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

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

NOTICE OF PROPOSED RULEMAKING

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By the Commission: Chairman Genachowski and Commissioners McDowell, Clyburn, Rosenworcel, and Pai issuing separate statements.

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I. INTRODUCTION

1. By this Notice of Proposed Rulemaking (NPRM), we propose to amend Part 15 of our rules governing the operation of Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band.[1] U-NII devices are unlicensed intentional radiators that operate in the frequency bands 5.15-5.35 GHz and 5.47-5.825 GHz, and which use wideband digital modulation techniques to provide a wide array of high data rate mobile and fixed communications for individuals, businesses, and institutions.[2] Since the Commission first made available spectrum in the 5 GHz band for U-NII in 1997, we have gained much experience with these devices. We believe that the time is now right for us to revisit our rules, and, in this NPRM, we propose to modify certain technical requirements for U-NII devices to ensure that these devices do not cause harmful interference and thus can continue to operate in the 5 GHz band and make broadband technologies available for consumers and businesses.

2. We also seek comment on making available an additional 195 megahertz of spectrum in the 5.35-5.47 GHz and 5.85-5.925 GHz bands for U-NII use. This could increase the spectrum available to unlicensed devices in the 5 GHz band by approximately 35 percent and would represent a significant increase in the spectrum available for unlicensed devices across the overall radio spectrum. The initiation of this proceeding satisfies the requirements of Section 6406 (a) of the "Middle Class Tax Relief and Job Creation Act of 2012" which requires the Commission to begin a proceeding to modify part 15 of title 47, Code of Federal Regulations, to allow unlicensed U-NII devices to operate in the 5350-5470 MHz band.[3] We believe that an increase in capacity gained from 195 megahertz of additional spectrum, combined with the ease of deployment and operational flexibility provided by our U-NII rules, would continue to foster the development of new and innovative unlicensed devices, and increase wireless broadband access and investment.

II. BACKGROUND

3. Part 15 of the Commission's rules permits the operation of radio frequency devices without issuing individual licenses to operators of these devices. The Commission's Part 15 rules are designed to ensure that there is a low probability that these devices will cause harmful interference to other users of the same or adjacent spectrum. Typically, unlicensed devices operate at very low power over relatively short distances, and often employ various techniques, such as dynamic spectrum access or listen-before-talk protocols, to reduce the interference risk to others as well as themselves. The primary operating condition for unlicensed devices is that the operator must accept whatever interference is received and must correct whatever interference it causes. Should harmful interference occur, the operator is required to immediately correct the interference problem or cease operation.[4]

4. In 1997, the Commission made available 300 megahertz of spectrum at 5.15-5.25 GHz (referred to hereinafter as U-NII-1), 5.25-5.35 GHz (referred to hereinafter as U-NII-2A), and 5.725-

[1] *See* 47 C.F.R. Part 15 Subpart E – Unlicensed National Information Infrastructure Devices.

[2] *See* 47 C.F.R. § 15.403(s).

[3] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, § 6406, 126 Stat. 156, 231 (2012), 47 U.S.C. § 1453 (Spectrum Act).

[4] *See* 47 C.F.R. §§ 15.5(b) and (c).

5.825 GHz (referred to hereinafter as U-NII-3) for use by a new category of unlicensed equipment, called U-NII devices which are regulated under Part 15, Subpart E of the Commission's rules.[5] In 2003, the Commission made an additional 255 megahertz of spectrum available in the 5.47-5.725 GHz (referred to hereinafter as U-NII-2C) for U-NII devices.[6] These actions align the frequency bands used by U-NII devices in the United States with the frequency bands used by U-NII devices in other parts of the world, thus decreasing development and manufacturing costs by allowing for the same products to be used in most parts of the world.

5. The U-NII-1 band is allocated on a primary basis to the Aeronautical Radionavigation Service for both Federal and non-Federal operations and on a primary basis for Fixed Satellite Service (Earth-to–space) for non-Federal operations.[7] The U-NII-2A band is allocated on a primary basis to the Earth Exploration Satellite (active), Radiolocation, and Space Research (active) Services for Federal operation, and for non-Federal operation on a secondary basis.[8]

6. The U-NII-2C band is allocated on a primary basis to the Radiolocation Service for Federal operation. The sub-band at 5.47-5.65 GHz band is allocated on a primary basis to the Radiolocation Service for non-Federal operation, and on a primary basis to the Maritime Radionavigation Service for both Federal and non-Federal operations. The 5.47-5.570 GHz band segment is allocated on a primary basis to the Earth Exploration-Satellite (active) and Space Research (active) Services for Federal operation and on the secondary basis for non-Federal operation. The 5.6-5.65 GHz band segment is allocated on a primary basis to the Meteorological Aids Service for both Federal and non-Federal operations. The band segment at 5.65-5.725 GHz is allocated on a secondary basis to the Amateur Radio Service for non-Federal operation.[9]

7. The U-NII-3 band is allocated on a primary basis to the Radiolocation Service for Federal operation, and is allocated on a secondary basis to the Amateur Radio Service for non-Federal operation.[10]

8. In early 2009, Federal Aviation Administration (FAA) reported interference to their Terminal Doppler Weather Radar (TDWR) that operates within the 5.60-5.65 GHz band. Early field studies performed by the National Telecommunications and Information Administration's (NTIA's) Institute for Telecommunications Sciences (ITS) and FAA staff indicated the interference sources were

[5] *See* Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range, *Report and Order*, ET Docket No. 96-102, 12 FCC Rcd 1576 (1997). *(U-NII Report and Order)*. *See* 47 C.F.R. Part 15 Subpart E. In this NPRM, we have assigned sequential numbers to identify the 5 GHz band segments, both the current U-NII bands and future potential U-NII bands, which are discussed below. We recognize that different organizations, both Federal and non-Federal, have used a variety of different identifiers for these band segments, but we have chosen sequential numbering to make it easier for the reader to follow the discussion in the NPRM.

[6] *See* Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band, *Report and Order*, ET Docket No. 03-122, 18 FCC Rcd 24484 (2003). In this decision, the Commission also required that U-NII devices in the U-NII-2A and U-NII-2C bands employ dynamic frequency selection (DFS) to protect Federal radar operations and transmit power control (TPC) to protect the Earth exploration satellite service. *See* 47 C.F.R § 15.407(h).

[7] *See* 47 C.F.R. § 2.106, Table of Frequency Allocations.

[8] *Id.*

[9] *Id*.

[10] *Id.*

unlicensed U-NII devices that incorporated dynamic frequency selection (DFS),[11] from different manufacturers, and operated in the same frequency band as these Federal radar systems.

9. The Commission brought together all of the principal parties including NTIA, FAA, industry participants and the FCC's Enforcement Bureau and Office of Engineering and Technology to analyze the interference situation. Based on these investigations, the Commission has taken actions to mitigate the interference situation, including issuing enforcement advisories to heighten users' awareness of TDWR interference issues,[12] and the Office of Engineering and Technology has placed conditions on U-NII device certifications to curtail the interference risk. The Commission also has sent enforcement teams to work with FAA staff in the field, and has taken enforcement actions against operators of U-NII devices that caused interference to TDWR installations including issuing Letters of Inquiry and Notices of Apparent Liability for Forfeitures to operators found to be causing interference.[13] Most of these interference cases were caused by devices not certified for operation in the U-NII-2C band, which includes the 5.6-5.65 GHz band used by the TDWRs. Instead, these devices had been certified for operation in the U-NII-3 band, either as U-NII devices under Section 15.407 of our rules or as digitally modulated intentional radiators under Section 15.247 of our rules, and which were operating at high power levels in elevated locations. The Commission's investigations found that most U-NII devices are manufactured to enable operation across a wide range of frequencies, extending down into the 4-GHz bands and up to almost 6 GHz. In many cases, the interference was caused by third parties modifying software configurations to enable operation in frequency bands other than those for which the device had been certified but without meeting the technical requirements for operation in those frequency bands. There was also an issue with devices that employed frame based architectures that allowed operators to reconfigure the talk/listen ratio of their devices.

10. In 2006 the Commission issued measurement procedures that it would use to test the devices to ensure that they comply with the radar detection and the dynamic frequency selection (DFS) requirements for the U-NII-2A and U-NII-2C bands.[14] In response to the TDWR interference cases,

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[11] DFS is a mechanism that detects the presence of radar signals and dynamically guides a transmitter to switch to another channel whenever a particular condition is met. Prior to the start of any transmission, a U-NII device equipped with DFS capability must continually monitor the radio environment for radar's presence. If the U-NII device determines that a radar signal is present, it must either select another channel to avoid interference with radar, or go into a "sleep mode" if no other channel is available.

[12] *See* FCC Enforcement Advisory, TDWR and U-NII Devices, "Enforcement Bureau Takes Action to Prevent Interference to FAA-Operated Terminal Doppler Weather Radars Critical to Flight Safety," (TDWR Enforcement Advisory) DA 12-459, September 27, 2012, Enforcement Advisory No. 2012-07, available at: http://www.fcc.gov/encyclopedia/weather-radar-interference-enforcement. Users of U-NII devices include wireless Internet service providers (WISPs), which were the focus of the Enforcement Advisory for outdoor fixed installations, as well as consumers for indoor wireless networking.

[13] *See VPNet, Inc.*, Notice of Apparent Liability for Forfeiture and Order, 27 FCC Rcd 2879 (Enf. Bur. 2012); *Argos Net, Inc.*, Notice of Apparent Liability for Forfeiture and Order, 27 FCC Rcd 2786 (Enf. Bur. 2012); *Insight Consulting Group of Kansas City, LLC*, Notice of Apparent Liability of Forfeiture and Order, 26 FCC Rcd 10699 (Enf. Bur. 2011); *Ayustar Corp.,* Notice of Apparent Liability for Forfeiture and Order, 26 FCC Rcd 10693 (Enf. Bur. 2011); *Rapidwave, LLC*, Notice of Apparent Liability for Forfeiture and Order, 26 FCC Rcd 10678 (Enf. Bur. 2011); *AT&T, Inc.,* Notice of Apparent Liability for Forfeiture, 26 FCC Rcd 1894 (Enf. Bur. 2011); *Utah Broadband*, Notice of Apparent Liability for Forfeiture, 26 FCC Rcd 1419 (Enf. Bur. 2011) (forfeiture paid). *See also Ayustar Corp.*, Memorandum Opinion and Order, 25 FCC Rcd 16,249 (Enf. Bur. 2010); *Sling Broadband, LLC*, Forfeiture Order, 26 FCC Rcd 13062 (Enf. Bur. 2011).

[14] These procedures were based on the work of the International Telecommunication Advisory Committee-Radiocommunication (ITAC-R) Government/Industry Project Team (Project Team) /Industry Project Team (Project Team) and recommendations from NTIA. *See* Letter from Fredrick R. Wentland, Associate Administrator, NTIA to Julius Knapp, Deputy Chief, OET, filed in ET Docket No. 03-122 on March 30, 2006, and the enclosure

(continued....)

NTIA and the Federal Aviation Administration (FAA) have recently recommended to the Commission that the 2006 compliance and measurement procedures for DFS be revised[15]to include modified definitions, technical requirements (*e.g.*, detection bandwidth and pulse repetition interval values), radar test waveforms, test procedures, and test report guidelines.

11. In recent years, there has been an industry wide push to increase the amount of spectrum available for unlicensed use. In June 2010, the President issued an Executive Memorandum that encouraged the Commission to work closely with the Department of Commerce, through NTIA, to make available a total of 500 megahertz for commercial mobile and fixed wireless broadband use by the year 2020.[16] The FCC's 2010 National Broadband Plan recommended that the Commission make available 500 megahertz of new spectrum for wireless broadband within 10 years.[17] In analyzing the need for broadband spectrum, the Commission also concluded that nearly 300 megahertz of spectrum is needed by 2014, and that making available additional spectrum for mobile broadband would create value in excess of $100 billion through avoidance of unnecessary costs.[18]

12. In addition, Congress has enacted legislation that addresses unlicensed use of the 5 GHz band. The Spectrum Act requires the Commission to begin a proceeding to modify Part 15 of the title 47, Code of Federal Regulations (CFR), to allow unlicensed U-NII devices to operate in the 5.35-5.47 GHz band (referred to hereinafter as U-NII-2B) no later than 1 year after the date of the enactment of the Act[19] if, in consultation with the Assistant Secretary of Commerce (*i.e.*, the NTIA Administrator), it determines that licensees will be protected by technical solutions and that the primary mission of Federal spectrum users in the band will not be compromised by the introduction of unlicensed devices in this band.[20]

13. The Spectrum Act also requires NTIA, in consultation with the Department of Defense and other impacted agencies, to conduct a study evaluating known and proposed spectrum sharing technologies and the risks to Federal users if unlicensed U-NII devices were allowed to operate in the U-

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Compliance Measurement Procedures for Unlicensed National Information Infrastructure Devices Operating in the 5250-5350 MHz and 5470-5725 MHz bands Incorporating Dynamic Frequency Selection (Compliance Measurement Procedures). *See also* Revision of Parts 2 and 15 of the Commission's Rules to permit Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz Band, *Memorandum Opinion and Order*, ET Docket No.03-122,21 FCC Rcd 7672 Appendix Compliance Measurement Procedures for Unlicensed-National Information Infrastructure Devices Operating in the 5250-5350 MHz and 5470-5725 MHz Bands Incorporating Dynamic Frequency Selection.

[15] *See* Letter from Lawrence E. Strickling, Administrator, NTIA to Julius Genachowski, Chairman, FCC, filed February 19, 2013, and the enclosure *Appendix - Proposal for New Unlicensed National Information Infrastructure Dynamic Frequency Selection Certification Waveforms.* A copy of this document has been placed in the docket file for this proceeding.

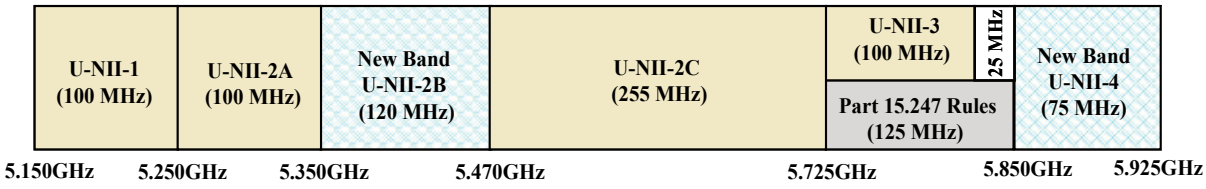
[16] *See* Presidential Memorandum: Unleashing the Wireless Broadband Revolution (Executive Memo) (June 28, 2010), *available at*: http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution.

[17] FCC, Connecting America: The National Broadband Plan at Chapter 5, *available at*: http://www.broadband.gov.

[18] See Omnibus Technical Report, *Mobile Broadband: The Benefits of Additional Spectrum* (Oct. 2010), pg 18, *available at*: http://download.broadband.gov/plan/fcc-staff-technical-paper-mobile-broadband-benefits-of-additional-spectrum.pdf. While the statements in the paper were aimed at unleashing 300 megahertz of licensable spectrum, unlicensed spectrum has the potential to ease the strain of the spectrum deficit. Unlicensed wireless networks operating in the U-NII bands help to decrease the demands on mobile cellular providers that use mobile data offloading. Mobile data offloading is the process by which data that would normally be transmitted over the cellular network is rerouted to complementary networks. For cellular phones and smart phones in particular, the offloaded data is typically routed over unlicensed wireless networks. This decreases the traffic load and helps to alleviate the congestion created by increased broadband data use on the cellular networks.

NII-2B band as well as in the 5.85-5.925 GHz band (referred to hereinafter as U-NII-4). NTIA was required to publish a report on the U-NII-2B band no later than 8 months after the date of enactment of the Spectrum Act and a report on the 5.85-5.925 GHz band (referred to hereinafter as U-NII-4) no later than 18 months after the date of enactment of the Spectrum Act. NTIA published a report (hereinafter referred to as "NTIA 5 GHz Report") on both the U-NII-2B and U-NII-4 bands on January 25, 2013.[21]

14. The chart below summarizes the frequency bands for U-NII device operation that are discussed in the NPRM. The chart also indicates that unlicensed devices may be authorized to operate in the U-NII-3 band, as well as the 25 megahertz between that band and the potential future U-NII-4 band, under the digital modulation rules in Section 15.247.



III. DISCUSSION

15. Wireless broadband services are in high demand by the public and that demand is expected to grow significantly in the coming years. Increasingly, U-NII devices have played a role in meeting some of that demand, particularly U-NII devices used for wireless local area networking and broadband access. The U-NII bands hold significant promise for helping to accommodate the needs of businesses and consumers for fixed and mobile broadband communications, and thus it is important that we explore fully ways to reduce significantly the potential for interference to authorized users of the 5 GHz band that arise from U-NII operations.

16. The Commission's U-NII rules were developed to address the particular sharing scenarios presented by each frequency band. For example, devices in the U-NII-1 band operate only indoors and at very low power (50 mW); devices in the U-NII-2A and U-NII-2C bands may operate either indoors or outdoors at higher power (250 mW) but must deploy dynamic frequency selection (DFS) to protect incumbent radar operations and transmit power control (TPC) to protect the Earth exploration–satellite service; and devices in the U-NII-3 band may operate either indoors or outdoors at even higher power (1 W).[22] A U-NII device uses radar detection along with DFS in the U-NII-2A and U-NII-2C bands to monitor the spectrum and operate only on frequencies not already in use by Federal radar systems.[23] TPC is used in the U-NII-2A and U-NII-2C bands to further protect operations in the Earth

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[19] *See supra* note 3 at Section 6406(a).

[20] *Id.* The Spectrum Act states that technical solutions may include existing, modified or new spectrum-sharing technologies and solutions, such as dynamic frequency selection.

[21] *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," available at http://www.ntia.doc.gov/files/ntia/publications/ntia_5_ghz_report_01-25-2013.pdf. A copy of this report has been placed in the docket of this proceeding.

[22] A chart displaying the different technical requirements for each band is provided in Appendix C.

[23] Before starting any transmission, a U-NII device equipped with DFS capability must continually monitor the radio environment for the presence of a radar system. If the U-NII device determines that a radar system is present, it must either select another channel or enter a "sleep mode" if no channels are available. *See* 47 C.F.R. §§ 15.403(g) and 15.407(i).

Exploration-Satellite Service (active) (EESS) and the Space Research Service (active) (SRS) from harmful interference.[24]

17. Over time, we have gained considerable experience with U-NII devices operating in each of these bands as both indoor and outdoor uses have evolved and increased. Based on this experience, we have identified issues that we need to address so that the spectrum in the 5 GHz band can continue to provide much needed support for broadband and other wireless services while protecting authorized operations. In particular and as described above, we have seen an increase in interference incidences in U-NII bands that are caused by users unlawfully modifying and operating unlicensed devices that have not been certified to meet the required technical rules for these bands. This type of conduct occurs mainly because devices are designed and manufactured that are capable of operating over a wide swath of frequencies, and only the software configuration of these devices limits their operation to permissible bands or operational parameters that comply with the Commission's rules. Also, unlicensed devices in the U-NII-3 band and above can be authorized under two different sets of rules as either spread spectrum devices or U-NII devices, which introduces complexity in the compliance testing process and also permits an uneven playing field for band sharing with authorized services.[25]

18. There are other forces at work that make this an opportune time for the Commission to re-examine the U-NII rules. A new Wi-Fi standard—IEEE 802.11ac that is expected to be finalized in the near future—would allow for wider bandwidth transmissions by devices that would operate over more than one U-NII band, thus increasing use of the band for broadband services.[26] Also, the amount of contiguous spectrum available for U-NII devices may increase as we, in conjunction with NTIA, investigate opening the U-NII-2B and U-NII-4 bands to these devices. Both of these circumstances present exciting opportunities for new unlicensed uses of the 5 GHz band. Three sets of Wi-Fi standards are used for the 5 GHz U-NII bands: 802.11a, 802.11n and 802.11ac. Each standard specifies different channel bandwidths and data rates. For example, the 802.11a standard defines a 20 megahertz channel bandwidth with maximum data rate up to 54 Mbit/s,[27] and the 802.11n standard specifies 20 and 40 megahertz channel bandwidths with maximum data rate from 54 Mbit/s to 600 Mbit/s.[28] The new 802.11ac standard would allow for a significant increase in bandwidth and data rates in the 5 GHz band—it specifies bandwidths of 20, 40, 80, and 160 megahertz with a link data rate of approximately 1 Gbit/s.[29]

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[24] TPC is a feature that adjusts a transmitter's output power based on the signal level present at the receiver. As the signal level at the receiver rises or falls, the transmit power will decrease or increase as needed. Therefore, TPC will cause the transmitter to operate at less than the maximum power when lower signal levels can provide acceptable quality of service. *See* 47 C.F.R. § 15.407(h).

[25] *See infra* para. 23.

[26] *See* www.Wi-Fi.org. How does Wi-Fi technology work? Wi-Fi is a short range technology that is often used in conjunction with a customer's DSL, FIOS, or cable modem service to connect end-user devices, such as PCs, laptops and smart phones, located within the customer's home or business to the Internet. In these cases, Wi-Fi allows users to move Wi-Fi enabled devices around within their homes or businesses without installing additional inside wiring, but the actual "connection" to the service provider is via the customer's DSL, FIOS, or cable modem service. Wi-Fi is widely available in airports, city parks, restaurants, bookstores and other public places called "hotspots," allowing those who are away from their homes or businesses to access the Internet.

[27] The 802.11a standard is an amendment to the original standard that was ratified in 1999. The amendment was incorporated into the published IEEE 802.11-2007.

[28] IEEE 802.11n is an amendment to the IEEE 802.11-2007 standard and was published in 2009.

[29] At the time of writing this document, the 802.11 ac standard is still under development. The IEEE 802.11ac standard is expected to be finalized in February 2014. *See* http://grouper.ieee.org/groups/802/11/Reports/802.11_Timelines.htm.

19. The current U-NII bands can easily accommodate implementation of the new 802.11ac standard. For example, 160 megahertz channels do not need to rely on contiguous spectrum, and a single transmission can aggregate multiple smaller channels by simultaneously transmitting in different bands. The current U-NII bands can accommodate two 160 megahertz high-speed channels, and, if additional 5 GHz spectrum is made available for U-NII devices, would provide for five high-speed channels. However, each U-NII band presents its own sharing challenges, and thus the technical and operational requirements for U-NII devices are not consistent across the 5 GHz band. We should strive to provide as much consistency in our rules as possible so that wide bandwidth U-NII devices operating across multiple bands are not driven to comply with the most restrictive requirements for any one band and forfeit opportunities for new broadband applications that may be permitted in other bands.

20. In this NPRM, we take the first steps towards ensuring the U-NII bands continue to meet the demand for broadband spectrum, while ensuring protection of authorized operations, by proposing modifications to the Part 15 rules. In particular, we are proposing to align the provisions for operation of digitally modulated devices in the 5.725-5.85 GHz band, now permitted under Section 15.247 of our rules,[30] with the rules for the U-NII-3 band under Section 15.407. This will expand the U-NII-3 band by 25 megahertz and provide consistent rules across 125 megahertz of spectrum. We also seek comment on aligning the power limits and permissible location for operations in the U-NII-1 and U-NII-2A bands to permit the introduction of a new generation of wireless devices in 200 megahertz of contiguous spectrum.

21. We also address ways to ensure compliance with our rules across all of the U-NII bands and, in particular, the U-NII-2A and U-NII-2C bands to curtail interference to incumbent Federal operations (*e.g.* TDWR installations). We seek comment on various ways to prevent unlawful modification and operation of unlicensed devices in the U-NII bands as well as compliance issues that are likely to arise as we move toward wider bandwidth systems operating across multiple U-NII bands. Although some of the methods discussed below would ensure that manufacturers and users comply with the Commission's requirements across any of the U-NII band segments, we also seek comment on some techniques that may be useful mainly in curtailing interference to incumbent Federal operations, such as TDWR installations, in the U-NII-2A and U-NII-2C bands, such as geo-location and database registration, unwanted emissions limits, and guard band requirements. We also seek comment on several issues specific to the U-NII-2A and U-NII-2C bands regarding DFS functionality, the sensing threshold for co-channel operation, and revised DFS measurement procedures. We ask that commenters address the benefits of adopting any of the proposals in the NPRM as well as the costs to do so, and that they weigh and compare the benefits and costs in each case. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

22. In this NPRM, we also seek comment on modifying Part 15 Subpart E of the Commission's rules governing the operation of U-NII devices to make available an additional 195 megahertz of spectrum in the 5.350 – 5.470 GHz (U-NII-2B) and 5.850 – 5.925 GHz (U-NII-4) bands. This would increase the spectrum available to unlicensed devices in the 5 GHz band by nearly 35 percent and would represent a significant increase in spectrum available for unlicensed operations. Finally, we seek comment on transition periods for requiring compliance with any modified rules that we ultimately adopt in this proceeding.

A. The Current U-NII Bands

1. Unlicensed Operations in the U-NII-3 Band

23. *Background.* Prior to the adoption of the DFS requirements for U-NII devices in the U-NII-2A and U-NII-2C bands in 2003, the Commission amended Part 15 to provide for the introduction of digital transmission technologies and to improve spectrum sharing by unlicensed devices operating under

[30] *See* 47 C.F.R. §15.247.

the provisions of Section 15.247 of its rules.[31] Specifically, the Commission revised Section 15.247 to allow new digital transmission technologies and direct sequence spread spectrum systems to operate under the same rules in the 5.725-5.85 GHz band.[32] The Commission noted that the permitted uses under Section 15.247 were similar to the rules for U-NII devices in the U-NII-3 band and sought comment on whether these new digital technologies could be accommodated under the U-NII rules. The Commission recognized that in order to accommodate the proposed digital devices under the U-NII rules, the upper limit of the U-NII-3 band would need to be extended 25 megahertz to 5.85 GHz to align the requirements with those permitted under Section 15.247. The Commission declined to modify the U-NII rules and determined that digitally modulated devices were best accommodated under Section 15.247 for digitally modulated systems.[33] Consequently, digital devices are permitted to operate in the 5.725 – 5.85 GHz band under Section 15.247 rules as well as in the 5.725 – 5.825 GHz band under the U-NII rules in Section 15.407. Thus, our rules permit manufacturers to examine the different technical requirements for digitally modulated devices in Section 15.247 and the U-NII rules in Section 15.407 to determine which requirements are best suited for a particular 5.7 GHz digital device.

24. The primary differences between the two rule sections are that 25 megahertz of spectrum covered by Section 15.247 are not part of the U-NII rules and that point-to-point devices authorized under Section 15.247 are permitted higher power based on increasing antenna gain. Although the total conducted power levels for Section 15.247 and U-NII-3 devices are the same (1 W), the radiated power levels permitted under Section 15.247 are higher for point-to-point operations because we do not apply a power penalty for high antenna gain. In general, the power spectral density (PSD) limit under Section 15.247 is higher (8 dBm/3 kHz, which is equivalent to 33 dBm/MHz) [34] than the power spectral density limit for U-NII-3 devices (17 dBm/MHz).[35] In addition, while we use an absolute unwanted emissions limit of -17 dBm/MHz for the U-NII-3 devices, the unwanted emissions limit for Section 15.247 devices is a function of the in-band power which could be as much as 33 dBm higher than that of a U-NII-3 device.[36] Finally, the unwanted emission limits from Section 15.247 require emissions in all restricted frequency bands to meet the Section 15.209 general emission limits, while Section 15.407 requires all emissions below 1 GHz to meet the Section 15.209 general emission limits. The result of this rule disparity is that manufacturers are opting to certify devices under Section 15.407 for the U-NII-1, U-NII-

[31] *See* Amendment of Part 15 of the Commission's Rules Regarding Spread Spectrum Devices, *Second Report and Order*, ET Docket No. 99-231, 17 FCC Rcd 10755 (2002) *(Spread Spectrum Second Report and Order)*.

[32] *Id.* Spread spectrum modulation reduces the power density of the transmitted signal at any frequency, thereby reducing the possibility of causing interference to other signals occupying the same spectrum. Similarly, at the receiver end, the power density of interfering signals is minimized, making spread spectrum systems relatively immune to interference from outside sources. In frequency hopping spread spectrum (FHSS) systems, an information signal, usually a data stream, modulates a radio frequency carrier that quickly moves from frequency to frequency in concert with a receiver. In direct sequence spread spectrum (DSSS) systems, the information data stream is combined with a high speed digital spreading code that is used to modulate a radio carrier, producing a radio signal that has a bandwidth covering anywhere from 0.5 to hundreds of megahertz. *See also* 47 C.F.R. § 2.1(c). Digital systems spread their transmitted energy across a wide bandwidth, thereby minimizing the amount of energy transmitted in any one portion of the occupied frequency band. Therefore, such digital modulation systems may exhibit no more potential to cause interference to other devices than direct sequence systems. However, because digital modulation systems do not meet the Commission's definition of a spread spectrum system, the rules were amended in 2002 to allow their operation under the Section 15.247 rules, which had previously allowed for only FHSS and DSSS systems.

[33] *See Spread Spectrum Second Report and Order* at 10761.

[34] *See* 47 C.F.R. §15.247(e).

[35] *See* 47 C.F.R. § 15.407(a)(2).

[36] *See* 47 C.F.R. §15.247(c).

2A and U-NII-2C frequency bands, but opting to certify devices operating in the U-NII-3 band under Section 15.247 in order to access more spectrum and use higher PSD levels.

25. This rule disparity has led to several difficulties in managing digital devices in the 5.725 – 5.85 GHz band. For example, the introduction of devices capable of operating across multiple frequency bands and under different rule parts introduces complexity to the equipment authorization process.[37] In addition to the complexity in equipment authorization, our investigation of interference complaints has shown that equipment 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. Most frequently we have seen devices certified to operate in the 5.725-5.85 GHz band with higher power levels and later modified to enable operation in the U-NII-2 frequency bands. These device modifications have resulted in non-compliant devices creating interference scenarios that were not anticipated when the U-NII rules were created.

26. *Discussion.* We believe that now is an appropriate time to review our rules to eliminate the disparity and decrease the complexity associated with interpreting our rules for digitally modulated devices operating in the U-NII-3 band under Section 15.407 and in the 5.725 – 5.85 GHz band under Section 15.247 We believe the changes we propose below will ensure compliance with requirements designed to protect authorized services in the U-NII bands, simplify our authorization procedures, and reduce certification cost for manufacturers of these devices. The spectrum ecosystem has changed considerably since the Commission allowed the certification of "digitally modulated" devices. For example, the standards for wireless broadband devices are now capable of producing data rates in excess of 1 Gbits/s. In addition, devices are now able to utilize advances in antenna technology that allow the multiple data streams to be transmitted over multiple antennas. This provides an opportunity for us to reflect on recent industry developments and propose new rules that have the potential to increase consistency in the process of certifying 5 GHz wireless broadband devices, while continuing to protect authorized services.

27. As we discuss in more detail below, we are proposing two changes that will eliminate the disparity in our rules for 5.7 GHz digitally modulated devices. First, we propose to extend the upper edge of the U-NII-3 band from 5.825 GHz to 5.85 GHz to match the amount of spectrum available for digitally modulated devices under Section 15.247. We believe that this change would eliminate the complexity and costs associated with multiple rule part certifications for these devices which are technically similar. Adopting this proposal would not increase the potential for harmful interference because this 25 megahertz segment is already available for devices certified under Section 15.247. We seek comment on the potential benefits of expanding the U-NII-3 band to include an additional 25 megahertz of spectrum at the upper band edge. We invite comment on whether there are cost advantages of this proposal. We ask that commenter's assessment of adopting the proposal weigh and compare the benefits and costs to do so. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

[37] In addition to higher emissions limits, the measurement procedures for Sections §15.247 and §15.407 vary considerably. The FCC's Lab has issued guidance through its knowledge data base program (KDBs) for testing of emissions for compliance with Sections 15.247 and the U-NII device rules in Sections 15.401 through 15.407. *See* KDB 644545 D01 – Guidance for IEEE 802.11ac and Pre-ac Device Emission Testing and KDB 644545 D02 Alternative Guidance for IEEE 802.11ac and Pre-ac Emissions Testing. These KDB documents are available at: www.fcc.gov/labhelp. The alternative guidance permits all emissions testing for operation between 5.725 and 5.85 GHz to be performed using testing procedures for U-NII devices and emission limits based on the U-NII rules at Section 15.407 even though operations may extend above the 5.825 GHz upper bound of the U-NII-3 band. We discuss compliance issues for composite devices more fully in Section III. B., below.

28. Second, we propose to consolidate all equipment authorizations for digitally modulated devices in the 5.725-5.85 GHz band under the U-NII rules, while maintaining many of the technical rules that currently make equipment authorization under Section 15.247 more attractive for equipment manufacturers. We also propose to remove the 5.725-5.85 GHz band for digital modulation devices from Section 15.247. By doing this, we will ensure that all digitally modulated equipment, which is technically similar, operates under a single rule part using identical technical rules.[38] We propose to modify Section 15.407 for digitally modulated devices as discussed below, and we seek comment on all of these proposed rule changes. We invite comment on the benefits of adopting any of the proposed rule changes below as well as the costs to do so. We ask that commenter's assessment of adopting the proposals weigh and compare the benefits and costs to do so. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

29. *Frequency Band*. Section 15.247 allows operation throughout the 5.725-5.85 GHz band, while Section 15.407 allows operation only in the 5.725-5.825 GHz band. The extra 25 megahertz of spectrum that is allowed under Section 15.247 provides incentive for device manufacturers to certify devices under that rule rather than under Section 15.407. We propose to expand the frequency band of operation in Section 15.407 to include the 5.825-5.85 GHz band. This will allow U-NII-3 devices to operate across the full range of spectrum that can currently be accessed by digitally modulated devices under Section 15.247.

30. *Power*. Section 15.247 allows 1 Watt of total peak conducted power (alternate measurement procedures are permitted), whereas Section 15.407 limits maximum conducted output power to the lesser of 1 Watt or 17 dBm + 10 log B (in MHz, alternate measurement procedure in Section 15.247 is required).[39] In addition to the 1 watt power limit, there is a separate PSD limit in both Sections 15.247 and 15.407 such that 1 Watt of total power is available only when the 6-dB bandwidth is 500 kilohertz or more under Section 15.247 and when the 26-dB bandwidth is 20 megahertz or more under Section 15.407.[40] Because we are trying to accommodate digitally modulated devices that are currently permitted under both rules, we propose to remove the bandwidth dependent term (*i.e.,* remove 17 + 10 log B) from Section 15.407 so that the power limit will be 1 Watt. We do not believe removing the variable power limit in 15.407 would increase any potential for interference, because under current rules manufacturers are able to certify equipment that uses up to 1 Watt of power under Section 15.247.

31. *Power Spectral Density*. Section 15.247 requires a maximum PSD of 8 dBm/3 kHz (33 dBm/MHz), whereas Section 15.407 requires a maximum PSD of 17 dBm/MHz. The only difference between these two PSD limits is the bandwidth at which the 1 Watt total power, rather than the PSD, becomes the limiting factor. Specifically, Section 15.247 allows a higher PSD when the device emission bandwidth is between 0.5 to 20 megahertz. Above 20 megahertz emission bandwidth, the 1 Watt power limit becomes the limiting parameter, and PSD is the same for both Sections 15.247 and 15.407. We propose to modify Section 15.407 to require the PSD limit used in Section 15.247 (*i.e.,* 8 dBm/3 kHz (33 dBm/MHz)), so that digitally modulated devices designed to meet this limit will continue to comply with the new PSD requirement in Section 15.407. This will ease the transition of all digitally modulated devices in the 5.725-5.85 GHz band to authorization and compliance under Section 15.407. The only

[38] We would continue to authorize under Section 15.247 frequency hopping spread spectrum devices in the 5725-5850 MHz band and hybrid devices, *i.e.,* those that can function as either spread spectrum or digitally modulated systems because these devices have not been observed to cause interference to TDWRs and do not have the similarities to U-NII devices that other digitally modulated systems have.

[39] *See* 47 C.F.R. §§ 15.247(b)(3) and 15.407(a)(3). *See* also KDB 644545 D01 – Guidance for IEEE 802.11ac and Pre-ac Device Emission Testing and KDB 644545 D02 Alternative Guidance for IEEE 802.11ac and Pre-ac Emissions Testing. These KDB documents are available at: www.fcc.gov/labhelp.

[40] *See* 47 C.F.R. §§ 15.247(e) and 15.407(a)(3).

change for digitally modulated devices will occur when emission bandwidth is between 500 kilohertz and 20 megahertz. High-bandwidth devices like those typically used in U-NII applications will still be limited by 1 Watt total power, and thus the proposed change in PSD limits would not increase the risk of any potential interference. However, we do realize that limiting the PSD to 8dBm/kHz (33dBm/MHz) would result in a PSD that is higher than the total power limit of 1 watt (30dBm). In addition, we realize that requiring devices that employ wider bandwidths to utilize a measurement bandwidth of 3 kHz may unnecessarily increase the time that it takes to complete measurement tests. We seek comment on whether we should increase the measurement bandwidth to 1 megahertz to reduce the complexity in measurement tests. We note that changing the measurement bandwidth would promote consistency within the U-NII rules. Should we consider implementing a different PSD limit and measure this limit across differing bandwidths, e.g. 500 kHz or 100 kHz measurement bandwidths?

32. *Emission Bandwidth*. Section 15.247 requires a minimum 6-dB bandwidth of 500 kilohertz. No minimum or maximum bandwidth is required under Section 15.407, but the emission bandwidth is defined and measured as the 26-dB down points of the U-NII signal and is used to determine the total power allowed under that rule. Because we are proposing to eliminate the bandwidth-dependent limit on total power, we propose to modify Section 15.407 to eliminate the 26-dB bandwidth requirement and to add the minimum 6-dB bandwidth requirement from Section 15.247.

33. *Antenna Gain*. Under Section 15.247, the assumed antenna gain is 6 dBi, with a 1 dB reduction in power required for every 1 dB that the antenna gain exceeds 6 dBi. For fixed point-to-point systems, no power reduction is required. Section 15.407 assumes the same antenna gain of 6 dBi, with 1 dB reduction in power required for every 1 dB that gain exceeds 6 dBi. For fixed point-to-point systems, a 1 dB reduction in power is required for every 1 dB that gain exceeds 23 dBi. The only difference between the two rule parts is the maximum antenna gain that can be deployed without a penalty in transmitter power. We propose to apply the more stringent 23 dBi maximum antenna gain that is currently required under Section 15.407. We believe that using the more stringent antenna gain requirement will ensure that there is no increase in the potential for interference from unlicensed devices operating under the new combined rule parts.

34. *Unwanted Emissions*. Section 15.247(d) requires 20 dB of attenuation (30 dB if the alternate measurement procedure detailed in Section 15.247(b)(3) is used). In restricted bands,[41] emissions must meet the Section 15.209 general emission limits.[42] Section 15.407 requires unwanted emissions to be below -17 dBm/MHz within 10 megahertz of the band edge, and below -27 dBm/MHz beyond 10 megahertz of the band edge.[43] Also, all emissions below 1 GHz must comply with the Section 15.209 general emission limits. The unwanted emission limits in Section 15.407 are somewhat more restrictive than those in Section 15.247. Because unwanted emission can be reduced without affecting the utility of the device, and because using the more stringent unwanted emissions requirement will ensure that there is no increase in the potential for interference from unlicensed devices operating under the new combined rule parts, we are proposing that the more restrictive limits in Section 15.407 be required for digitally modulated devices.

[41] *See* 47 C.F.R. § 15.205(a). There are a number of restricted bands in which low power, non-licensed transmitters are not allowed to operate because of potential interference to sensitive radio communications such as aircraft radionavigation, radio astronomy and search and rescue operations. Only spurious emissions from Part 15 devices are permitted in these restricted bands.

[42] *See* 47 C.F.R. § 15.247(d). *See also* 47 C.F.R § 15.209.

[43] In KDB 789033 D01– UNII General Test Procedures v01r02 (available at: http://www.fcc.gov/labhelp) , our Office of Engineering and Technology (OET) has advised applicants that they can demonstrate compliance with the -27 dBm/MHz and -17 dBm/MHz out-of-band emission limits outside of the restricted bands with spectrum measurements performed with the peak detection and "max hold" settings of the spectrum analyzer.

35. *Peak to Average Ratio*. Section 15.407 contains a requirement to maintain a peak-to-average ratio of no more than 13 dB across any 1 megahertz band, whereas Section 15.247 does not contain any peak-to-average ratio requirement. We believe that using the more stringent peak-to-average requirement will ensure that there is no increase in the potential for interference from unlicensed devices operating under the new combined rule parts, thus we are proposing to keep the peak-to-average ratio requirement that is currently in Section 15.407.

2. Unlicensed Operations in the U-NII-1 Band

36. *Background*. The U-NII-1 band is one of the first 5 GHz band segments made available for U-NII devices in 1997.[44] The frequency band is allocated on a primary basis for Federal and non-Federal Aeronautical Radionavigation and non-Federal Fixed Satellite Service (FSS) (Earth-to-space) to provide feeder links for non-geostationary orbit (NGSO) satellite systems in the Mobile Satellite Service (MSS).[45] The Commission adopted technical rules for U-NII devices in this band to protect the nascent NGSO/MSS industry which had gained an international FSS allocation at 5 GHz in 1995.[46] Specifically, the Commission adopted a peak transmitter output power limit of 50 mW with up to 6 dBi antenna gain permitted, which equates to 200 mW EIRP, and a transmitter peak power spectral density of 2.5 mW/MHz (4 dBm/MHz) for the same 6 dBi antenna gain. The Commission believed that a 50 mW peak output power with up to 6 dBi gain antenna would provide U-NII devices with sufficient flexibility in using the band. The Commission also restricted U-NII devices to indoor operation to provide additional protection to co-channel NGSO/MSS operations. The Commission determined that the low power limits would allow U-NII devices to provide a variety of short-range communications within a very local area, such as in a room or in adjoining rooms, and, along with the restriction on outdoor operation, balanced the need to provide sufficient power for U-NII devices with protection of co-channel NGSO/MSS operations.

37. *Discussion*. The Commission adopted technical rules for the U-NII-1 band in 1997 that it believed would provide sufficient flexibility for the introduction of a variety of short-range communication devices within localized indoor settings. Although that vision was reasonable at the time, we find that today—over 15 years since those rules were adopted—the wireless device market has changed dramatically and the assumptions made in 1997 may not be valid for today's market. Unlicensed communication links are included in a wide variety of devices which are increasingly mobile or portable in nature, not easily limited to indoor locations, and often needing more power to link with other networks at farther locations.

38. At the same time, we must protect incumbent authorized services, both Federal and non-Federal. The U-NII-1 band is used for feeder links by a global NGSO/MSS network that requires co-channel interference protection.[47] We also need to consider the potential for interference to services in the

[44] *See supra* para. 5.

[45] We note that NTIA in conjunction with the Federal agencies performed an assessment of the viability of accommodating commercial wireless broadband services in the1.755-1.85 GHz band, and that they have identified the 5.15-5.25 GHz band as a comparable band to relocate aeronautical mobile telemetry systems. *See* United States Department of Commerce, *An Assessment of Viability of Accommodating Wireless Broadband in the 1755-1850 MHz Band* (March 2012).

[46] *See* Amendment of Parts 2, 25 and 97 of the Commission's Rules with Regard to the Mobile-Satellite Service Above 1 GHz, ET Docket No. 98-142, *Report and Order*, 17 FCC Rcd 2658 (2002) (FCC 02-23).

[47] Globalstar Licensee LLC and GUSA Licensee LLC (collectively referred to as "Globalstar") are wholly owned subsidiaries of Globalstar, Inc. Globalstar's space stations are authorized to receive uplink transmissions from the feeder link stations in the 5096-5250 MHz band. Globalstar's feeder link earth stations in Clifton, Texas also transmit telecommand signals to the satellites in the 5091-5092 MHz band. *See* Globalstar Licensee LLC Application for Modification of Non-geostationary Mobile Satellite Service Space Station License, *Order*, 26 FCC Rcd 3948 (DA 11-520).

bands immediately adjacent to the U-NII-1 band. Microwave landing systems operate below 5.15 GHz, and the Commission has proposed to add an allocation for Aeronautical Mobile Telemetry at 5.091-5.15 GHz.[48]

39. We seek comment on whether the rules for the U-NII-1 band should be modified to harmonize with the rules for the U-NII-2A band in three areas.[49] Specifically, we seek comment on whether we should increase the power limits to those applicable in the U-NII-2A band, *i.e.,* 250 mW with a maximum EIRP of 30 dBm with 6 dBi antenna gain.[50] We also invite comment on whether the rules for the U-NII-1 band should be modified to increase the PSD limits to those applicable in the U-NII-2A band, *i.e.*, 11 dBm/MHz.[51] Finally, we seek comment on whether the rules for the U-NII-1 band should be modified to eliminate the restriction on outdoor operation, and, if we were to do so, whether we should allow outdoor operation only under the current power and PSD limits for the band or under the limits now permitted only in the U-NII-2 bands. We believe that these changes would permit a new generation of wireless devices to be developed in the U-NII bands, particularly if industry develops wider bandwidth devices that would operate across multiple U-NII band segments. Harmonizing the power and use conditions across the lower 200 megahertz of U-NII spectrum would likely permit the introduction of a wide-range of new broadband products capable of operating at higher data rates than is now possible. We seek comment on these assumptions, and on the potential impacts to incumbent services, including any suggestions for mitigating interference.

40. We also seek comment on whether the rules for the U-NII-1 band should be modified to harmonize with the rules for the U-NII-3 band to: (a) increase the power limits to 1 W with a maximum EIRP of 36 dBm with 6 dBi antenna gain; (b) increase the PSD limits to 17 dBm; and (c) limit out-of-band emissions to an EIRP of -27 dBm/MHz and (d) eliminate the restriction on outdoor operation. We believe that these changes would permit for wider bandwidth devices that would not rely on contiguous spectrum under new Wi-Fi standards, discussed below, and would permit the introduction of more outdoor access points for broadband use. We seek comment on these assumptions, and on the potential impacts to incumbent services, including any suggestions for mitigating interference.

41. We invite comment on the benefits of adopting either of these approaches as well as the costs of doing so. We ask that commenter's assessment of adopting either approach weigh and compare the benefits and costs to do so. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

3. Ensuring Compliance with the Rules for the U-NII Bands

42. *Background.* As stated above, in early 2009, the FAA reported interference to their TDWR systems that operate within the 5.6-5.65 GHz band.[52] The interference manifests itself as a strobe or lines on the radar display. Through further study, investigation, and enforcement activity, we have

[48] *See* Amendment of Parts 1, 2, 15, 74, 78, 87, 90, and 97 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2007) (WRC-07), Other Allocation Issues, and Related Rule Updates, ET Docket No. 12-338, *Notice of Proposed Rulemaking and Order*, 27 FCC Rcd 14598 (2012) (FCC 12-140).

[49] The U-NII-2A band includes requirements for DFS to protect radar operations and TPC to protect EESS operations, neither of which operates in the U-NII-1 band. Thus U-NII-1 devices would not need to include these functions.

[50] *See* 47 C.F.R. § 15.407(a)(2).

[51] *Id.*

[52] *See also* NTIA, Technical Report TR 11-473. John E. Carroll et.al., Case Study: Investigation of Interference into 5 GHz Weather Radars from Unlicensed National Information Infrastructure Devices, Part I (Technical Report Part I), p. 1, available at http://www.its.bldrdoc.gov/publications/.

found that the interference at each location has generally been caused by a few fixed 5 GHz wireless transmitters operating outdoors in the vicinity of the airports at high elevations that are line-of-sight to the TDWR installations. In most instances, the interference is caused by operations in the same frequency band as TDWR, but there are some instances where the interference is caused by adjacent channel emissions. Such interference is unacceptable and must be eliminated, given the public safety risks.[53]

43. The Commission's Enforcement Bureau working cooperatively with the FAA has been successful in finding and resolving a large number of interference cases. 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.[54] In many cases, however, the Commission staff found that the interfering devices were not certified or otherwise were not compliant with our rules.[55] For example, we found that devices that were certified as digital devices under Section 15.247 for operation in the 5.725-5.850 GHz band had been unlawfully modified to transmit in the U-NII-2C band without demonstrating compliance with the DFS and TPC requirements for those bands. Typically, these modifications are made by operators of the devices, but manufacturers have produced equipment that is easily modified, especially through software changes, to permit devices to operate in non-compliant modes. The Enforcement Bureau is continuing to take action against companies for operating devices that cause interference to the TDWRs.[56] We note that, while the TDWRs have been the focus of Commission investigations, DFS was designed to protect all incumbent radar operations and modification of devices as described above poses a risk of interference to more than just TDWRs.

44. 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. In its Third Technical Report, NTIA explores frequency separations, distance separations, and maximum U-NII emissions limits needed to preclude harmful interference into the TDWR.[57] The report analyzes the distances at which U-NII transmissions can be expected to routinely interfere with TDWR receivers. U-NII devices on rooftops, towers, and other high points that are 153 m to 305 m (500 to 1000 ft.) above ground level, as NTIA observed in San Juan, PR, will interfere with a TDWR mainbeam at distances within 25 km to 41 km (16 mi to 25 mi), respectively, of a TDWR station.[58] The report also specifies frequency separations necessary to protect TDWR from interference due to unwanted emissions from U-NII devices.

45. As a result of its ongoing discussions with NTIA, FAA and industry representatives, as well as the results of investigations conducted by the Commission, NTIA and FAA, and discussed above, the Office of Engineering and Technology has provided applicants for certification a representative way for demonstrating that their U-NII devices should not cause harmful interference to TDWR installations operating in the U-NII-2C band and accordingly can be authorized for manufacture and use. Specifically,

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[53] *See* Memorandum from Julius Knapp, Chief, Office of Engineering and Technology, FCC, and P. Michele Ellison, Enforcement Bureau, FCC, to Manufacturers and Operators of Unlicensed 5 GHz Outdoor Network Equipment Re: Elimination of Interference to Terminal Doppler Weather Radar (TDWR) (dated July 27, 2010), available at: http://www.fcc.gov/encyclopedia/weather-radar-interference-enforcement.

[54] *Id. See also* Technical Report Part I, p. 23, available at http://www.its.bldrdoc.gov/publications/.

[55] *See supra* para. 9.

[56] *See supra* note 13.

[57] *See* NTIA Technical Report TR-12-486, Case Study: Investigation of Interference into 5 GHz Weather Radars from Unlicensed National Information Infrastructure Devices, Part III (Technical Report III), available at: http://www.its.bldrdoc.gov/publications/2677.aspx

[58] *Id.* at 10-13.

OET has advised applicants that it will approve such devices upon assurance by the applicant that: (a) U-NII devices may not operate co-frequency with TDWR operations at 5.6-5.65 GHz;[59] (b) grantee will provide owners, , operators and installers of these devices with instructions that a master or client device within 35 km of a TDWR location must be separated by at least 30 megahertz (center-to-center) from the TDWR operating frequency and procedures for registering the devices in an industry-sponsored database;[60] (c) the device does not include configuration controls to change the frequency of operation to any frequency other than those specified in the grant of certification; and (d) the device's software configurations do not allow for ad hoc networking, country code selection, or other mode of operation that would disable the DFS functionality of the U-NII device.[61]

46. The interference cases we have seen to date raise serious concerns with ensuring compliance with the Commission's rules in the U-NII-2C band, but there are other circumstances that also make this an opportune time for the Commission to consider compliance issues across the 5 GHz U-NII bands. For example, unlicensed wireless broadband device manufactures are now designing devices employing wider bandwidths (e.g., IEEE 802.11ac standard currently in development) using transmitters that are capable of operating across two or more U-NII bands. When devices are designed to operate across multiple frequency bands, the Commission's rules require that applicants demonstrate compliance with the rules for each of the individual frequency bands in which they intend to operate in order to be certified for operation in each band.

47. We expect that more and more devices with even wider bandwidths will continue to be introduced in the 5 GHz band in the not too distant future as a result of new technical standards. The introduction of wider bandwidths under the IEEE 802.11ac standard presents complex issues for emissions testing to demonstrate compliance with the various requirements in the different U-NII bands. The Office of Engineering and Technology has published two guidance documents addressing these issues for testing of devices designed under this new standard as well as "pre-ac" devices, taking into account the current rules that permit authorization of digitally modulated devices under both Sections 15.407 and 15.247.[62]

48. *Discussion.* The Commission, NTIA, and the FAA have been working with manufacturers of U-NII devices and the WISPA to fully understand the causes of interference to TDWR systems and to identify ways to mitigate and significantly reduce the likelihood of interference. The Commission believes the rules proposed herein, in addition to continuing enforcement efforts, will enable us to achieve this goal while allowing U-NII devices to continue to operate successfully in the 5 GHz band.

49. Wireless networking devices that operate within the 5 GHz band typically have similar operational parameters, so that a device certified for operation in any one of the 5 GHz frequency bands, whether a U-NII band or not, can be easily tuned to another frequency band in the same spectrum range through software modifications. Our experience with these devices shows that some of these devices are

[59] This restriction is placed on the certification grant as a condition of operation.

[60] We note that the Wireless Internet Service Providers Association (WISPA) maintains a (voluntary) database accessible to the public, containing TDWR system locations. *See* http://www.wispa.org.

[61] *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. *See, e.g.,* KDB 594280 available at: http://www.fcc.gov/labhelp.

[62] *See supra* note 37. The Commission has already approved devices designed to the 802.11ac standard, which IEEE has published as an interim standard. The Commission's rules permit OET to recognize the use of measurement procedures endorsed by industry standards groups, which often includes interim published standards, or even suggested by equipment applicants themselves, provided they fully document the approach. *See* 47 C.F.R. § 2.947(a).

designed so that end-users can modify them to operate in bands for which they are not certified and thus do not meet the specific requirements intended to protect sensitive incumbent services. For example, in some recent interference cases investigated by the Commission's Enforcement Bureau, operators of devices certified under Section 15.247 were tuned down into the U-NII-2C frequency band and operated with a higher gain antenna than what is permitted by our U-NII rules.[63] The modification of devices in this manner resulted in both in-band and out-of-band emissions that were far in excess of what Section 15.407 allows in the U-NII-2C band. Such unlawful modification and operation of these devices could considerably increase the distance at which these non-compliant devices cause harmful interference to incumbent services. We believe that our proposals, discussed above, to authorize all digitally modulated devices under identical rules in a modified Section 15.407 will allow us to more effectively and efficiently address interference risk to incumbent operations in the U-NII-2C and U-NII-3 bands.

50. 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. We recognize that one of the difficulties in ensuring compliance with our current rules comes from the fact that these devices can easily be re-configured by operators modifying the software that controls the device's operational parameters, such as frequency band. This makes it difficult for the Commission not only to ensure compliance with its rules but also to enforce those rules.

51. Because the current and future use of the 5 GHz bands is heavily reliant on the successful implementation of our technical rules, we propose 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. We propose and seek comment on adopting this safeguard regardless of whether or how we modify Sections 15.247 or 15.407. We are particularly concerned that U-NII devices- which are not certified under the Commission's rules as software defined radios (SDRs)[64] and thus may lack safeguards that are required for certified SDRs – may nevertheless be susceptible to manipulation by third parties who can modify the operating parameters of country code, frequency range, modulation type, maximum output power or the circumstances under which the transmitter has been approved.[65] Specifically, we seek comment on whether we should require manufacturers to make it difficult for third parties to reprogram the embedded transmitter chip in certified devices. For example, should we require that manufacturers ensure that modifying or reconfiguring firmware or software will make a device inoperable in certain bands? We also seek comment on whether we should require U-NII devices to transmit identifying information so that, in the event interference to authorized users occurs, we can identify the source of interference and its location. What type of information should be transmitted and in what format?[66]

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[63] *See, e.g., VPNet, Inc.*, Notice of Apparent Liability for Forfeiture and Order, 27 FCC Rcd 2879 (Enf. Bur. 2012).

[64] The Commission will approve a device as an SDR, which permits authorized third parties to make certain changes to the radio's operating parameters consistent with the scope of the radio's certification, provided that the grantee has incorporated security measures to prevent unauthorized third parties from modifying the radio. *See* 47 C.F.R. § 2.944.

[65] The Office of Engineering and Technology has published guidance on these issues which clarifies that any installer, fabricator, or operator cannot modify a radio to operate outside the parameters for which the device is certified. *See* Restrictions on Software Configuration for devices not approved as Software Defined Radios, KDB 594280, published October 24, 2012, available at www.fcc.gov/labhelp.

[66] We note, for example, that our rules require unlicensed fixed TV band devices to transmit identifying information that conforms to a standard established by a "recognizable industry standards setting organization" and should be sufficient "to identify the device and its geographic coordinates." *See* 47 C.F.R. § 15.711(d).

52. Although we believe that requiring manufacturers to secure the software in their radios to prevent modifications by third parties provides a clear public benefit in ensuring that these devices comply with our rules as more devices are introduced and the number of users increases, we recognize that this requirement will add some cost to these devices. We seek comment on the proposals discussed above, particularly information on the costs to manufacturers for implementing them. We invite comment on the benefits of adopting these proposals as well as the costs to do so. We ask that commenter's assessment of adopting the proposals weigh and compare the benefits and costs to do so. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

53. We believe that our proposals to modify the technical rules in the U-NII-3 band, along with our proposal to enhance the security requirements of all U-NII devices, would have prevented most of the interference cases that we have observed to date. We also note, however, that the NTIA Third Technical Report and our own discussions with NTIA, FAA and industry representatives have identified additional techniques that could mitigate in-band and adjacent band interference to incumbents. These include using a database registration process combined with geo-location technology to determine whether there is any potential interference to radar systems such as the TDWR; limiting the unwanted emission levels of the U-NII devices; or increasing the sensing frequency range (*e.g.*, detection bandwidth) of U-NII devices operating in the U-NII-2A and U-NII-2C bands. These other techniques, could supplement or replace the assurances (described above in paragraph 45) that OET has accepted from certification applicants on an *ad-hoc* basis as sufficient to address interference concerns that might otherwise warrant denial of equipment certification requests for U-NII devices in the U-NII-2C band. We also observe that these techniques would place responsibility on users, rather than on manufacturers, for mitigating interference. We invite comment on whether the security requirements we are proposing to place on U-NII devices, along with the more stringent unwanted emission limits that we are proposing for devices that would previously have been certified under Section 15.247, are sufficient to protect incumbent radar operations, including TDWR installations, from interference, or whether we should further modify our rules to require implementation of other techniques, discussed below. In particular, we seek comment on the likely effectiveness of each technique discussed below in reducing the incidence of interference to TDWR systems or other incumbent operations by ensuring compliance with and in facilitating enforcement of our rules. We invite comment on whether any of these techniques would be beneficial in protecting other incumbents from interference, not only in the U-NII-2C band but also in other segments of the 5 GHz band. We invite comment on the benefits of adopting any of the methods discussed below as well as the costs to do so. We ask that commenters' assessment of adopting any of the methods below weigh and compare the benefits and costs to do so. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

54. *Geo-Location/Database:* The NTIA Third Technical Report specifies the frequency separations and distance separations needed to preclude interference from U-NII devices into the TDWR under the study conditions used for NTIA's investigation. The separation requirements differ for the various types of devices, but, in general, as the frequency separation increases the required separation distance between the U-NII devices and the TDWR decreases. For example, with main-beam coupling and ±30 megahertz of frequency separation from 20 megahertz-wide 802.11-based U-NII devices operating at an EIRP of 17 dBm, a TDWR needs a protection distance of 11 km. For 40 megahertz-wide 802.11 devices with a frequency separation of ±30 megahertz, the distance is 35 km; that distance is reduced to 15 km at a frequency separation of 50 megahertz above the center frequency and 10 km below the center frequency with a 50 megahertz frequency separation.[67] As noted above, the Office of

[67] These frequency separations are based on the difference in center frequency of the TDWR and the center frequency of the U-NII system. In the case of a 20 megahertz-wide U-NII device, 30 megahertz of separation (continued....)

Engineering and Technology has implemented these geographic and frequency separations as part of its equipment authorization program. Industry representatives have recommended to Commission staff that we should implement these protections for high power point-to-point systems, and have argued that no additional limits or requirements are necessary for lower power, indoor systems.[68] We seek comment on whether we should require these geographic and frequency separations from TDWR and other Federal radars operating in the U-NII-2C band for high power outdoor U-NII devices authorized for operation in this band. How should we define and distinguish outdoor versus indoor U-NII devices, or high power versus low power U-NII devices? How would we enforce compliance with these distinctions?

55. One way to implement frequency and distance separation requirements is to require geo-location and database registration. Because the TDWR locations are known and somewhat limited in number, implementation of geo-location and database registration might be very straightforward and easy to accomplish.[69] With this interference avoidance method, the location of an unlicensed device could be determined by a professional installer or by using geo-location technology such as GPS incorporated within the device. Using either of these methods, a user could determine from either an internal or external database whether the unlicensed device is located far enough from the TDWR to avoid causing harmful interference; if not, it could transmit on a frequency farther away from the TDWR's center frequency. CSMAC, for example, recommends implementing a Dynamic Database approach to device authorization.[70] On a going-forward basis, devices and systems sharing a band would be "connected" devices and a geo-location/database approach could enforce permission and terms-of-use updates on an automated basis. The concept of database-enabled cognitive radios can lend itself to many applications, including ultimately sharing spectrum with Federal users. As noted above, a voluntary database has been implemented by WISPA, which disseminates the location of TDWR to WISPs and encourages operators that install devices within 35 km or the line-of-sight of a TDWR, to operate at least 30 megahertz away from the TDWR operation frequencies.[71] WISPA has also agreed to voluntarily provide a database where WISPs can register the locations of the outdoor transmitters that they use. We seek comment on whether, given the limited number of TDWR locations, a geo-location/database approach could be effectively implemented and maintained for numerous U-NII devices that would operate in the 5.6-5.65 GHz band. How will this approach protect other incumbent operations?

56. We recognize that our rules already require radar avoidance via the DFS mechanism. We further recognize that requiring the implementation of a database for TDWR could increase the complexity of U-NII devices if we require that they include a geo-location capability. Alternatively, we could modify our rules to specifically require professional installation and permit manufacturers to pass on this cost to the user of the device. In addition, a database for registering TDWR locations and,

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(...continued from previous page)
between the center frequency of the TDWR and the U-NII device is equivalent to 20 megahertz of separation between the TDWR center frequency and the band edge of the U-NII device.

[68] *See* Letter to Dr. Rashmi Doshi, OET, FCC from Broadcom, Marvell, Intel and Qualcomm Atheros, dated Sept. 9, 2011; Letter to Dr. Rashmi Doshi, OET, FCC from Cisco Systems, dated Jan. 1, 2013. The companies suggest criteria for identifying devices operating in the 5.57-5.68 GHz band that are primarily consumer access points that pose little risk of interference to TDWR operations. Copies of these letters have been placed in the docket file for this proceeding.

[69] The FAA could add additional TDWR stations and/or make changes to the TDWR transmission parameters in the future.

[70] CSMAC, Unlicensed Subcommittee, Presentation of Final Report of Recommendations, July 24, 2012, at pages 5-8. The Commerce Spectrum Management Advisory Committee (CSMAC) advises the Assistant Secretary for Communications and Information at NTIA on a broad range of spectrum policy issues.

[71] *See* http://www.wispa.org/?q=node/84 . *See also* http://spectrumbridge.com/udrs/home.aspx.

perhaps, U-NII device users and locations as well would entail some cost to establish and maintain. We seek comment on what the cost would be to implement geo-location/database protection, what the requirements should be, and how to define "professional installation." We also seek comment on whether requiring the implementation of both DFS and geo-location interference protection mechanisms would be overly burdensome for equipment manufacturers and whether it is necessary to require both. Are there alternative approaches that can be implemented to protect the incumbent radar systems? Because higher power outdoor devices (such as those used by Wireless Internet Service Providers) in the U-NII-2C band have a greater potential to cause harmful inference as compared to lower power consumer type devices, we request comment on whether a geo-location/database requirement should apply only to those devices or to lower power indoor U-NII devices as well.

57. *Unwanted emission limits*. Emissions outside of the U-NII device's occupied bandwidth may have the potential to cause harmful interference into TDWR. Aside from increasing frequency separation or distance separation, U-NII devices may avoid causing interference by lowering the emissions on the radar's fundamental frequency. This equates to lowering all emissions from U-NII devices at the frequencies outside of the device's operating bandwidth.[72] We seek comment as to whether TPC also contributes to reductions in unwanted emissions. For example, if the TPC function reduces the fundamental power level by 1 dB, is there a corresponding 1 dB reduction in unwanted emissions?

58. NTIA's report details the measurements and analysis that determine the power levels at which TDWR receivers experience interference from U-NII emissions at an interference-to-noise (*I/N*) ratio of -8 dB.[73] In its report, NTIA finds that the maximum allowable co-channel interference power that can be received in the TDWR without exceeding the *I/N* level of -8 dB is shown to be -119 dBm/MHz at the antenna terminals. This equates, for example, to a mainbeam-to-mainbeam interference power density of -43 dBm/MHz between TDWR and U-NII transmitters at a distance of 8 km, or an interference power density of -22 dBm/MHz when the mainbeam of the U-NII device is in the TDWR sidelobe at a distance of 2 km. These power density thresholds are a function of separation distance between TDWR receivers and U-NII transmitters as well as the receive antenna gain of the TDWR in the direction of the U-NII transmitter.[74]

59. Our existing rules for the U-NII-2C band specify that the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6dBi are used, both the maximum conducted output power and the peak power spectral density must be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.[75] These rules implicitly allow a maximum EIRP of 17 dBm/MHz in the U-NII-2C band.[76] Additionally, for devices operating within the U-NII-2C band, our rules specify that all emissions transmitted outside of the U-NII-2C band shall not exceed an EIRP of -27 dBm/ MHz.[77] We recognize, based on NTIA's report, that these

[72] Commission rules typically specify unwanted emission levels outside of the frequency band in which the unlicensed device is intended to operate, without requiring further attenuation on frequencies outside of the device's occupied bandwidth, but still within the specified frequency band.

[73] See NTIA Technical Report III at pages ix and 15. NTIA notes that the value of -8 dB *I/N* is used solely for the purpose of demonstrating interference analysis techniques. A different value, either higher or lower, could have just as easily been used for such demonstration purposes. The FAA has not determined interference protection criteria for this receiver.

[74] *See* Technical Report III at pages ix-x, 19-20, available at http://www.its.bldrdoc.gov/publications/.

[75] *See* 47 C.F.R. §15.407(a)(2).

[76] Though the rules do not explicitly state a spectral density limit on EIRP, Section 15.407(a)(2) imposes an 11 dBm/MHz limit on conducted power spectral density for devices with antenna gains up to 6dBi. Thus, the effective limit on EIRP spectral density is 17 dBm/MHz. *See* 47 C.F.R. § 15.407(a)(2).

[77] *See* 47 C.F.R. §15.407(b)(3).

two limits may not be sufficient to protect the TDWR from adjacent channel emissions from U-NII devices. Accordingly, we seek comment on whether requiring new unwanted emission[78] limits for U-NII devices operating in the U-NII-2A and UNII-2C bands is appropriate and whether we should modify our emission limits to reflect NTIA's findings.

60. If we were to impose new limits on U-NII devices, as suggested above, we believe that different limits can be set for lower power indoor and higher power outdoor devices. For indoor devices, we believe that setting an out-of-channel emissions limit of -27dBm/MHz maximum EIRP may be appropriate because building materials would likely further attenuate these emissions. When measured outside of the building, the emissions from an indoor device would likely drop to a level that would appear as no more than -41dbm/ MHz.[79] An out-of-channel emissions limit of -41 dBm/MHz for outdoor devices may be appropriate as well. We seek comment modifying our rules to adopt these out-of-channel limits for indoor versus outdoor U-NII devices, including how we should define the terms "indoor" and "outdoor", and how different operating requirements for indoor versus outdoor operations can be accommodated through our equipment authorization and our enforcement procedures.

61. As an alternative, if we determine that reductions in unwanted emissions are necessary, we could allow outdoor devices to operate with an out-of-channel emissions limit of -27 dBm/MHz peak EIRP as long as the separation distance between the device and the TDWR is at least 53 km.[80] Should the Commission impose this new out-of-channel limit based on the maximum power levels of the devices rather than whether a device is based indoor or outdoor? For instance, we recognize that lower power device devices provide short-range communications, such as those between computing devices within a very local area and therefore pose less of a potential risk to TDWR operations. Higher power devices, however, are intended to be used in an outdoor environment for longer-range communications. We seek comment on the assumptions made in our analysis.

62. *Sensing.* If we decide to require that a U-NII device move more than 30 megahertz[81] in frequency from the TDWR, one way to enable this is to require the U-NII device to sense for radar in the channels adjacent to its occupied bandwidth. This will ensure that the unwanted emissions from U-NII devices are placed far enough away in frequency from the TDWR fundamental frequency to preclude harmful interference. We seek comment on this alternative approach.

63. The DFS mechanism is designed to avoid co-channel interference to the TDWR by dynamically detecting radar signals and avoiding co-channel operation with those systems. 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. Specifically, our current measurement procedures require that a U-NII device sense for radar across 80 percent of its occupied bandwidth. With respect to the remaining 20 percent, we do not require sensing in a 10 percent region above or below the occupied

[78] The out-of-channel limit refers to the region of spectrum between the edge of the occupied bandwidth of the U-NII device and the edge of the U-NII band of operation.

[79] *See* National Institute of Standards and Technology, NISTIR 6055, William C. Stone, NIST Construction Automation Program, Report No. 3, Electromagnetic Signal Attenuation in Construction Materials*, available at* http://fire.nist.gov/bfrlpubs/build97/PDF/b97123.pdf.

[80] *See* NTIA Technical Report III , page 15, *Equation - 6*. -27dBm/MHz used for $EIRP_{max}$ and solved for the separation distance, available at http://www.its.bldrdoc.gov/publications/.

[81] Requiring 30 megahertz separation between the U-NII device and the TDWR frequencies is specific to a U-NII device employing a 20 megahertz bandwidth. For devices with wider bandwidths, the frequency separation will have to be greater than 30 megahertz means 20 megahertz separation from the edge of the emission bandwidth to the fundamental frequency of the TDWR.

bandwidth.[82] We recognize that currently implementation of the 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. Therefore, 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. When the radar signal falls within the region of occupied bandwidth that does not require sensing, the U-NII device will continue to transmit. This could result in simultaneous and overlapping transmissions from the U-NII device and the TDWR, which would increase the potential for harmful interference.

64. In addition, NTIA's Third Technical Report suggests that adjacent channel interference is possible when the frequency separation between the radar and the U-NII device is less than a specified amount. 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. If we require that U-NII devices sense for radar on the frequencies immediately adjacent to the occupied bandwidth, we would ensure that the fundamental frequency is more than 30 megahertz away from the radar.

65. We seek comment on whether we should implement a rule requiring that U-NII devices sense for radar signals at or exceeding 100 percent of its occupied bandwidth, or whether we should continue to reference this, as we do now, as part of the U-NII measurement procedures. We believe that expanding the sensing bandwidth will prevent the co-channel operations between U-NII devices and radars receiver and thus will reduce the potential for harmful interference. We also invite comment on the technical difficulty and cost of implementing this capability in U-NII devices.

4. The U-NII-2A and U-NII-2C Bands

66. *Background.* The DFS mechanism is designed to avoid co-channel interference to incumbent Federal radar systems by dynamically detecting radar signals and avoiding co-channel operation with those systems. Our rules require that U-NII devices use two detection thresholds to ascertain whether radar signals are present, and we have issued measurement guidelines and procedures for testing the DFS functionality as part of our equipment certification program. We have found that even devices certified to operate in the U-NII band have the potential to cause harmful interference to the TDWR and potentially other radar systems in the U-NII-2A and U-NII-2C. For instance, NTIA has found that certain manufacturers provided an option for users to deactivate the DFS mechanism. Furthermore, evidence from our Enforcement Bureau also suggests that the deactivation of DFS in certain devices caused harmful interference to the TDWR. In addition, certain parameters of the DFS mechanism may need improvement to enhance protection to vital incumbent systems within the U-NII-2A and U-NII-2C bands.

67. *Discussion.* DFS is an essential element allowing U-NII devices to share the U-NII-2A and U-NII-2C bands successfully with vital government and military radar systems. As we have gained experience with these devices and the implementation of DFS in the field, we are proposing changes in three areas to improve the utility and reliability of this function, thus ensuring that incumbent services in these bands are protected from interference. These changes include lowering the permitted PSD for lower power devices that use the relaxed sensing threshold, and modifying the Bin-1 radar simulating waveform used in our measurement procedures. We believe that these changes will reduce the potential for co-channel interference to the TDWR and other radar systems. We are also proposing to remove the uniform channel loading requirement found in our measurement procedures.

[82] *See* Compliance Measurement Procedures for Unlicensed National Information Infrastructure Devices Operating in the 5250-5350- MHz and 5470-5725 MHz Bands Incorporating Dynamic Frequency Selection (*DFS Compliance Measurement Procedures*) at: http://transition.fcc.gov/oet/ea/eameasurements.html.

68. *DFS Functionality*. To be certified for operation in the U-NII-2A and U-NII-2C bands, devices must include a DFS radar detection function. In its field investigations, the Commission's Enforcement Bureau found that certain models of devices certified for use in these bands were designed so that users could disable the DFS mechanism by setting the device's operating mode to "Compliance test." In other cases, the device's DFS mechanism could be turned off by manually changing the "Country Code" for the device. If the DFS mechanism is not active, the device could transmit on an active radar channel and cause harmful interference. We therefore propose that manufacturers prevent the DFS mechanism from being disabled in devices certified to operate in the U-NII-2A and U-NII-2C bands. We also propose that U-NII devices certified to operate in these bands must be operated with the DFS function on.

69. Recently, the Office of Engineering and Technology has had to clarify which types of U-NII devices are required to demonstrate compliance with the DFS requirement.[83] We know that many U-NII devices operate in a master-client configuration, *i.e.*, the master device controls the operational parameters of the client devices.[84] Typically, DFS-enabled master devices would include both the radar sensing and DFS functions, but new configurations are being designed. For example, radios can operate in a network configuration with the sensing function distributed among various "client" devices. Also, some radios are designed so that they can communicate directly with each other, rather than through a control point, and thus they could function as either a "master" that initiates a network or as a "client" device within the network. We propose that any U-NII device that is subject to the DFS requirements in Section 15.407 that is capable of initiating a network must have radar detection functionality and must be approved with that capability.

70. We believe that responsible operation of U-NII devices in these bands is a joint responsibility of both manufacturers and users. We seek comment on these proposals regarding DFS functionality as well as information on costs to implement them. We also invite comment on whether the DFS requirement has limited in any way the types of applications that have been or could be implemented in the U-NII-2A and U-NII-2C bands, particularly if wider bandwidth devices are deployed in this spectrum. We invite comment on the benefits of adopting this proposal as well as the costs to do so. We ask that commenters' assessments of adopting the proposal weigh and compare the benefits and costs to doing so. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

71. *Sensing Threshold for Co-channel operation:* The current rules require that the DFS mechanism continuously monitor the device's environment for the presence of radar, both prior to and during operation. We further require that U-NII devices certified under our rules use two detection thresholds to ascertain whether radar signals were present. The required threshold levels are: (a) -62 dBm for lower power devices with a maximum EIRP less than 200 mW (23 dBm), and (b) -64 dBm for higher power devices with a maximum EIRP between 200 mW (23 dBm) and 1 W (30 dBm), averaged over 1 μs.[85] We also require that the conducted peak power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, we require that both the maximum conducted output power and the power spectral density be reduced by the amount in

[83] *See supra* note 65.

[84] The Commission's rules define a client device as "a device operating in a mode in which the transmissions of the device are under control of the master. A device in client mode is not able to initiate a network." *See* 47 C.F.R. § 15.202.

[85] *See* 47 CFR §15.407(h)(2). The DFS detection threshold is defined as the received power averaged over 1 μs referenced to a 0 dBi antenna.

dB that the directional gain of the antenna exceeds 6 dBi. Thus, the implicit limit on the EIRP spectral density is 17 dBm in any 1 megahertz band.[86]

72. The lower power U-NII devices are permitted to use the relaxed sensing threshold because the range at which these devices can potentially cause interference is reduced and thus they are allowed to operate closer to the radar. In order to ensure that interference potential does not increase with the use of the relaxed sensing threshold, we believe that applying a reduction in EIRP spectral density for devices that use the -62 dBm sensing threshold is appropriate. We propose that devices must operate with both an EIRP of less than 200 mW (23 dBm), and an EIRP spectral density of less than 10 dBm/MHz (10 mW/MHz), in order to use the relaxed sensing detection threshold of -62 dBm. Devices that do not meet the proposed EIRP and EIRP spectral density requirements must use the -64 dBm sensing threshold. The proposed changes will further enhance protection for radars from co-channel interference by reducing both the range and the in-band spectral density emissions of the U-NII device. We seek comment on this proposal, including the cost to manufacturers to implement it. We note that a reduction in the EIRP spectral density limit would be consistent with recent actions taken by European Telecommunications Standards Institute (ETSI).[87] Specifically, ETSI chose to restrict a device's use of the relaxed sensing threshold by reducing both the EIRP and the EIRP spectral density by 7 dB to 23 dBm (200 mW) and 10 dBm/MHz (10 mW/MHz), respectively. We invite comment on the benefits of adopting this proposal as well as the costs to do so. We ask that commenter's assessment of adopting the proposal weigh and compare the benefits and costs to do so. This assessment should address which costs should be borne by U-NII device manufacturers, U-NII device operators or other third parties, as appropriate.

73. *Measurement and Testing Procedures*. Under Section 2.947(a) of the rules, the Commission will accept data that is measured in accordance with (1) procedures or standards set forth in bulletins or reports prepared by the Commission's Office of Engineering and Technology (OET), (2) procedures or standards that are acceptable to the Commission and are published by a national engineering society, or (3) any other measurement procedure acceptable to the Commission.[88] With respect to the first option, OET's most recent bulletin on measurement procedures for U-NII devices with DFS capabilities was published in 2006.[89] NTIA has recommended modifications to these 2006 measurement procedures, to further enhance protection for the TDWR.[90] We invite interested parties to comment on these modifications to the measurement procedures, which are set forth in Appendix B, and to propose any additional modifications that are appropriate. Consistent with our rules and prior practice,

[86] *See* 47 CFR §15.407(a)(2). The EIRP power spectral density is the amount of power per unit of spectrum.

[87] ETSI EN 301 393 V1.6.1, Broadband Radio Access Networks; 5 GHz high performance RLAN; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive (2011-11), Page 70. The proposed limits are those that were adopted by ETSI. This new ETSI standard did not exist when our previous rules were written. Adopting a rule that is consistent with ETSI standards will allow us to continue to harmonize with worldwide standard that will, in turn, foster American industry's flexibility to develop devices for international markets and promote economies of scale in production of equipment.

[88] 47 C.F.R. § 2.947(a)(1)-(3).

[89] *See U-NII Reconsideration Order*, 21 FCC Rcd at 7681 (Appendix A).

[90] *See* Letter from Lawrence E. Strickling, Administrator, NTIA to Julius Genachowski, Chairman, FCC, filed February 19, 2013, and the enclosure *Appendix - Proposal for New Unlicensed National Information Infrastructure Dynamic Frequency Selection Certification Waveforms*. A copy of this document has been placed in the docket file for this proceeding.

the Office of Engineering and Technology will evaluate comments on the recommended changes to the measurement procedures and will issue updated measurement procedures in the future as needed.[91]

74. Our current rules and measurement procedures require that the DFS function provide a uniform spreading of loading over all available channels.[92] The measurement procedure further explains this provision by stating that "Uniform Channel Spreading" is the spreading of U-NII devices operating over the DFS bands to avoid dense clusters of devices operating on the same channel. Some manufacturers comply with this requirement by using random channel selection, but we believe that similar benefits could be obtained by manual selection of channels and may actually result in better spectrum usage at a given location. In particular, we note that enhanced spectrum use may be possible when devices use a very high bandwidth and the number of usable channels is small. We also note that the trend for U-NII devices is to operate with ever wider bandwidths. Operation over wider bandwidths causes U-NII energy to be spread throughout the frequency band in which the device is operating, rather than concentrated in a narrow bandwidth. This potentially makes the uniform channel spreading requirement unnecessary. We propose to remove the "Uniform Channel Spreading" requirement from our rules and measurement procedures. We also propose to permit either random channel selection or manual selection of the initial channel. For example, should we permit a device to create a master list of available channels that it would use if they continue to be available? We seek comment on whether these changes will, in any way, negatively impact spectrum reuse or potentially increase interference to incumbent users. In addition, our measurement procedures require that system testing be performed with an MPEG test file that streams full motion video at 30 frames per second for channel loading. Experience certifying U-NII devices has indicated that not all U-NII devices are designed for video transmission or support the specific coding format, and so other methods of channel loading are used. We seek comment on whether specifying video streaming as the preferred channel loading method for compliance measurements is as appropriate today as it was when the measurement procedures were created, or whether the channel loading requirement in our test procedures should be specified in a more general manner so as only to specify that measurements be conducted with the device under test operating in a loaded condition. We seek comments on how we should specify alternate means of channel loading for measurement purposes. Additionally, we seek comment on the effects of wider U-NII device bandwidths on channel loading requirements.

B. Future Unlicensed Operations at 5 GHz

75. The 5.35 – 5.47 GHz (U-NII-2B) and 5.85 – 5.925 GHz (U-NII-4) bands have great potential for fostering ongoing technological innovation, expanding broadband access, and encouraging competitive entry. The additional spectrum also would expand opportunities for innovative spectrum access models by creating new avenues for opportunistic and unlicensed use of spectrum and increasing research into new spectrum technologies. Creating ways to access spectrum under a variety of new models, including unlicensed uses, increases opportunity for entrepreneurs and other new market entrants to develop wireless innovations that may not have otherwise been possible under licensed spectrum models.

76. These bands currently are used for various Federal and non-Federal services, and the Spectrum Act requires that the Commission begin a proceeding to modify the Part 15 rules to permit unlicensed devices in the U-NII-2B band[93] if, in consultation with NTIA, it determines that licensed users will be protected by technical solutions and that the primary mission of Federal spectrum users will not be

[91] *See* 47 C.F.R. § 2.947(a). We note that, although these revisions to the 2006 measurement procedures are not substantive rule changes that require notice and comment under the Administrative Procedures Act, this proceeding provides a convenient vehicle to assist OET in crafting reliable and efficient measurement procedures.

[92] *See* 47 C.F.R. §15.407(h)(2).

[93] Spectrum Act, § 6406(a)(1).

compromised by the introduction of unlicensed devices in these bands.[94] Thus, our goal in this proceeding is to promote efficient use of radio spectrum through spectrum sharing. As part of this collaborative effort and as required by the Spectrum Act, NTIA has published a report, prepared in consultation with Department of Defense and other impacted Federal agencies, evaluating spectrum-sharing technologies and the risk to Federal users of unlicensed operations in the U-NII-2B and U-NII-4 bands.[95]

77. In the discussion below, we explore the potential for future unlicensed operations in the 5 GHz band, incumbent operations in the U-NII-2B and U-NII-4 bands, and the technical requirements and sharing technologies and techniques that could be used to protect Federal and non-Federal incumbent operations. We also invite comments on the NTIA 5 GHz Report itself, including its underlying assumptions and risk assessments.

1. Future Unlicensed Operations at 5 GHz

78. The current U-NII bands are already being used for a variety of different commercial uses such as wireless internet services, cordless phone, scientific and medical applications, etc. In this proceeding, we seek comment on what types of uses could be deployed in the U-NII-2B and U-NII-4 bands, used either independently of the current U-NII bands or in conjunction with them. We are interested in knowing how companies of different types might deploy U-NII devices, what types of services they might offer, and where they might deploy them. We are particularly interested in gathering information on ongoing industry standards activity and international efforts to harmonize uses of the 5 GHz band to make more efficient use of the 5 GHz spectrum.

79. We know, for example, that unlicensed and licensed broadband networks often complement one another in important ways. The availability of unlicensed Wi-Fi networks in many locations enables licensed wireless providers to take data traffic off of their networks, thus reducing network congestion and delivering a better overall quality of service.[96] Wi-Fi technology also can be "networked" to provide wider geographic coverage and, when configured this way, may be used by some service providers in offering broadband service.

80. The introduction of the IEEE 802.11ac standard, discussed above, can open new windows to wireless broadband for many users. The deployment of wide channel bandwidths with higher data rates in the 5 GHz band can help meet the challenge that rapid growth in demand has posed for the wireless industry which has called for more spectrum to increase network capacity. The new standard has the potential to create new avenues for opportunistic use of spectrum in diverse broadband services. Some forecasts predict that in 2015, shipments of mobile phones with embedded Wi-Fi are projected to approach 800 million and by the same time 100 percent of mobile hotspot shipments will be 802.11ac enabled.[97] Infonetics forecasts the global carrier Wi-Fi equipment market to grow significantly at least through 2016, when it will hit $2.1 billion.[98] We seek comment on how the introduction of this new standard might be implemented in the U-NII bands and how these developments should inform our consideration of technical requirements for these bands and sharing technologies and techniques, which are discussed in more detail below. We also invite comment on whether some technologies or techniques,

[94] *Id*. at §6406(a)(2).

[95] *See* NTIA 5 GHz Report.

[96] *See supra* note 17. National Broadband Plan at 95.

[97] Zero to a Billion; 802.11ac-Enabled Device Shipments to Soar by 2015, In-Stat (February 08, 2011), available at http://www.marketwire.com/press-release/zero-to-a-billion-80211ac-enabled-device-shipments-to-soar-by-2015-says-in-stat-1391854.htm.

[98] Carrier Wi-Fi equipment market exploding to $2.1 billion by 2016, Infonetics research (May 10, 2012), *available at*: http://www.infonetics.com/pr/2012/Carrier-WiFi-Equipment-Market-Highlights.asp.

such as DFS, might limit the types of applications that could be implemented in the U-NII bands, particularly if wider bandwidth devices are deployed in this spectrum.

81. Also, at the 2012 World Radio Conference, the United States along with other countries agreed that the next World Radio Conference in 2015 (WRC-15) should consider additional spectrum allocations to the mobile service for the development of terrestrial mobile broadband applications. In preparation for WRC-15, the International Telecommunications Union initiated spectrum sharing studies that consider possible expansion of the existing international allocations to the mobile services in the 5 GHz band which are used primarily by the radio local area network (RLAN) devices.[99] We seek comment on how these activities should inform our consideration of technical requirements for these bands and sharing technologies and techniques, which are discussed in more detail below. We also seek comment on importance and benefits of harmonization between our U-NII rules and the international radio regulations.

2. Incumbent Services in the U-NII-2B Band

82. The 5.35 – 5.47 GHz band is allocated on a primary basis to the Earth Exploration Satellite, Space Research, and Radiolocation Services for Federal operations and on a secondary basis for non-Federal operations.[100] The 5.35-5.46 GHz band segment is allocated on a primary basis to the Aeronautical Radionavigation Service for both Federal and non-Federal operations.[101] The 5.46-5.47 GHz band segment is allocated on a primary basis to the Radionavigation Service for both Federal and non-Federal operations.[102] The Table below summarizes these incumbent service allocations.

Frequency Band	Service Type	Federal Primary	Non-Federal Primary	Non-Federal Secondary
5.35 -5.47 GHz	Earth Exploration Satellite	X		X
5.35 -5.47 GHz	Space Research	X		X
5.35 -5.47 GHz	Radiolocation	X		X
5.35 -5.46 GHz	Aeronautical Radionavigation	X	X	
5.46 -5.47 GHz	Radionavigation	X	X	

a. Overview of Federal Systems

83. *RADAR Systems*. The DoD uses the 5.35-5.47 GHz band for a wide variety of ground-based, shipborne, and airborne radars. These military radars have the operational capability to tune across the entire 5.25-5.725 GHz frequency range and can operate on a fixed frequency or can employ frequency hopping techniques. In the past, these radars have operated on or near military installations. However, situations may arise where these radars have to be used more widely in support of homeland security. One of the areas of concern in assessing interference to military radars stems from future radar deployments and the expanding role of military radars in support of homeland defense. This expanded role could result in a requirement to deploy military radars in cities and metropolitan areas where

[99] The pre-conference studies are being conducted by the ITU-R Joint Task Group (JTG) 4-5-6-7. Refer to ITU-R Document 4-5-6-7/109, 16 November 2012.

[100] *See* 47 C.F.R. § 2.106.

[101] *Id.*

[102] *Id*.

unlicensed devices will have their highest usage.[103] In addition to DoD, several other agencies operate radar systems in the band. The Coast Guard operates shipborne radars, which are vital sensors for safe navigation of waterways. NASA uses this band for test and launch range instrumentation radars to track rockets, missiles, satellites, launch vehicles, and other targets. NOAA operates radar systems in this band on "Hurricane Hunter" aircraft. The Department of Energy operates radar systems and associated transponders in the band at two test ranges in the United States.

84. *Spaceborne Altimeter Radar Systems***.** NASA, in joint ventures with the French agency, Centre National d'Etudes Spatiales (CNES), operates a space-based altimeter system in the 5.14-5.46 GHz band that is used to obtain measurements of the Earth's ocean surface height.

85. *Earth Exploration Satellite*. Synthetic aperture radar (SAR) systems in the 5.35-5.47 GHz band perform space-based observations and measurements of surface topography, soil moisture, and sea surface height. The higher quality data collected using wideband SARs allow scientists to gain new insights into the prediction of climatic changes. These wideband SARs also provide the higher resolution necessary for commercial applications, such as high-resolution surface mapping. Canada operates an Earth exploration-satellite, known as RADARSAT, in the 5.35-5.47 GHz band to provide mission critical data in support of national security, public safety, law enforcement, and civilian applications in Canada and the United States. These applications include disaster management, response and recovery for safety of life, ice monitoring, surveillance, hydrology, mapping, and geology, safety of navigation, agriculture, and forestry. For example, the United States Coast Guard International Ice Patrol uses RADARSAT data operationally to detect and track icebergs.

86. *Unmanned aircraft systems (UAS)*.[104] DoD utilizes this band for the testing and operation of unmanned aircraft system (UAS) datalinks from aircraft-to-ground and from ground-to-aircraft. The command link, a ground data terminal transmitter, operates at 5.625-5.85 GHz and the return link (UAS transmitter) transmits at 5.25-5.475 GHz. The Army, Navy, and Air Force operate UASs in the 5 GHz frequency range for intelligence, surveillance, and reconnaissance; combat search and rescue; and real-time full-motion video for target development. The Department of Homeland Security also operates UASs in this band for drug interdiction and border surveillance operations.[105] In addition, NASA also operates a limited number of systems in the 5.35-5.47 GHz band that are used for downlink transmissions of data to ground control receivers.

b. Overview of Non-Federal Systems

87. The types of Federal and non-Federal systems in the 5.35-5.47 GHz band are similar except that non-Federal users in the Earth Exploration Satellite, Space Research, and Radiolocation Services operate on a secondary basis. Broadcast and media entities 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. Weather radars are employed by broadcasters throughout the USA and used to detect supercell storms capable of developing tornados and severe weather. Local TV stations throughout the country utilize 5.35-5.47 GHz band providing viewers with weather maps, weather pictures, and informing the public on a range of local and regional weather warnings. Part 90 of FCC rules permit the operation of weather radar services in the 5.35-5.47 GHz band.

[103] NTIA 5 GHz Report at 4-1 to 4-2.

[104] There is no allocation for UAS operations in the 5.35-5.47 GHz band; however, NTIA has authorized Federal agencies to operate UAS systems throughout the United States on a non-interference basis.

[105] NTIA 5 GHz Report at 4-2.

3. Incumbent Services in the U-NII-4 Band

88. The 5.85 – 5.925 GHz band is allocated on a primary basis to the Radiolocation Service for Federal operations and to the Fixed Satellite (Earth to space) and Mobile Services for non-Federal operations.[106] This band is also allocated on a secondary basis to the Amateur Service for non-Federal operations. The Table below summarizes these incumbent service allocations.

Frequency Band	Service Type	Federal Primary	Non-Federal Primary	Non-Federal Secondary
5.85-5.925 GHz	Radiolocation	X		
5.85-5.925 GHz	Fixed Satellite(Earth to Space)		X	
5.85-5.925 GHz	Mobile Service		X	
5.85-5.925 GHz	Amateur Service			X

a. Overview of Federal Systems

89. The radars that operate in the 5.825-5.925 GHz band are primarily military surveillance and test range instrumentation systems and can be either mobile or transportable. In addition to the DoD operation, NASA, NOAA, and Department of Energy operate radar systems in the 5.85-5.925 GHz band throughout the United States.[107]

b. Overview of Non-Federal Systems

90. *Fixed Satellite Services (FSS)*. The C-band is divided into a heavily-used "conventional" segment (3.7-4.2 GHz downlink and 5.925-6.425 GHz uplink) and a lightly-used "extended" segment (3.6-3.7 GHz downlink and 5.85-5.925 GHz and 6.425-7.075 GHz uplink). The non-Federal fixed-satellite service allocation in the extended C-band FSS (5.85-5.925 GHz) is limited to international inter-continental systems and is subject to case-by-case electromagnetic compatibility analysis.[108] Earth stations in stationary locations communicate uplink with geostationary satellites such as Intelsat, Inmarsat, JCSAT-2, Mabuhay, New Skies, and Galaxy. The earth stations and satellites use directional antennas which, along with the separation between the satellites, prevent interference with earth stations communicating with adjacent satellites. The FSS operations in the 5.85-5.925 GHz band are authorized under Part 25 of the FCC rules.

91. The FSS is widely used to provide a variety of commercial services domestically and internationally. For example, the FSS supports video distribution both on point-to-point basis and point-to-multipoint bases. The FSS also provides network services consisting of "backbone" capacity for point-to-point trunking for voice, data or Internet traffic; backhaul of communications services; and redundancy and restoration of communications services when other primary technologies fail. Further, the FSS is used to provide corporate, government, and military voice and data communications, as well as broadband and video services directly to the home.

92. *Intelligent Transportation Service (ITS)*. The non-Federal Mobile allocation is limited to Dedicated Short Range Communications Service (DSRC) systems operating in the Intelligent

[106] *See* 47 C.F.R. § 2.106.

[107] NTIA 5 GHz Report at 5-2 to 5-3.

[108] *See* 47 C.F.R. § 2.106 Table of Allocations, footnote US245. The FCC policy for this band is codified at 47C.F.R. § 2.108.

Transportation System radio service.[109] ITS is a national program aimed at using state-of-the-art communications system to make travel more efficient, safer and convenient for motorists, transit riders, commercial vehicle operators and public safety providers. Through the use of technologies such as roadside and/or overhead Variable Message Signs, Closed Circuit TV, Highway Advisory Radio transmitters, traffic counter loops and Transcom's System for Managing Incidents and traffic flow monitors, real-time traffic information is collected and conveyed to the traveling public. This multi-modal information then allows motorists to make smarter choices about how, when and where to travel.

93. DSRC is a wireless ITS system designed for automotive use. In October 1999, the FCC allocated 75 megahertz of spectrum in the 5.85-5.925GHz band for DSRC to be used by ITS.[110] DSRC is a two-way short- to- medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications.[111] DSRC which involves vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications can save lives by warning drivers of an impending dangerous condition or event in time to take corrective or evasive actions.[112] Vehicle safety applications that use V2V and V2I communications need secure, wireless interface dependability in extreme weather conditions, and short time delays; all of which are facilitated by DSRC.[113] FCC grants licenses for state and regional transportation agencies to operate DSRC roadside units, while DSRC onboard units are licensed by rule under Part 95.[114]

94. *Amateur Radio*. Amateur service stations are permitted to transmit in the 5.85-5.925 GHz frequency segment on a secondary basis. Operation of these stations in this frequency segment must not cause harmful interference to, and must accept interference from, authorized stations in the fixed-satellite (earth to space) and mobile services (DSRC) and also stations authorized by other nations in the fixed service.[115] The FCC does not have detailed information on use of this band by amateur service stations.

4. Technical Requirements for U-NII-2B and U-NII-4 Bands

95. The technical requirements for U-NII devices operating in the U-NII-2B and U-NII-4 bands will depend ultimately on a determination of the types of unlicensed operations that can be supported while maintaining interference protection to incumbent Federal and non-Federal users. Nonetheless, we believe that because the types of incumbent services across the 5 GHz spectrum share

[109] *See* 47 C.F.R. § 2.106 Table of Frequency Allocations- Non-Federal Government footnote NG-160.

[110] *See* Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services, ET Docket No. 98-95, *Report and Order,* 14 FCC Rcd 18221 (1999)(FCC 99-305).

[111] U.S. Department of Transportation Research and Innovative Technology Administration, DSRC: The Future of Safer Driving Fact Sheet, http://www.its.dot.gov/factsheets/dsrc_factsheet.htm (last visited Jan. 16, 2013).

[112] *See* Amendment of the Commission's Rules Regarding Dedicated Short-Range Communication Services in the 5.850-5.925 GHz Band (5.9 GHz Band); Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services; WT Docket No. 01-90, ET Docket No. 98-95, *Report and Order,* 19 FCC Rcd 2458 (2004)(FCC 03-324).

[113] *See supra* note 111.

[114] The DSRC Road Side Units (RSUs) are authorized under Part 90 (Subpart M) of the Federal Communications Commission (FCC) rules. The On-Board Units (OBUs) are authorized under Part 95 (Subpart L) of the FCC rules. In addition, Section 90.371of the Commission's rules indicates that DSRCS Roadside Units (RSUs) in the 5.85-5.925 GHz require NTIA coordination if operating within 75 kilometers of 59 DoD radar installations.

[115] *See* 47 C.F.R. § 97.303(r)(2).

similar characteristics, the technical requirements for unlicensed devices also could share similar characteristics.

96. *U-NII-2B Band.* The U-NII-2B band falls between the existing U-NII-2A and U-NII-2C bands. Most significantly, all three bands are allocated for Federal Earth Exploration Satellite, Space Research and Radiolcoation Services on a primary basis, and sensitive services such as Federal radar systems operate across all three bands. This suggests that U-NII devices could likely operate under the same technical framework specified in rule Section 15.407 in all three bands ranging from 5.25 – 5.725 GHz.[116] Thus, U-NII devices could operate across 475 megahertz either indoors or outdoors under the following power and emission limits: maximum output power limit is the lesser of 250 milliwatts and 11dBm+10 Log (B), where B is 26 dB emission bandwidth; antenna gain requirement is 6 dBi for non-point to-point systems and 23 dBi for point-to-point system; and power and power spectral density reduction is applied if the antenna gain exceeds these values. The maximum power spectral density should not exceed 11 dBm in any 1 megahertz band, and the out-of-band emission limit shall not exceed an EIRP limit of -27 dBm/MHz.[117] The out-of-channel emissions limit for an outdoors device should not exceed -41 dBm/MHz. We invite comment on these technical parameters for U-NII-2B devices.

97. *U-NII-4 Band.* The U-NII-4 band is situated 25 megahertz above the U-NII-3 band. A primary Federal allocation for Radiolocation Services and a non-Federal secondary allocation for Amateur Services range across the U-NII-3 and U-NII-4 bands, including the 25 megahertz located between them at 5.825-5.85 GHz. This suggests that U-NII devices should operate under the same framework and technical requirements specified in Section 15.407 in all three bands ranging from 5.725 – 5.925 GHz. We propose that the U-NII-3 rules be applied to the upper adjacent 25 megahertz band segment at 5.825-5.85 GHz. If we adopt this proposal, we believe that the same framework and technical requirements specified in Section 15.407 should apply across the expanded U-NII-3 and the U-NII-4 bands. Thus, U-NII devices could operate across 200 megahertz either indoors or outdoors under the following power and emission limits: maximum output power limit is the lesser of 1Watt and 17dBm+10 Log (B) where B is 26 dB emission bandwidth; antenna gain requirements is 6 dBi for non-point to-point systems and 23 dBi for point-to-point systems; and power and power spectral density reduction is applied if the antenna gain exceeds these values. The maximum power spectral density should not exceed 17 dBm in any 1 megahertz band, and out-of-band emissions within the frequency range from the band edge to 10 megahertz above or below the band edge should not exceed an EIRP limit of -17 dBm/MHz, and for frequencies 10 megahertz or greater, the emissions should not exceed an EIRP of -27 dBm/MHz.[118] We invite comment on these technical parameters for U-NII-4 devices.

98. *Spectrum Sensing/DFS and TPC.* The rules require that U-NII devices operating in the U-NII-2A and U-NII-2C bands employ Dynamic Frequency Selection (DFS) in order to avoid causing interference to Federal radar systems. We seek comment whether and how to integrate a DFS algorithm into U-NII-2B and U-NII-4 bands. What are the advantages and/or disadvantages of utilizing DFS in these bands? What are the technical challenges of DFS technology implementation in the U-NII-2B and U-NII-4 bands? What changes are necessary in the existing DFS model to mitigate possible interference with incumbent radar system in the new bands? What radar parameters/signal detection threshold should be used for DFS to avoid assigning the occupied radar channel to U-NII device? If the U-NII device would have to perform sensing outside its occupied bandwidth (adjacent channel sensing), what would be the technical and cost implications of such deployment? Should the radar signal detection be sensed by base/fix stations, mobile stations or all? Are there technical solutions other than DFS that would prevent

[116] *See* 47 C.F.R. § 15.407 (a)(2)-(3).

[117] *See* 47 C.F.R. § 15.407(b)(2)

[118] *See* 47 C.F.R. § 15.407(b)(4)

interference to Federal radar systems? Could database access offer any benefits for providing access to this spectrum while protecting incumbent services against harmful interference?

99. The signal detection technology currently used by U-NII-2A and U-NII-2C DFS devices senses radar signals whose parameters (such as pulsewidth, pulse repetition interval, and the number of pulses per burst) are well-known and can be used to improve signal detection. To improve range resolution and accuracy, some radar systems operating in the U-NII-2B and U-NII-4 bands employ short (sub-microsecond) pulse widths.[119] The smallest pulsewidth used in the development of the existing U-NII DFS regulations was 1 microsecond. 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.[120] We seek comment on the ability of signal sensing spectrum-sharing technologies to detect sub-microsecond pulses and whether the current DFS mechanism would protect the current and future radars that employ sub-microsecond pulses. Are there other detection mechanisms that could be considered?

100. In addition, some fielded and in-development radar systems in the U-NII-2B and U-NII-4 bands include low-power modes or are designed to avoid detection to meet their mission requirements.[121] We seek comment on whether DFS or any other spectrum-sharing technology would be capable of protecting such radar systems from possible interference.

101. Finally, what measures should be taken to protect non-radar systems that operate in the U-NII-2B and U-NII-4 bands and what is the cost implication for manufacturers, vendors and consumers? We seek comment on what types of sharing technology or techniques could be used to protect non-radar systems, such as the DSRCS which includes both road side units (RSU-fixed) and on board units (OBU-mobile) operating under a primary allocation. For example, U-NII signal detection technologies used for DFS may not be able to detect signals from incumbents other than radar systems. Could U-NII devices detect signals from both DSRC fixed and mobile stations? We seek comments on evolving technologies that may help to detect non-radar signals and to protect those operations from harmful interference.

5. NTIA 5 GHz Report

102. NTIA has published a report of its initial study on the potential for U-NII devices to share the U-NII-2B and U-NII-4 bands with incumbent Federal operations.[122] The report includes an initial evaluation of known and proposed spectrum-sharing technologies and also completed a high-level evaluation of the risk to Federal users if the Commission allows U-NII devices to operate in the U-NII-2B and U-NII-4 bands.[123]

103. NTIA, in collaboration with the Federal agency members of the Policy and Plans Steering Group (PPSG), developed a work plan for evaluating the risks to Federal systems operating in the U-NII-2B and U-NII-4 bands. The plan outlined the technical and operational information necessary to perform the evaluation. Several Federal agencies also conducted preliminary electromagnetic compatibility and

[119] NTIA 5 GHz Report at 5-8. A narrow pulsewidth also improves radar detection capabilities in cluttered environments.

[120] *Id*.

[121] *Id*.

[122] We note that the NTIA 5 GHz Report does not use the same numerical designation for the 5 GHz band segments that we use in this proceeding. The report refers to both the U-NII-2A and U-NII-2C bands as "UNII-2." The report does use the same numerical designations as this proceeding for the U-NII-1 and U-NII-3 bands, but it does not assign numerical designations for the two new bands that we have designated as U-NII-2B and U-NII-4.

[123] NTIA 5 GHz Report at 1-1.

interference analyses to begin to quantify risks to their systems.[124] NTIA also used input from industry stakeholders related to their projected technical and deployment parameters for U-NII devices,[125] and reviewed domestic and international technical studies used in the development of the existing U-NII regulations in performing their study. For the study, NTIA assumed that the FCC's existing U-NII TPC and DFS regulations would be extended to the U-NII-2B and U-NII-4 bands, and that the Federal agencies will not have to alter their systems or operations to accommodate U-NII devices.[126] The report concludes that additional analysis is needed to determine the feasibility of introducing U-NII devices into these two bands and includes a tentative schedule and milestones for quantitative study consistent with the ongoing work for WRC-15, discussed above.

104. We seek comments on all aspects of the NTIA 5 GHz Report, particularly the spectrum sharing technologies and risk analysis described below.

a. Spectrum Sensing Technologies

105. The report addresses three spectrum sharing technologies that might be used as reference models in the U-NII-2B and U-NII-4 bands. These are classified as sensing based, geo-location based, and beaconing/pilot channel technologies.

106. *Sensing based technology*. Sensing based spectrum sharing approaches enable radio devices to identify unused spectrum by assessing and determining current use of a particular frequency through, for example, transmitter detection, cooperative sensing, or interference detection. Transmitter detection is the capability of determining if a signal from another transmitter is using a frequency nearby by correlating a known signal with an unknown signal (matched filter detection), measuring signal energy (signal detection), or utilizing statistical means. Cooperative sensing incorporates information about the spectral environment from multiple sensing devices to accurately determine if spectrum is in use. Interference detection refers to sensing changes in the local noise floor to determine if additional traffic can be tolerated by primary users.[127]

107. *Geo-Location based technology*. This approach requires the development of a database infrastructure that contains information about incumbent spectrum users which, when used in combination with a geo-location system (*e.g.*, the Global Positioning System (GPS)) and an interference-free location-data communications link, provides a mechanism to facilitate spectrum sharing with incumbents operating at fixed or known locations with known technical parameters.[128] Geo-location spectrum-sharing technologies can be used in conjunction with a well maintained updated database to define geographic areas where device operation will and will not be permitted, or where limitations should be placed on the operating parameters to enable spectrum sharing.[129]

108. *Beaconing/pilot channel technology*. In a beacon spectrum sharing approach, a new entrant's transceiver must have the ability to receive a control signal sent continuously by incumbent systems at times when transmissions by the new entrant are permitted. The new entrant may not

[124] *Id*.

[125] NTIA 5 GHz Report at 1-3 (citing Letter from Mary L. Brown, Director, Government Affairs, Cisco Systems, Inc. to Karl Nebbia, Associate Administrator, Office of Spectrum Management, NTIA (Sept. 26, 2012) (*Industry Input*).

[126] NTIA 5 GHz Report at 1-2.

[127] NTIA 5 GHz Report at 2-4 to 2-5. The report discusses about each sensing technologies and presents the advantages and disadvantages of each sensing approach.

[128] *See supra* note 70. *See also* NTIA 5 GHz Report on at 2-6.

[129] *Id*.

commence transmissions if beacon signals are not received. If any beacon signal is present but then stops while the new entrant is transmitting, transmissions must cease within a specified time interval. The beacons could be a radio frequency signal sent by incumbents on designated control frequencies, or they may be signals received over a physical connection such as fiber, copper, or coaxial cable. Transmission by the new entrant would cease if any beacon signal suffers from unfavorable propagation conditions or the physical connection is lost such that the beacon signals are not properly received by the new entrant. In other words, if the new entrant cannot hear the beacon signal, it must cease transmission.[130]

b. Risk Analysis

109. The NTIA 5 GHz Report provides an overview of the risk elements to each type of Federal operation and suggests some mitigation strategies associated with each risk element for further investigation.

110. *Description of risk elements in U-NII-2B band*. The report indicates that changes in radar signal parameters may impact U-NII device detection of radar and changes in U-NII device deployment and technical parameters may result in harmful interference into radar systems. The report also emphasizes that the current U-NII regulations may introduce hidden node interference[131] and may not adequately protect current and future radar systems while changes in the existing U-NII DFS detection parameters, including channel response time, may not sufficiently shield current and future radar systems from serious degradation. The report extends the risk element to the U-NII devices operating on an adjacent channel and states this may cause harmful interference into radar systems. The report also specifies that the radar receiver interference protection criteria used to develop existing U-NII DFS regulations may not address low-level interference effects.[132]

111. The report states that the existing U-NII signal detection technologies may not be capable of detecting UAS signals because the existing U-NII regulations were not developed to detect such signals (there is no UAS signal in the bands governed by the existing U-NII regulations) and changes to U-NII DFS detection parameters may not protect UAS operations from performance degradation. The report also points out that existing U-NII regulations were not developed to protect spaceborne receivers.[133] The report also states that the density of U-NII devices is one of the key parameters in determining the amount of potential interference to the incumbent Federal systems.

112. *Description of risk elements in U-NII-4 band*. The report cites the same risks to radar systems operating in the U-NII-4 band as it cites for the U-NII-2B band discussed above.[134] The report also states that the existing U-NII signal detection technologies may not be capable of detecting DSRC signals because the existing U-NII regulations were not originally developed to detect such signals (there is no DSRC signal in the bands governed by the existing U-NII regulations) and changes to U-NII DFS detection parameters may not protect DSRC operations from performance degradation.

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

[131] Hidden node refers to a scenario where the propagation path between the radar system and the U-NII master device is obstructed but the propagation path between radar system and U-NII client device is unobstructed. Since the master device cannot detect the radar signal, it may assign an occupied radar channel to the client device, which could result in excessive interference into the radar system.

[132] NTIA 5 GHz Report at 4-4 to 4-5.

[133] *Id*.

[134] NTIA 5 GHz Report at 5-4 to 5-5.

C. Other Issues

1. Miscellaneous Rule Modifications

113. In addition to the proposals outlined above, we believe that there are a number of other changes that need to be considered to simplify and clarify Part 15 of the rules. Our analysis revealed several sections that reference procedures or provisions that are no longer in use and therefore, may no longer be necessary. We have also identified sections that need to be updated with minor revisions. The proposed changes are listed below, and text of the proposed rules is provided in Appendix A. We request comment on each of these proposals.

● **Section 15.403 Definitions.** We are proposing to clarify this section by replace the wording in paragraph (m) from "Peak Power Spectral Density" with "Maximum Power Spectral Density." In addition, we are proposing to delete "peak or" from paragraph (o) for clarity.

● **Section 15.407 General technical requirements.** We are proposing to delete the second sentence in paragraph (a)(4) because it contains language that is no longer relevant. We also propose to correct the wording in paragraph (a)(5) by replacing "peak" with "maximum". In addition, we are updating the language in paragraph (a)(6) to clarify that all peak excursion measurements are to the highest average rather than to the average in each corresponding 1 megahertz band

● **Section 15.215 Additional provisions to the general radiated emission limitations.** This section includes language regarding the 20 dB bandwidth being contained entirely within a specific band as specified in our rules. This 20 dB language was included in the UWB proceeding to preclude UWB devices from operating at the same power levels as narrowband and wideband devices. We consider Section 15.407 devices to be wideband devices. The 20 dB bandwidth limitation was not intended to limit the simultaneous operation of a composite U-NII device over multiple channels. U-NII Band straddling in the 5GHz-6GHz region of spectrum is allowed (This applies to 802.11ac bonded 80 megahertz and 160 megahertz channels). We propose to update this section to clarify that this rule does not apply to 15.407 devices.

● **Section 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5850 MHz.** We propose to correct the references in paragraph propose (b)(4)(iii) by replacing "(b)(3)(i) and (b)(3)(ii)" with "(b)(4)(i) and (b)(4)(ii)".

2. Transition Periods

114. We propose to establish a 12-month timetable after the effective date of any new or modified rules that we eventually decide to adopt in this proceeding for manufacturers to produce U-NII devices that comply with new or modified rules. We also propose to establish a 2-year timetable after the effective date of any new or modified rules for requiring that any U-NII devices manufactured in or imported into the United States for sale comply with the new or modified rules. We believe that a 12-month transition period should provide sufficient time for manufacturers to design equipment that complies with any new or modified rules and to obtain equipment certification. Therefore, we would provide transitional provisions in our rules to allow for the certification of U-NII devices under the current rules for up to 12 months after the new or modified rules are published in the Federal Register. Beginning 12 months after the effective date of the new or modified rules, equipment certification could no longer be obtained for U-NII devices that do not meet the new requirements. However, until the end of the 2-year transition period, we would permit Class II permissive changes for equipment certified prior to the 12-month transition date[135] as well as their continued manufacture, marketing, installation, and

[135] *See* 47 C.F.R. § 2.1043(b)(2).

importation. After the end of the 2-year transition period, Class II permissive changes for such devices would not be permitted nor would their manufacture, marketing, installation, or importation. We find that these requirements would facilitate the transition to new requirements without unduly impairing the availability or cost of U-NII devices or imposing undue burdens on manufacturers, translation services providers, or the public. Comments are requested on these proposed transition provisions.

115. We also propose that U-NII devices that are already installed or in use should be grandfathered for the life of the equipment. Requiring the immediate upgrade or replacement of existing U-NII devices would be a financial burden on operators of these devices. We believe that grandfathering equipment that is installed and operating will ensure that entities will be permitted to operate their existing U-NII devices until replacement is necessary or desired due to age, malfunction, or other concerns. We seek comments on this proposal.

IV. PROCEDURAL MATTERS

A. Ex Parte Rules – Permit-But-Disclose

116. The proceeding this Notice initiates shall be treated as a "permit-but-disclose" proceeding in accordance with the Commission's *ex parte* rules.[136] Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation (unless a different deadline applicable to the Sunshine period applies). Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter's written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are deemed to be written *ex parte* presentations and must be filed consistent with rule 1.1206(b). In proceedings governed by rule 1.49(f) or for which the Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in their native format (*e.g.*, .doc, .xml, .ppt, searchable .pdf). Participants in this proceeding should familiarize themselves with the Commission's *ex parte* rules.

B. Comment Period and Procedures

117. Pursuant to sections 1.415 and 1.419 of the Commission's rules, 47 CFR §§ 1.415, 1.419, interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. Comments may be filed using the Commission's Electronic Comment Filing System (ECFS). *See Electronic Filing of Documents in Rulemaking Proceedings*, 63 FR 24121 (1998).

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: http://fjallfoss.fcc.gov/ecfs2/.

- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number.

[136] 47 C.F.R. §§ 1.1200 *et seq.*

Filings can be sent by hand or messenger delivery, by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.

- All hand-delivered or messenger-delivered paper filings for the Commission's Secretary must be delivered to FCC Headquarters at 445 12th St., SW, Room TW-A325, Washington, DC 20554. The filing hours are 8:00 a.m. to 7:00 p.m. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes and boxes must be disposed of before entering the building.

- Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9300 East Hampton Drive, Capitol Heights, MD 20743.

- U.S. Postal Service first-class, Express, and Priority mail must be addressed to 445 12th Street, SW, Washington DC 20554.

118. People with Disabilities: To request materials in accessible formats for people with disabilities (braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202-418-0530 (voice), 202-418-0432 (tty).

C. Initial Regulatory Flexibility Analysis

119. As required by the Regulatory Flexibility Act of 1980 (RFA),[137] the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on small entities of the policies and rules proposed in the Notice. The IRFA is found in Appendix D. We request written public comment on the analysis. Comments must be filed in accordance with the same deadlines as comments filed in response to the Notice, and must have a separate and distinct heading designating them as responses to the IRFA. The Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, will send a copy of this Notice, including the IRFA, to the Chief Counsel for Advocacy of the Small Business Administration.

D. Paperwork Reduction Analysis

120. This document does not contain a proposed information collection(s) subject to the Paperwork Reduction Act of 1995 (PRA, Public Law 104-13. In addition, therefore, it does not contain any new or modified information collection burden for small business concerns with fewer than 25 employees, pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198, *see* 44 U.S.C. 3506(c)(4).

E. Further Information

121. For further information regarding this Notice of Proposed Rulemaking, please contact Aole Wilkins, Technical Rules Branch, Policy and Rules Division, Office of Engineering and Technology, Federal Communications Commission, 445 12th Street, S.W., Washington, DC 20554, at 202-418-2406 or via the Internet at Aole.Wilkins@fcc.gov.

V. ORDERING CLAUSES

122. IT IS ORDERED that pursuant to Sections 1, 4(i), 7(a), 301, 303(f), 303(g), 303(r), and 307(e) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 151, 154(i), 157(a), 301, 303(f), 303(g), 303(r), and 307(e), and Section 6406(a) of the Middle Class Tax Relief and Job Creation

[137] *See* 5 U.S.C. § 603.

Act of 2012, Pub. L. No. 112-96, §6406(a), 126 Stat. 156, 231 (2012), this Notice of Proposed Rule Making IS ADOPTED.

123. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this Notice of Proposed Rule Making, including the Initial Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

Proposed Rules

PART 15 – RADIO FREQUENCY DEVICES

1. The authority citation for Part 15 continues to read as follows:

Authority: 47 U.S.C. 154, 302a, 303, 304, 307, 336, 544a, and 549

2. Section 15.215 is amended by revising paragraph (c) to read as follows:

§ 15.215 Additional provisions to the general radiated emission limitations.

*****

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of Subpart E, the emission bandwidth may span across multiple frequency bands identified in that Subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

3. Section 15.247 is amended by revising paragraphs (a)(2), (b)(3) and (4) and by revising paragraph (c)(1)(ii) and (iii) and paragraph (f) to read as follows:

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

*****

(a) ***

(2) Systems using digital modulation techniques may operate in the 902-928 MHz, and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

*****

(b) ***

(3) For systems using digital modulation in the 902-928 MHz, and 2400-2483.5 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

*****

(c) ***

(1) ***

(ii) Frequency hopping systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted output power.

(iii) Fixed, point-to-point operation, as used in paragraph (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

*****

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

*****

4. Section 15.403 is amended by revising the definition in paragraph (m) to read as follows:

§ 15.403 Definitions.
*****

(m) *Maximum Power Spectral Density.* The maximum power spectral density is the maximum powerin the specified measurement bandwidth, within the U-NII device operating band.

*****

5. Section 15.407 is amended by revising paragraphs (a) (3), (4), (5) and (6) and paragraph (b)(4) and by adding new paragraphs (f) and (j) and by redesignating paragraphs (f) through (h) as paragraphs (g) through (i) to read as follows:

§ 15.407 General technical requirements.

*****

(3) For the band 5.725-5.850 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 8 dBm in any 3-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain up to 23 dBi without any corresponding reduction in the transmitter peak output power or maximum power spectral density. For fixed, point-to-point U-NII transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in peak transmitter power and maximum power spectral density for each 1 dB of antenna gain in excess of 23 dBi would be required. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

NOTE TO PARAGRAPH (a)(3): The Commission strongly recommends that parties employing U-NII devices to provide critical communications services should determine if there are any nearby Government radar systems that could affect their operation.

(4) The maximum conducted output power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage.

(5) The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

(6) The ratio of the maximum peak excursion of the modulation envelope (measured in a 1 MHz bandwidth using a peak hold function) to the maximum power spectral density during an interval of continuous transmission (measured in a 1 MHz bandwidth) shall not exceed 13 dB. Each of the two maxima shall be separately determined across the full emission bandwidth. If the emission bandwidth is

less than 1 MHz, the measurement may be performed in a resolution bandwidth narrower than 1 MHz but wider than or equal to the emission bandwidth.

*****

(b) ***

(4) For transmitters operating in the 5.725-5.850 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of -27 dBm/MHz.

*****

(f) Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

(g) U-NII devices are subject to the radio frequency radiation exposure requirements specified in § 1.1307(b), § 2.1091 and § 2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

(h) Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

(i) Transmit Power Control (TPC) and Dynamic Frequency Selection (DFS).

*****

(j) All U-NII Devices must contain security features to protect against modification of software by unauthorized parties.

APPENDIX B

Changes to Compliance Measurement Procedures For Unlicensed-National Information Infrastructure Devices Operating in The 5250-5350 MHz and 5470-5725 MHz Bands Incorporating Dynamic Frequency Selection

In 2006, the FCC released measurement procedures to be used in certifying U-NII equipment that requires implementation of Dynamic Frequency Selection (DFS). Based on investigations into complaints of interference to Terminal Doppler Weather Radar (TDWR), NTIA has recommended changes to the measurement procedures that are described within this Appendix. The original 2006 measurement procedures have been placed into the docket of this proceeding, and are proposed to be modified as described in this appendix.

Throughout the measurement procedures, the old waveform 1 would be renamed waveform 0. A new waveform 1is then added to Section 6 of the measurement procedures as described below. In addition, channel availability check and non-occupancy tests that originally specified use of waveform 1 are proposed to now allow use of any of the waveform types 0 - 4.

In table 4 of the measurement procedure, the U-NII Detection Bandwidth is specified as a minimum of 80% of the 99% transmission power bandwidth. This sensing bandwidth is one of the technical issues on which we are seeking comment in the NPRM, and thus we will modify the measurement procedures to reflect the determination made in the proceeding with respect to the U-NII Detection Bandwidth.

Finally, Section 6.1 (Short Pulse Radar Test Waveforms) of the measurement procedures is proposed to be modified to read as shown below:

6.1 Pulse Radar Test Waveforms

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Note 1: Short Pulse Radar Type 0 shall only be used for the channel availability and detection bandwidth tests. It should be noted that any of the radar test waveforms 0 – 4 can be used for the channel availability and detection bandwidth tests.

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B.

For example if in Short Pulse Radar Type 1 Test B a PRI of 3066 usec is selected, the number of pulses would be $\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{3066}\right)\right\} = \text{Roundup}\{17.2\} = 18.$

Table 5a - Pulse Repetition Intervals Values for Test A

Pulse Repetition Frequency Number	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)
1	1930.5	518
2	1858.7	538
3	1792.1	558
4	1730.1	578
5	1672.2	598
6	1618.1	618
7	1567.4	638
8	1519.8	658
9	1474.9	678
10	1432.7	698
11	1392.8	718
12	1355	738
13	1319.3	758
14	1285.3	778
15	1253.1	798
16	1222.5	818
17	1193.3	838
18	1165.6	858
19	1139	878
20	1113.6	898
21	1089.3	918
22	1066.1	938
23	326.2	3066

The aggregate is the average of the percentage of successful detections of Short Pulse Radar Types 1-4. For example, the following table indicates how to compute the aggregate of percentage of successful detections.

Radar Type	Number of Trials	Number of Successful Detections	Minimum Percentage of Successful Detection
1	35	29	82.9%
2	30	18	60%
3	30	27	90%
4	50	44	88%
Aggregate (82.9% + 60% + 90% + 88%)/4 = 80.2%			

APPENDIX C

EXISTING TECHNICAL SUMMARY CHARTS FOR UNLICENSED BANDS

Current technical characteristics of UNII devices for Rule Section 15.407

	UNII-1 (5.150 – 5.250 GHz)	**UNII-2A (5.250 – 5.350 GHz)**	**UNII-2C (5.470 – 5.725 GHz)**	**UNII-3 (5.725 – 5.825 GHz)**
Indoor-Outdoor operations	Indoor Only	Indoor-Outdoor	Indoor-Outdoor	Indoor-Outdoor
Max TX Power, Lesser of two(B= 26 dB emission BW)	50 mW or 4 dBm + 10 log B	250 mW or 11 dBm + 10 Log B	250 mW or 11 dBm + 10 Log B	1W or 17 dBm + 10 log B
Max EIRP (with 6 dBi Ant.)	23 dBm / 200 mW	30 dBm / 1 W	30 dBm / 1 W	36 dBm / 4 W (53 dBm / 200 W for PTP)
Power reduction required when antenna gain exceeds	> 6 dBi	> 6 dBi	> 6 dBi	> 6 dBi (>23 dBi for PTP)
Out of band emission	-27 dBm/MHz EIRP	-27 dBm/MHz EIRP	-27 dBm/MHz EIRP	-17 dBm/MHz EIRP for up to 10 MHz outside the band edge and -27 dBm/MHz for further than 10 MHz
Power Spectral Density/MHz	4 dBm	11 dBm	11 dBm	17 dBm
Dynamic Frequency Selection (DFS) required	No	Yes	Yes	No
Transmit Power Control (TPC) required	No	Yes (Not required if EIRP<500 mW)	Yes (Not required if EIRP<500 mW)	No

Current technical characteristics of devices in UNII-3 band (under Rule Section15.407) and devices under Rule Section 15.247

	UNII-3 (Rule Section 15.407) (5.725 – 5.825 GHz)	**Rule Section 15.247 (5.725 – 5.850 GHz)**
Indoor-Outdoor operations	Indoor-Outdoor	Indoor-Outdoor
Max TX Power	1W or 17 dBm + 10 log B - Lesser of two (B= 26 dB emission BW)	1 W
Max EIRP (with 6 dBi Ant.)	36 dBm / 4 W (53 dBm/200 W for PTP)	36 dBm / 4 W (No Maximum for PTP)
Power reduction required when antenna gain exceeds	> 6 dBi (>23 dBi for PTP)	> 6 dBi (No limit for PTP)
Out of band emission	-17 dBm/MHz EIRP for up to 10 MHz outside the band edge and -27 dBm/MHz for further than 10 MHz	For any 100 KHz outside band, power should be 20 dB below that in any 100 KHz within the band.
Power Spectral Density/ MHz	17 dBm	8dBm/3KHz of TX power(33dBm/MHz)
Dynamic Frequency Selection (DFS) required	No	No
Transmit Power Control (TPC) required	No	No
Minimum BW Requirement	N/A	Minimum 500 KHz for 6dB BW

APPENDIX D

Initial Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[1] the Commission has prepared this present Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on small entities by the policies and rules proposed in this Notice of Proposed Rule Making (NPRM). Written public comments are requested on this IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines specified in the NPRM for comments. The Commission will send a copy of this NPRM, including this IRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).[2] In addition, the NPRM and IRFA (or summaries thereof) will be published in the Federal Register.[3]

A. Need for, and Objectives of, the Proposed Rules

This NPRM proposes to amend Part 15 of the FCC's rules governing the operation of unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band. U-NII devices are unlicensed intentional radiators that operate in the frequency bands 5150-5350 MHz and 5470-5825 MHz that use wideband digital modulation techniques to provide a wide array of high data rate mobile and fixed communications for individuals, businesses, and institutions. The NPRM proposes to modify certain technical requirements for U-NII devices to ensure that these devices can continue to operate successfully while protecting incumbent spectrum users..

B. Legal Basis

2. This action is authorized under Sections 1, 4(i), 302, 303(f) and (r), 332, and 337 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 1, 4(i), 154(i), 302, 303(f) and (r), 332, 337.

C. Description and Estimate of the Number of Small Entities to Which the Proposed Rule Will Apply

3. The RFA directs agencies to provide a description of, and, where feasible, an estimate of, the number of small entities that may be affected by the rules adopted herein.[4] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[5] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[6] A "small business concern" is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3)

[1] *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. § 601-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996, (SBREFA) Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[2] *See* 5 U.S.C. § 603(a).

[3] *See* 5 U.S.C. § 603(a).

[4] 5 U.S.C. § 604(a)(3).

[5] 5 U.S.C. § 601(6).

[6] 5 U.S.C. § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

satisfies any additional criteria established by the Small Business Administration (SBA).[7]

Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing. The Census Bureau defines this category as follows: "This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment."[8] The SBA has developed a small business size standard for Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing, which is: all such firms having 750 or fewer employees. According to Census Bureau data for 2007, there were a total of 939 establishments in this category that operated for part or all of the entire year. Of this total, 912 had less than 500 employees and 17 had more than 1000 employees.[9] Thus, under that size standard, the majority of firms can be considered small.

D. Description of Projected Reporting, Record Keeping, and Other Compliance Requirements

4. The NPRM proposes to establish a 12-month timetable after the effective date of any new or modified rules that we eventually decide to adopt in this proceeding for manufacturers to produce U-NII devices that comply with new or modified rules. We also propose to establish a 2-year timetable after the effective date of any or modified rules for requiring that any U-NII devices manufactured in or imported into the United States for sale comply with the new or modified rules. We believe that a 12-month transition period should provide sufficient time for manufacturers to design equipment that complies with any new or modified rules and to obtain equipment certification. Therefore, we would provide transitional provisions in our rules to allow for certification of U-NII devices under the current rules for up to 12 months after the new or modified rules are published in the Federal Register. Beginning 12 months after the effective date of the new or modified rules, equipment certification could no longer be obtained for U-NII devices that do not meet the new requirements. However, until the end of the 2-year transition period, we would permit Class II permissive changes for equipment certified prior to the 12-month transition date[10] as well as their continued manufacture, marketing, installation, and importation. After the end of the 2-year transition period, Class II permissive changes for such devices would not be permitted nor would their manufacture, marketing, installation, or importation. We find that these requirements would facilitate the transition to new requirements without unduly impairing the availability or cost of U-NII devices or imposing undue burdens on manufacturers, translation services providers, or the public.

E. Steps Taken to Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

5. The RFA requires an agency to describe any significant alternatives that it has considered in reaching its proposed approach, which may include the following four alternatives (among others): (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design,

[7] 15 U.S.C. § 632.

[8] The NAICS Code for this service 334220. *See* 13 C.F.R 121/201. *See also* http://www.census.gov/econ/industry/current/c334220.htm.

[9] *See* http://factfinder2.census.gov/bkmk/table/1.0/en/ECN/2007_US/31SG3//naics~334220.

[10] *See* 47 C.F.R. § 2.1043(b)(2).

standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.[11]

The proposals contained in this Notice of Proposed Rulemaking (NPRM) are aimed at improving the sharing of the spectrum between U-NII devices and other spectrum users. This NPRM proposes to amend Part 15 of our rules governing the operation of Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band.[12] U-NII devices are unlicensed intentional radiators that operate in the frequency bands 5.15-5.35 GHz and 5.47-5.825 GHz, and which use wideband digital modulation techniques to provide a wide array of high data rate mobile and fixed communications for individuals, businesses, and institutions.[13] Since the Commission first made available spectrum in the 5 GHz band for U-NII in 1997, we have gained much experience with these devices. We believe that the time is now right for us to revisit our rules, and, in this NPRM, we propose to modify certain technical requirements for U-NII devices to ensure that these devices do not cause harmful interference and thus can continue to operate in the 5 GHz band and make broadband technologies available for consumers and businesses.

We also seek comment on making available an additional 195 megahertz of spectrum in the 5.35-5.47 GHz and 5.85-5.925 GHz bands for U-NII use. This could increase the spectrum available to unlicensed devices in the 5 GHz band by approximately 35 percent and would represent a significant increase in the spectrum available for unlicensed devices across the overall radio spectrum. The initiation of this proceeding satisfies the requirements of Section 6406 (a) of the "Middle Class Tax Relief and Job Creation Act of 2012" which requires the Commission to begin a proceeding to modify part 15 of title 47, Code of Federal Regulations, to allow unlicensed U-NII devices to operate in the 5350-5470 MHz band.[14] We believe that an increase in capacity gained from 195 megahertz of additional spectrum, combined with the ease of deployment and operational flexibility provided by our U-NII rules, would continue to foster the development of new and innovative unlicensed devices, and increase wireless broadband access and investment.

F. Federal Rules that May Duplicate, Overlap, or Conflict With the Proposed Rule

6. None.

[11] *See* 5 U.S.C. § 603(c).

[12] *See* 47 C.F.R. Part 15 Subpart E – Unlicensed National Information Infrastructure Devices.

[13] *See* 47 C.F.R. § 15.403(s).

[14] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, § 6406, 126 Stat. 156, 231 (2012), 47 U.S.C. § 1453 (Spectrum Act).

STATEMENT OF CHAIRMAN
JULIUS GENACHOWSKI

Re: *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.*

Most everyone in this room or watching at home has had a direct experience with the problem we're seeking to solve.

You're at an airport, a convention, or hotel and you break out your laptop, tablet, or smartphone, hoping you can get a Wi-Fi connection.

One moment you're saying, "Great, I can get online." Moments later, you're saying, "Not so fast," literally.

Wi-Fi congestion is a very real and growing problem. Like licensed spectrum, demand for unlicensed spectrum threatens to outpace supply. The core challenge is the dramatically increased use of wireless devices, which require spectrum.

Recently published data from Cisco estimates that commercial wireless networks are already offloading 33% of all traffic to Wi-Fi and project that offloading will grow to 46% by 2017.

So while Wi-Fi offload is part of the solution to the problem of congested cellular networks, Wi-Fi's popularity is creating congestion issues of its own.

And Wi-Fi congestion isn't just a problem at airports or public venues. It's becoming a problem in the home, where it's increasingly common to have multiple data-hungry devices using Wi-Fi at the same time.

For the past few years, the Commission has been pursuing a strong agenda to free up both licensed and unlicensed spectrum for broadband. We have been and will continue to be relentless in our work to free up spectrum, and we will lean into every opportunity that can meet the country's spectrum needs.

We're moving forward with world-leading policies, like freeing up spectrum for auctions to unleash very large amounts of licensed spectrum for our commercial wireless networks – a very high priority.

Spectrum auctions have had, and will continue to have, a huge positive impact on our economy and lives.

And as part of the incentive auctions proceeding, we're also paving the way for next-generation Wi-Fi by ensuring for the first time that low-band unlicensed spectrum will be available on a nationwide basis, using consistent frequencies.

Today, the FCC takes a big step to ease congestion on traditional Wi-Fi networks, which will mean faster speeds and fewer headaches for U.S. consumers.

Unlicensed spectrum is also a great success story for both the FCC and the U.S. economy.

In the 1980s, the FCC became the world's first agency to make available unlicensed spectrum suitable for WiFi-type uses, meaning anyone could use it as long as they follow basic rules to prevent interference. The use of this unlicensed spectrum sparked innovative technologies like Bluetooth and, perhaps most notably Wi-Fi.

These technologies have spurred job creation and economic growth – hundreds of billions of dollars of value creation for our economy and consumers, resulting in billions of dollars to the Treasury.

We must keep nurturing today's Wi-Fi, as we also continue to be forward-looking, and develop the next generation of unlicensed spectrum use policies.

Today's proposal would modify the rules to make the existing unlicensed 5GHz spectrum more usable, and to provide access to additional new unlicensed spectrum in that band.

Specifically, the proposal would increase and free up the unlicensed spectrum available for ultra-high-speed, high-capacity Wi-Fi – known as "Gigabit Wi-Fi" – by up to 35 percent – from 555 megahertz to 750 megahertz of spectrum: the largest block of unlicensed spectrum to be made available for expansion of Wi-Fi since 2003.

This additional spectrum will increase speeds and alleviate Wi-Fi congestion at major hubs, such as airports, convention centers and large conference gatherings.

In addition, this would also increase speed and capacity for Wi-Fi in the home where multiple users and devices are often on the network at the same time.

Because the 5GHz band is already used for other purposes by both federal and non-federal users, the effort will require significant consultation with stakeholders to enable non-interfering shared use of the spectrum.

But consultation can't be an excuse for inaction or delay.

We must all be guided by the President's directive to free up spectrum for commercial use, and by the critical importance of increasing the availability of spectrum to drive economic growth, job creation, and our country's global competitiveness.

These are goals and interests we all share. We must pursue all ideas to accelerate freeing up spectrum.

We are committed to a process of consultation, and we're also committed to moving expeditiously to free up additional spectrum for Wi-Fi. We look forward to working with all government and non-government stakeholders.

Thank you to OET, WTB, EB, IB and OGC for your excellent work on this item, and Renee Gregory in my office.

STATEMENT OF
COMMISSIONER ROBERT M. McDOWELL

Re: *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.*

Last night, I had the privilege of attending the National Academy of Engineering Awards ceremony. There is no Nobel Prize for engineering, so these awards are intended to fill that gap. Included in the amazing array of honorees was my friend Marty Cooper, the inventor of the cell phone. Also in attendance was Dr. Robert Kahn, whom I also have gotten to know over the years. Dr. Kahn is the co-inventor of TCP/IP, the protocol that allows the Internet to work.

It ends up that Marty Cooper and Bob Kahn were fans of each other but had never met. Last night, I had the incredible honor of being able to introduce them to each other. Although I still haven't recovered from the awe of the moment where an Internet pioneer met the father of the cell phone – quite literally the personification of the Internet meeting mobility – I was able to ask each of them at once whether, at the time of their inventions, they had foreseen the incredible effect their work would have on the human condition. With characteristic honesty and humility, they both said "no."

The point for all of us to learn from these great minds is that none of us can guess what innovations may be coming over the horizon or their potential to improve the lives of all human beings. Liberal arts majors who make public policy, such as myself, should learn to exercise regulatory humility and allow engineers to have the freedom to experiment. I am hopeful that this proceeding does just that.

Marty's and Bob's inventions are doing just fine. In fact, in 2012, U.S. mobile data traffic reached 207 petabytes per month, a 62 percent increase over the previous year. To put this amazing growth into context, processing 207 petabytes per month is equivalent to watching 52 million DVDs per month or sending 570 million text messages each second over our wireless networks.[15] And mobile usage will only continue to surge well into the future. It is estimated that mobile data traffic will grow nine fold in the next five years.[16] Furthermore, wireless devices are proliferating at an unprecedented rate. Fifty-one million new devices were connected to U.S. mobile networks in the last year alone to bring the total of American mobile-enabled devices to 424 million. It is estimated that 775 million wirelessly-connected devices will be used by Americans in 2017.[17]

To relieve congested cell networks, consumers are choosing to move wireless data to unlicensed systems. Last year, 96 percent of U.S. traffic associated with portable devices was carried on Wi-Fi networks at some point. Not only does this percentage include data that originated on Wi-Fi systems, but also the 47 percent of mobile data that was offloaded from cellular to Wi-Fi networks.[18] What does this

[15] *VNI Mobile Forecast Highlights, 2012-2017, United States – 2012 Year in Review*, CISCO SYSTEMS, http://www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlight/index.html (last visited Feb. 20, 2013) (filter by country to obtain information for the United States and select 2012 Year in Review).

[16] *VNI Mobile Forecast Highlights, 2012-2017, United States – 2017 Forecast Highlights*, CISCO SYSTEMS, http://www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlight/index.html (last visited Feb. 20, 2013) (filter by country to obtain information for the United States and select 2017 Forecast Highlights).

[17] *VNI Mobile Forecast Highlights, 2012-2017, United States – Network Connections*, CISCO SYSTEMS, http://www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlight/index.html (last visited Feb. 20, 2013) (filter by country to obtain information for the United States and select 2017 Network Connections).

[18] *Id*. (select Offload Traffic).

mean? The spectrum that is used for unlicensed Wi-Fi is also experiencing congestion, which will only increase in the coming years if we do not make appropriate bands, like the 5 GHz band, more attractive for investment and innovation.

Accordingly, I am pleased to vote in support of this notice which initiates the review of the current requirements and takes steps to increase the amount of spectrum available for unlicensed use in the 5 GHz band. Our proposals to harmonize the rules and requirements across the 5 GHz band will make this spectrum more attractive to investors and innovators by providing certainty and consistency across a wide swath of spectrum. This initiative, combined with the proposal to permit unlicensed use on an additional 195 megahertz of spectrum, will make the 5 GHz band more attractive for the deployment of faster, more robust Wi-Fi networks using the latest industry standards that provide the greatest efficiencies on 80 to 160 megahertz slices of spectrum. I am also pleased that we specifically seek comment on international efforts to harmonize uses of the 5 GHz band.

Launching this proceeding is just the beginning, of course, and we have a lot of work ahead us. Federal and non-federal primary users are prevalent throughout the 5 GHz band – both in the bands where unlicensed use is already permitted, and in the 195 megahertz of spectrum we hope to open to such use. Today, we take the initial steps to fulfill Congress's mandate in the Spectrum Act that we, along with NTIA, look into opening certain 5 GHz frequencies for unlicensed use.[19] Although we seek comment on protecting incumbent licensees from harmful interference, the Commission, affected government agencies, Wi-Fi providers and others will have to work together to ensure the successful unlicensed deployment of this spectrum.

Although allowing unlicensed use in an additional 195 megahertz of spectrum will promote continued innovation and investment in unlicensed devices and wireless broadband systems, it does not mean that we can be complacent and stop advocating for additional federal spectrum to be auctioned for exclusive use licenses. The federal government, specifically the executive branch, needs to evaluate its spectrum usage with the goal of relinquishing bandwidth for exclusive and flexible private sector uses. Spectrum "sharing" and the auctioning of exclusive use licenses are not equivalent.

I thank the Chairman for prioritizing this important proceeding. I also thank the dedicated and tireless staff of the Office of Engineering and Technology for all of their work in preparing this notice and for all of their efforts to come in opening up the 5 GHz band for new and improved unlicensed use and opportunities that will benefit Americans.

[19] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156 (2012).

STATEMENT OF
COMMISSIONER MIGNON L. CLYBURN

Re: *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.*

In his State of the Union Address, President Obama spoke of "a smarter government that sets priorities and invests in broad-based growth." Our first priority, he said should be "making America a magnet for new jobs and manufacturing." Without a doubt, the wireless service industry is one sector where smart policy can promote tremendous growth. One wireless analyst stated that, in 2011, this industry was responsible for 3.8 million jobs, or 2.6 percent of all domestic employment. According to other reports, the wireless industry now contributes, more to our nation's GDP, than the agriculture, hotels and lodging, air transportation, and motor vehicle manufacturing industries. In light of all the wireless industry brings to our economy, promoting growth in this sector can greatly advance the President's domestic policy goals.

Under Chairman Genachowski's leadership, the Commission has been adopting innovative policies to promote broader deployment and adoption of mobile broadband services. These include the data roaming order, the TV White Spaces proceeding, the interoperability in the lower 700 MHz band proceeding, mHealth initiatives, and the Learning On The Go pilot program. This proceeding to promote unlicensed services, in the 5 GHz band, is another prime example of how smart government policy can advance growth in the wireless industry and the overall economy.

When the FCC first allocated unlicensed spectrum, in the 1980s, it was primarily used for cordless phones, baby monitors, and garage door openers. Then Wi-Fi hit the scene and the demand has been off the charts. In 2005, "tens of millions" of Wi-Fi devices were sold globally. In 2011, at least 150 million of those devices were sold only in the U.S. Unlicensed Wi-Fi offload is now an integral part of the way mobile carriers deliver their services. In 2011, Consumer Federation of America found that Wi-Fi offload allows wireless carriers to save more than $25 billion per year, in deployment costs. According to some commenters, the annual contribution of the unlicensed wireless sector to our Nation's economy is estimated to be more than $50 billion per year.

The Nation's demand for unlicensed services has increased so dramatically that we need more spectrum to support these services. The 2.4 GHz band, while critical to the success of Wi-Fi and other unlicensed technologies, is increasingly congested particularly in major cities. Densely populated centers are the most expensive geographic areas to deploy licensed networks.

Therefore, I commend the staff, for recommending rule proposals that could make up to an additional 195 megahertz of spectrum, available for unlicensed services. I hope commenters will provide us with thoughtful detailed recommendations on how we can adopt technical rules that will create incentives for the industry to make the most efficient use of this spectrum. As the item points out, there are a number of technical issues to be resolved and we will have to coordinate with NTIA on the impact of these proposed rules on federal users in the 5 GHz band. But it is important that we get started on resolving these issues right away. The sooner we solve these issues, the sooner American innovation can show leadership in developing this band for unlicensed services.

Special thanks are due to Julie Knapp, Mark Settle, Aole Wilkins, and the other talented members, of OET, the Enforcement, International, and Wireless Bureau, for presenting us with an excellent NPRM.

STATEMENT OF
COMMISSIONER JESSICA ROSENWORCEL

Re: *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.*

Look around. The wireless devices we pull to our ears, place in our pockets, tap on our laps, read with at night, and hover over our desks at day—they are multiplying. We own more of them, do more with them, and power more aspects of our lives with them than ever before. We are a nation whose every day depends on wireless connectivity. It is an essential part of our economic and civic life.

So it is no surprise that the demand for our airwaves is growing at a fast clip. But it is important to remember that the speed with which we face demand for our spectrum is not confined to licensed wireless services. Congestion in our unlicensed spectrum bands is fast approaching a breaking point, too.

Why does this coming crush in unlicensed spectrum matter?

For starters, the unlicensed economy represents economic growth. Today, unlicensed wireless devices contribute between $16-37 billion to our economy annually. To put that in perspective, that is more than Americans spend on milk and bread each year, combined.

The unlicensed economy also represents innovation. Countless innovations that have made our lives easier and more convenient every day are dependent on unlicensed spectrum. If you have ever called on a cordless phone, changed the channel with a television remote, or pushed the button on a garage door opener, you have benefited from the power of unlicensed technology.

The unlicensed economy also represents a critical pathway for Internet connectivity. Today, more than one third of wireless data connections are offloaded onto unlicensed spectrum. Most of that traffic uses the 2.4 GHz band, which is also the home of countless other devices, like cordless phones, microwave ovens, and Bluetooth. Although the 2.4 GHz band continues to serve us well, it is becoming mighty crowded.

So it is no wonder that the search is on to find more spectrum for unlicensed services. It is a search that this Commission needs to support, consistent with the law. Because good spectrum policy requires both licensed and unlicensed services—across multiple spectrum bands.

The proposals we make in this rulemaking regarding the 5 GHz band are good first steps. These are ideas that can mean new near-term opportunities for unlicensed and long-term possibilities for expanding unlicensed down the road.

Let us start with what we can do today. This rulemaking explores how to synchronize the varying technical restrictions in place throughout the 5 GHz bands, while still respecting existing government and commercial users. In practice, this means working to expand to more 5 GHz frequencies the kind of flexible rules that have been the script for an unlicensed success story in the 5.725-5.825 GHz band. As a result of these flexible rules, cable operators right now use this band to offer Wi-Fi services at hotspots in their franchise areas, allowing consumers to take their broadband with them when they leave the house. This means consumers can save money and reduce congestion on licensed wireless networks. So we should explore whether or not restrictions impeding the expansion of unlicensed in other 5 GHz bands are still necessary. At the same time, this investigation can include asking whether parts of the 5 GHz band are appropriate for other federal services. But once those questions are answered, we should not hesitate to remove limitations that are no longer needed.

Fast forward from what we can do now to what we may be able to do down the road. Consistent with the direction from Congress in the Middle Class Tax Relief and Job Creation Act, we are proposing to make an additional 195 megahertz in the 5 GHz band available for unlicensed use. These airwaves can be a colossal catalyst for new innovation, because it features enough continuous spectrum to unlock the full potential of a new Wi-Fi standard, 802.11ac. Undoubtedly, cool new ways of connecting await.

But as enticing as it is to be swept away by that future promise, we must deal with present realities. These 195 megahertz are occupied by federal users. The National Telecommunications and Information Administration reports that additional testing of this spectrum will take at least until the end of 2014. Plus, the types of uses that have been proposed in this spectrum will require resources like new databases, dynamic frequency selection, and transmit power control. In short, finding ways to share this 195 megahertz of spectrum without interfering with critical government missions may take a long time.

So I think it is necessary to start identifying ways to accelerate this process by incentivizing federal authorities to be more efficient with spectrum right now. To do this, we must look for ways that federal users can realize value from using spectrum efficiently instead of only seeing loss from its commercial reallocation. These incentives need not be purely financial. And the rewards do not have to come directly from the spectrum rights being released. Instead, the incentives can come from benefits in appropriations, budgeting, or through structured use of synthetic currency, as proposed by the President's Council of Advisors on Science and Technology.

When it comes to transitioning spectrum from strictly federal to new or shared commercial use, we need not only use sticks—we should explore carrots. I think the latter is bound to facilitate more opportunity in the 5 GHz spectrum—and beyond. Given the multiplying number of wireless devices in our lives and the growing demands on our airwaves—licensed and unlicensed—now is not a moment too soon.

Thank you to the Office of Engineering and Technology for your hard work on this rulemaking and great dedication to these issues.

STATEMENT OF
COMMISSIONER AJIT PAI

Re: *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.*

Flexible unlicensed spectrum use was one of this country's great innovations in the 1980s. The Commission expanded several so-called "junk" bands to permit additional unlicensed uses and streamlined the Part 15 rules accordingly. Unlicensed spectrum in the 2.4 GHz and 5 GHz bands is now some of the most valuable spectrum in the world for broadband. And consumers are the ultimate beneficiaries of unlicensed-use technologies such as Wi-Fi and Bluetooth. Millions of Americans rely on Wi-Fi every day to connect their laptops, their smartphones, and their tablets to the Internet. And in the words of *The Big Bang Theory*'s Sheldon Cooper: "Everything is better with Bluetooth."

What excites me about today's Notice of Proposed Rulemaking is that we are building on these past successes and using spectrum ideally suited for unlicensed use. The short-range propagation characteristics of 5 GHz spectrum enable localized reuse with minimal risk of interference. The next-generation Wi-Fi standard, IEEE 802.11ac, will be finalized soon. Manufacturers are already building devices to work on 5 GHz spectrum. And enhancing the contiguity and size of the 5 GHz blocks contemplated in the item should allow wider channels for higher bandwidth transmissions. For example, a 160 MHz-wide channel could deliver 1 gigabit of data per second. *That's* "Super Wi-Fi."

I am most pleased that today we are teeing up the expansion of unlicensed use by a full 195 MHz in the 5 GHz band. I have called on the Commission to do so since October.[20] We were not obligated to go this far—the Spectrum Act only required that we commence a proceeding on opening up 120 MHz[21]—but taking this step just makes sense. More spectrum will allow higher-speed, higher-capacity connections and will mean less congestion in apartment buildings and coffee shops, libraries and offices. For all these reasons, putting these bands to better commercial use could have tremendous benefits.

Achieving this vision will not be without its challenges. The statute lets us expand unlicensed use into the 5350–5470 MHz band only if we determine that "licensed users will be protected by technical solutions, including use of existing, modified, or new spectrum-sharing technologies and solutions." We also must find that "the primary mission of Federal spectrum users . . . will not be compromised by the introduction of unlicensed devices."[22] To help us in these tasks, the National Telecommunications and Information Administration (NTIA) has reported on the potential impacts to federal government users from expanding unlicensed use.[23] And I appreciate their work. But Congress gave the FCC the ultimate responsibility, so I look forward to reviewing comments with an open mind. Given the wide swaths of spectrum already allocated to the federal government, I hope that we will consider whether Federal users *should* alter their systems or operations to accommodate unlicensed devices in this spectrum[24] and what solutions will work, keeping in mind the costs and benefits of all potential options.

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[20] Remarks of Commissioner Ajit Pai at CTIA's MobileCon (Oct. 10, 2012), http://go.usa.gov/4tkA; *see also* Statement of Ajit Pai, Commissioner, Federal Communications Commission, Hearing before the Subcommittee on Communications and Technology of the U.S. House of Representatives Committee on Energy and Commerce (Dec. 12, 2012), http://go.usa.gov/4t8Q.

[21] Middle Class Tax Relief and Job Creation Act of 2012, § 6406(a)(1).

[22] *Id*. § 6406(a)(2).

[23] NTIA, 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 (Jan. 2013), *available at* http://go.usa.gov/4tZH.

[24] *See id.* at ii ("NTIA assumed that the federal agencies will not alter their systems or operations to accommodate U-NII devices on a shared basis in the potential 5 GHz expansion bands.").

Today's Notice is just the beginning of what will surely be a highly technical process. Suffice it to say that the Commission could not do it without the support of the Office of Engineering Technology, especially Julius Knapp, Bruce Romano, Aole Wilkins, Geraldine Matise, Mark Settle, Karen Ansari, and Navid Golshahi. Thank you for your work on this item and for all the work you do each day to advance the FCC's mission.