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

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

COMMENTS OF INTEL CORPORATION

November 30, 2004

EXECUTIVE SUMMARY

Intel commends the FCC for initiating this rulemaking proceeding which proposes to allow unlicensed radio transmitters to operate on unused frequencies in the television ("TV") broadcast spectrum. Intel strongly supports the Commission's proposal as operation by new wireless devices in underutilized portions of the TV broadcast bands would (i) vastly improve spectrum management; (ii) produce substantial public interest benefits; and (iii) not cause harmful interference to authorized users.

First, permitting new wireless devices to share the TV broadcast spectrum would vastly improve spectrum management. Indeed, the traditional spectrum management system – which was developed years ago to accommodate a limited number of TV broadcast licensees – needs to be updated. The rapid proliferation of wireless devices and standards, such as WiFi, and the emergence of WISPs have sparked considerable demand for additional spectrum for wireless products and services in recent years. The FCC correctly proposes to meet this demand by allowing access to the significant underutilized spectrum, or "white space," in the "core" TV broadcast bands – spectrum which is well-suited for sharing with wireless services.

Second, allowing new wireless devices to share the TV broadcast spectrum would generate substantial public interest benefits. It would enhance competition in the broadband marketplace, which would lead to ubiquitously affordable wireless broadband products and services – especially in rural and underserved areas. Moreover, it would incentivize manufacturers to develop new, unlicensed wireless communications products and services capable of exploiting synergisms with existing TV broadcast services and digital television ("DTV"), thereby benefiting both consumers and broadcasters. In

addition, it would spur investment in cognitive technologies and techniques, which could be utilized to improve spectrum management in other bands – thus creating a virtuous cycle for the development and deployment of innovative cognitive products and services.

Third, permitting new wireless devices to share the TV broadcast bands would not cause harmful interference to TV broadcasters or other authorized services. To this end, the Commission offers three methods for determining whether a portion of the TV broadcast spectrum is in use at a specific time and/or location: (i) professional installation/GPS; (ii) sensing; and (iii) control signal. Intel generally supports all three methods – with certain modifications.

Specifically, Intel believes that utilization of the control signal approach by "personal/portable" devices is an appropriate method for avoiding harmful interference to licensed users. Intel, however, opposes Commission proposals requiring such devices to have a permanently attached integral antenna and to automatically and periodically transmit a unique identification signal ("ID"). Intel further asserts that utilization of the sensing approach by "personal/portable" devices is another appropriate method for avoiding harmful interference to licensed users. Intel believes that Dynamic Frequency Selection ("DFS") and Transmit Power Control ("TPC") – two interference mitigation techniques – would, when used with omni directional antennas, effectively protect TV broadcasters from harmful interference from "personal/portable" devices. Intel also asserts that utilization of the professional installation/GPS approach by "fixed/access" devices is an appropriate method for avoiding harmful interference to licensed users. Intel, however, opposes FCC proposals requiring such devices to determine geographic location within 10 meters, permitting the Commission to specify the particular geo-

location technology, and requiring manufacturers to incorporate into their devices mechanisms for tampering detection and device deactivation.

In sum, Intel strongly supports the FCC's plan to allow unlicensed radio transmitters to operate on unused frequencies in the TV broadcast spectrum. Indeed, Intel recommends that the Commission expeditiously modify its Part 15 rules to permit use of the TV broadcast bands by new wireless devices. At a minimum, the rule changes should enable wireless broadband operation in underutilized portions of the TV broadcast spectrum. Intel believes that such modernization of the FCC's spectrum management system is essential to ensure that the Commission's policies evolve with the consumer-driven evolution of new wireless technologies, devices, and services.

Table of Contents

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COMMENTS OF INTEL CORPORATION

I. INTRODUCTION

Intel Corporation ("Intel") hereby submits the following comments in response to the *Notice of Proposed Rulemaking* released in the above-referenced proceeding of the Federal Communications Commission ("FCC" or "Commission").[1] Intel is the world's largest semiconductor manufacturer and a leader in technical innovation. Intel is also a leading manufacturer of communications and networking chips and equipment.

Intel commends the FCC for initiating this rulemaking proceeding which proposes to allow unlicensed radio transmitters to operate on unused frequencies in the TV broadcast spectrum.[2] Intel believes that permitting new wireless devices to operate in

[1] *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* Notice of Proposed Rulemaking, ET Docket Nos. 04-186, 02-380, rel. May 25, 2004 ("*Vacant TV Channels NPRM*").

[2] *Id.* at 2.

underutilized portions of the TV broadcast bands would (i) vastly improve spectrum management; (ii) produce substantial public interest benefits; and (iii) not cause harmful interference to authorized users.[3] Intel believes that expeditious modernization of the FCC's spectrum management system in this manner is essential "to ensure that the Commission's policies evolve with the consumer-driven evolution of new wireless technologies, devices, and services."[4]

II. PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD VASTLY IMPROVE SPECTRUM MANAGEMENT

In order to meet the considerable demand for additional spectrum for new wireless products and services, "[w]e must be willing to get away from the old models and explore new ones."[5] Allowing wireless devices to operate in the underutilized portions of the TV broadcast bands is a prime example of a new, improved model for spectrum management. Indeed, "[w]hile technological advances [in the wireless industry] are contributing to the increased diversity of spectrum-based consumer applications and, consequently their use is resulting in more demand for spectrum, [these same] technological advances are also are also providing some potential answers to current spectrum policy challenges."[6]

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[3] As discussed below, Intel strongly supports the FCC's proposal to share the TV broadcast spectrum. Intel, however, diverges on certain details regarding implementation of the proposal. Intel addresses these minor divergences in its Comments.

[4] Spectrum Policy Task Force Report, ET Docket No. 02-135, Nov. 15, 2002, at 1 ("Spectrum Policy Task Force Report").

[5] Remarks of Michael K. Powell, Chairman, Federal Communications Commission, CTIA Wireless IT & Entertainment Convention, San Francisco, CA, Oct. 26, 2004, at 4 ("Powell CTIA Remarks").

[6] Spectrum Policy Task Force Report at 13.

A. THE TRADITIONAL SPECTRUM MANAGEMENT SYSTEM NEEDS TO BE UPDATED TO MEET THE CONSIDERABLE DEMAND FOR ADDITIONAL SPECTRUM FOR WIRELESS PRODUCTS AND SERVICES

The biggest obstacle facing the coming radio revolution is artificial spectrum scarcity created by over reliance on a "command and control" system of spectrum management.[7] This outdated system was developed years ago to accommodate a limited number of TV broadcast licensees[8] – long before the proliferation of wireless technologies was even contemplated.[9] Such a spectrum management system tends to lock in inefficient uses and inadequately accommodate new technologies.[10]

The rapid proliferation of wireless devices and standards, such as WiFi,[11] and the emergence of WISPs have sparked considerable demand for additional spectrum for wireless products and services in recent years.[12] Indeed, "WiFi technology, unknown

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[7] Statement of Patrick P. Gelsinger, Chief Technical Officer, Intel Corporation, Before the Senate Committee on Commerce, Science and Transportation, June 9, 2004, at 8 ("Gelsinger Statement"). *See also* Spectrum Policy Task Force Report at 14 ("[I]f the Commission were to permit greater access to the radio spectrum, the effects of the physical scarcity of the spectrum resource could be minimized.").

[8] Channels 2-69 were originally allocated to TV broadcasting in 1939-1953. Thomas W. Hazlett, "The U.S. Digital TV Transition: Time to Toss the Negroponte Switch," AEI-Brookings Joint Center for Regulatory Studies, Working Paper 01-15, Nov. 2001, at 2.

[9] *See* Powell CTIA Remarks at 4 ("Over the past four years, the number of wireless subscribers has increased by 50 million, producing a penetration rate of 55 percent of the U.S. population.").

[10] Gelsinger Statement at 8. *See also* Michael Calabrese, Vice President, New America Foundation, *Forum on Spectrum Efficiency and New Technology* at U.S. Department of Commerce, Dec. 9, 2003 (transcript available at http://www.ntia.doc.gov/ntiahome/ntiageneral/specinit/forum1/12092003forumtrasncript.htm) (citing the inefficiency of the current spectrum management system for the TV broadcast bands).

[11] Intel notes that Bluetooth, Zigbee, and Home RF have also contributed to the enormous demand for additional spectrum for wireless products and services.

[12] *Vacant TV Channels NPRM* at 5, 7. *See also* Dr. Sam Bodman, Chief Operating Officer, U.S. Department of Commerce, *Forum on Spectrum Efficiency and New Technology* at U.S. Department of Commerce, Dec. 9, 2003 (transcript available at http://www.ntia.doc.gov/ntiahome/ntiageneral/specinit/forum1/12092003forumtrasncript.htm) (describing the "explosion in wireless voice and data communications systems and the growing demand for spectrum-based technology").

only a few years ago[,] … now provides wireless Internet connections to about 28 million people in [the United States]."[13]

In an effort to meet some of this demand for additional spectrum for wireless services, the FCC recently adopted an innovative sharing approach in the 5 GHz bands that protects sensitive federal government operations from harmful interference, while allowing "smart" short-range unlicensed devices to utilize the spectrum.[14] This update to the traditional spectrum management system is an example of a step in the right direction. However, such new and innovative spectrum management approaches are necessary on a much larger scale in order to keep up with the relentless growth and demands of the wireless marketplace (particularly in rural and underserved areas)[15] – growth and demands which will only intensify as WiMAX and other advanced wireless technologies come to fruition in the near future.[16]

B. THE FCC CORRECTLY PROPOSES TO MEET THE DEMAND FOR ADDITIONAL SPECTRUM FOR NEW WIRELESS PRODUCTS AND SERVICES BY ALLOWING ACCESS TO "WHITE SPACE" IN THE TV BROADCAST BANDS

The Commission proposes to meet the demand for additional spectrum for wireless products and services by amending its rules to permit unlicensed operation in the

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[13] Bodman.

[14] *See generally Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Report and Order, ET Docket No. 03-122, rel. Nov. 18, 2003. Section IV.B. of these Comments discusses cognitive, or "smart," devices in detail.

[15] Spectrum Policy Task Force Report at 1. *See also* Powell CTIA Remarks at 4 ("Spectrum policy, like technology, must stay on the cutting edge. We must be willing to get away from the old models and explore new ones to match the dynamic demands of the industry."); Bodman ("[O]ur policy and legal environment must keep up with the dramatic changes in technology.").

[16] Intel notes that the industry has been collaborating on IEEE 802.16 standards for WiMAX. Intel expects initial WiMAX certified systems to be available in 2005.

underutilized portions – or "white space" – in the "core" TV broadcast channels.[17] Specifically, the FCC proposes to authorize unlicensed operation in the following TV broadcast bands: 76-216 MHz (channels 5-13); 470-506 MHz (channels 14-20); 512-608 MHz (channels 21-36); and 614-698 MHz (channels 38-51).[18] The FCC's proposal is a very fitting solution because (i) there is significant "white space" in the TV broadcast spectrum and (ii) the TV broadcast bands are especially well-suited for sharing with wireless services.

1. There is and Will Continue to Be Significant "White Space" in the TV Broadcast Bands

Under the FCC's current "command and control" system of spectrum management, the TV broadcast spectrum is highly underutilized.[19] Although channels 2 through 69 – a total of 67 channels and 402 MHz – are allocated to TV broadcast service in the United States, the average TV market receives a mere 7 channels and the largest TV market receives only 23 channels.[20] Clearly, there is significant underutilization, or "white space," in the TV broadcast bands.[21]

This substantial "white space" will be present both during and after the DTV transition. In fact, there are and will continue to be a number of "core" channels in any

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[17] *Vacant TV Channels NPRM* at 4. The "core" TV broadcast channels are 2-51 (58 MHz - 698 MHz).

[18] *Id.* at 17-18.

[19] *See id.* at 4 ("[T]here is significant bandwidth available because each TV channel occupies 6 MHz and multiple channels are generally vacant in a particular area."); Comments of New America Foundation, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, April 7, 2003, at 8 ("NAF Comments") ("The broadcast band is famously underutilized."); Calabrese ("[V]ery little of the broadcast spectrum … is in use, particularly in the upper channels.").

[20] Hazlett at 3-4. There is a variance across TV broadcast markets; for example, the largest metropolitan TV market may receive 23 TV broadcast channels, whereas a small rural TV market may receive only one TV broadcast channel. *Id.* at 4.

[21] *See* Spectrum Policy Task Force Report at 14 ("[T]he Commission's current policies do not allow new technologies to take advantage of geographic white space.").

given geographic area that are not being used by analog TV or DTV stations – because full power TV stations cannot operate without causing interference to co-channel or adjacent channel TV stations.[22] This means that there is tremendous bandwidth available for operation by wireless devices – in both less densely populated and more congested areas.[23]

Indeed, even in purported congested areas, there are and will continue to be significant underutilized portions of the "core" TV broadcast spectrum.[24] For example, an Intel examination of the overlapping coverage of multiple TV broadcast stations in the San Francisco Bay area illustrates that there are at least six vacant TV channels between channels 20-51 in this highly congested area.[25] A survey of the same area by Adaptrum, Inc. observes that, "on average, [there is] 20 MHz vacant bandwidth in channels 14-20, 80 MHz in channels 21-36 and 38-51, and 70 MHz in channels 52-69."[26]

The amount of vacant bandwidth in the "core" TV broadcast channels in both less densely populated and more congested areas will only increase as analog TV transmission is phased out. Thus, there is and will continue to be ample "white space" in

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[22] *Vacant TV Channels NPRM* at 7. The minimum required separations between co-channel and adjacent channel TV stations assume maximum power operation. *Id*. However, a wireless transmitter operating at a much lower power would require less separation to avoid causing interference. *Id.* Thus, there are large vacant spaces of more than 100 kilometers between co-channel TV stations – spaces that can be utilized by lower power services requiring interference ranges of less than 50 kilometers. *Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service*, Sixth Report and Order, MM Docket No. 87-268, 12 FCC Rcd 14588, 14816-17 (1997).

[23] *See* Spectrum Policy Task Force Report at 14 ("[S]ignificant spectrum capacity remains untapped.").

[24] *Vacant TV Channels NPRM* at 5.

[25] Letter from Peter K. Pitsch, Intel Corporation, to Marlene Dortch, Secretary, FCC, Notice of Written *Ex Parte* Presentation, August 22, 2003.

[26] Comments of Adaptrum, Inc., *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket No. 02-380, September 1, 2004, at 20.

the TV broadcast bands that could be used for valuable new wireless products and services and last mile broadband solutions.[27]

2. The TV Broadcast Bands are Well-Suited for Sharing with Wireless Services

Various characteristics of the TV broadcast bands make them remarkably well-suited for sharing with wireless devices. First, analog TV operation, including Grade A and Grade B services contours, is well comprehended. Similarly, the industry has become quite familiar with DTV operation after years of extensive research followed by seven years of deployment. Second, the fixed operation of existing TV broadcast stations is precisely documented in the FCC's database such that operators of wireless devices can know the physical location of TV stations and plan operation accordingly.[28] Third, as discussed above, for any given geographic location, there are a number of channels in the TV broadcast spectrum that are not being used by broadcasters. For these reasons, the TV broadcast bands are especially well-suited for sharing with wireless devices.

III. PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD GENERATE SUBSTANTIAL PUBLIC INTEREST BENEFITS

Allowing new wireless devices to share the TV broadcast spectrum would create significant public interest benefits. It would (i) enhance competition in the wireless broadband marketplace and improve service to less densely populated areas; (ii)

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[27] Comments of Information Technology Industry Council, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, April 7, 2003, at 5 ("ITI Comments") (observing that the TV broadcast bands offer ample spectrum for unlicensed devices and last mile broadband solutions).

[28] Intel notes that this characteristic is only applicable to sharing the TV broadcast bands with high power "fixed/access" devices. Section IV.C. of these Comments discusses "fixed/access" devices in detail.

encourage the manufacturing of new products and services complementary and ancillary to TV; and (iii) foster innovation of "cognitive" technologies and techniques.

A. ALLOWING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST BANDS WOULD ENHANCE COMPETITION IN THE BROADBAND MARKETPLACE AND IMPROVE SERVICE TO LESS DENSELY POPULATED AREAS

Permitting wireless devices to share the TV broadcast bands would stimulate further competition in the broadband industry.[29] This increased competition would lead to ubiquitously available and more affordable wireless broadband products and services[30]– particularly in less densely populated areas where "the greater distances between people … can make it difficult for certain types of unlicensed operations [*i.e.*, WISPs and wireless LANs] … to provide adequate signal coverage."[31]

Improvements in wireless broadband service would be possible because the TV broadcast bands offer highly favorable propagation characteristics, including the ability to "pass[] through objects such as buildings, weather, and foliage…."[32] These propagation characteristics would allow wireless devices to serve applications requiring greater range of operation and signal coverage than that afforded to similar devices operating in higher frequency bands.[33] The upshot for some rural and underserved areas

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[29] *Vacant TV Channels NPRM* at 4.

[30] *Id.* at 5-6.

[31] *Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies*, Notice of Proposed Rulemaking and Order, ET Docket No. 03-108, rel. Dec. 30, 2003, at 13 ("*Cognitive Radio NPRM and Order*"). *See also* Remarks of President George W. Bush, American Association of Community Colleges Annual Convention, Minneapolis, MN, Apr. 6, 2004 (available at http://www.whitehouse.gov/news/releases/2004/04/20040426-6.html#) (stating goal of delivering broadband technology to every corner of the United States by 2007).

[32] NAF Comments at 6, 7. *See also* Gelsinger Statement at 12 ("[B]ecause TV frequencies … penetrate walls, they would be less dependent on line of sight transmission to outdoor antennas.").

[33] *Vacant TV Channels NPRM* at 2, 4, 6 n.23, 7. *See also* ITI Comments at 4 (stating that the propagation characteristics of spectrum below 1 GHz could solve some of the current distance and coverage issues

is that opening the TV frequencies to wireless broadband use would likely make the difference between a high quality wireless broadband alternative and none at all.[34]

In addition to improving transmission:

> [t]he ability to use TV frequencies would … reduce the cost … of broadband wireless services. Even when compared to 2.5 GHz frequencies – the best alternative available to WiMAX in the U.S. – the TV frequencies make it far more economical to serve rural areas …. For a given level of quality to a given coverage area, these frequencies require fewer antennas and less power.[35]

For example, Intel estimates that "using 2.5 GHz frequencies … would require 4 to 5 as many base stations to achieve equal geographic coverage, for a given air interface and bandwidth."[36] The impact of these numbers is extremely significant, especially for rural and underserved areas where "the allocation of [TV broadcast] frequencies for … unlicensed use could dramatically accelerate broadband deployment …."[37]

In recent years, the FCC has become increasingly focused on providing wireless broadband service to such areas. In 2002, the Spectrum Policy Task Force recommended ways to improve spectrum access in rural areas.[38] In 2003, the Commission adopted measures to increase spectrum access in rural areas.[39] In October 2004, the Wireless

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associated with unlicensed broadband devices).

[34] Gelsinger Statement 12-13.

[35] *Id.* at 10-11.

[36] *Id.* at 12. *See also* Chris Knudsen, Vulcan Capital, "Lower Frequencies Improve the Subscriber Operating Model," WCA Convention, Washington, D.C., June 3, 2004 (concluding that using the 700 MHz TV band to provide wireless broadband service in Bellevue, Washington – as opposed to the 2.6 GHz band – requires one-third to one-quarter of cell sites and one-half to one-third of capital).

[37] Gelsinger Statement at 12-13.

[38] *See* Spectrum Policy Task Force Report at 58.

[39] *See generally Facilitating the Provision of Spectrum-Based Services to Rural Areas and Promoting*

Bureau launched the "Rural Wireless Community VISION Program," a contest in which the FCC and the Rural Utilities Service will assist winning communities with wireless broadband deployment.[40] Intel believes that permitting wireless devices to share the TV broadcast bands would provide a very effective solution for such deployment.

B. PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD INCENTIVIZE MANUFACTURERS TO DEVELOP COMPLEMENTARY AND ANCILLARY PRODUCTS AND SERVICES

Intel asserts that allowing wireless operation in the TV broadcast spectrum would provide enormous incentive to develop new, unlicensed wireless communications devices and systems[41] – including those capable of exploiting synergisms with existing TV broadcast services. Indeed, "new unlicensed broadband operations may provide synergy with traditional broadcast operations and offer broadcasters the opportunity to provide new services."[42] Moreover, allowing unlicensed devices to share the TV broadcast bands would incentivize manufacturers to create complementary and ancillary products and services,[43] which could very well accelerate the DTV transition.

In this manner, both consumers and broadcasters would benefit as additional means of receiving DTV signals enter the marketplace. "Existing broadcasters will …

Opportunities for Rural Telephone Companies to Provide Spectrum-Based Services, Report and Order and Further Notice of Proposed Rulemaking, WT Docket No. 02-381, rel. Sept. 27, 2004.

[40] "Wireless Bureau Announces VISION Program for Rural Broadband," *Telecom A.M.*, Warren Communications News, Vol. 10, No. 200, Oct. 18, 2004.

[41] *Vacant TV Channels NPRM* at 4.

[42] *Id.* at 2.

[43] *See* Comments of Consumer Electronics Association, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, April 7, 2003, at 7 ("CEA Comments") ("If the Commission allows unlicensed use of vacant TV channels it could provide a win-win for broadcasters, TV [set] manufacturers, and new 700 MHz licensees by enabling and providing support for new service, including some which are complementary to DTV.").

find benefits as they explore more advanced television services."[44] Additionally, consumers will benefit as increased competition among wireless broadband providers enables interactivity through a return path for broadcast stations or wireless video program home distribution.[45]

C. ALLOWING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD FOSTER INNOVATION OF COGNITIVE TECHNOLOGIES AND TECHNIQUES

Permitting cognitive devices to share the TV broadcast bands would provide enormous incentive for manufacturers to advance cognitive technologies and techniques.[46] Indeed, history has shown that, when the FCC opens "new" spectrum, manufacturers embrace the technology that is authorized to operate in the newly available spectrum, thereby causing that technology to grow exponentially. The development of WiFi technology provides the most recent example of this phenomenon. WiFi, which started as a 2 megabits per second ("Mbps") industry standard just seven years ago, is now a 54 Mbps standard[47] – and is likely to become a 150 Mbps standard in the near future.[48]

The authorization of access to vacant TV broadcast channels via cognitive devices would spur similar dramatic research and development ("R&D") investment in cognitive technologies and techniques. These technologies could then be utilized to improve

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[44] Statement of Michael K. Powell, Chairman, Federal Communications Commission, *Vacant TV Channels NPRM.*

[45] CEA Comments at 7.

[46] Section IV.B. of these Comments discusses "cognitive" devices in detail.

[47] IEEE 802.11g is the 54 Mbps industry standard for WiFi.

[48] Intel notes that engineers are in the process of developing, IEEE 802.11n, a 150 Mbps standard for WiFi.

spectrum management in other bands, which would further incentivize R&D investment – thus creating a virtuous cycle for the development and deployment of innovative cognitive products and services.

IV. PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST BANDS WOULD NOT CAUSE HARMFUL INTERFERENCE TO AUTHORIZED SERVICES

The Commission asserts that, "with appropriate safeguards, it would be possible to allow unlicensed operation in the TV bands without causing … harmful interference to television services, disrupting the DTV transition, or adversely affecting other services that use [the TV broadcast spectrum]."[49] To this end, the FCC states that an unlicensed device sharing the TV broadcast spectrum must be able to determine whether a TV broadcast channel is in use before it transmits.[50]

The Commission notes that such technologies already exist[51] and offers "three methods that could be used to determine whether a portion of the TV broadcast band is in use at a specific time and/or location."[52] The three methods are: (i) professional installation/GPS, whereby the location of an unlicensed device could be determined by a

[49] *Vacant TV Channels NPRM* at 7. *See also* CEA Comments at 3-4 (stating that there is capacity in the TV broadcast bands that could be used if unlicensed devices are built with new technologies appropriate for preventing interference); ITI Comments at 4 (asserting that the use of the TV broadcast bands by unlicensed devices is feasible).

[50] *Vacant TV Channels NPRM* at 8.

[51] *See id.* ("[T]here are technical options now available that make it feasible for new types of unlicensed equipment to share spectrum in the TV bands without causing harmful interference to TV broadcast or other licensed services ….") Some in the industry assert that "the technology required to implement the kinds of [spectrum] sharing mechanisms envisioned [here] are quite modest compared to the technology already incorporated in radio devices today." Comments of Software Defined Radio Forum, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, April 7, 2003, at 6.

[52] *Vacant TV Channels NPRM* at 9-10.

professional installer or geo-location technology incorporated within the device; (ii) "sensing," whereby an unlicensed device has the capability to detect whether other transmitters are operating in an area; and (iii) "control" signal, whereby an unlicensed device receives information transmitted by an external source indicating which channels are available at its geographic location.[53]

The FCC then proposes to divide unlicensed broadband devices into two general functional categories for the purpose of developing interference protection criteria in the TV broadcast bands. The two categories are: (i) low power "personal/portable" devices and (ii) high power "fixed/access" devices.[54] Low power "personal/portable" devices include, but are not limited to, products such as WiFi cards in laptops and wireless LANs in the home.[55] High power "fixed/access" devices consist of those generally operated from a fixed location which may be used to provide a commercial service such as wireless broadband Internet access.[56]

Finally, the Commission proposes that "personal/portable" devices sharing the TV broadcast bands employ the "control" signal approach and that "fixed/access" devices sharing the TV broadcast bands employ the professional installation/GPS approach.[57] Intel generally supports these proposals – with certain modifications. In particular, Intel provides a detailed technical analysis, link budget, and proposed rules that would enable

[53] *Id.*

[54] *Id.* at 9.

[55] *Id.*

[56] *Id.*

[57] *Id.* at 10, 13.

"personal/portable" devices employing the "sensing" approach to share the TV broadcast bands.[58]

A. UTILIZATION OF THE "CONTROL" SIGNAL APPROACH BY LOW POWER "PERSONAL/PORTABLE" DEVICES IS AN APPROPRIATE METHOD FOR AVOIDING HARMFUL INTERFERENCE TO LICENSED USERS

As noted above, the FCC proposes to permit low power "personal/portable" devices to transmit only after receiving a "control" signal that positively identifies which TV broadcast channels are available for use.[59] Intel believes that the "control" signal method is one effective way to prevent harmful interference from "personal/portable" devices sharing the TV broadcast bands.[60]

Intel generally supports the FCC's proposed technical specifications for "personal/portable" devices – with minor modifications. Intel agrees that "personal/portable" devices should transmit and update control signal information on a daily basis to take into account changes in TV broadcast station operations that arise due to the DTV transition and the commencement of new stations.[61] Intel also agrees that the maximum output power of "personal/portable" devices should be limited to 100 milliwatts.[62]

Intel recommends two minor changes to the FCC's proposed technical specifications for "personal/portable" devices utilizing the "control" signal approach.

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[58] *See generally* Technical Analysis of Intel Corporation, Nov. 2004 (attached as Appendix A) ("Appendix A").

[59] *Vacant TV Channels NPRM* at 10.

[60] As discussed in Section IV.B. of these Comments, Intel believes that the "sensing" approach is another highly effective method for preventing harmful interference from "personal/portable" devices sharing the TV broadcast bands.

[61] *Vacant TV Channels NPRM* at 10.

[62] *Id.* at 11; Appendix A at 5-6; Proposed Rule Changes at 2 (attached as Appendix B) ("Appendix B").

First, Intel opposes the FCC's proposal requiring "personal/portable" devices to have a permanently attached integral antenna.[63] Intel believes that such antennas should not be permanently attached because optimal external placement of antennas will improve functionality. Also, permanently attached antennas may create product design and implementation issues. Second, Intel opposes the Commission's proposal requiring "personal/portable" devices to automatically and periodically transmit a unique ID.[64] Intel contends that, because the transmissions of "personal/portable" devices are relatively local, detection of an interfering device would be limited to immediate neighbors, making the automatic and periodic transmission of a unique ID overly burdensome under the circumstances. Additionally, the transmission of a unique ID in this scenario would have privacy implications because "personal/portable" devices might be linked to individuals, rather than businesses.

B. UTILIZATION OF THE "SENSING" APPROACH BY LOW POWER "PERSONAL/PORTABLE" DEVICES IS AN APPROPRIATE METHOD FOR AVOIDING HARMFUL INTERFERENCE TO LICENSED USERS

As the FCC notes, another method for determining whether a portion of the TV broadcast spectrum is in use at a specific time and/or location is the "sensing" approach.[65] The Commission has recognized that "[s]pectrum sensing may be appropriate in bands … where services may transmit for long periods of time, *e.g.*, broadcast type services, and sensing techniques would not need to be repeated frequently to be effective."[66] Intel agrees with the FCC and highly recommends the "sensing" approach – or a similar

[63] *Contra Vacant TV Channels NPRM* at 11.

[64] *Contra id.*

[65] *Id.* at 10.

[66] *Cognitive Radio NPRM and Order* at 10.

"cognitive" or "smart" technology approach – for avoiding harmful interference from low power "personal/portable" devices sharing the TV broadcast bands.

Indeed, devices with "sensing" or cognitive radio technologies are able "to determine their location, sense spectrum use by neighboring devices, change frequency, adjust output power, and even alter transmission parameters and characteristics."[67] As a result, cognitive radio technologies "open spectrum for use in space, time, and frequency dimensions that until now have been unavailable."[68] Thus, devices utilizing "sensing" or cognitive radio technologies "have the potential to vastly improve the efficiency of spectrum usage at a time when the demand for wireless communications is rapidly increasing."[69]

A comprehensive technical analysis by Intel clearly demonstrates that the "sensing" approach is a highly effective method for determining whether a TV broadcast channel is in use. Specifically, Intel asserts that DFS and TPC – two interference mitigation techniques – would, when used with omni directional antennas,[70] effectively protect TV broadcasters from harmful interference from "personal/portable" devices.[71] DFS enables a radio transmitter to dynamically select a vacant TV broadcast frequency in

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[67] *Id.* at 2. *See also* Spectrum Policy Task Force Report at 14 (stating that cognitive radio devices can search the TV broadcast spectrum, sense the environment, and operate in spectrum not used by others).

[68] *Cognitive Radio NPRM and Order* at 2.

[69] *Id.* at 5. *See also id.* at 2 ("Smart radio technologies can enable better and more intensive access to spectrum."); *id.* at 4 (stating that cognitive radio technologies "hold tremendous promise in helping to facilitate more … efficient access to the spectrum"); *id.* at 8 ("Cognitive radio technologies have the potential to … increase[] access to the spectrum …."); Gelsinger Statement at 6 (stating that smart radios can "alter their operating parameters to make the most efficient use of the available frequencies").

[70] The antenna(s) used for transmitting and sensing are required to have identical patterns within in +/- 1 dB and the maximum gain in any direction is not to exceed 1 dBi. Appendix B at 3.

[71] *See* Appendix A at 1-6 (providing technical data to show that DFS and TPC would effectively prevent harmful interference to broadcasters from "personal/portable" unlicensed devices).

order to avoid co-channel operation with TV broadcasters.[72] TPC enables a device to dynamically transmit at different power levels in order to prevent harmful interference to TV broadcast stations.[73] Intel has developed a detailed link budget for determining safe detection threshold values for "personal/portable" devices.[74] (Intel believes that the threshold values it has chosen for "personal/portable" devices operating in the TV broadcast bands would rectify the "hidden node" problem because reliable detection is feasible at these values.[75])

Furthermore, radio transmitters with "sensing," or cognitive, capabilities are already in use in various bands. For example:

> Some radios such as wireless LAN devices and CDMA networks [voluntarily] incorporate cognitive capabilities to allow more efficient spectrum use…. There are other devices that the Commission's rules require to have cognitive capabilities. For example, … cordless phones operating in the 43.71-44.49 MHz band are required to incorporate an automatic channel selection mechanism that prevents establishment of a communications link on any occupied frequency in this band. Similarly, unlicensed PCS devices are required to monitor the spectrum prior to transmission to avoid interference to other unlicensed PCS devices. Further, Unlicensed National Information Infrastructure (U-NII) devices operating in the 5.25-5.35 GHz and 5.47-5.725 GHz bands are required to incorporate

[72] Although there are multiple methods to detect vacant TV channels, Intel believes that the simplest method for preventing harmful interference is pilot tone detection using a narrow band filter. Appendix A at 1.

[73] Intel believes that utilization of TPC based on the lower power in either of the adjacent channel signals can reduce the potential for interference from "personal/portable" devices. Appendix A at 3. TPC has long been incorporated into various communications systems and devices. *Cognitive Radio NPRM and Order* at 11.

[74] Appendix A at 6. Intel agrees with the FCC's establishment of protection contours for TV broadcast services.

[75] Appendix A at 5-6. "The hidden node problem refers to the case of a signal that reaches a desired receiver near the sensor, but is undetected at the sensor due to local terrain features…." *Cognitive Radio NPRM and Order* at 10 n.35.

> dynamic frequency selection and transmit power control to avoid interference to Federal Government operations.[76]

Moreover, DFS and TPC are the basis for a recent World Radio Conference resolution which established new frequency allocations to the mobile service in the bands 5 150-5 350 MHz and 5 470-5 725 MHz for the implementation of wireless access systems including radio LANs.[77]

C. UTILIZATION OF THE PROFESSIONAL INSTALLATION/GPS APPROACH BY HIGH POWER "FIXED/ACCESS" DEVICES IS AN APPROPRIATE METHOD FOR AVOIDING HARMFUL INTERFERENCE TO LICENSED USERS

As noted above, the FCC proposes that high power "fixed/access" devices sharing the TV broadcast spectrum utilize the professional installation/GPS approach to avoid harmful interference to TV broadcast stations.[78] Specifically, the Commission proposes to allow "fixed/access" unlicensed devices to operate under the same technical provisions as digital transmission systems that operate under Section 15.247 of the FCC's rules.[79] Intel believes that "these power levels are sufficient to be useful for WISPs and other wireless networking applications and will ensure that these devices can successfully share the TV spectrum" without causing harmful interference to authorized users.[80] Intel notes

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[76] *Cognitive Radio NPRM and Order* at 5.

[77] World Radio Conference Resolution COM5/16, International Telecommunications Union, July 2003. Specifically, the World Radio Conference 2003 ("WRC03") resolved that, in the bands 5 250-5 350 MHz and 5 470-5 725 MHz, systems in the mobile service shall either employ TPC to provide, on average, a mitigation factor of at least 3 dB on the maximum average output power of the systems, or if the transmitter power control is not in use, then the maximum EIRP shall be reduced by 3 dB. *Id.* at Resolve 7. WRC03 also resolved that, in the bands 5 250-5 350 MHz and 5 470-5 725 MHz, DFS shall be implemented by systems in the mobile service to ensure compatible operation with radio determination systems. *Id.* at Resolve 8; Recommendation ITU-R M.1652.

[78] *Vacant TV Channels NPRM* at 13.

[79] *Id.* at 12; 47 C.F.R. § 15.247(b)(3) (providing rules regarding maximum peak output power for frequency hopping and direct sequence spread spectrum intentional radiators).

[80] *Vacant TV Channels NPRM* at 12. Intel notes that, when utilizing the professional installation approach,

that the FCC's proposal for "fixed/access" devices is similar to that which has been employed for 30 years by Low Power TV stations operating on channels 14-20 in order to avoid harmful interference to land mobile services.[81]

Intel generally agrees with the FCC's proposed technical specifications for "fixed/access" devices – with a few minor exceptions. Intel believes that, professional installation, where a qualified individual uses well-defined spectrum criteria, is a time-tested and effective method of preventing harmful interference.[82] Intel also concurs with the Commission's proposal to require "fixed/access" devices to automatically and periodically transmit a unique ID.[83] Intel believes that, because "fixed/access" devices are authorized to operate at higher powers and are not restricted to local operation, the automatic and periodic transmission of a unique ID could help detect a potentially interfering device.

Intel recommends three minor changes to the FCC's proposed technical specifications for "fixed/access" devices sharing the TV broadcast spectrum. First, with respect to determining geographic location, Intel believes that a minimum accuracy of 100 meters – as opposed to the 10 meters suggested by the Commission – is more than adequate to protect licensed services.[84] In fact, 100 meters represents only two percent of the protection distance currently needed for 100 milliwatt operation and thus is well

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the installer must measure the adjacent channel power and set the transmitter power accordingly in order to avoid harmful interference to TV broadcast stations.

[81] *Id.* at 18; 47 C.F.R. § 74.709 (providing rules for land mobile station protection).

[82] *Vacant TV Channels NPRM* at 13.

[83] *Id.* at 12-13.

[84] *Contra id.* at 13.

within the safety margin. Moreover, an accuracy requirement of 10 meters would impose an undue cost burden on manufacturers who would likely pass this burden on to consumers by increasing prices for "fixed/access" devices. Second, while Intel believes that "fixed/access" devices could be safely constructed using geo-location technology,[85] Intel suggests that the FCC specify only the required accuracy, not the particular geo-location technology. Third, Intel opposes a requirement that manufacturers of "fixed/access" devices incorporate into their products a means to detect tampering and to deactivate the device in the event of tampering.[86] Intel believes that the devices' software should be protected from malicious modification, but that it is prohibitively costly, unnecessary, and impractical to require manufacturers to make the devices' hardware tamper resistant.

[85] *Id.*

[86] *Contra id.* at 20. Intel, however, supports all other security requirements proposed in the *Vacant TV Channels NPRM*.

V. CONCLUSION

For the reasons set forth above, Intel recommends that the Commission expeditiously modify its Part 15 rules to permit use of the TV broadcast bands by new wireless devices.[87] At a minimum, the rule changes should enable wireless broadband operation in underutilized portions of the TV broadcast spectrum.

Respectfully submitted,

By: \s\ Marjorie J. Dickman
Marjorie J. Dickman
Senior Attorney, Government Affairs
Intel Corporation
1634 I Street NW, Suite 300
Washington, D.C. 20006

Mike Chartier
Director of Regulatory Policy
Corporate Technology Group

Jeffrey Schiffer
Co-Director, Wireless Research
Communications and Interconnect Tech. Lab.

Alan Waltho
Senior Staff Engineer
Wireless Technology Development

[87] *See generally* Appendix B (proposing rule changes to 47 C.F.R. Part 15.244, *Operation Within the Bands 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz*).

APPENDIX A

TECHNICAL ANALYSIS

OF

INTEL CORPORATION

November 2004

Intel believes that the use of dynamic frequency selection ("DFS") and transmit power control ("TPC") techniques are completely adequate to protect broadcast television services from harmful interference from low power "personal/portable" unlicensed devices. Appendix A discusses in detail: (i) DFS; (ii) TPC; (iii) the detection threshold for low power devices; and (iv) out of band emissions.

DYNAMIC FREQUENCY SELECTION OF VACANT TV CHANNELS

Intel believes that multiple methods of Dynamic Frequency Selection ("DFS") are available to detect vacant TV channels. Methods for detecting pilot signals in a 6 MHz channel include the narrow band filter approach and the digital signal processing ("DSP") approach. Intel believes that the pilot tone detection approach using a narrow band filter is the simplest method of feature detection that can be used for both DTV and NSTC.

Narrowband filter approach. Utilizing this approach, if you go from a 6 MHz bandwidth, to a 3 KHz bandwidth, you can achieve a 33 dB ($10*\log_{10}$[6 MHz/3 KHz] = 33 dB) reduction in the noise floor, which is equivalent to a 33 dB processing gain (*i.e.*, improvement in receiver sensitivity).

DSP approach. For example, utilizing the DSP approach and performing a fast Fourier transform ("FFT") across the band of interest, the following equations/results apply:

1. Sampling rate/FFT size = BIN width; 26.9 MHz/256 = 105.08 KHz width

2. Using the equation derived for the narrow band approach, this result in a 17.5 dB processing gain (*i.e.*, $10*\log_{10}[6\text{ MHz}/105.08\text{ KHz}] = 17.5$ dB).

3. By averaging over a number of segments, we can also increase the processing gain (*i.e.*, if we average the FFT over 1 millisecond, we get $10*\log_{10}[105] = 20.2$ dB).

4. We then can add the two processing gains to achieve the final result: 17.5 + 20.2 = 37.7 dB total processing gain for the system

Multipath fading issues. Various models can be used to calculate the probability of the pilot tone signal at the unlicensed device being deeply faded with respect to the signal at the TV receiver. Very deep fading occurs when the signal at the antenna is the vector sum of two multipath signal components with the same amplitude, but opposite in phase. In more complex multipath environments, fading depth has been quantified by Bullington to be less than 19 dB for 99 percent of occurrences over 50 to 70 kilometer paths.[88]

System sensitivity can be increased through the use of a reduced filter bandwidth or other noise averaging techniques to address the fade depth applicable to any desired probability of detection. The consequence of this increased sensitivity is that, under more benign conditions, detection of very distant TV stations will occur.

An alternative to increasing the detection sensitivity is to use diversity. By using simple antenna diversity, the fade depth for a narrow band pilot tone can be reduced to less than 6 dB for a separation of antenna phase centers of only 2 centimeters. Detection of NTSC is much less vulnerable to deep narrow band fading effects since the NTSC signal includes additional high level pilot tones that can be exploited using frequency diversity to avoid the effects of deep fading.

[88] ITT Reference Data for Radio Engineers.

TRANSMIT POWER CONTROL

Intel believes that potential adjacent channel interference to TV broadcast receivers from low power unlicensed devices can be further reduced by transmit power control ("TPC") based on adjacent channel signal level detection.

The initial and subsequent scans of all channels conducted using techniques such as those described above will identify the power level in occupied adjacent channels even in the least favorable scenarios. This adjacent power level is then used to control the transmitter power.

Favorable scenario – At the DTV Grade B Service Contour. At the DTV Grade B service contour, the DTV signal level at an unlicensed receiver located indoors near a window would be:

-83 dBm[89] – 10 (antenna gain correction factor) – 6 (average building loss) =

-99 dBm (or -110 dBm for DTV pilot tone)

Under this scenario, the DTV pilot tone can easily be used to measure the power received and to control the unlicensed transmitter power accordingly at "X" dB above the level of the detected signal. The value of "X" is derived by considering the total power received from the unlicensed device at a DTV receiver operating on the adjacent channel via a 10 dB outdoor antenna. The slant range to the outdoor antenna at a height of 8 meters above the unlicensed device antenna is 30 meters and the free space path loss is 57 dB. The required D/U is -26 dB. Hence, the maximum allowable transmitter power ("Tx power") is:

[89] This calculation uses the value of -83 dBm based on assumptions used in the FCC's DTV allotment plan.

-83 dBm – (-26 dB) + path loss (57 dB) – antenna gain (10 dB) = -10 dBm

Where Tx power = minimum usable adjacent channel signal + "X":

"X" = -10 dBm – (-99 dBm) = 89 dB with respect to the adjacent channel signal power detected by the unlicensed receiver or 100 dB above the adjacent channel pilot tone.

This gives the required D/U of -26 dB. From this, it is recommended that radiated power control be used in which the actual radiated power is 100 dB above the weaker of the usable pilot carrier levels detected in either of the two adjacent channels.

Less favorable scenarios. In less favorable scenarios (*e.g.*, multipath fades, building penetration losses, etc.), the detected pilot tone would appear as a lower signal, thus reducing the transmitter power. Although this would reduce the performance of the unlicensed system, it would be fail safe with respect to TV interference.

When the signal in either or both of the adjacent channels is below the usable TV signal threshold, the unlicensed device would control the transmit power in accordance with the rules shown in Tables 1 and 2 below.

DETECTION THRESHOLD VALUES FOR LOW POWER DEVICES

The following is a detailed analysis and link budget for determining safe threshold values for detecting unused channels for use by low power unlicensed devices.

Table 1 summarizes the parameters assumed for a TV receiver.

Table 1: DTV Receiver Parameters

Receiver	Parameters
Minimum usable signal at the DTV TV receiver (-83 dBm)	-83 dbm
The required signal to co-channel interference ratio of the TV signal to be protected	23
DTV Receiver co-channel interference threshold protection	-106 dbm
The gain of the DTV receiver antenna with respect to the antenna of the unlicensed device	+10
Receive frequency (MHz)	600

Table 2 summarizes the parameters for the non-fixed unlicensed device.

Table 2: Unlicensed Device Parameters

Unlicensed Device	Parameters
Maximum transmit EIRP when receiving signal at detection threshold (100 mW)	+20 dBm
Detection receiver bandwidth (kHz)	1
Antenna Gain (dBi)	0 dB

Link Budgets. The following steps detail the link budget for determining safe threshold values for detecting unused channels for use by low power unlicensed devices.

Step 1: Determine the separation distance needed between a 100 mW unlicensed device and a potential victim receiver.

Link Budget	Values
Unlicensed device transmit power (100 mW)	20 dBm
Receiver interference protection threshold	-106 dBm
Loss needed between unlicensed device and each victim receiver (20 dBm - -106 dBm)	126 dB
Average building losses	6 dB
Off axis DTV antenna gain	-14 dB
Loss needed to be attributed to path loss at 600 MHz (126 dB – 6-14 dB)	106 dB[90]
Free space interference range outside of Grade B service contour	8 km

Step 2: Determine the detection threshold to protect potential victim receiver from a 100 mW unlicensed device.

Link Budget	Values
DTV signal at Grade B service contour	-83 dBm
Excess path loss at 8 km beyond DTV service contour[91]	2 dB
Antenna gain differential	-10 dB
Building loss due to walls, antenna height, and multipath	-23 dB
Power level of feature detected relative to DTV signal	-11 dB
Required pilot tone detection threshold to protect DTV Receiver	-129 dBm

[90] This value (*i.e.*, 106 dB) is adjusted to correct for average building losses and backdoor antenna gain.

[91] ITU P.1546-1.

OUT OF BAND EMISSIONS

Other than in the 6 MHz channel on which the device is operating, out of band emissions (as defined in the *NPRM*) are required to comply with Part 15.209.[92] Part 15.209 is intended to specify the emissions at frequencies well removed from the intended channel and would be unduly restrictive if applied to the adjacent channel. Intel believes that, in order to protect TV channels other than the co-channel on which the device is operating, the out of band emissions should be a total of 49 dB below the peak power at which the unlicensed transmitter is operated.

At other frequencies, the requirements of Part 15.209 would be applicable. For "fixed/access" unlicensed devices, which would be subject to (i) the general requirements of Part 15.209 to not cause harmful interference and (ii) the proposed requirements to ensure that the D/U ratios for acceptable TV service are always maintained,[93] the above mask should be more than adequate.

Within the UHF TV band that is most likely to be used by "personal/portable" devices, Intel proposes that transmitter power be controlled to prevent saturation of DTV receivers in close proximity. Figure 1 shows the transmitter power as a function of distance from a TV station and hence the desired signal strength. Figure 1 shows that, when the unlicensed device is near the edge of the Grade B contours, the transmitter power reduces to -10 dBm.

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[92] 47 C.F.R. § 15.209.

[93] *Vacant TV Channels NPRM* at 16.

Figure 1. Transmitter power levels from "personal/portable" devices required to protect DTV receivers from saturation.

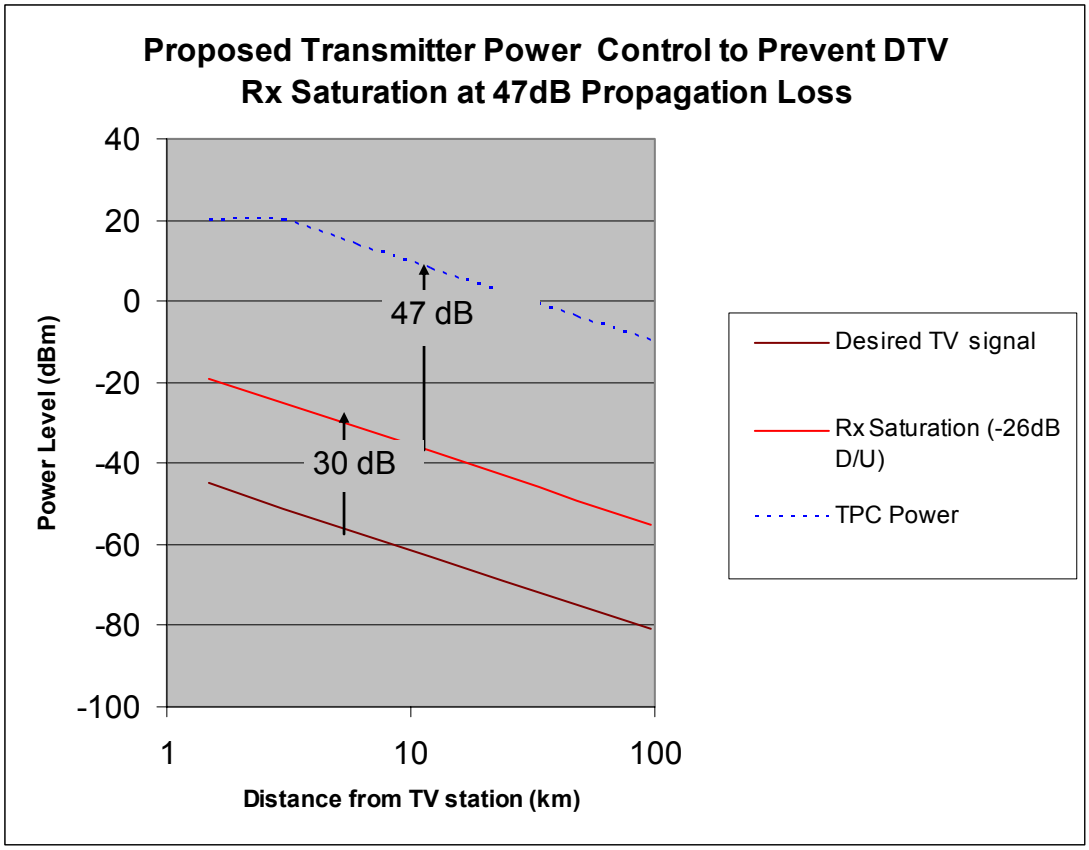
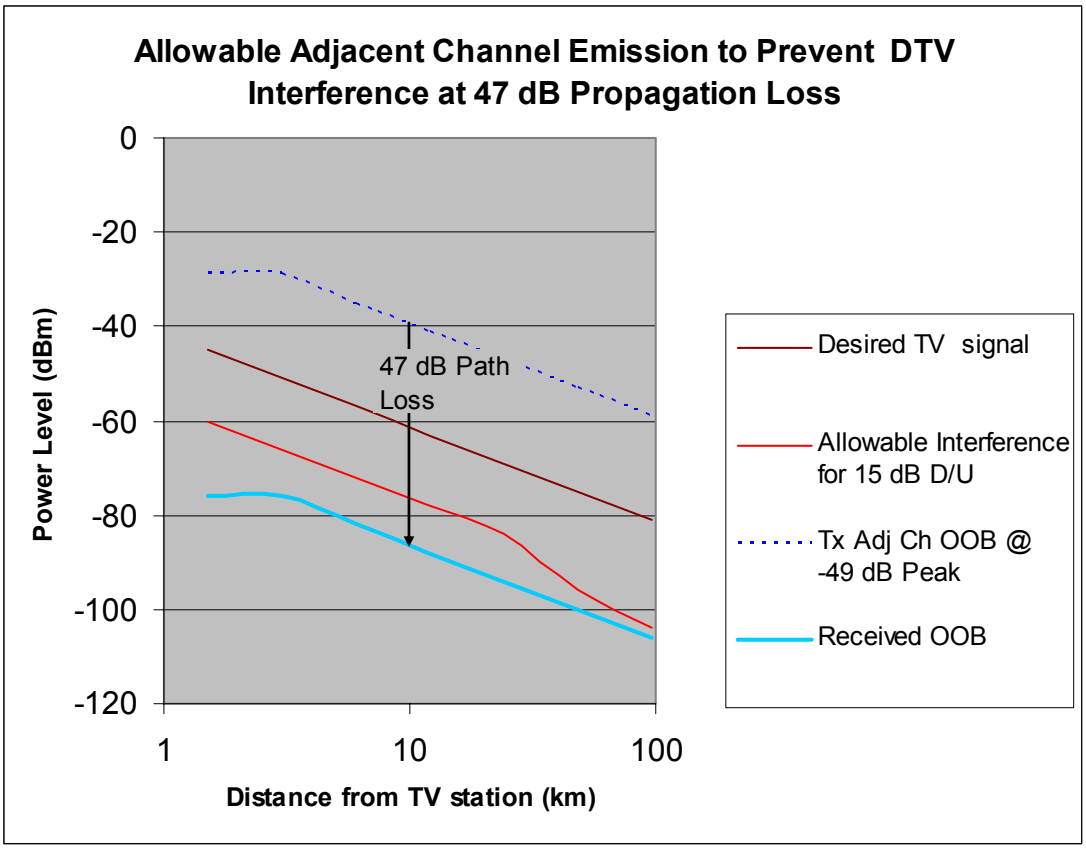


Figure 2 illustrates the susceptibility of DTV receiver to co-channel interference (*i.e.*, the interference due to out of band emissions from the unlicensed device) due to a propagation loss of 47 dB. With a relative level of adjacent channel emissions at -49 dB, a power level of -10 dBm, and allowing for 47 dB path loss, the emissions as seen at the TV receiver are -104 dBm and results in no discernible degradation. In practice, if the relative out of band emissions applicable at -10 dBm are maintained as the transmitter output is increased, the DTV receiver is protected by the TPC at all locations within the Grade B contour. Intel believes that, in order to protect TV channels other than the co-

channel on which the device is operating, the out of band emissions of "personal/portable" devices should be a total of 49 dB below the peak power at which the unlicensed transmitter is operated. At other frequencies, the requirements of Part 15.209 would be applicable.

Figure 2. Allowable emissions from "personal/portable" devices in the adjacent channel.



APPENDIX B

PROPOSED RULE CHANGES

Based on the analysis in Appendix A, Intel proposes the following changes to Section 15.244 of the Commission's rules, *Operation Within the Bands 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz for Fixed Operation and 470-608 MHz and 614-698 MHz for Personal/Portable Operation*:

(d) In the first adjacent channels outside the channel(s) in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 49 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either an RF conducted or radiated measurement. Attenuation below the general limits specified in §15.209(a) is not required. Radiated emissions that fall outside the first adjacent and TV broadcast channel(s) where the device operates must comply with the radiated emission limits specified in §15.209(a).

(f) An intentional radiator used for "personal/portable" operation must comply with one of the following subparagraphs:

> (1) It must be capable of receiving a control signal from an unlicensed transmitter, or a TV or FM broadcast station indicating which TV channel(s) are vacant within the service area of the unlicensed transmitter, TV, or FM station. The intentional radiator must transmit only on channels that are designated as vacant. The intentional radiator shall not operate if no unoccupied frequency band is available within its frequency range of operation or if it does not detect any unlicensed transmitters, FM, or TV broadcast stations transmitting channel availability information. Communications between unlicensed devices can take place on occupied channels as long as they are short non-interfering transmissions such as those used for handshaking and control purposes.
>
> (2) The "personal/portable" device shall employ active interference avoidance mechanisms to detect active broadcast stations:
>
> > (i) It must employ DFS and cease operation upon detection of a received DTV signal level (R_{SS}) of -118 dBm (equivalent pilot tone level of -129 dBm), and a received NTSC signal level (R_{SS}) of -96 dBm.
> >
> > (ii) It must employ a TPC mechanism that is able to limit transmit power per the tables below:

Table A: TPC (DTV signal)

Lower adjacent channel signal	**Higher adjacent channel Signal**	**Unlicensed device power limit**
Below threshold of usable signal in adjacent channel	Below threshold of usable signal in adjacent channel	100 mW
Below threshold of usable signal in adjacent channel	DTV pilot above threshold of usable adjacent channel	100 dB above DTV detected pilot signal of higher power adjacent channel
DTV pilot above threshold of usable adjacent channel	DTV pilot above threshold of usable adjacent channel	100 dB above threshold of lower power adjacent channel

Table B: TPC (DTV and NTSC signals)

Lower adjacent channel Signal	**Higher adjacent channel Signal**	**Unlicensed device power limit**
Below threshold of usable adjacent channel	NTSC Carrier above threshold of usable adjacent channel	33 dB above NTSC carrier signal of higher power adjacent channel
DTV pilot above threshold of usable adjacent channel	NTSC Carrier above threshold of usable adjacent channel	100 dB above DTV detected pilot signal of lower power adjacent channel
NTSC Carrier above threshold of usable adjacent channel	DTV pilot above threshold of usable adjacent channel	The lesser of 100 dB above DTV detected pilot signal of higher power adjacent channel or 33 dB above the NTSC carrier power in lower adjacent channel
NTSC Carrier above threshold of usable adjacent channel	NTSC Carrier above threshold of usable adjacent channel	33 dB above NTSC carrier signal of lower power adjacent channel

Note: Useable signal threshold for DTV pilot tone is -110 dBm and for NTSC carrier -74 dBm.

(iii) The device must use an omni directional antenna with a nominal gain of 0 dBi. The antenna(s) used for transmitting and sensing are required to have identical patterns within in +/- 1 dB and the maximum gain in any direction is not to exceed 1 dBi.

(iv) The unlicensed devices shall check for channel occupancy once a day.

(v) Communications between unlicensed devices can take place on occupied channels as long as they are short non-interfering transmissions such as those used for handshaking and control purposes.

….

(j) Devices must not be equipped with any controls accessible to any party, other than a professional installer, that allow selection of the transmit channel or output power. Devices must include features to ensure that only the software that was approved with the device can be loaded into the device, and the software may not allow the user to operate the device with parameters outside those that were approved. "Software" in this context includes:

(1) the software that selects a device's operating frequency;
(2) the software that is used in determining a device's geographic location or identifying TV channels that are vacant; and
(3) any information retrieved from a database accessed by a device.

The application for certification must describe how the device complies with these requirements.

(k) "Fixed/access" devices operating under the provisions of this section shall be equipped with a means to automatically and periodically transmit a unique identification signal.