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 GG\Hz Band	)	ET Docket No. 02-380
	)	

REPLY COMMENTS OF THE NATIONAL CABLE & TELECOMMUNICATIONS ASSOCIATION

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The National Cable & Telecommunications Association ("NCTA") hereby submits its reply comments in the above-captioned proceeding.

INTRODUCTION AND SUMMARY

In its initial comments on the Further Notice of Proposed Rulemaking ("Notice"), NCTA supported the concept of introducing advanced wireless communications devices in the TV broadcast bands, provided the appropriate technical parameters are adopted to ensure that they are not a major source of interference to cable service. We sought to shed light on the fact that unlicensed devices could adversely impact any cable channel because cable systems use *all* of the channels in the broadcast TV band for the delivery of programming and other services to their customers. As such, there are no "white spaces" in cable operations.

This fundamental fact – the lack of vacant channels on cable – heightens the risk of harmful interference to cable television viewing from unrestrained TV band devices and requires certain protective measures to ensure that cable customers will continue to receive high quality, interference-free programming and services.

In particular, NCTA demonstrated, based on a technical paper by David Large Consultants, Inc., that television receivers and VCRs directly connected to cable systems are highly susceptible to "direct pickup" ("DPU") interference from unlicensed devices operating in close proximity because of inadequate shielding in TV receivers. To address this concern, NCTA urged the Commission to limit the power output of new personal/portable devices to a range of 10-20 mW and prohibit their operation on channels 2 - 4 in order to preserve cable's ability to cure any interference that occurs through the use of a well-shielded set top converter.

In addition, NCTA expressed concern that the Commission's emphasis on protecting a defined area around a broadcast transmitter does not address cable's concern with interference to cable headend antenna reception. Many cable systems receive distant broadcast signals beyond the protected Grade B contour and many of these signals have "must carry" status under the Commission's rules. We urged the Commission, therefore, to not only restrict operation of personal/portable devices within the Grade B contour but require spectrum coordination before any unlicensed devices (fixed or portable) are permitted to operate outside the Grade B boundary.

The cable industry is not alone in its concerns about the substantial risks of wide-scale interference from unlicensed devices and the insufficiency of the interference-avoidance methodology advocated by some parties. The broadcast industry, led by MSTV and NAB, demonstrated the very real risk of co-channel, adjacent channel, out-of-band emissions and other types of interference to broadcast operations. NCTA, MSTV, NAB and other parties, including the Canadian Research Center, IEEE, and Motorola, showed that signal sensing alone is inadequate to guard against interference. With the exception of a coalition of computer and Internet technology companies and the New America Foundation, there is widespread agreement

that signal sensing must be accompanied by some form of a geo-location/database system to enable unlicensed devices to accurately identify channels open for transmission. And many parties recognize that personal/portable devices pose unique hazards because of the difficulty with tracing them and enforcing non-interference once they are unleashed in the consumer marketplace.

Indeed, one thing comes through loud and clear in this proceeding – the potential for interference is so significant that parties on both sides of the issue urge the Commission to proceed with caution and to conduct comprehensive lab and field testing to assure that only those devices that can coexist with authorized services without causing harmful interference are approved. Without such measures, the perceived benefits of TV band devices for the delivery of broadband services to the public will be overshadowed by pervasive interference to existing communications services. Indeed, the cable industry has invested more than $100 billion in the last decade to deploy advanced digital technology that has transformed the delivery of video programming and access to high-speed Internet service. The failure to take adequate interference-avoidance steps could hamper cable and other broadband providers in their ability to serve their customers with new and innovative services, as well as vital news and information.

In the following sections, NCTA responds to specific issues raised by various commenters as they relate to direct pickup interference, headend reception interference, and other issues.

DISCUSSION

Direct Pickup Interference and Operation on Channels 2 - 4

A coalition of advocates for unlicensed personal/portable devices, including Dell, Google, Intel, Hewlett-Packard and Microsoft (collectively the "Coalition"), recognize implicitly that the Commission's proposed 100 mW power level combined with a 6 dBi antenna, is way off the mark to avoid direct pickup interference. But the solution they propose – *i.e.*, reducing the antenna gain to 0 dBi – is insufficient. They simply assert that "by operating within the parameters it is proposing, devices will not cause [DPU] problems" without providing any technical analysis to verify their claim.[1] NCTA has analyzed the issue and found that simply lowering the antenna gain from 6 dBi to 0 dBi in a 100 mW device, while helpful, *will not* solve the DPU problem.[2] Moreover, as we demonstrated in our comments, putting the onus on the customer to rectify the situation by increasing the separation between the device and the receiver is not the answer either. The distance that would be required is simply not practical, particularly in light of the unique problems posed by multi-dwelling buildings (where the television viewer will be unable to ascertain the source of the interference from adjacent apartments).

The Coalition also asserts that having an output power control on the portable device will reduce interference. But that ignores the fact that the power level will likely not adjust to minimize interference to TV reception, but rather (as in cell phones) serves to equalize signal

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1 Coalition Comments at 29.

2 As reflected in the report by David Large, Consultants Inc., attached to our comments, NCTA calculated and graphed the maximum possible unlicensed device transmitted power level as a function of distance to a co-channel-operated receiver receiving cable television signals and located in an adjacent apartment where the intervening wall exhibited 5 dB of field attenuation. The interference mechanism is direct pickup due to imperfect shielding of the internal tuner circuitry in the receiver. Assuming that the receiver met the shielding requirements of Part 15.118 for cable-ready devices (even though the Carl T. Jones measurements on actual receivers show far less effective average shielding at low VHF channels), the results show that a 100 mW device with 0 dBi antenna gain would generate the same level of interference at a distance of about 70 feet.

levels as received by a fixed or other portable device. This approach simply can not guarantee that the maximum output power will be constrained to the 10-20 mW range that we believe is necessary to ensure that interference is substantially reduced, especially if the device is near a receiving location or near a TV receiver. It still may transmit at full power.[3] In fact, to the extent that portable devices are operated indoors (and thus close to television receivers), the attenuation of exterior building walls will tend to require greater power to communicate successfully with external fixed devices.

Other commenters revealed a fundamental misunderstanding of the depth and scope of direct pickup interference, focusing instead on TV antenna interference. In urging the Commission to adopt performance-based standards to protect against interference, New America Foundation et al ("NAF") argues, for example, that the Commission's policy decisions in this area should be driven by what is "reasonable to protect the 14 percent of American households who actually rely on over-the-air reception of TV signals."[4] However, this ignores the fact that *100 percent* of such households use television receivers that would be affected by direct pickup interference from unlicensed devices and that the approximately *60 percent* of viewers in cable households receive their television signals from cable operators, who in turn, rely on interference –free over-the-air reception of broadcast signals.

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[3] In addition, we agree with IEEE that the Commission should specify a minimum unlicensed bandwidth of 6 MHz. If the bandwidth of each television channel were to be subdivided, this would raise the possibility of multiple interfering signals being received simultaneously, resulting in the total interfering signal power being higher than a 6 MHz bandwidth scheme. *See* Comments of IEEE at 7; Comments of NCTA, Large Paper, at 27, Section 3.2.

[4] *See* NAF Comments.

The separate NAF technical comments similarly evidence a lack of understanding of the near-field DPU interference problem. In discussing distance protection issues, *i.e.*, the minimal distance between a TV band device and a TV receiver that is necessary to avoid significant interference, NAF contends that 86% of households "with TV sets next to the TV band devices will experience no interference *regardless of separation distance*."[5] Here again they completely miss the point. As NCTA explained in our initial comments, DPU interference is the result of imperfect shielding in television sets. NAF suggests that a wired connection between the television set and the cable outlet insulates TV viewing from interference but this offers no protection against signal ingress to the television receiver from nearby radiating devices.

Moreover, the risk of direct pickup interference is even more heightened for receivers connected to cable systems because operators typically use a 256 QAM standard for video programming and other services, which as we demonstrated in our initial comments, is more sensitive to interference than the over-the-air 8VSB standard. And NAF's interference-tolerance threshold is based on the underlying assumption that unlicensed devices will never operate on a channel used to receive television signals, which is not the case for cable operations which utilize *all* TV band channels.

NAF urges the Commission to adopt a 10-meter distance interference protection standard.[6] It argues that no greater distance is needed because "it is entirely reasonable to expect that individuals in the same household – or even proximate neighbors – can coordinate the positioning and use of their respective devices . . . ."[7] But, as we demonstrated in our initial

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[5] NAF Technical Comments at 9, fn. 13 (emphasis in original).

[6] NAF's 10-meter separation standard is between the TV receiver and TV band device antennas, not between devices, and thus has nothing to do with DPU.

[7] NAF Technical Comments at 10.

comments, even in a single family home, the distance that the consumer would have to maintain between the device and the TV receiver to ensure non-interference is so significant – far greater than 10 meters – as to be impractical.[8] But even assuming that consumers could somehow ameliorate likely interference in the same household, the idea that devices capable of interfering with existing communications services should be introduced in the marketplace and allowed to proliferate based on the notion that *neighbors* will just work it out is hardly a sound spectrum policy. Indeed, putting the elimination of interference in the hands of consumers in adjacent apartments is simply unrealistic, especially when a consumer may not even know which apartment is causing the interference.

In support of its assertion that a 10-meter separation requirement is all that is required to avoid interference, NAF submitted the results of a study by the University of Kansas. It did not submit the study itself. The study purportedly analyzes two types of interference: out-of-band radiation from an unlicensed device that falls into the channel being received by the DTV receiver; and receiver desensitization due to radiation from an unlicensed device that operates on a channel adjacent to the one being received by the DTV receiver. Although the measurement techniques and the spread leading to its results are unavailable, the limited efficacy of the study for evaluating interference in the cable environment is readily apparent.

First, the study assumed that the unlicensed device would be operated on an adjacent channel. While this might be a good assumption for an over-the-air receiver (since local broadcast channels would not be accessible for unlicensed operation), it is not for a receiver connected to a cable system where every channel is in use. Second, the study tests for interference to 8VSB broadcast signals, whereas cable typically uses 256 QAM, which as noted

[8] NCTA Comments at 11 - 12, citing Large paper at 6, Table 2.

above is more sensitive to interfering signals. Third, the study sets up the desired signal to be -68 dBm at the receiver, which is 15 dB higher than the -83 dBm minimum usable level specified in the ATSC A/74 receiver performance guidelines. If the study had used -83 dBm, the receiver's interference sensitivity would have been greater. Fourth, the study tested primary radiation interference only for its effect on desensitization of the receiver due to the primary radiation of the unlicensed device when it is operated on a channel adjacent to the one being received by the DTV receiver (rather than DPU interference from the unlicensed device when it is operated on a channel directly received by the DTV receiver).

Furthermore, the Kansas study did not use external fields at all, but rather combined the desired and undesired signals in a single cable connected to the normal receiver input port. It set the undesired signal based on the assumption of 0 dBi antennas at both the receiver and unlicensed device (whereas 6 dBi antennas are proposed for portable devices and consumer-grade television receiving antennas can have much higher gains), and 10 m separation between antennas (48 dB of field attenuation at 600 MHz, but much less at VHF channels). The study tests only for out-of-band radiation from the unlicensed device that fell in the received channel and desensitization due to adjacent or semi-adjacent operation of the unlicensed device. Its detailed results shows a need to avoid both adjacent channels to avoid interference and that it was marginal with semi-adjacent operation. If the desired signal had been anywhere near the ATSC A/74 minimum level, it would have caused interference even with semi-adjacent channel usage.

Apart from these issues, there are a number of unknown factors that may have skewed the analysis to reach more favorable results:

(1) It is not known what channel was used for the tests. This is important because the shielding in television receivers is much more effective at UHF than at VHF, so a UHF test signal would produce more optimistic results.

(2) It is not known whether the study tested interference at various azimuths relative to the television receiver.[9] This is important since the Carl T. Jones study submitted by NCTA found that the shielding effectiveness varied considerably with azimuth and, thus, CEA-23 testing standard requires rotating the receiver for maximum sensitivity since, in the field, the receiver can be at any orientation relative to the unlicensed transmitter.

(3) It is not known whether the receiving antenna was close to the unlicensed transmitter and, thus, receiving the unlicensed signal, or whether it was remotely located, so that the only signals received were due to receiver shielding effectiveness.

In sum, the University of Kansas study did not test for the most critical technical parameter for determining the risk of direct pickup interference to TV receivers connected to cable systems – co-channel interference with a 256 QAM signal. And without the actual study itself, there is insufficient technical information to determine the validity of the testing and to fully analyze the study, even within the limited parameters tested. We urge the Commission, therefore, to give no weight to the NAF-commissioned study in evaluating the impact of unlicensed devices on cable operations.

Channels 2 - 4

In our comments, NCTA made clear that prohibiting TV band devices from operating on channels 2 - 4 is crucial to protecting against harmful interference to TV interface devices, including cable set top boxes, VCRs and DVD players, that operate on or adjacent to those channels.[10] The Consumer Electronics Association ("CEA") similarly recommended against

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[9] Azimuth in this case is defined as the angle (horizontal) between the unit under test and unlicensed device that establishes the orientation of maximum susceptibility to interference.

[10] *See also* Comments of IEEE 802.18, the Radio Regulatory Technical Advisory Group, at 23-24. IEEE asserts that channels 2 - 4 should be precluded from use "due to interference issues related to the large number of consumer devices (VCRs, DVD players, etc.) that use those channels for an RF interface.

operation on channels 2 - 4.[11] This interference-avoidance mechanism is essential given the tens of millions of set top boxes deployed today which tune incoming cable programming services to one of these low-VHF channels that are typically not assigned to a local over-the-air broadcast station. The installation of a well-shielded set top box converter is the primary means for a cable operator to ensure that other radiating signals do not interfere with high quality television viewing. NAF argues nonetheless that channels 2 - 4 should be opened up to the operation of unlicensed devices, displaying again the fundamental misunderstanding that "consumer devices usually connect to each other using shielded cables, reducing the risk of possible interference."[12] But, as we have repeatedly explained, it is the lack of adequate *receiver* shielding, not cable shielding, that is the source of the problem.

NAF's technical comments further assert that cable set top boxes must accept whatever interference occurs because they are merely Part 15 "unintentional emitters."[13] But this misrepresents the intent of the rule and ignores that it is precisely the set top box that serves as the primary *interference-avoidance* mechanism for cable television service. And its effectiveness in curing interference is predicated on the assurance that TV band devices are prohibited from operating on channels 2 - 4.

In an environment where unlicensed portable devices would be permitted to operate on virtually every channel used by cable operators, excluding channels 2 - 4 from unlicensed operation would protect cable services by permitting an operator to install equipment in a customer's home if DPU interference arises.

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[11] Comments of CEA at 6-7.

[12] NAF Comments at 83.

[13] NAF Technical Comments at 29.

In sum, the Commission should protect against direct pickup interference by restricting the maximum allowable power output of personal/portable devices to a range of 10 – 20 mW and preclude transmission on TV channels 2 - 4.

Headend Reception Interference

In our initial comments, NCTA expressed the importance of not only restricting operation of personal/portable devices inside the Grade B contour of broadcast stations, but requiring spectrum coordination before any unlicensed devices are permitted to operate outside the Grade B boundary given the potential for interference with cable headends. As we explained, cable systems receive terrestrial broadcast signals through tower-mounted, high gain directional antennas, particularly in fringe areas, and many of these signals are received at headend locations outside the station's predicted Grade B contour. Moreover, these "distant signals" are often entitled to mandatory carriage on the cable system pursuant to the Commission's rules. Without adequate protection of these headend sites, unlicensed and untraceable TV band devices will be allowed to freely transmit within the beam width of the headend receiving antenna outside the Grade B boundary.

The Coalition and other commenters take the view that signal sensing technology is a reliable and efficient means to avoid harmful interference by determining the availability of clear channels for unlicensed device transmission. They are quick to minimize the interference risks but provide no substantiation for their claims. But the record shows that signal sensing, particularly for personal/portable devices, is fraught with weaknesses.

The Coalition argues, for example, that a -114 dBm sensing threshold is acceptable on the basis that it is 30 dB below the useful threshold for DTV receivers. But the example they use assumes only 6 dBi antenna gain ahead of the DTV receiver and tries to push all of the other

variables, including the effect of antenna placement and the "hidden node" problem, in the remaining margin.

In favoring a "listen-before-transmit" approach, the NAF technical comments assert that the "hidden node" is not a problem as sense receivers in a TV band device can be made much more sensitive to radiating signals than DTV receivers.[14] But this ignores the difference between levels at a headend receiving antenna that is hundreds of feet in the air and a portable device that is inside a building at ground level. Indeed, headend antennas outside the Grade B contour are mounted at a height and gain designed to receive distant signals that may be undetectable at ground level using regular receiver technology. This is regardless of the detection method or sensitivity used. Simply put, headend reception of distant broadcast signals is unique to cable television, but it is precisely the kind of hidden node problem that the Commission wishes to avoid. And relying solely on a sensing threshold will result in TV band devices identifying the wrong channel to transmit on which in turn will likely lead to such signals causing DPU interference in the home.

Detection Methodology

As noted above, NAF and the Coalition advocate signal sensing as an interference detection method because it is entirely self-contained in the device and simple to implement, whereas geolocation/database approaches are more sophisticated and costly and allegedly "deprive white spaces of flexibility."[15] However, even if it were practical to build adequate sensitivity into signal sensing receivers to solve the headend reception issues, the threshold would have to be set so low as to unreasonably restrict the operation of unlicensed devices

[14] NAF Technical Comments at 15.

[15] Comments of NAF at 70; Comments of Coalition at 11.

(where the probability of interference is very low). By contrast, geolocation, combined with a database, has the potential to define safe areas of operation with a precision unattainable with any of the alternate approaches proposed. It provides greater, not less, flexibility for unlicensed operations as well as greater protection for television reception.

Moreover, signal sensing alone simply does not work if the goal, as the Commission has stated, is to protect authorized services in the TV bands from harmful interference. This is particularly the case when portable unlicensed devices proliferate and it becomes virtually impossible to identify and track down the source of the interference. As shown by numerous parties, including MSTV and NAB, NCTA, Motorola, and IEEE, signal sensing technology is highly imprecise and will not assure interference protection. Only when it is joined with some type of reliable geolocation/database technique will it be able to definitively protect reception at cable headends located outside the station's predicted Grade B contour.

One of the objections to the geolocation/database solution is that GPS often does not work indoors where portable devices will be located. But there are other possible approaches.

The Canadian Research Center puts forth a promising alternative methodology to GPS that can by used by unlicensed devices to establish geolocation and appears to work reliably indoors. It uses "watermark" transmitter ID signals that have been under study by the Advanced Television Systems Committee (ATSC).

Another example consists of a small national database created from information files submitted by broadcasters, cable operators, and other licensed users of the broadcast spectrum. Any broadcast station could transmit the portion of this database covering its entire usable reception area using a very small portion of its available bandwidth. An unlicensed device would first determine its own latitude and longitude, then receive from a local broadcaster the

permissible channels for that location, and finally choose among those channels using conventional technology. Such an approach, if technically feasible, would require analysis of its feasibility in terms of creating and maintaining the database and other reliability issues.

Testing

The quagmire of potential interference risks posed by the introduction of unlicensed TV band devices, particularly personal/portable devices, has caused parties representing a broad spectrum of services and equipment to call for extensive lab and real-world testing. Those parties include the broadcast, cable, wireless communications, standards-setting and other organizations. As the Radio Television News Directors Association pointed out, unlicensed TV band devices should be subject to "the most stringent testing standards" and "extensive real-world tests" to ensure that they will not impair the ability of *licensed* users of this spectrum.[16]

Even the Coalition comprised of Dell, Hewlett-Packard, Intel, Microsoft, Philips Electronics and Google – strong advocates for personal/portable unlicensed devices – support "rigorous" testing, although they believe that such tests will confirm that spectrum sensing with the appropriate technical parameters will work.[17] As we discussed above, and many other parties agree, signal sensing is wholly inadequate to protect against harmful interference.[18]

From cable's perspective, it is crucial for the Commission to fully evaluate the wide-scale potential for both near-field interference to television receivers and fringe-area headend

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[16] Comments of RTNDA at 1.

[17] Comments of Coalition at ii (the Coalition notes that it intends to provide the Commission with a prototype device for testing purposes.)

[18] *See e.g.,* Comments of Qualcomm Incorporated at ii ("remains skeptical that the interference from mobile devices to existing licensed services can be eliminated or limited to minimal levels, and in particular, that any 'spectrum sensing' technology for mobile devices will actually work"); Comments of Motorola at iii ("it is premature to rely on spectrum sensing as a spectrum access method because of the difficulties involved in implementing sensing technology in this environment and continues to recommend that database and location information should be the final source for determination on whether or not to transmit.")

reception interference and to adopt appropriate technical and operational rules. In its comments, NCTA urged the Commission to determine whether the shielding effectiveness of television receivers has changed since a representative sample of such receivers was tested by Carl T. Jones on behalf of CableLabs. We believe that it is important, therefore, for the Commission to measure a representative sample of analog and digital TV receivers to determine their ability to tolerate direct pickup interference as a function of frequency in its upcoming testing in this proceeding.

Wireless Microphones

In addition to direct pickup and headend reception interference, the cable industry shares the concerns of many parties about interference to wireless microphones if unlicensed devices with high output power are permitted to operate in the TV broadcast bands.[19] Wireless microphones are used extensively by cable programmers in support of electronic newsgathering and coverage of live sports and entertainment productions. Low-powered wireless microphones are essential to electronic journalists covering breaking news events, particularly on-the-scene coverage of emergency situations. And they are ubiquitous tools for the distribution of audio in all major sports and entertainment events in large venues.

Several parties have detailed the technical characteristics of wireless microphones, the need for adequate spectrum in the Broadcast Auxiliary Service (especially in crowded metropolitan areas), and the minimum detection thresholds and interference mitigation measures that would have to be incorporated into technical rules for fixed TV band devices.[20] And many

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[19] *See* NCTA ex parte letter in ET Docket No. 04-186, ET Docket No. 02-380, filed Oct. 4, 2006; Comments of Shure Incorporated, The Microphone Interests Coalition, the Professional Audio Manufacturers Alliance, and RTNDA.

[20] *See e.g.*. Comments of Shure Incorporated.

parties urge the Commission not to permit the introduction of personal/portable devices until experience is gained with fixed devices.

Given the potential for unlicensed devices to cripple wireless microphones, we too urge the Commission to proceed cautiously and gather extensive test data to ensure that adequate measures are in place to protect the functionality of this vital technology before newer TV band devices are authorized.

CONCLUSION

In the Commission's desire to incorporate new wireless devices in the TV bands, it should take full stock of the broad range of interference risks to existing users of the spectrum. As we fully laid out in our initial comments, the minimum technical parameters that should be adopted with respect to cable operations include: restrict the power output of personal/portable devices to 10 – 20 mW and prohibit their operation on VHF channels, particularly low-VHF channels; restrict operation of fixed devices to at least 400 feet from external walls of residential buildings and prohibit operation on VHF channels; and require spectrum coordination before portable devices are permitted to operate. Most importantly, channels 2-4 should be protected from operation to preserve cable operators' ability to utilize set-top converters to address interference problems in cable households.

Respectfully submitted,
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