Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

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

PETITION FOR RECONSIDERATION OF ADAPTRUM, INC.

Introduction

Pursuant to Section 1.429 of the rules of the Federal Communications Commission ("Commission"), 47 C.F.R. § 1.429, Adaptrum, Inc. hereby seeks reconsideration of aspects of the Commission's *Second Report and Order*[1] ("*2nd R&O*") in the above-captioned proceeding. This decision was a precedent breaking document with many difficult policy challenges for the Commission. As a whole, we agree on most of the Commission's policy and technical decisions, but some of the details that were adopted will make the practical implementation of this policy difficult to realize.

Adaptrum is a small "Silicon Valley start-up" company that is technologically driven. It has been active in this proceeding since 2004 and has made numerous filings. In particular it has submitted the only hardware for the FCC requested testing that was capable of *both* detecting the presence of TV channel signals and automatically transmitting on a vacant channel.[2] In the tests that were performed, Adaptrum's detection system consistently and reliably detected occupied TV channels. Also, FCC's white space transmission tests showed that Adaptrum's white space device could operate on adjacent channels without causing interference.

Wireless Microphone Detection - §15.711(c)(1)(i)(C)

The *2nd R&O* requires a detection threshold for wireless microphones of " -114 dBm, averaged over a 200 kHz bandwidth."[3] We believe such sensitivity can only be achieved when the wireless microphone signal format and channel plan are known. In lack of such

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[1] *Second Report and Order and Memorandum Opinion and Order*, ET Docket 04-186, ET Docket 02-380, November 14, 2008, FCC 08-260

[2] During the FCC Laboratory test program, the Adaptrum unit was never tested in this automatic mode.

[3] §15.711 (c)(1)(i)(C)

information, it is challenging to impossible to meeting this level of performance in practice.[4] The new rules do not specify the wireless microphone test procedure. The absence of any information on measurement procedures at best creates uncertainty for device manufactures and at worst makes the rule too vague to be workable.[5]

We continue to believe only legal wireless microphone uses are entitled for interference protection from unlicensed white space devices. The database serves as an adequate protection mechanism for legal wireless microphones in static situations like sports and entertainment events. The safe harbor TV channels will be able to accommodate the microphone uses in more dynamic situations like fast breaking new events, which usually only require a small number of audio channels. Further protection of legal wireless microphones may be accomplished using the beacon approach as proposed by various parties[6] including Adaptrum[7].

We recognize most of the wireless microphones in the Unite Sates today are not used legally. In principle these devices should have the same rights and share the same responsibilities as those of the unlicensed white space devices. The current rules have already provided special protection for these devices by prohibiting all mobile TVBD use in channels 2-20 and in two additional channels near channel 37 in the 13 major metropolitan areas with TV/Land Mobile sharing. As a further protection, we recommend the Commission to consider also granting these wireless microphones the right to register in the database as long as such registration request is reasonable and best effort has been made to exhaust the safe harbor TV channels.

In view of the above discussion, we believe the combination of database, safe harbor TV channels, and possibly beacons will be adequate to address all wireless microphone use in the TV bands. We urge the Commission to omit the wireless microphone sensing requirement in the rules.

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[4] Without *a priori* information about a target signal, only energy detection is possible. The thermal noise floor over 200 kHz alone is -121 dBm. Consider receiver noise figure and environmental noise, reliable detection (with low false alarm probability) of an arbitrary wireless microphone signal at -114 dBm is not practical.

[5] While we recognize that the Commission commonly adopts metrics in the Rules and allows the Office of Engineering and Technology to adopt measurement procedures documents, *e.g.* http://www.fcc.gov/oet/info/documents/measurement/ that give details on how to make such measurements, in this case the impact of different possible measurement procedures is so large as to make the underlying rule almost meaningless without some stated assumptions about measurement.

[6] http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520030268

[7] http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520033059, http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520047208

White Space Device Power Limits - §15.709(a)(2)

§15.709(a)(2) limits power for personal/mobile TVBDs to 100 mW EIRP on a non-adjacent TV white space channel and 40 mW on an adjacent TV white space channel. §15.709(a)(1) limits the operation of fixed device (4 W EIRP limit) only on non-adjacent TV channels. We believe these requirements are excessive and may hinder the commercial deployment of white space technology especially in wide area broadband applications where the spectrum is best suited for.

Figure 1 shows the physics of adjacent channel problem. The only TVBD power that actually impacts adjacent channel TV reception is that in the central solid trapezoid[8] in Figure 1 - the overlap of the TVBD OOBE and the receiver bandpass. As long as this power in the overlap is low compared to the TV signal power input to the receiver there will be no interference. The interference power affecting the TV receiver can be reduced through a variety of approaches and we urge the Commission to give designers the flexibility to select the approach that maximize functionality of TVBDs while also achieving the desired protection goals. Possible approaches are:

1) Reducing TVBD inband transmission power
2) Reducing TVBD inband transmission bandwidth (noting less interference power will be integrated into the TV receiver filter response if the TVBD transmission bandwidth is reduced)
3) Improve the TVBD OOBE

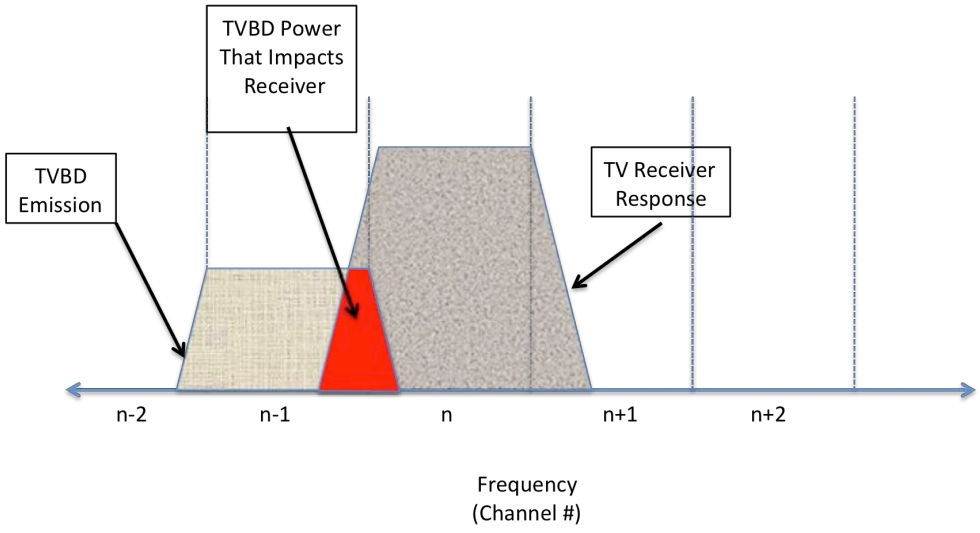

Figure 1: TVBD OOBE that actually impacts adjacent channel TV receivers

[8] In actual systems, the shapes of the TVBD OOBE and the TV receiver response would not be *exact* trapezoids, but the same concepts apply with the detailed shape of each.

Note further that the extent of the interference also depends on the actual received TV signal level since only the D/U ratio between the TV signal (desired) and interference (undesired) will affect the performance of the TV reception.

In the worst case scenario, the TV receiver is operating close to its sensitivity (which is about -85 dBm for consumer TV receivers), as long as the integrated interference power is reasonably below that level, no interference will occur. In the majority of the operating conditions, the TV receivers will be operating at considerably higher desired signal levels (usually around -50 dBm) and thus tolerate a considerably higher interference level. Based on the above observations, a higher total transmission power on the adjacent TV channel is possible with the right combination of TVBD signal bandwidth and TVBD OOBE. Reducing the TVBD transmission bandwidth is especially effective when OOBE is usually fixed by design.

Given a keep-out distance of ~10 m between a personal/portable TVBD and a TV receiver and ~100 m between a fixed TVBD and a TV receiver, the potential for adjacent channel interference is extremely small if the personal/portable device is operating around 100 – 250 mW EIRP and the fixed device around 4 W EIRP. Adaptive sensing and transmission techniques like transmission power control and adaptive bandwidth reduction will further reduce the interference potential and guarantee no harmful interference to TV reception even in the worst case scenarios.

Another consideration for reducing the personal/portable TVBD EIRP from the 400 mW proposed in the original NPRM[9] to the 100 mW in the current rules is the issue of cable television direct pick-up.[10] We believe in doing so the Commission did not consider the longstanding precedents adopted in Docket 20780[11] where the unintended emission limits for digital devices/person computers were adopted. These limits were controversial at the time as early personal computers with unregulated emissions often interference with TV and other services. A key question was the minimum distance separation from PCs to TV receivers that protection would be based on. The Commission then stated,

> "(W)e are assuming that the home computing device is at least 10 meters from the receiver. The separation distance is a basic parameter in computing tolerable levels of signal that may be radiated by a computer. We are most interested in protecting an individual who is receiving interference from his neighbor's computer. To a lesser extent, we are concerned about devices in the same household. In a household, the homeowner or apartment dweller can choose which device he wants to operate. For example, if a second TV set in the same house is receiving interference from a computing device in an adjacent room, there are a number of steps he can take to remedy or minimize the problem, or as a last option, he can always choose which is most important to operate--the TV set or the computing device."[12]

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[9] 2ndR&O at para. 116
[10] *Ibid.* at para. 126
[11] *First Report and Order*, Docket 20780, 79 F.C.C.2d 28 (1979)
[12] *Ibid.* at para. 53-4

The Docket 20780 decision goes on to state,

> "We believe that in most cases interfering radiation from computing devices is a less valuable use of spectrum than the radio and television services that would be interfered with. Therefore, we consider it appropriate that our regulations deny to computing devices an interfering use of the spectrum (except where the interference is to other equipment of the computer owner). We have made this judgment by comparing the benefits of allowing current uses of spectrum to continue without interference from computing equipment with the costs of denying interfering use of the spectrum to computers."

Thus this decision was based on the assumption that the interference signal from the digital device/PC was unintended emissions of no value in themselves. But the emissions under consideration in the instant proceeding are deliberate information carrying communications signals so by the logic of the Docket 20780 precedent should be allowed to impact television related equipment in the user's own residence at a distance of at least 10m. We note that while the protection standards adopted in Docket 20780 were controversial at the time, the more than quarter century of experience with practical implementation of these standards has resulted in virtually zero controversy over their effectiveness when compliant equipment is used in residential environments.

Based on the above discussion, we recommend the Commission to consider a power limit of 250 mW for personal/portable TVBDs on both adjacent and non-adjacent TV white space channels and allow fixed TVBDs to operate on adjacent TV white space channels. We are open to further white space field trial and testing to increase the Commission's confidence in any new changes.

Propagation and Protection - §15.712 (a)

The NPRM in this proceeding proposed three independent ways of detecting the presence of "white space": listen-before-talk, geolocate/database lookup, and beacons. The 2nd R&O took a further step of requiring both listen-before-talk and geolocate/database lookup as part of a "belt and suspenders" approach. With this new policy the details of propagation prediction become vital to the availability of white space and the ability of TVBS to serve the public without causing harmful interference.

§15.712 bases separation from existing broadcast stations on "the R-6602 curves contained in Section 73.699 of this chapter". The R-6602 curves derive from a 1966 FCC technical report.[13] These curves were intended for planning protection of high power large coverage area TV stations from similar stations using the best data collection and calculations that were available at the time. The Commission continues to use these

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[13] J. Damelin, W. Daniel, H. Fine and G. Waldom, Development of VHF and UHF Propagation Curves for TV and FM Broadcasting, FCC, Office of Chief Engineer, Research Div., Report No. R-6602, September 1966 http://www.fcc.gov/oet/info/documents/reports/R-6602.pdf

curves for TV licensing because of the administrative certainty for existing broadcaster associated with them. The new DTV rules state

> "(C)overage is to be determined in accordance with paragraph (b) of this section. Under actual conditions, the true coverage may vary from these estimates because the terrain over any specific path is expected to be different from the average terrain on which the field strength charts were based. Further, the actual extent of service will usually be less than indicated by these estimates due to interference from other stations. Because of these factors, the predicted field strength contours give no assurance of service to any specific percentage of receiver locations within the distances indicated."[14] (Emphasis added.)

The Commission in recent years has used a variety of more accurate propagation models to predict broadcast station coverage at specific locations.[15] In general, contemporary radio propagation software gives better and better predictions of signal coverage in cases where detailed terrain information is used and more detailed calculations are made.[16] The criteria described in §15.712 is a 1966 state of the art calculation appropriate for manual calculation. Indeed, since §15.712 does not explicitly reference the detailed procedure of §73.625(b) or any comparable methodology, it is not even clear if terrain can be considered at all in predicting TV station coverage in determining where TVBDs can transmit. **Thus, §15.712 not only uses an obsolescent concept for predicting coverage in a small area, but it is basically ambiguous as presently written.**

In Docket 98-201 the Commission tentatively concluded that

> "the Commission's traditional predictive methodology for determining a Grade B contour is inappropriate for predicting signal strength at individual locations. Our rules state that this methodology is for three purposes only: (1) estimation of coverage resulting from the selection of a particular transmitter site, (2) problems of coverage related to 47 C.F.R. § 73.3555 (ownership restrictions), and (3) determination of compliance with § 73.685(a) concerning minimum field strength over the principal community. The traditional methodology predicts signal strength on the basis of average terrain elevation along radial lines extending only ten miles from a television station's transmitter. The traditional methodology does not accurately reflect all the topographic differences in a station's transmission area, and explicitly does not account for interference from other signals. These omissions make it an imperfect methodology for predicting whether an individual

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[14] 47 C.F.R. 73.625(a)(3)

[15] As a recent example, the Commission released on December 23, 2008 a set of coverage maps of all TV stations in the US, FCC Reports Show Analog and Digital Coverage of TV Stations, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-287579A1.pdf. While the reports do not give a detail explanation of the calculations used other than "standard engineering techniques used by the FCC to predict coverage", it is clear that it is not prediction for specific points within the Grade B contours is **not** R-6602, although R-6602 was apparently used to draw the new and old contours. The very existence of "orange triangles" within grade B contours in these maps showing no coverage is a demonstration of the severe limitations of using R-6602 to predict local coverage as an R-6602 analysis per §73.625(b) would show coverage *everywhere* within the contour. The FCC DTV coverage maps are available at http://www.fcc.gov/dtv/markets/

[16] In the cellular industry, it is common to use detailed propagation models for cell site planning

> household can receive an adequate signal. For example, the model may fail to account for terrain features that could block a house's reception."[17] (References omitted and emphasis added)

A Commission technical report also states "Terrain features (such as hills), buildings, and land cover (such as forests) have a major effect on the strength of received signals".[18] Since the geolocation concept in the *2nd R&O* is based on databases and calculations at a distant database, there is no reason to require only a simplistic dated propagation model such as R-6602.

The Commission should consider revising the language of this rule to allow the use of more accurate TV signal strength prediction models in the future.[19] Furthermore, if TVBDs have both geolocation ability and sensing ability, the database administrators should be allowed to improve their coverage predictions by incorporating field signal strength observations made by the TVBDs. Such field observations can be used to adjust the propagation model to give accurate predictions of the available TV white space channel in a given area.

Transmitter Identification Requirement - §15.711(e)

This rule section provides,

> (e) Fixed TVBDs shall transmit identifying information. The identification signal must conform to a standard established by a recognized industry standards setting organization. The identification signal shall carry sufficient information to identify the device and its geographic coordinates.

Adaptrum fully supports the concept of transmitter identification requirement of §15.711(e). However as presently drafted the rule creates an incentive for delaying the market adoption of TVBDs through the standardization process and the details of the rule violate the due process provisions of the Administrative Procedures Act and are an unlawful delegation of the Commission's powers to a nongovernmental group.

§15.711 (e) requires that Fixed TVBDs transmit identifying information conforming to a standard established by a recognized industry standards setting organization. This requirement is to ensure that the TVBD can be identified if interference occurs. This

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[17] R&O, Docket 98-201 (February 2, 1999) at para. 67

[18] OET Bulletin Number 72, The ILLR Computer Program, July 2, 2002 at p. 1 (http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet72/oet72.pdf)

[19] One such model is the Individual Location Longley-Rice ("ILLR") model of OET Bulletin Number 72 that the Commission adopted in Docket 98-201 to determine whether consumers had actual access to network affiliates' over-the-air signals when they wished to get such signals from broadcasting satellites such as DirecTV. It is our understanding that this is basic model used for the DTV coverage predictions on the Commission's website - http://www.fcc.gov/mb/engineering/maps/

requirement was not placed on mobile devices since it was expected that the information may be of limited use since the potential interfering TVBD would not easily be located.

The likely effect of the present provision is delaying the practical implementation of the new rules until some action is taken by a nongovernmental group with no relationship to FCC. The use of *specified* industry standards has been used by the FCC before.[20] However, in all such cases those standards established prior to the issuance of specific technical rules.

We petition the Commission to provide an immediate and unbiased solution for providing the indentifying information in order to allow timely implementation of the TVBD rules. Instead of the current provisions in §15.711(e) which relies on an unspecified future standard, the Commission should instead require that TVBDs submitted for equipment authorization use a transmitter identification signal that "carr(ies) sufficient information to identify the device and its geographic coordinates". The format of the signal should then be described in the application and a description of a configuration of commonly available electronic test equipment capable of recording and displaying the identification signal should be included.

Adaptrum supports the concept of a future incorporation by reference of standard signal format of carrying such identification information although we note that the nature of possible ID formats will vary with the signal's physical layer design so that overly narrow regulation in this area will restrict innovation in the physical layer. The incorporating of a specific standard should be done in a notice and comment rulemaking and in accordance with 1 C.F.R. 51.1,11.

We believe that this alternative approach will meet the intent of the rule, be consistent with the law, and allows maximal flexibility moving forward.

Sensing Only Systems - §15.717

Adaptrum applauds the Commission's decision to allow personal/portable TVBDs that rely solely on sensing. As provided in §15.717, the rule states that

- "(d)evices authorized under this section must demonstrate with an extremely high degree of confidence that they will not cause harmful interference to incumbent radio services."

- "The application must include a full explanation of how the device will protect incumbent authorized services against interference"

- "Applications will be placed on public notice for a minimum of 30 days for comments and 15 days for reply comments."

[20] For example, 47 C.F.R. 2.948(b)(8)

> • Public testing "to evaluate proof of performance of the device, including characterization of its sensing capability and its interference potential."
>
> •Then another "minimum" 30 day comment period for any objections -which in view of the record of this proceeding are certain.

While these requirements on sensing only TVBDs are unprecedented, we do not object to them *per se* as they offer a positive conclusion to the rulemaking process of the past 5 years. However what we consider to be overly restrictive is the *a priori* finding that such devices are subject to 50 mW transmission power limit as opposed to the 100 mW permitted for other devices. We note that in the discussion of this new rule in the *2nd R&O* in paras. 257-261 there is no explanation on the 50 mW limit nor any citation of comments addressing this issue. Thus the 50 mW transmission power limit for sensing only personal/portable TVBDs appears to be arbitrary.

In view of the inverse relationship between sensitivity and interference-free power a cognitive radio system can transmit, it is appropriate under the "proof of performance" testing scheme outlined in the rules to incentivize TVBD developers to "push the envelope" in sensor performance. High performance sensors should be allowed higher transmission power than 50 mW as long as it can be demonstrated under the fully open and transparent testing procedures of §15.717(a) that "with an extremely high degree of confidence that they will not cause harmful interference to incumbent radio services".

Cable Headend and Translator Site "Keyhole" - §15.712(b)

§15.712(b) in the *2nd R&O* states,

> (b) Translator receive sites and cable headends. For translator receive sites and cable headends registered in the TV bands database, TVBDs may not operate within an arc of +/-30 degrees from a line between the registered translator or cable headend receive site and the TV station being received within a distance of 80 km from the protected contour for co-channel operation and 20 km from the protected contour for adjacent channel operation. Outside of this +/-30 degree arc, TVBDs may not operate within 8 km from the receive site for co-channel operation and 2 km from the receive site for adjacent channel operation.

While the *2nd R&O* has extensive discussions on the need to protect cable headends and translator sites, it doesn't explain how the specific distance numbers are derived. In particular the need for adjacent channel protection of at least 2 km in all directions and 20 km within +/- 30 degrees of the receive antenna boresight is questionable in view of the data in the FCC Laboratory tests. In particular, the FCC Laboratory Report states:

> "The Adaptrum WSD[21] transmit system (transmitter and supplied antenna) was initially placed at a distance of 12.2 meters (40 feet)from the base of the receive antenna mast along the same radial as the receive antenna boresight and oriented

[21] TVBD in present jargon

> to maximize mainbeam-to-mainbeam coupling (not considering cross-polarization losses). The transmitter was tuned to each of the immediately adjacent channels (29 and 31) and the OFDM signal was transmitted at full power in a 4.5 MHz bandwidth. No interference was observed to the set-top box/DTV receiver while receiving WNVT programming on channel 30."[22]

The report also states that "channel 30 (WNVT-DT in Goldvein, VA, approximately 50-miles distant) was selected as the desired channel for this test. The measured channel power of WNVT-DT was found to vary between -75 and -77 dBm at the test location."[23] This configuration was similar to that commonly used in cable headends and translators except that cable headends and translators usually use narrowband yagi antennas[24] with higher gain and more frequency selectivity than the broadband antenna used by FCC.

To put the reported FCC test in context, one could go to the DTV Reception Map section of the FCC DTV website[25], and enter the Laboratory's address: 7435 Oakland Mills Rd., Columbia, MD 21046. WNVT is shown as a "weak signal" in Columbia MD with an expected strength of -78 dBm.[26] Even with this marginally receivable signal, consumer grade antenna and receiver, a modest 10m antenna height and a worst case geometry in which the Adaptrum prototype was only 12.2m away from the receive antenna and "along the same radial as the receive antenna boresight and oriented to maximize mainbeam-to-mainbeam coupling" there was no interference observed. Generally cable headends and translators are located on either higher towers on in remote locations such as hilltops and are unlikely to have consumers "12.2m" away from their tower base.

In view of the adjacent channel performance of the Adaptrum prototype demonstrated in the test and the subsequent 55 dBc adjacent channel OOBE requirement specified in the rules, strict distance limitations to cable headend and translator sites in the multiple kilometer range for adjacent channel use are unjustified. We fully appreciate the need to protect cable headends and translators from interference from TVBDs, but in view of the standards adopted for OOBE in §15.709(c), the adjacent channel restriction of 2 km is excessive. We propose a 100m[27] protection distance in view of the usual configuration of cable headend and translator sites.

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[22] FCC, Evaluation of the Performance of Prototype TV-Band White Space Devices - Phase II, October 15, 2008, FCC/OET 08-TR-1005 At p. 30
http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-08-2243A3.pdf

[23] *Ibid.*

[24] Typical antennas for headends and translators are the Blonder Tongue BTY-10 Series, http://www.tonercable.com/Files/ProductFiles/530/PDFFile/BT-BTY%20SINGLE.pdf

[25] http://www.fcc.gov/mb/engineering/maps/

[26] Agreeing well with the report's observation of "between -75 and -77 dBm" and confirming that contemporary propagation software give more reliable results that R-6602 methods.

[27] At 600 MHz, free space loss at 100 meter from a TVBD transmitter is 68 dB assuming 0 dBi antennas. With 55 dBc adjacent channel OOBE, the total signal power in the adjacent channel at 100 meter from the transmitter is 123 dB below the TVBD transmission power, which is already close to the thermal noise floor even though we have not considered any other loss mechansim other than free space.

Conclusions

Adaptrum applauds the bold decision the Commission made in the *2nd R&O*. Like the decision it made in Docket 81-413[28] almost 25 years ago that laid the foundation for Wi-Fi, Bluetooth, and a myriad of other products that have changed our world, it is a controversial decision challenged by those who seek to preserve the *status quo* and who fear innovation by others they can not control.

We ask that the Commission examine carefully our requests above that will significantly increase the functionality and practicality of TVBDs to the benefit of all Americans while preserving essential interference protection policies.

/S/

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March 18, 2009

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[28] Report and Order, Docket 81-413, FCC 85-245 (1985)