensing without the use of geo-location and a TV bands device database may be authorized at a power level up to 50 mW EIRP.¹³⁶ The Commission did not specify minimum bandwidth limits for transmissions by TV bands devices or power spectral density (PSD) limits in the *Second Report and Order*.

¹³¹ Section 15.713(a)(1) states that the TV bands device database will calculate available channels based on the interference requirements of Section 15.712, which contains a separation table that takes fixed device antenna height into account. The only way the database can perform this calculation is if the fixed device submits its antenna height along with its geographic coordinates to the database.

¹³² See *Second Report and Order* 23 FCC Rcd 16846 at ¶105.

¹³³ *Id.* ¶178.

¹³⁴ *Id.* at 16852, 16853, ¶¶126-127.

¹³⁵ *Id.* at 16868, ¶176.

¹³⁶ *Id.* at 16895, ¶258.