Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's Rules to	)	ET Docket No. 13-49
Permit Unlicensed National Information	)	
Infrastructure (U-NII) Devices in the 5 GHz Band	)	

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EXECUTIVE SUMMARY

As a leading manufacturer of C-band broadcast weather radar systems authorized to operate in the 5.35-5.47 GHz and 5.6-5.65 GHz bands, Baron Services, Inc. ("Baron") submits these comments to express its deep concern regarding the Commission's consideration of expanded Unlicensed National Information Infrastructure ("U-NII") operations in the 5 GHz band. The Terminal Doppler Weather Radar ("TDWR") systems operated by the Federal Aviation Administration, as well as the C-band weather radars operated by Baron's customers, have been, and continue to be, subjected to harmful interference caused by U-NII devices. Given the critical public safety services provided by weather radar systems, this interference is unacceptable and must be eliminated.

Baron therefore strongly urges the Commission to continue to prohibit U-NII operations in the 5.35-5.47 GHz band because this is the most intensively-used spectrum band by weather radar systems. It would be extremely difficult, if not impossible, to adequately protect these weather radar operations from harmful co-channel interference even if the Commission adopts stringent service and technical rules for U-NII operations in this spectrum band. Significantly, not only does the Spectrum Act not require the Commission to authorize U-NII operations in the 5.35-5.47 GHz band, it expressly forbids the Commission from doing so absent empirical evidence that "licensed users *will be protected*…"

As aptly demonstrated by the TDWR interference investigations, prohibiting U-NII devices from operating in the same frequencies as weather radars, by itself, would be insufficient because of the potential for U-NII operations to also cause adjacent-channel interference to weather radars. Thus, if the Commission permits U-NII operations in the 5.35-5.47 GHz band despite the demonstrated potential for harmful interference, the Commission must revise its

existing U-NII regulations in order to prevent future instances of both co-channel and adjacent-channel interference. Even if the Commission properly declines to expand U-NII operations into the 5.35-5.47 GHz band, these technical and service rule revisions will be necessary to protect the weather radar systems currently operating in the 5.6-5.65 GHz band.

Specifically, in order to adequately protect weather radars from both co-channel and adjacent-channel interference, Baron urges the Commission to implement every reasonable interference protection mechanism in order to mitigate, to the maximum extent possible, the likelihood of interference to weather radar systems. Specifically, the Commission should improve its current dynamic frequency selection ("DFS") mechanism in order to address past instances of co-channel interference and to prevent adjacent-channel interference; implement a database approach with accompanying geo-location capabilities built into U-NII devices; revise the radar receiver interference protection criteria which form the basis of the U-NII regulations; and require manufacturers to implement security measures to prevent U-NII device software modifications and the deactivation of a device's DFS functionalities.

With respect to the technical criteria on which the new and revised technical and service rules should be based, Baron generally agrees with the findings by the National Telecommunications and Information Administration ("NTIA") in its Third Technical Report, subject to any revisions based on the NTIA's further studies, because broadcast weather radar receiver sensitivity is comparable to TDWR receiver sensitivity. Baron therefore urges the Commission to apply the same interference mitigation protections it adopts with respect to TWDRs – *e.g.*, mandatory frequency and geographic separation requirements – to non-Federal weather radar systems operating in the 5 GHz band.

Finally, Baron notes that the NTIA emphasized the need for further testing with respect to each of the eight identified risk factors for weather radar operations if the Commission permits U-NII operations in the 5.35-5.47 GHz band. As a consequence, it would premature for the Commission to take any action in this proceeding prior to the release of the NTIA's final recommendations and an opportunity for the public to comment on those recommendations. The Commission should not allow unlicensed uses of the 5 GHz band without actual proof – in the form of detailed engineering studies and field tests – that such uses will not cause harmful interference to weather radar systems and other incumbent licensed services.

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Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band	)))	ET Docket No. 13-49

COMMENTS OF BARON SERVICES, INC.

Baron Services, Inc. ("Baron") submits these comments in response to the Notice of Proposed Rulemaking ("NPRM") released February 20, 2013 in the above-captioned proceeding. In the NPRM, the Commission proposes to amend Part 15 of its rules governing the operation of Unlicensed National Information Infrastructure ("U-NII") devices in the 5 GHz band, including modifying certain technical requirements for U-NII devices to ensure that these devices do not cause harmful interference. The NPRM also seeks comment on making available an additional 195 megahertz of spectrum in the 5.35-5.47 GHz ("U-NII-2B") and 5.85-5.925 GHz ("U-NII-4") bands for U-NII use.[1] These comments are supported by the attached Technical Analysis prepared by Bill Walker, Baron's Vice President and Chief Engineer.

Baron has a significant interest in this proceeding because it designs and develops C-band weather radar systems for the broadcast industry that are authorized to operate within the 5.35-5.47 GHz and 5.6-5.65 GHz bands.[2] Currently, there are approximately 150 Baron C-band weather radar systems, primarily in the 5.35-5.47 GHz band,[3] deployed in the United States that would experience significant harmful interference from U-NII devices absent adequate operating

[1] *See* NPRM, 28 FCC Rcd 1769, 1770.

[2] *See* Equipment Authorization Identification Nos. NX5XDD-350C, NX5XDD-250C, NX5DSSR-250C, NX5KHDD-1000C, and NX5XDD-1000C.

[3] The attached map illustrates the locations and coverage areas of Baron's C-band weather radar systems.

prohibitions and technical and service rules.[4] Baron's concern arises from the demonstrated potential for U-NII devices, including those in compliance with the Commission's current rules, to cause both co-channel and adjacent-channel interference to weather radar systems.

In light of the critical public safety services provided by broadcast weather radars, as well as weather radar's susceptibility to interference from communications transmissions, Baron strongly urges the Commission to continue to prohibit U-NII operations in the 5.35-5.47 GHz band. Simply put, even with stringent technical and service rules, it will be extremely difficult to ensure the protection of co-channel weather radar operations. In this respect, Baron notes that, although Congress required the Commission to initiate this proceeding,[5] the decision to make additional 5 GHz spectrum available for U-NII device operations is solely in the Commission's discretion, and the Commission is prohibited by law from doing so unless it can ensure that "licensed users *will be protected*."[6] If, however, the Commission permits U-NII operations to expand into the 5.35-5.47 GHz band despite the likelihood of harmful interference to weather radar systems and the "significant technical challenges surrounding the potential introduction of U-NII devices" into this band,[7] the Commission must implement every reasonable interference protection mechanism in order to mitigate, to the maximum extent possible, the likelihood of co-channel interference to weather radars.

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[4] *See* Technical Analysis at 3, 5; *see also* Department of Commerce, *Effects of RF Interference on Radar Receivers*, NTIA Technical Report TR-06-444, p. xx (Sept. 2006) ("NTIA 2006 Report") ("[T]o avoid impairment of radar operations, care must be taken to ensure that radar receivers are not subjected to unnecessary interference from non-radar signals above identified thresholds.").

[5] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, §6406(a)(1), 126 Stat. 156, 231 (2012) ("Spectrum Act").

[6] *Id.* at §6406(a)(2) ("The Commission <u>may make</u> the modification described in paragraph (1) <u>only if</u> the Commission, in consultation with the Assistant Secretary, determines that – (A) <u>licensed users will be protected</u> by technical solutions...") (emphasis added); *see* Department of Commerce, *Evaluation of the 5350-5470 MHz and 5850-5925 MHz Bands Pursuant to Section 6406(b) of the Middle Class Tax Relief and Job Creation Act of 2012*, p. 6-2 (Jan. 2013) ("NTIA 5 GHz Report") ("As the Tax Relief Act requires, the FCC and NTIA must determine that licensed users will be protected by technical solutions…").

[7] NTIA 5 GHz Report at 6-2.

Service and technical rules designed only to address the potential for harmful co-channel interference, however, would be insufficient to ensure adequate protection for weather radar systems operating in either the 5.35-5.47 GHz band or the 5.6-5.65 GHz band because of the demonstrated capacity of U-NII devices to also cause adjacent-channel interference. Accordingly, regardless of whether the Commission permits U-NII operations to expand into the 5.35-5.47 GHz band, Baron urges the Commission to revise its existing U-NII regulations in order to prevent future instances of adjacent-channel interference to weather radar systems.

Absent adequate interference protections, existing services in the 5 GHz band, including critical weather radar operations, will suffer severe and irreparable interference, and thereby endanger the public safety. The Commission has previously concluded that it is "most important [to] ensure that new unlicensed devices do not interfere with the incumbent licensed services…"[8] The Commission should not retreat from this sound regulatory policy.

Finally, at a minimum, the Commission must delay any action in this proceeding pending the completion of studies by the National Telecommunications and Information Administration ("NTIA"), the issuance of the NTIA's final recommendations regarding the feasibility of allowing U-NII operations in the 5.35-5.47 GHz band, and the opportunity for the public to comment on those studies and recommendations. The Commission should not allow new unlicensed uses of this spectrum without actual proof – in the form of detailed engineering studies and field tests – that such uses will not cause harmful interference to weather radar systems and other incumbent licensed services.

[8] *Unlicensed Operation in the TV Broadcast Bands*, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807, 16821 (2008) ("*White Spaces Order*").

I. EXPERIENCE DEMONSTRATES THE GREAT POTENTIAL FOR U-NII DEVICES TO CAUSE HARMFUL INTERFERENCE TO WEATHER RADARS

The substantial threat of harmful interference to weather radar systems posed by U-NII devices operating in the 5 GHz band is not merely hypothetical. Rather, in early 2009, the Federal Aviation Administration ("FAA") became aware of interference to its Terminal Doppler Weather Radar ("TDWR") systems that operate in the 5.6-5.65 GHz band.[9] Subsequent investigations revealed that U-NII devices were the source of this interference.[10] Although the interference typically has been caused by U-NII operations in the same frequency band as TDWR, interference also has been caused by adjacent-channel emissions.[11] Although, in many cases, the interfering U-NII devices were not certified or otherwise did not comply with the Commission's rules,[12] the investigation also found that interference has been caused by fully-compliant U-NII devices.[13] Baron notes that its C-band weather radar customers also have experienced harmful interference arising from U-NII operations in the 5 GHz band.[14]

As a result of the documented TDWR interference, the Commission issued enforcement advisories,[15] pursued enforcement actions,[16] and began to require additional assurances from

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[9] *See* NPRM, 28 FCC Rcd at 1771.

[10] *See id.*

[11] *See id.* at 1782; *id.* at 1783 ("Interference studies conducted by NTIA and the FAA indicate that there may be some potential for interference from U-NII devices operating in frequencies occupied by or adjacent to radar systems.").

[12] *See id.* at 1783.

[13] *See* NTIA 5 GHz Report at 3-4 ("U-NII device DFS functionality performed properly, causing the device to move to an adjacent channel, but still caused interference;" "U-NII device complied with FCC DFS certification requirements but failed to detect TDWR"); NPRM, 28 FCC Rcd at 1782-83 ("In some cases, equipment that met the Commission's certification standards nonetheless caused interference, due to a variety of factors such as the configuration of the transmitter, its height and azimuth relative to the TDWR, and the device's failure to detect and avoid the radar signal.").

[14] *See* Technical Analysis at 3.

[15] *See* NPRM, 28 FCC Rcd at 1772.

[16] *See id.*

applicants seeking U-NII device certifications.[17] However, despite these remedial efforts, "instances of interference to TDWRs continue."[18] In fact, the Commission has "seen an increase in interference incidences in U-NII bands..."[19] In other words, despite four years of investigation and remedial measures, the Commission has not been fully successful in preventing harmful interference to weather radars, which demonstrates the importance of taking a cautious and conservative approach in this proceeding based on substantial empirical information.

Based on the TDWR investigations and subsequent studies, the NTIA has identified eight separate risk factors associated with U-NII devices operating in the 5.35-5.47 GHz band:

1. Changes in Radar Signal Parameters May Impact U-NII Device Detection of Radar Systems.

2. Changes in U-NII Device Deployment and Technical Parameters May Result in *Harmful Interference*.

3. Existing U-NII Regulations May Not Adequately Protect Current and Future Radar Systems from *Serious Degradation*.

4. Changes to U-NII DFS Detection Parameters May Not Protect Current and Future Radar Systems from *Serious Degradation*.

5. Existing U-NII Regulations May Introduce "Hidden Node" Interference that *Seriously Degrades Performance*.

6. U-NII Devices Operating on an Adjacent Channel Can Cause *Harmful Interference* to Radar Systems.

7. Radar Receiver Interference Protection Criteria Used to Develop Existing U-NII DFS Regulations May Not Adequately Address Low-Level Interference Effects.

8. Channel Response Time Requirements in the Current DFS Regulations May Not be Adequate to Protect All Radar System Operational Scenarios.[20]

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[17] *See* FCC, OET, *Interim Plans to Approve UNII Devices Operating in the 5470-5725 MHz Band with Radar Detection and DFS Capabilities*, KDB Publication No. 443999 DO1 (Oct. 14, 2010) ("OET Publication").

[18] NTIA 5 GHz Report at 3-5; *see Directlink, LLC*, Notice of Apparent Liability for Forfeiture and Order, 28 FCC Rcd 37 (EB 2013) (arising from a Commission investigation that took place as recently as January 2012).

[19] NPRM, 28 FCC Rcd at 1775.

[20] *See* NTIA 5 GHz Report at 4-6 to 4-11.

Clearly, there can be no doubt that expanded U-NII operations in the 5 GHz band have the significant potential to cause harmful interference to weather radars and other licensed users of this spectrum.[21] Baron therefore agrees with the NTIA that these risk factors and the past "interference to TDWR demonstrate[] the importance of the FCC certification and enforcement processes that must be taken into consideration to effectively preclude harmful interference…"[22]

II. THE COMMISSION SHOULD CONTINUE TO PROHIBIT U-NII OPERATIONS IN THE 5.35-5.47 GHz BAND BECAUSE THE TECHNICAL CHARACTERISTICS THAT MAKE WEATHER RADAR SO CRUCIAL TO PUBLIC SAFETY ALSO MAKE IT VERY SUSCEPTIBLE TO INTERFERENCE

As the NPRM notes, broadcasters "use radars operating in the 5.35-5.47 GHz band for tracking storms and providing weather radar information to the public via news and weather reporting."[23] Weather radars permit broadcasters to "inform[] the public on a range of local and regional weather warnings," including "supercell storms capable of developing tornados and severe weather."[24] In other words, broadcast weather radars provide a crucial public safety service, protecting viewers' lives and property.[25] Unfortunately, the technical characteristics which permit weather radars to provide these critical services also "make[] them very vulnerable

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[21] *See id.* at ii ("[T]his report identifies a number of risk elements due to the likelihood of harmful interference from large numbers of U-NII devices to protected federal systems in the 5350-5470 MHz and 5850-5925 MHz bands.") (emphasis added).

[22] *Id.* at 3-5; *see id.* at 6-2 (noting the "significant technical challenges surrounding the potential introduction of U-NII devices in these bands") (emphasis added).

[23] NPRM, 28 FCC Rcd at 1796.

[24] *Id.* Tragically, the importance of broadcasters' weather radar systems was demonstrated just this past week in Oklahoma, which led Oklahoma Governor Mary Fallin to publicly "thank the media for all that you've done to help our community get information that's critical at a time like this." *See* Al Tompkins, *Oklahoma Governor Thanks Media for Tornado Coverage*, Poynter.org (May 21, 2013) (available at www.poynter.org/latest-news/als-morning-meeting/214008/oklahoma-governor-thanks-media-for-tornado-coverage/) (last viewed May 21, 2013).

[25] *See* FCC Public Safety and Homeland Security Bureau, *Impact of the June 2012 Derecho on Communications Networks and Services: Report and Recommendations*, p. 14 (Jan. 2013) ("The key role broadcasters played during and following the derecho should also be recognized. As in many times of crisis, broadcasters served as 'first informers,' providing the public with information on the storm's path, the damage it caused, and its effects on other communications services."); NTIA 2006 Report at 1 ("Radars play critical roles in national security, air traffic control, weather observation and warning, scientific applications, mapping, search and rescue operations, and other safety-of-life missions.").

to interference."[26] In recognition of this fact, the Commission has typically established "exclusive, or at least primary, spectrum allocations for [radar] operations."[27]

As the NTIA detailed in a 2006 report, "radar receivers are not generally robust against low-level interference from non-radar (communication-type) radio signals."[28] For instance, the "duty cycle of the U-NII devices (typically 40% or greater) is well above the TDWR receiver's ability to process and mitigate that type of interference."[29] This interference to weather radars is compounded by the fact that the "[i]nterference can (and will) cause loss of targets at any distance from any radar station; loss of targets due to radio interference is not directly related to distance of targets from radar stations."[30] In other words, unlike interference to communications signals, interference to weather radars has the potential to completely destroy the radar's utility, even with respect to nearby weather events that pose the greatest and most urgent threat to a television station's viewers.

The importance of ensuring that weather radars do not experience harmful interference in the first place is even greater because broadcasters often are unaware that their radars are experiencing harmful interference, and therefore cannot take remedial measures to address such interference. As the NTIA has explained, weather radar's "loss of targets at low interference levels is insidious; there is no overt indication to radar operators or even to sophisticated radar

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[26] NTIA 2006 Report at 82 ("Weather radars, designed to track particles in the atmosphere and hydrometeors of submillimeter size, utilize extensive processing to extract signals from received noise… In addition, meteorological radars detect more than just the presence of return pulse energy; the processing derives data on return pulse characteristics to determine factors such as wind velocity, wind shear, turbulence, and precipitation type. This processing makes them very vulnerable to interference.").

[27] *Id.* at 1.

[28] *Id.* at xx.

[29] Department of Commerce, *Case Study: Investigation of Interference into 5 GHz Weather Radars from Unlicensed National Information Infrastructure Devices, Part I*, NTIA Technical Report TR-11-473, p. 23 (Nov. 2010) ("NTIA First Technical Report").

[30] NTIA 2006 Report at 137; *see id.* ("Interference can cause loss of desired, large cross section targets … at long distances, as well as small cross section targets at close distances.").

software that losses are occurring."[31] In fact, "[e]ven when radars experience serious performance degradation due to low-level interference, it is very unlikely that such interference will be identifiable as such."[32] As a result, it is "unlikely that such interference will ever result in reports to spectrum management authorities even when it causes loss of desired targets." *Id.*

But this does not mean interference is not occurring.[33] Thus, unbeknownst to a broadcaster, its weather radar may be failing to identify potentially severe weather events, and thus jeopardizing the lives of viewers' who are accustomed to relying on the accuracy of their local broadcast weather reports. Another consequence of this unknown interference is that the principal Part 15 operating condition that an unlicensed device must correct whatever interference it causes would fail to provide any relief because these instances of interference would not be detected, and thus could not be reported to the Commission.[34]

Baron also notes that, in attempting to prevent interference to weather radars, the Commission's focus must be on U-NII devices, not on any claims that radars could somehow mitigate the harmful interference that will likely arise from expanded U-NII operations. In fact, the NTIA has found that "improvements to the radar performance will [] cause the radar to be adversely affected by interference *at even lower levels*."[35]

In sum, as the NTIA has concluded, "[l]ow interference thresholds for communication-type signals, insidious behavior of target losses, and potential loss of targets at any range all

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[31] *Id.*; *see id.* at 1 ("Therefore operators are usually unaware that they are losing targets due to low-level interference.").

[32] *Id.* at 137.

[33] *See id.* ("Since low-level interference is not expected to be identified or to generate reports when it occurs, lack of such reports *cannot* be taken to mean that such interference does not occur.") (emphasis in original).

[34] *See* 47 C.F.R. §15.5(c) ("The operator of a radio frequency device shall be required to cease operating the device upon notification by a Commission representative that the device is causing harmful interference.").

[35] NTIA 2006 Report at 82 (emphasis added).

combine to make low-level interference to radar receivers a *very serious problem*."[36] It is for this reason that Baron strongly urges the Commission to continue to prohibit U-NII operations in the 5.35-5.47 GHz band. If the Commission fails to do so, the likely resulting interference "will adversely impact data quality, degrade the meteorological products, and compromise the system's ability to accomplish its mission of providing data necessary for public weather forecasting, severe weather warning, and rainfall measurement for flash flood prediction and water management."[37] In the NPRM, the Commission correctly concluded that interference to weather radar systems "is unacceptable and must be eliminated, given the public safety risks."[38] Baron asserts that the only way to ensure this outcome is for the Commission to prohibit U-NII operations in the 5.35-5.47 GHz band and, as detailed below, adopt new regulations that sufficiently protect these radars from U-NII devices' harmful out-of-band emissions.

III. IF, DESPITE THE GREAT POTENTIAL FOR HARMFUL INTERFERENCE TO WEATHER RADARS, THE COMMISSION NEVERTHELESS PERMITS U-NII OPERATIONS IN THE 5.35-5.47 GHz BAND, IT MUST ADOPT ADEQUATE SAFEGUARDS

Baron strongly urges the Commission to implement as many reasonable interference protection mechanisms as possible with respect to the current, and potentially expanded future, use of the 5 GHz band by U-NII devices because of "the importance of these bands … and the potential risks of introducing a substantial number of new, unlicensed devices into them without proper safeguards."[39] Specifically, as detailed below, the Commission should improve its current dynamic frequency selection ("DFS") mechanism in order to address past instances of co-channel interference and to prevent adjacent-channel interference; implement a geo-

[36] *Id.* at 1 (emphasis added).

[37] *Id.* at 69.

[38] NPRM, 28 FCC Rcd at 1782.

[39] NTIA 5 GHz Report at 6-2; *see* NTIA 2006 Report at xx ("[T]o avoid impairment of radar operations, care must be taken to ensure that radar receivers are not subjected to unnecessary interference from non-radar signals above identified thresholds.").

location/database approach; revise the radar receiver interference protection criteria which form the basis of the U-NII regulations; require manufacturers to implement security measures to prevent end users from modifying the operating parameters of U-NII devices; and require that a U-NII device's DFS functionality cannot be turned off.

A. In Addition to Revising the Current DFS Mechanism, the Commission Must Implement a Geo-Location/Database Approach to Spectrum Sharing Because Spectrum Sensing Alone is Wholly Insufficient to Protect Weather Radars from Harmful Interference.

As the Commission notes, the current DFS mechanism is designed only to avoid co-channel interference to weather radars.[40] And, even in this respect, the current mechanism is insufficient because the required "sensing bandwidth will ensure co-channel interference protection only when the radar signal falls within 80 percent of the U-NII device's occupied bandwidth." *Id.* As a result, "it is possible for the U-NII device to transmit on the same frequency as the radar when the radar signal falls within the 20 percent of occupied bandwidth that does not require sensing," which "increase[s] the potential for harmful interference." *Id.* Baron therefore supports the Commission's proposal to "implement a rule requiring that U-NII devices sense for radar signals at or exceeding 100 percent of its occupied bandwidth" because, as the Commission notes, "expanding the sensing bandwidth will prevent co-channel operations between the U-NII devices and radar receivers and thus will reduce the potential for harmful interference." *Id.* at 1790.

Simply preventing co-channel interference, however, is insufficient because of the potential for interference from U-NII devices operating in frequencies adjacent to radar.[41] As the NTIA explained in its Third Technical Report, "adjacent channel interference is possible when

[40] *See* NPRM, 28 FCC Rcd at 1789.

[41] *See* NTIA 5 GHz Report at 4-10 ("As part of the TDWR interference investigation, NTIA determined that, under certain conditions, U-NII devices operating on an adjacent channel could cause interference."); NPRM, 28 FCC Rcd at 1787 ("Emissions outside of the U-NII device's occupied bandwidth may have the potential to cause harmful interference into TDWR.").

the frequency separation between the radar and the U-NII device is less than a specified amount."[42] Here, it is particularly important to take adjacent-channel interference into account "[g]iven the anticipated increase in U-NII device density" under the NPRM's proposals.[43]

Baron therefore urges the Commission to "require the U-NII device to sense for radar in channels adjacent to its occupied bandwidth" in order to "ensure that the unwanted emissions from U-NII devices are placed far enough away in frequency from the [radar's] fundamental frequency to preclude harmful interference."[44] Baron agrees that requiring 30 megahertz separation would be sufficient for U-NII devices employing a 20 megahertz bandwidth.[45] However, as noted by both the Commission and NTIA, greater frequency separations will be required for U-NII devices with wider bandwidths.[46] Accounting for these wider bandwidths is crucial because the new IEEE 802.11ac Wi-Fi standard, which is expected to be finalized in the near future, specifies bandwidths of 20, 40, 80, and even 160 megahertz.[47]

In addition to spectrum sensing, Baron strongly urges the Commission to also develop a geo-location/database approach because, even with the proposed improvements to the current DFS mechanism, spectrum sensing alone would be wholly insufficient to protect weather radar systems. Notably, the Commission has previously concluded that spectrum sensing, by itself,

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[42] NPRM, 28 FCC Rcd at 1789; *see id.* at 1789-90 ("For example, when a radar signal falls outside of the sensing bandwidth and occupied bandwidth, and is within 30 megahertz from the U-NII devices' fundamental frequency, the unwanted emissions from the U-NII devices could still cause harmful interference to the TDWR.").

[43] *See* NTIA 5 GHz Report at 4-10.

[44] NPRM, 28 FCC Rcd at 1789.

[45] *See id.*; Department of Commerce, *Case Study: Investigation of Interference into 5 GHz Weather Radars from Unlicensed National Information Infrastructure Devices, Part III*, NTIA Technical Report TR-12-486, p. 30 (June 2012) ("NTIA Third Technical Report").

[46] *See* NPRM, 28 FCC Rcd at 1789, n. 81 ("For devices with wider bandwidths, the frequency separation will have to be greater than 30 megahertz…"); NTIA Third Technical Report at 30 ("[T]he wider bandwidth of 40 MHz wide 802.11 signals results in greater separation distances when the devices are off-frequency."); *see also* OET Publication at 1, n. 4 ("[D]evices with bandwidths greater than 20 MHz may require greater frequency separation.").

[47] *See* NPRM, 28 FCC Rcd at 1775; *see also* NTIA Third Technical Report at 30 ("If the U-NII bandwidths were even wider (*e.g.*, 80 and 160 MHz wide 802.11 channels), the separation distances will increase.").

would fail to adequately protect incumbent licensed operations from unlicensed devices being introduced into a spectrum band for the first time.[48]

Moreover, as the NPRM notes, the "efficacy of the DFS mechanism is dependent upon the U-NII device's ability to detect and avoid a radar pulse within a region of its occupied bandwidth."[49] However, past NTIA testing confirms that DFS-equipped U-NII devices often fail to properly detect weather radar emissions, and thus fail to protect these radars from harmful interference. For instance, a U-NII device tested by the NTIA "fail[ed] to sense the TDWR emissions when it was off-tuned by 10 MHz, yet its detection bandwidth, based on DFS compliance test results performed by the FCC, was listed as ±11 MHz."[50] Another U-NII device tested by the NTIA repeatedly began to transmit on TDWR frequencies even after performing the required channel availability check. These interfering transmissions lasted for three and five minutes before the U-NII device "finally shut itself off after detecting the TDWR signal."[51] This device performed even worse when facing away from the TDWR. Specifically, "[w]hen facing 180 degrees from the TDWR, the device operated for 15 minutes but never detected the actual TDWR signal." *Id.* When facing 90 degrees away from the TDWR, the device "eventually detected the TDWR signal, but only after 12 minutes (two complete volume scans of the radar) had elapsed." *Id.* These substantial delays occurred even though interference strobes plainly indicated that the U-NII device was causing harmful interference to the TDWR.[52]

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[48] *See White Spaces Order*, 23 FCC Rcd at 16836 ("[S]pectrum sensing with capabilities as presented in the record of this proceeding would not, by itself, be sufficient to adequately protect from interference television and other licensed services that use the TV bands.").

[49] NPRM, 28 FCC Rcd at 1789.

[50] NTIA First Technical Report at 19; *see id.* ("Based on the FCC's results, it should have detected the TDWR even though it was off-tuned by 10 MHz.").

[51] *Id.* at 20.

[52] *See id.*

This U-NII device performed even more poorly when operating on spectrum adjacent to the TDWR, even while its antenna was facing the radar. For instance, when the device was off-tuned by 15 MHz, it never detected the TDWR signal.[53] When the device was off-tuned by 10 MHz below the TDWR frequency, it failed to detect the radar for five minutes, and when the device was tuned 10 MHz above the TDWR frequency, "it never detected the TDWR signal after 10 minutes of elapsed operation…" *Id.*

Baron also notes that the current signal detection technology used by DFS-equipped U-NII devices, even if capable of adequately detecting some radar signals, may not be able to detect radars that employ short, sub-microsecond pulsewidths because the "smallest pulsewidth used in the development of the existing U-NII DFS regulations was 1 microsecond."[54] As the NPRM notes, a "narrower radar pulsewidth used in conjunction with the higher data rates associated with the 802.11ac standard could affect a device's ability to detect pulsed radar signals." *Id.* Similarly, in its 5 GHz Report, the NTIA noted that the "ability of signal sensing spectrum-sharing technologies to detect sub-microsecond pulses is not known at this time."[55]

Baron therefore believes that adopting a geo-location system, with an accompanying database, is the best approach to try to ensure that U-NII devices consistently operate outside of weather radars' interference zones.[56] Baron also agrees with the Commission and the NTIA that implementation of geo-location and database registration could be feasible in the 5 GHz band

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[53] *See id.*

[54] NPRM, 28 FCC Rcd at 1799.

[55] NTIA 5 GHz Report at 4-9.

[56] *See White Spaces Order*, 23 FCC Rcd at 16841 ("[W]e believe that given the available alternatives, requiring use of geo-location and a database for fixed TV band devices is necessary to ensure protection of the licensed television and other services that operate in the TV bands.").

given that weather radar locations are "known and somewhat limited in number."[57] The geo-location/database approach can only be effective, however, if the Commission requires that U-NII devices include a built-in geo-location capability. In other words, simply requiring that U-NII transmitters be professionally installed[58] would be entirely insufficient to protect weather radar operations because the reported U-NII device location could not reasonably be confirmed by the Commission or weather radar licensees. Moreover, a regulatory obligation would not prevent a U-NII operator from subsequently moving the transmitter's location. Notably, in finding that a geo-location/database approach could be a feasible mechanism to facilitate spectrum sharing, the NTIA referred only to "a geo-location system such as the Global Positioning System" rather than the possibility of a professional installation requirement.[59]

With respect to the required U-NII device frequency and distance separations that should be included in this database, Baron generally agrees with the NTIA's findings in its Third Technical Report regarding TDWR[60] because broadcast weather radar receiver sensitivity is comparable to TDWR receiver sensitivity.[61] However, as the NTIA stressed in its 5 GHz Report, significant additional studies and detailed analyses are required before the NTIA will be able to make final recommendations to the Commission.[62] Once the NTIA has presented the complete results of this testing and the Commission formulates TDWR interference protection criteria

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[57] NPRM, 28 FCC Rcd at 1786; *see* NTIA 5 GHz Report at 4-7 ("Since the transmitter and receiver for a radar system are at the same location, geo-location technology could be effective, particularly for fixed ground-based radar systems.").

[58] *See* NPRM, 28 FCC Rcd at 1787 ("Alternatively, we could modify our rules to specifically require professional installation…").

[59] *See* NTIA 5 GHz Report at 2-6.

[60] *See* NTIA Third Technical Report at Appendix A.

[61] *See* Technical Analysis at 11.

[62] *See* NTIA 5 GHz Report at 4-7 to 4-8 ("NTIA … will examine in more detail whether geo-location spectrum-sharing technology could be used to mitigate the risks associated with signal sensing spectrum-sharing technologies.").

based upon those results, the Commission should apply the same criteria to broadcast weather radar systems operating in the 5.35-5.47 GHz and 5.6-5.65 GHz bands.[63]

B. Baron Also Supports Additional Interference Protection Mechanisms.

As noted, the crucial services provided by the incumbent licensees in the 5 GHz band and the significant risks associated with introducing a substantial number of new, unlicensed devices into this band require the Commission to implement various safeguards in order to prevent harmful interference. Thus, in addition to a more robust DFS spectrum sensing mechanism and a geo-location/database approach, the Commission should pursue, to the extent feasible, the other interference mitigation approaches outlined in the NPRM and by the NTIA.[64]

Specifically, the Commission, in close consultation with the NTIA and industry, should revise the radar receiver interference criteria which form the basis of the current U-NII rules. These revisions are necessary for a variety of reasons. For instance, "U-NII device deployment parameters related to the total number of U-NII devices and the distribution of U-NII devices have changed from those used in the development of the existing regulations because U-NII technology is now incorporated in so many types of wireless devices."[65] As a result, the NTIA concluded that "these new deployment parameters need to be considered to determine whether the existing U-NII regulations are appropriate or what revisions are necessary…"[66] Further, the existing U-NII DFS regulations are based on an interference threshold for radar receivers which uses an interference-to-noise ratio of -6 dB. However, the NTIA has "determined that harmful

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[63] *See* Technical Analysis at 11-12. Subject to the NTIA's additional testing, the only change to the NTIA's current recommendations Baron believes is necessary to fully protect C-band broadcast weather radars from U-NII device interference is to include the pulsewidths 0.4 µsec and 4.5 µsec with the existing TDWR PRIs. *See* Technical Analysis at 6.

[64] *See* NPRM, 28 FCC Rcd at 1785 ("We believe that we should consider additional steps to further reduce the likelihood of interference not only to TDWR systems but to all other incumbent services in the 5 GHz bands as more composite and wideband devices are introduced across the 5 GHz band.").

[65] NTIA 5 GHz Report at 4-8; *see id.* ("The density of U-NII devices is one of the key parameters in determining the amount of potential interference to the incumbent federal systems.").

[66] *Id.*

interference to radar systems can occur even when there are low levels of interference."[67] As a result, the NTIA concluded that, in order to "address these low-level interference effects, it may be necessary to use more stringent interference protection criteria for radar receivers." *Id.*

Baron also supports the Commission's proposal "to require that manufacturers implement security features in any digitally modulated device capable of operating in the U-NII bands, so that third parties are not able to reprogram the devices to operate outside the parameters for which the device was certified."[68] As the Commission explains:

> [E]quipment is often designed and manufactured in a way that the devices are able to operate over a swath of frequencies much wider than the bands in which they are certified to operate. This hardware capability is sometimes exploited by third parties who modify the device software to enable operation across more frequency bands without the device being certified to meet the technical rules necessary for operation in those other frequency bands.[69]

The TDWR interference investigation demonstrated not only that end users do in fact modify U-NII devices in this respect, but that these modifications can result in interference to weather radar systems.[70] Baron therefore supports the Commission's proposal to "require that manufacturers ensure that modifying or reconfiguring firmware or software will make a device inoperable in certain bands."[71] The NPRM also notes that, under the current U-NII rules, it is "difficult for the Commission not only to ensure compliance with its rules but also to enforce those rules." *Id.* Accordingly, Baron also supports the Commission's proposal to "require U-NII devices to transmit identifying information so that, in the event interference to authorized users occurs, [the Commission] can identify the source of interference and its location." *Id.*

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[67] *Id.* at 4-11.

[68] NPRM, 28 FCC Rcd at 1785.

[69] *Id.* at 1778.

[70] *See id.* at 1772 ("In many cases, the interference was caused by third parties modifying software configurations.").

[71] *Id.* at 1785.

Finally, Baron supports the Commission's proposals "that manufacturers prevent the DFS mechanism from being disabled" and that U-NII devices "must be operated with the DFS function on."[72] These requirements are necessary because, as the NTIA discovered, "certain manufacturers provided an option for users to deactivate the DFS mechanism."[73] Going forward, the Commission must prohibit this option because, "[i]f the DFS mechanism is not active, the device could transmit on an active radar channel and cause harmful interference."[74]

IV. AT A MINIMUM, THE COMMISSION MUST DELAY ANY ACTION IN THIS PROCEEDING PENDING COMPLETION AND PUBLIC ANALYSIS OF THE NTIA'S STUDIES AND FINAL RECOMMENDATIONS

As noted, the NTIA 5 GHz Report details eight separate risk factors for weather radar operations if the Commission permits U-NII operations in the 5.35-5.47 GHz band. Significantly, for each of these risk factors, the NTIA emphasizes the need for further testing:

- Risk Element 1: "NTIA … will examine in more detail whether geo-location spectrum-sharing technology could be used to mitigate the risks associated with signal sensing spectrum-sharing technologies."[75]

- Risk Element 2: "It will be critical, working with industry, to establish a realistic U-NII device density before conducting the detailed technical analysis to accurately assess the impact of expanding access to the 5350-5470 MHz band." *Id.* at 4-8.

- Risk Element 3: "NTIA … will determine if the sharing scenarios and analysis methodology previously used adequately protect ground-based and shipborne radars operating in the 5350-5470 MHz band." *Id.* at 4-9.

- Risk Element 4: "It will be necessary to perform laboratory and field measurements to evaluate the capability to detect radar signals employing sub-microsecond pulses." *Id.* at 4-9.

- Risk Element 5: "The conditions under which the 'hidden node' interference problem can occur will require examination…" *Id.* at 4-10.

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[72] *Id.* at 1790.

[73] *Id.*

[74] *Id.*

[75] NTIA 5 GHz Report at 4-7 to 4-8.

- Risk Element 6: "This more detailed analysis will consider various approaches to addressing the adjacent channel interference that can be included in the U-NII DFS regulations…" *Id.* at 4-10.

- Risk Element 7: "As part of the quantitative study, it will be necessary to evaluate the interference protection criteria used in the development of the current DFS regulations and revise the interference protection criteria as necessary to address low-level interference effects." *Id.* at 4-11.

- Risk Element 8: "The feasibility of establishing specifications for U-NII channel response time … must be investigated." *Id.* at 4-11.

In sum, the NTIA "conclude[d] that further analysis is required to determine whether and how the risk factors can be mitigated through, for example, by the promulgation of new safeguards in addition to the FCC's existing requirements."[76] Notably, "[t]his analysis will be more complex than that used to develop the existing U-NII DFS/TPC regulations…"[77] As a result, the NTIA does not anticipate finalizing its recommendations until at least the second half of 2014.[78]

Clearly, it would be imprudent for the Commission to take any action in this proceeding prior to the release of the NTIA's final recommendations. As the Commission recognizes, the 5 GHz Report "concludes that additional analysis is needed to determine the feasibility of introducing U-NII devices into these two bands…"[79] How can the Commission possibly adopt rules permitting expanded U-NII operations in the 5 GHz band before the NTIA even determines

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[76] *Id.* at 6-2.

[77] *Id.*; *see id.* (noting the "significant technical challenges surrounding the potential introduction of U-NII devices in these bands…").

[78] *See id.* at 6-4; *see also id.* at Note a ("The dates in this schedule are tentative because delays can occur during the different stages of the review and coordination process and can impact completing the milestones. Equipment availability is beyond the control of NTIA and would also impact completing the milestones.").

[79] NPRM, 28 FCC Rcd at 1800.

whether such use is feasible? Baron asserts that the Commission cannot, and that to do so would violate the Spectrum Act.[80]

Finally, because the NTIA will not complete its recommendations until long after the formal notice-and-comment period has concluded, the Commission must publicize the NTIA's findings and allow the public to respond in order to give interested parties the requisite opportunity to comment. Ensuring such an opportunity is a prerequisite to the development of rules that will protect weather radars and the critical public safety services they provide. As the Commission has previously concluded, this type of "cautious and conservative approach" is necessary when considering the introduction of unlicensed devices into a spectrum band that will remain occupied by incumbent licensees.[81]

V. CONCLUSION

Baron again emphasizes the substantial interference risk U-NII devices pose to weather radar systems, as demonstrated by the NTIA's analyses and the real-world instances of interference experienced by the FAA's TDWR installations and Baron's C-band weather radar customers. Accordingly, Baron strongly urges the Commission to continue to prohibit U-NII operations in the 5.35-5.47 GHz band, and to adopt adequate technical and service rules to ensure that adjacent-channel U-NII operations, as well as co-channel operations in the 5.6-5.65 GHz band, do not interfere with weather radar systems. In addition, the Commission must wait for the NTIA's final recommendations, and for the public to have an opportunity to comment on those recommendations, before it considers any expanded U-NII operations in the 5 GHz band or adopts the necessary technical and service rules for U-NII devices. Although Baron understands

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[80] *See* Spectrum Act at §6406(a)(2) ("The Commission may make the modification described in paragraph (1) only if the Commission, in consultation with the Assistant Secretary, determines that – (A) licensed users will be protected by technical solutions...") (emphasis added).

[81] *See White Spaces Order*, 23 FCC Rcd at 16810 ("We recognize the importance of protecting licensed services from harmful interference and the novel challenges involved in reliably identifying unused TV channels. We therefore are taking a cautious and conservative approach in this plan…").

the importance of identifying additional spectrum for wireless broadband applications, the Commission must not permit new uses of spectrum that could seriously impact other services, particularly where, as here, harmful interference would seriously undermine a service used to help ensure public safety.

Respectfully submitted,

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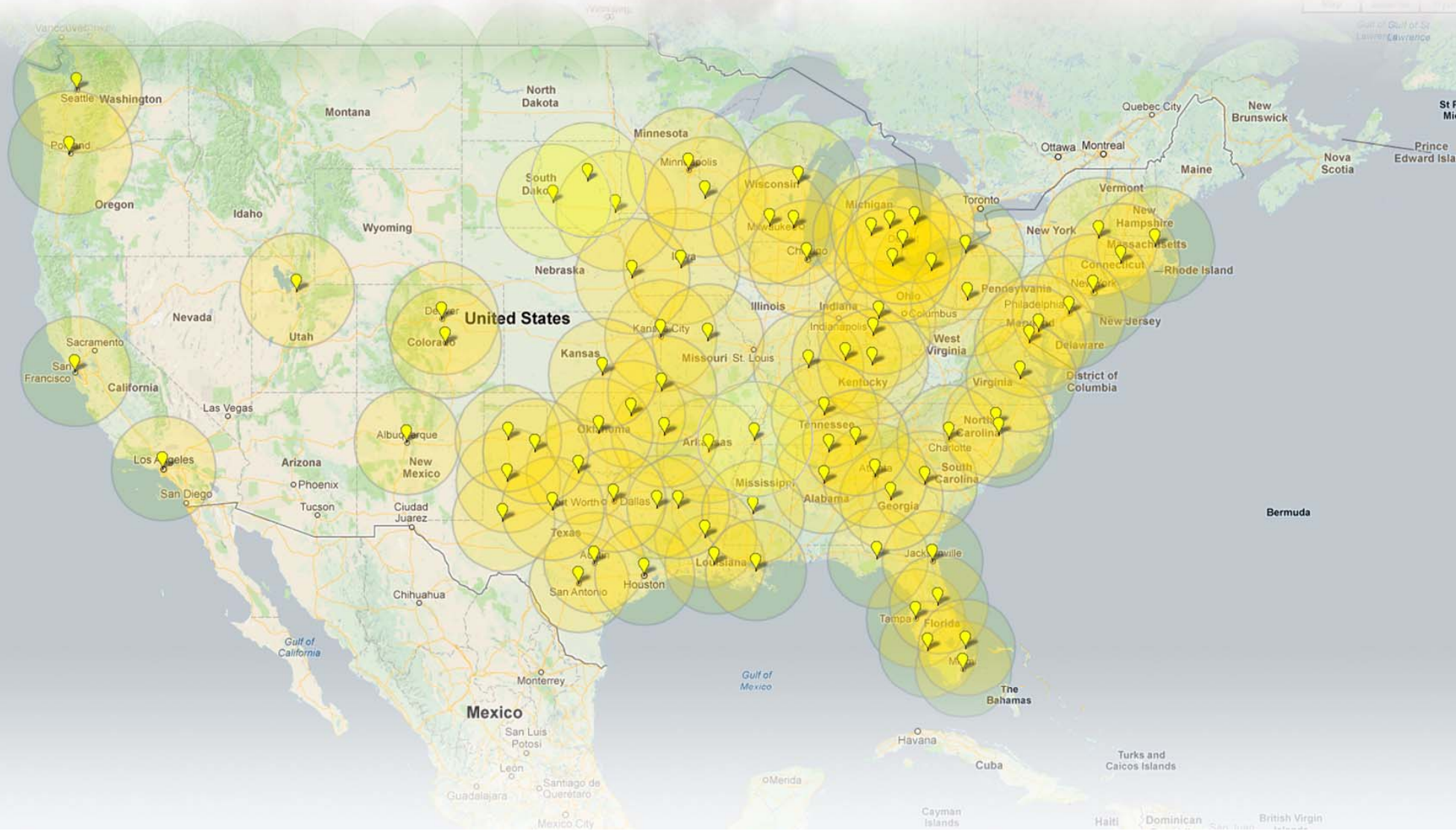
May 28, 2013

BARON

BROADCAST RADAR INSTALLATIONS COVERAGE



TECHNICAL ANALYSIS

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May 28, 2013

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Engineering Change Proposal

Revision of Part 15 of the Commission's Rules to Permit
Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band
(ET Docket No. 13-49)

1. Introduction

Baron Services, Inc. ("Baron") submits this Engineering Change Proposal ("ECP") concerning non-Federal systems in the 5.35-5.47 GHz and 5.6-5.65 GHz bands in response to the Notice of Proposed Rulemaking ("NPRM") released February 20, 2013 in the above-referenced proceeding.[1]

Baron is a privately-owned small business engaged in the design and development of weather radar systems and weather displays for the broadcast industry and government/international customers. There are approximately 150 C-band broadcast weather radar systems deployed in the U.S. that would be adversely affected by the proposed rule changes if sufficient precautions are not taken to prevent radar receiver interference from the emissions of Unlicensed National Information Infrastructure ("U-NII") devices operating in the 5.35-5.47 GHz band (hereinafter "U-NII-2B devices") and in the 5.6-5.65 GHz band. A listing of Baron's FCC-certified radar transmitters are shown in Figure 1-1 below.

Baron's broadcast customers already experience limited C-band radar interference from U-NII devices in a manner similar to the FAA's Terminal Doppler Weather Radar ("TDWR") systems. For the most part, this U-NII interference appears and disappears sporadically.

[1] *See Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd 1769, 1796, ¶ 87 (2013).

Baron Services Inc.
FCC Radar License
Site Frequency Assigned
To
Broadcast Station User

NX5KHDD-1000C: 5.6 - 5.65GHz 1MW Klystron
NX5XDD-1000C: 5.4 – 5.85GHz 1MW Magnetron
NX5XDD-250C: 5.3 -5.7GHz 250kW Magnetron
NX5XDD-350C: 5.4 – 5.8GHz 350kW Magnetron
NX5DSSR-250C: 5.4 – 5.7GHz 250Watt Solid-State

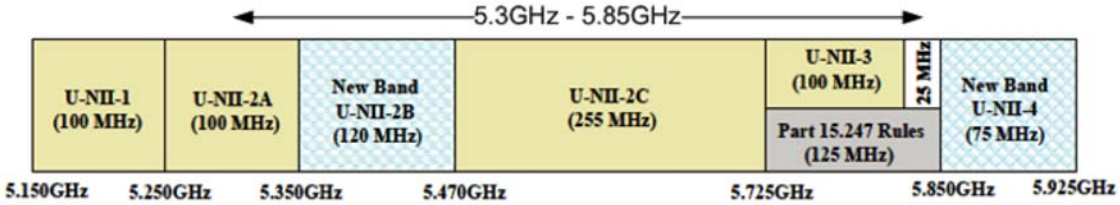

Figure 1-1:
Broadcast Weather Radar Frequencies and U-NII Band Designations

2. Proposed New U-NII-2B Band

Broadcast radar systems are licensed by the FCC to operate within the 5.35-5.47 GHz and 5.6–5.65 GHz bands.

As the FCC noted in the NPRM, much of the U-NII interference to radar systems, especially TDWR, has been caused by installers illegally programming software-controlled radios to operate outside their assigned frequency band, installing higher gain antennas and locating antennas above the height restrictions currently stated in the rules.

3. Baron's Proposals for the U-NII-2B Band[2]

In order to adequately protect incumbent broadcast C-band weather radars from harmful interference, Baron seeks to have the FCC adopt the same U-NII technical and service rules for the 5.35–5.47 GHz and 5.6–5.65 GHz bands as the rules ultimately adopted to accommodate TDWR in the U-NII-2C band (*i.e.*, 5.47-5.725 GHz).

Baron agrees with the NTIA Third Technical Report[3] in regard to the frequency and geographic separation distances necessary to prevent harmful interference to TDWR systems from U-NII operations. These values generally also apply to incumbent broadcast weather radar systems. We do not, however, have a <u>way of guaranteeing that "main beam coupling" will not occur</u>.

Most incumbent weather radar receivers employ a 20 MHz EMI filter in front of the LNA, followed by a digital 3 dB bandwidth IF bandpass filter equal to 1/transmit pulsewidth. The IF bandpass filter provides an additional 40 dB of IF rejection, centered on the EMI filter bandpass (point 2 in Figure 3-1).

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[2] *See id.* at 1798, ¶ 96.

[3] *See* Department of Commerce, *Case Study: Investigation of Interference into 5 GHz Weather Radars from Unlicensed National Information Infrastructure Devices, Part III*, NTIA Technical Report TR-12-486 (June 2012).

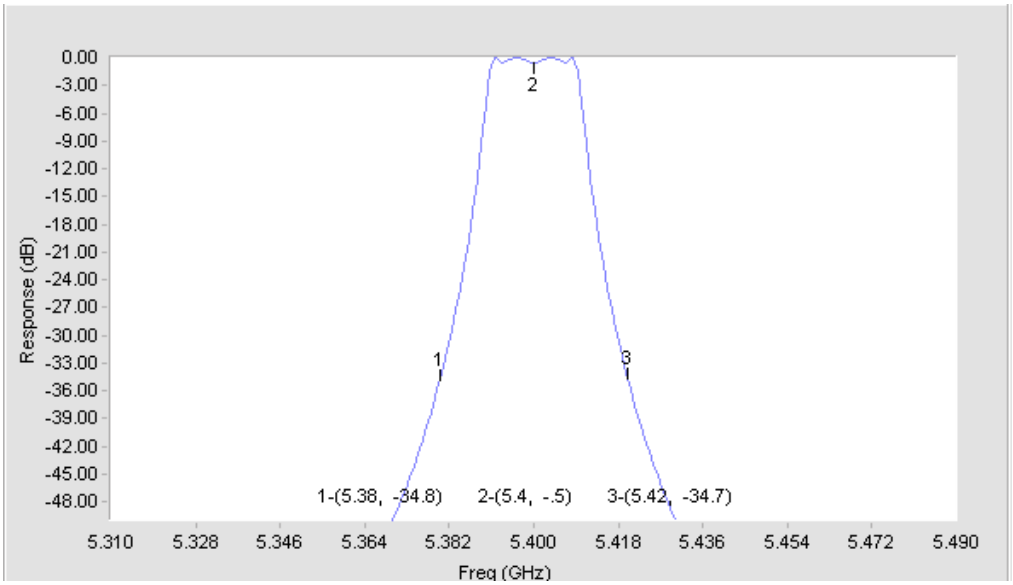

Figure 3-1: Typical Receiver EMI Filter Response 20MHz Offset

Transmit pulses are controlled by the signal processor and may vary by mode from 0.4 µsec to 4.5 µsec. We seek to have the NTIA's U-NII/TDWR Tests[4] modified to include the pulse widths of 0.4 µsec and 4.5 µsec with the existing TDWR PRIs.

We agree with the Commission's proposal to require that U-NII devices be equipped with dynamic frequency selection ("DFS"), and support the NTIA's proposals in this respect.[5] We believe this proposal can be accomplished through rule revisions alone, either in the initial installation for new systems or as a software update for legacy systems. In this respect, Baron notes that many older U-NII devices are software-programmable across the entire 5 GHz band.

We disagree with proposed outside Point-to-Point U-NII-2B systems, with 23 dBi antennas, as this will pose serious problems for both U-NII-2B devices and radar systems (*see* section 5 below).

3.1. U-NII-2B/2C Risk Assessment

Table 3.1-1 below was copied from the NTIA 5 GHz Report.[6] These risk elements also reflect our concerns in regard to U-NII-2B/2C interference with broadcast weather radar receivers operating in the 5.35-5.47 GHz and 5.6-5.65 GHz bands.

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[4] *See* NPRM, 28 FCC Rcd at 1810, Appendix B.
[5] *See* NTIA Third Technical Report at Appendix A.
[6] *See* Department of Commerce, *Evaluation of the 5350-5470 MHz and 5850-5925 MHz Bands Pursuant to Section 6406(b) of the Middle Class Tax Relief and Job Creation Act of 2012*, p. 6-2 (Jan. 2013).

System Category	Frequency Band (MHz)	Description of Risk Element
Radar Systems	5350-5470 and 5850-5925	• Changes in radar signal parameters may impact U-NII device detection of radar systems. • Changes in U-NII device deployment and technical parameters may result in harmful interference. • Existing U-NII regulations may not adequately protect current and future radar systems from serious degradation. • Changes to U-NII DFS detection parameters may not protect current and future radar systems from serious degradation. • Existing U-NII regulations may introduce "hidden node" interference. • U-NII devices operating on adjacent channels may cause harmful interference to radar systems. • Radar receiver interference protection criteria used to develop existing U-NII DFS regulations may not address low-level interference effects. • Channel response time requirements in the current DFS regulations may not be adequate to protect all radar system operational scenarios.
Airborne Systems	5350-5470	• Existing U-NII regulations were not developed to detect airborne signals. • U-NII signal detection technologies may not be capable of detecting airborne signals resulting in serious performance degradation. • Current U-NII DFS regulations were not developed to protect transmitters and receivers in different locations. • Changes to U-NII DFS detection parameters may not protect airborne operations from serious performance degradation.

Figure 3.1-1: Risk Assessment

The major risks we see are created by adjacent channel spillover into incumbent C-band radar receivers sharing the new U-NII-2B band.

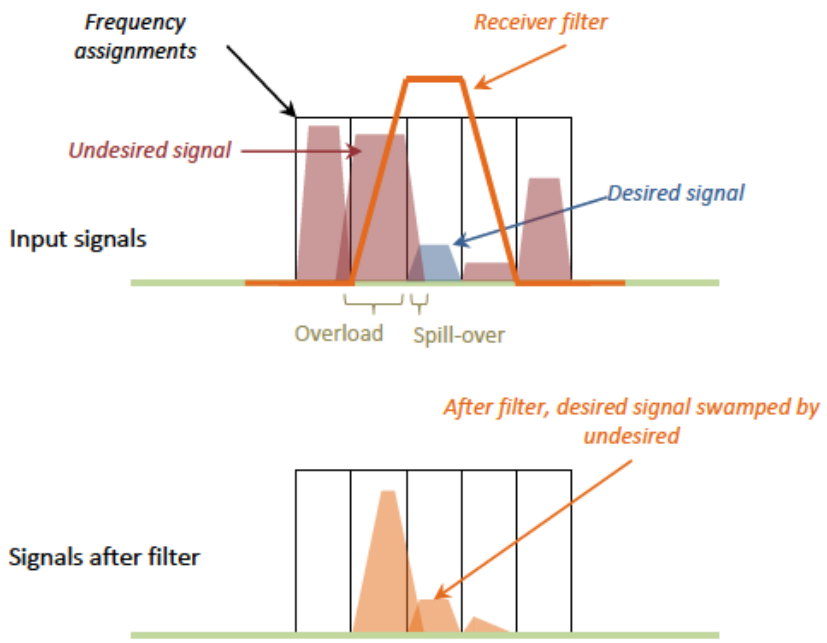

Figure 3.1-2: Spillover into Radar the Receiver[7]

If one assumes the desired signal in Figure 3.1-2 is the radar, then the diagram can be used to illustrate U-NII-2B interference with C-band radar system receiver(s).[8]

3.2. U-NII Victim Receiver/DFS Calculations (Note: for Point-to-Point add +17 dB)

The proposed U-NII-2B/2C DFS sensitivity thresholds of -62 dBm and -64 dBm[9] are adequate for radar detection, but the U-NII receiver may be overloaded or damaged by the strong emissions of the radar signal.

With direct antenna coupling, our calculations for 1 km radar/U-NII separation indicate peak radar signals of up to 1 W coupled to the U-NII receiver terminal. If not damaged, the 3rd Order Intercept Point is certainly exceeded.

With indirect antenna coupling, which assumes a radar antenna gain of 0 dBi, the signal levels intercepted in our calculations that follow are reduced by 45 dB.

[7] Taken from the FCC Technical Advisory Council White Paper on Interference Limits.
[8] Dual-polarization radar employs receivers for both horizontally- and vertically-polarized signals.
[9] *See* NPRM, 28 FCC Rcd at 1791-92, ¶¶ 71-72.

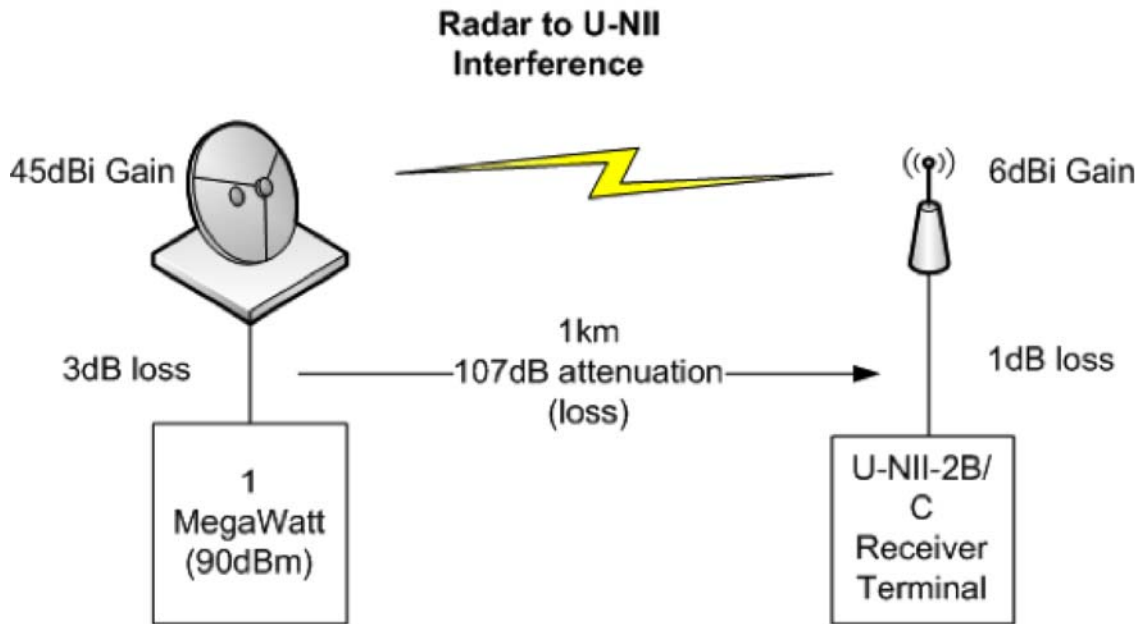

Figure 3.2-1: Interference Diagram Worst-Case

<u>Our calculations for an On-Tune condition Radar (Figure 1-1) to U-NII with 1 km separation follows</u>:

$$I = P_T + G_T + G_R - L_T - L_R - L_P - FDR_{if} \quad (1)$$

$I = 30dBm, Signal\ Intercepted\ by\ the\ UNII\ Receiver_{1km}\ worst\ case$

$I = -10Bm, Signal\ Intercepted\ by\ the\ UNII\ Receiver_{1km}\ (best\ case\ calc\ not\ shown)$

where:

$P_T = 90dBm, Peak\ Power\ of\ Radar\ Transmitter$

$G_T = 45dB, Main\ Beam\ Antenna\ Gain$

$G_R = 6dBi, Receive\ Antenna\ Gain\ in\ Direction\ of\ Radar$

$L_T = 3dB, Loss\ of\ RadarTransmitter$

$L_R = 1dB, Insertion\ Loss\ of\ UNII\ Receiver$

$L_P = 107dB, Propagation\ Path\ Loss\ between\ Radar\ and\ UNII\ Antennas$

$FDR_{if} = 0dB, On - Tune\ Condition$

and:

$$L_P = 20\log(d_{km}) + 20\log(f_{mhz}) + 32.44dB \quad (1.1)$$

Then for 1 km separation at 5400MHz;

$$L_P = 0 + 74.64 + 32.44$$

$$L_P = 107dB$$

Conclusion: The U-NII device DFS receiver operation requires some type of receiver protection to prevent overload and/or damage.

3.3. U-NII-2B/2C to Radar Victim Receiver Interference (Note: for Point-to-Point add +17 dB)

The radar "victim" interference diagram is shown below in Figure 3.3-1 below.

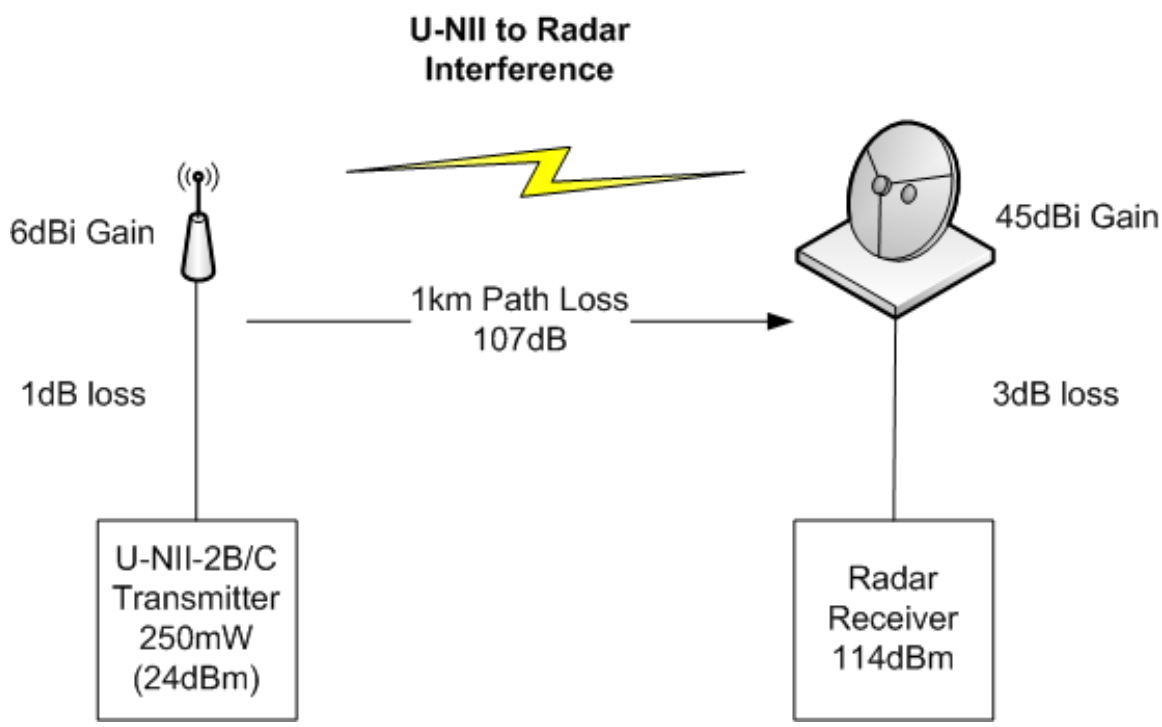

Figure 3.3-1: U-NII to Radar Interference Diagram

Then for a U-NII to Radar On-Tune Condition at 1 km range separation:

$$I = P_T + G_T + G_R - L_T - L_R - L_P - FDR_{if} \quad (2)$$

$$I = -36dBm, at\ the\ radar\ receiver\ input\ terminals$$

Where:

$$P_T = 24dBm, Peak\ Power\ of\ UNII\ device$$

$$G_T = 6dB, UNII\ Antenna\ Gain$$

$$G_R = 45dBi, Radar\ Antenna\ Gain$$

$$L_T = 1dB, Loss\ of\ UNII\ Transmitter$$

$$L_R = 3dB, Insertion\ Loss\ of\ Radar\ Receiver$$

$$L_P = 107dB, Propagation\ Path\ Loss\ between\ UNII\ and\ Radar\ Antennas$$

(from 1.1)

$$FDR_{if} = 0dB, On - Tune\ Condition$$

Conclusion: We agree with the Commission and the NTIA regarding the frequency separations required to protect weather radar systems from harmful interference from U-NII operations. As noted by the Commission and the NTIA, the size of the necessary frequency separation relates to a U-NII device's bandwidth, with greater frequency separations needed for U-NII devices with wider bandwidths.[10]

Incumbent broadcast weather radar receiver sensitivity is comparable to the TDWR receiver sensitivity (-118 dBm) and may be treated accordingly.

4. Potential U-NII/Radar Interference Solution Comments

The FCC has listed a number of techniques that could mitigate interference between radar systems and U-NII devices. Our comments follow:

- ***U-NII-2B/2C Guard Band –*** We propose guard bands around the radar operating frequency consistent with those set forth in Appendix A to the NTIA Third Technical Report.

[10] *See id.* at 1789, n. 81; NTIA Third Technical Report at 30.

- ***Modify Title 47, Part 15.407*** to include/define U-NII operations in the 5.35-5.47 GHz band. Include channel widths/designations.

- ***DFS Functionality*** – Include DFS with Channel Availability Check, Channel Move Time, and Non-Occupancy Period.

- ***Whitespace Database*** – Our understanding is that the Whitespace Database will be used as a model for listing the U-NII devices and commercial weather radar locations and operating frequencies. As an alternative to the Whitespace Database, the broadcast weather radar systems could be added to the TDWR site listings on the web.

- ***Geo-Location and Database Registration*** – Include requirements for U-NII devices to have built-in GPS functionality and to consistently connect to an up-to-date database. Include electronic "permission to radiate, or not radiate, on a specific frequency." Include in the database a list of radars detected and reported to already be radiating in that area.

- ***Point-to-Point U-NII Communications*** – This would be problematic, if not impossible, for both U-NII and radar users, even with casual antenna coupling. Encourage cooperation between local radar and U-NII Point-to-Point device users to prevent this problem from occurring, possibly using the Whitespace/TDWR Database. There does not appear to be a proposed <u>height limitation set for U-NII-2B Point-to-Point antennas operating in 5.35–5.47 GHz band. We recommend that the antenna height set for U-NII-2C operations in the 5.6–5.65 GHz band be adopted for the U-NII-2B band</u>.

5. Summary of Findings

This ECP generally agrees with the findings in the NTIA Third Technical Report regarding interference between U-NII-2C and TDWR. <u>Our investigation finds the same interference will occur between the incumbent broadcast weather radar systems operating in the 5.35–5.47 GHz and 5.6-5.65 GHz bands and the U-NII operations being considered in the NPRM. As a result, Baron strongly urges the Commission to apply the same service and technical rules (including sufficient frequency and geographic separation requirements) with respect to protecting non-Federal weather radar systems from harmful interference as the Commission adopts for TDWR systems</u>.

Respectfully submitted,

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System Engineer with combined 50 years of experience in the design, and development of military and commercial electronic systems.

Relevant experience includes ground-based, shipboard and airborne radar.

Designed and developed the first commercial broadcast C-Band weather radar and Video Integrator Processor in 1970. Designed and developed the present line of weather radar systems for the Baron Services product line.

Most recently designed and developed the Dual-Polarization Upgrade for the NEXRAD Weather Radar.

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Previous Employment: Vitro Systems, Metric Systems, Enterprise Electronics Corporation, Signal Technology Corporation, and BAE Radar Systems.