Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

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

To: The Commission

REPLY COMMENTS OF SES S.A. AND INTELSAT S.A.

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SES S.A. ("SES") and Intelsat S.A. ("Intelsat") hereby reply to the comments of other parties in response to the Commission's Public Notice in the above-captioned proceeding.[1] SES and Intelsat urge the Commission to reject the proposal in the Notice to permit Unlicensed National Information Infrastructure ("U-NII") devices to operate in the 5.85-5.925 GHz band ("5.9 GHz band").

I. INTRODUCTION AND SUMMARY

The joint SES/Intelsat comments express the satellite companies' grave concerns regarding the disruption to critical satellite services in the extended and conventional C-band spectrum[2] that would result from introduction of ubiquitously-deployed U-NII terminals.[3] The record provides no evidence that would allay those concerns. Instead, although there is broad

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[1] *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, ET Docket No. 13-49, FCC 13-22 (rel. Feb. 20, 2013) ("Notice").

[2] The conventional C-band refers to downlink (space-to-Earth) spectrum at 3700-4200 MHz and uplink (Earth-to-space) spectrum at 5925-6425 MHz. The adjacent frequencies, including the 3600-3700 MHz downlink (space-to-Earth) spectrum and 5850-5925 MHz uplink (Earth-to-space) spectrum, are referred to as the extended C-band. *See id.* at ¶ 90.

[3] Comments of SES S.A. and Intelsat S.A., ET Docket No. 13-49, filed May 28, 2013 ("SES/Intelsat Comments").

recognition among the commenters that unlicensed devices cannot be permitted to interfere with existing or future licensed operations, no party provides any analysis to demonstrate that U-NII devices can feasibly co-exist with important licensed services in the 5.9 GHz band. In addition to primary fixed-satellite service ("FSS") uplinks, these licensed services include Dedicated Short Range Communications Service ("DSRC") systems that are being developed and tested as part of the Intelligent Transportation Service ("ITS") and that promise substantial benefits in improving travel safety.

To determine the impact on FSS operations, aggregate interference from all U-NII devices within the satellite's coverage – an area tens of millions of square miles[4] – must be considered. A technical study commissioned by SES and Intelsat shows that given this cumulative effect, only a few thousand U-NII devices operating in the 5.9 GHz band would cause excessive interference into primary satellite operations.[5] DSRC interests express similar concerns regarding the aggregate impact of multiple U-NII devices on the integrity of DSRC signals that will be relied on for safety-of-life services. Yet proponents of allowing U-NII operations in the 5.9 GHz band contemplate the ability to operate devices whose numbers are expected to reach into the billions by the end of next year.[6] Deployments in such large numbers would disrupt primary satellite operations.

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[4] *See id.* at 6 & n.16.

[5] *See* attached Technical Annex, Analysis of Uplink Interference from Proposed U-NII Devices in the 5.9 GHz Band into the Fixed-Satellite Service ("Technical Annex"), Table A.3-1.

[6] *See* Wi-Fi Alliance, "Wi-Fi CERTIFIED™ ac takes Wi-Fi® performance to new heights," available at: http://www.wi-fi.org/media/press-releases/wi-fi-certified%E2%84%A2-ac-takes-wi-fi%C2%AE-performance-new-heights (citing research estimates that "shipments of dual-band Wi-Fi chipsets – including both Wi-Fi CERTIFIED n and Wi-Fi CERTIFIED ac - will exceed 1.5 billion by the end of 2014").

No practical methodology has been proposed for mitigating harmful interference from ubiquitously-deployed U-NII devices in the 5.9 GHz band into licensed operations. U-NII proponents oppose applying to the 5.9 GHz band the power limits and indoor-only limitation that the Commission employed to protect Mobile-Satellite Service ("MSS") feeder links in the 5.15-5.25 GHz U-NII-1 band. Furthermore, questions have been raised regarding the Commission's ability to enforce such restrictions on consumer devices. Other interference mitigation methods discussed in the record are unsuited to protecting satellite receivers located 22,236 miles above the earth. Developers of DSRC technology also express doubts that the mitigation measures proposed would allow U-NII devices to co-exist with robust DSRC operations. These concerns are heightened by the history of interference that federal weather radar systems have experienced from U-NII devices in other parts of the 5 GHz band.

Because the 5.9 GHz band is immediately adjacent to the intensively-used conventional C-band, the Commission must also consider possible adverse effects from out-of-band emissions into C-band FSS networks. The record shows that DSRC networks could be adversely affected by interference from U-NII operations in adjacent bands as well. Again, the Commission's experience in existing U-NII bands, where unauthorized modification of U-NII devices has led to both in-band and out-of-band emission limits being exceeded, is instructive here and demonstrates that these are not merely theoretical concerns.

In short, neither the Notice nor the record provides any evidence that U-NII devices can operate in the 5.9 GHz band without causing harmful interference to important licensed services, including primary FSS uplinks and future DSRC networks. As a result, any consideration of allowing U-NII operations in this band is clearly unjustified and premature. Instead, the Commission must abandon the proposal unless and until further study establishes a

basis for determining that U-NII operations are compatible with allocated uses of the 5.9 GHz band.

II. THE COMMENTS RECOGNIZE THE NEED TO PROTECT LICENSED SERVICES FROM INTERFERENCE

The SES/Intelsat Comments highlight the critical nature of C-band satellite services and the Commission's obligation to ensure such services are not subject to harmful interference.[7] Satellite operators use both the 5.9 GHz extended C-band and the adjacent conventional C-band to provide essential services to a broad range of customers. The Commission cannot allow unlicensed devices to disrupt these critical offerings.

Between them, SES and Intelsat alone operate a dozen satellites authorized to serve the U.S. in the 5.9 GHz band.[8] Existing Commission regulations limit FSS use of this band to international inter-continental systems.[9] As a result, the satellite beams that utilize these frequencies tend to be wide-area beams that span entire hemispheres or regions.[10] Some even span multiple continents, as in the case of Intelsat 805 and NSS-806. The 5.9 GHz band is used

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[7] SES/Intelsat Comments at 3-5.

[8] *See* Technical Annex, Table A.2-1.

[9] *See* Notice at ¶ 90, *citing* 47 C.F.R. § 2.106 Table of Allocations, footnote US245, and 47 C.F.R. § 2.108.

IEEE 802 appears to misunderstand this limitation and assume it means that the 5.9 GHz band cannot be used for FSS within the U.S. *See* Reply Comments of IEEE 802, ET Docket No. 13-49, filed July 23, 2013 ("IEEE 802 Reply Comments") at 22. Contrary to IEEE 802's suggestion, FSS *is* one of the "licensed uses of the [5.9 GHz] band inside the United States" (*see id.*). The rule simply means that U.S. earth stations in this band are used to originate transmissions that are received in other countries.

[10] If past Wi-Fi deployments are any guide, the proposed introduction of unlicensed Wi-Fi devices in the 5.9 GHz band is unlikely to be limited to the United States. This implies that satellite operators operating in the 5.9 GHz will have to contend eventually with aggregate interference from unlicensed 5.9 GHz devices throughout the large geographic footprints of their satellite beams.

extensively for a wide range of international offerings for commercial and government customers.[11]

The conventional C-band, which is not subject to the same restrictions applicable to extended C-band spectrum, is even more extensively used.[12] As the SES/Intelsat Comments explain, C-band capacity is used to distribute programming to cable systems and Direct Broadcast Satellite ("DBS") networks that together serve more than 90 million households.[13] In addition, conventional C-band satellite systems provide services to remote areas where terrestrial infrastructure is limited, supply communications to ships at sea, and are used for important government networks.[14]

The 5.9 GHz band has also been allocated for DSRC/ITS operations. As the Commission explains, "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."[15] Following allocation of the 5.9 GHz band for DSRC, the satellite industry worked closely with proponents of DSRC technology over a number of years to develop a framework to ensure that FSS and DSRC could

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[11] SES/Intelsat Comments at 4 (extended C-band capacity is used to provide "IP trunking to expand retail Internet services in developing nations and other underserved regions, international video distribution for U.S. programmers, government communications, and international private lines").

[12] *See* Notice at ¶ 90 (characterizing the conventional C-band as "heavily used").

[13] SES/Intelsat Comments at 4 (noting that the C-band is used to supply cable headends that serve more than 56 million U.S. households as well as to DBS providers DIRECTV and Dish, which serve more than 34 million additional households).

[14] *See id.* at 4-5.

[15] Notice at ¶ 92.

operate compatibly.[16] This cooperative effort culminated in the joint submission by the Satellite Industry Association ("SIA"), the Intelligent Transportation Society of America ("ITS America") and the American Association of State Highway and Transportation Officials ("AASHTO") of a proposed DSRC/FSS Earth Station Spectrum Sharing Protocol.[17] In addition to FSS and DSRC, other services in the 5.9 GHz band include federal radar systems and amateur radio.[18]

New unlicensed operations in the 5.9 GHz band cannot be permitted unless *all* these services can be effectively protected. As the Notice makes clear:

> 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.[19]

Commenters agree that the Commission cannot pursue expansion of U-NII operations into new bands unless there is clear evidence that licensed services will not be harmed or constrained. Parties involved in the development and deployment of DSRC technology emphasize the Commission's duty to protect primary DSRC systems from harmful interference to preserve the safety objectives of that service. For example, the Alliance of Automobile

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[16] *See, e.g., 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 the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Service,* Report and Order, FCC 03-324, 19 FCC Rcd 2458, 2494 (2004) (Commission commends "the efforts of ITS America and members of the satellite industry to resolve" issues relating to development of a sharing protocol for the 5.9 GHz band).

[17] *See* Letter of Carlos M. Nalda to Marlene H. Dortch, Secretary, FCC, WT Docket No. 01-90 and EB Docket No. 98-95, filed Feb. 18, 2008 (transmitting proposed sharing agreement on behalf of SIA, ITS America and AASHTO).

[18] *See* Notice at ¶¶ 89 & 94. Industrial, Scientific, and Medical (ISM) equipment may also emit in this band. *See* 47 C.F.R. § 2.106 and Part 18.

[19] Notice at ¶ 3, *citing* 47 C.F.R. §§ 15.5(b) and (c).

Manufacturers, Inc. and Association of Global Automakers, Inc. ("Alliance/Global") contends that "[c]onsistent with its legal mandate, the Commission should not allow U-NII operations in the 5.9 GHz band unless it is absolutely certain that such use will comport with its Part 15 rules."[20] SAE International concurs, stating that:

> the burden of resolving any potential interference issues resulting from use of this critical [5.9 GHz] spectrum by other devices is not optional and must lie with the secondary users of the band. . . . Therefore, whatever technical solution is implemented must absolutely guarantee the primary, incumbent safety use of the spectrum in all circumstances. That is, within the full operational range and use cases of DSRC for safety, U-NII-4 sources should not be seen by DSRC primary devices above the noise levels present in the current spectrum allocation.[21]

Similarly, the German Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway emphasizes "the importance of the protection of all incumbent radio services" in 5 GHz spectrum and observes that designating the spectrum for unlicensed devices "would have to be based on enforceable measures which are derived from compatibility and sharing studies."[22]

Proponents of allowing U-NII devices to operate in additional 5 GHz spectrum concur. Comcast states that it "agrees with the Commission that unlicensed devices should

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[20] Comments of the Alliance of Automobile Manufacturers, Inc. and Association of Global Automakers, Inc., ET Docket No. 13-49, filed May 28, 2013 ("Alliance/Global Comments") at 8.

[21] Comments of the SAE International, ET Docket No. 13-49, filed May 28, 2013 ("SAE International Comments") at 3.

[22] Comments of the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway, ET Docket No. 13-49, filed May 28, 2013 ("BNetzA Comments") at 3. *See also* Comments of the Safe America Foundation, ET Docket No. 13-49, filed June 23, 2013, at 1 (arguing that "DSRC must operate so that there will be virtually no interference with current and future vehicle communications technology" and that new users of the spectrum can be permitted only if they show that they can share the band without creating harmful interference).

operate on a non-interference basis relative to incumbent licensees in these bands, as is the case in each of the 5 GHz U-NII bands already open for unlicensed technologies."[23] Cisco supports exploring use of the 5.9 GHz band for U-NII, but argues that it is "imperative that the introduction of U-NII devices" into this spectrum does "not result in unwarranted interference to incumbents."[24] The Consumer Electronics Association similarly insists that "[a]ny changes to the FCC's rules adopted in this proceeding must continue to protect important federal and licensed incumbent operations from interference."[25]

No parties dispute the need to ensure protection of licensed services. Thus, the record reflects agreement that the key factor in evaluating whether additional spectrum can be allocated for U-NII devices is a determination of whether such devices are compatible with licensed services in the band.[26]

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[23] Comments of Comcast Corporation, ET Docket No. 13-49, filed May 28, 2013 ("Comcast Comments") at 20.

[24] Comments of Cisco Systems, Inc., ET Docket No. 13-49, filed May 28, 2013 ("Cisco Comments") at 58. *See also id.* at 62 ("the Commission can and should take care in this proceeding not to undermine the general directive of Section 15.5(b) of the Rules that unlicensed devices (including U-NII devices) may not cause harmful interference to authorized operations (including DSRC).")

[25] Comments of the Consumer Electronics Association, ET Docket No. 13-49, filed May 28, 2013 ("CEA Comments") at 11. *See also* Comments of Motorola Solutions, Inc., ET Docket No. 13-49, filed May 28, 2013 ("MSI Comments") at 8 ("MSI supports the Commission's proposals to open new 5 GHz band spectrum to unlicensed use; however, in doing so the Commission must also take care to provide adequate interference protection to incumbent services operating in these bands."); Comments of the Telecommunications Industry Association, ET Docket No. 13-49, filed May 28, 2013 ("TIA Comments") at 7-8 ("Consistent with the Commission's obligations under the Spectrum Act and its general mandate to advance the public interest, the Commission should provide appropriate levels of interference protection to federal and other incumbents in the 5 GHz band").

[26] In examining whether U-NII devices are compatible with licensed services in the 5.9 GHz band, the Commission should consider not just the risk of interference to licensed services but also the possibility of interference to U-NII operations from licensed systems. For example, transmit earth stations in the 5.9 GHz band and adjacent conventional C-band operate at high power levels in order to ensure the signal reaches the GSO satellite. As a result, FSS

III. CUMULATIVE INTERFERENCE FROM SMALL NUMBERS OF U-NII DEVICES WOULD HARM LICENSED 5.9 GHZ OPERATIONS

Despite acknowledging the need to protect licensed services, the comments present no actual evidence of compatibility between U-NII and the services authorized to use the 5.9 GHz band. Parties that favor allowing U-NII operations in the 5.9 GHz band claim that such operations would not cause interference to incumbents using the spectrum,[27] but do not provide any technical basis for that claim, especially with respect to satellite systems.

A critical element in assessing the risk to satellite uplinks is the need to consider the aggregate impact of millions of U-NII devices. A satellite receiver on a spacecraft in geostationary orbit ("GSO") will "see" interference from U-NII terminals located anywhere with the large portion of the earth's surface that is within view.[28] The Commission expressly recognized the need to address aggregate interference in deciding earlier this year to reject a

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transmissions could make it impossible to use the 5.9 GHz band for U-NII devices in the vicinity of a C-band transmit earth station. Under Commission rules, the U-NII device user would be obligated to accept such interference. The Commission should consider whether such interference to U-NII devices would render the 5.9 GHz band unsuitable for the types of services contemplated by U-NII proponents.

[27] *See, e.g.*, Comcast Comments at 3 ("Unlicensed devices would continue to operate on a non-interfering basis, and incumbents such as government users, intelligent transportation service licensees, and satellite licensees would continue to be able to operate in this spectrum. As is the case today, unlicensed devices would share the 5 GHz band subject to the Part 15 rules, and would not displace current operations.").

[28] SES/Intelsat Comments at 6 & n.16 (noting that the footprint of a GSO spacecraft with a global beam can encompass a quarter of the Earth's surface, an area of more than 49 million square miles).

Similarly, in discussing the interference environment affecting Mobile-Satellite Service ("MSS") operations in the U-NII-1 band, Cisco acknowledges that the ITU has recognized that "susceptibility of MSS satellites to interference will depend, in part, on the height above Earth of the orbit, which in turn impacts the extent of the Earth's surface that is within view." Cisco Comments at 56 n.145. Because their orbit is higher, GSO spacecraft have larger coverage areas than those of MSS satellites and can receive interference from devices throughout these larger footprints.

proposal for a new terrestrial service in Ku-band FSS uplink spectrum.[29] Yet as the initial SES/Intelsat Comments observe, the Notice here inexplicably fails to consider the aggregate impact of potentially hundreds of millions of U-NII devices[30] on 5.9 GHz satellite uplinks. The Part 15 U-NII rules do not impose any numerical limit on the number of U-NII devices that can be deployed, nor are any limits being contemplated or proposed by the proponents of the use of the 5.9 GHz band for U-NII devices.

The comments highlight the critical need to address aggregate interference in determining whether U-NII operations are consistent with other licensed 5.9 GHz services as well. AASHTO, for example, emphasizes that the "impact of interference to DSRC receivers is additive when more than one interfering signal is present."[31] Similarly, Alliance/Global states that even if "U-NII devices were running at very low power or operating at significant distance from the vehicles using DSRC, the aggregation of many such U-NII devices would raise the noise floor within the DSRC band, potentially causing harmful interference."[32] Similarly, ARRL, the national association for Amateur Radio, indicates that even though there is significant compatibility between amateur radio services and U-NII devices, "ARRL remains concerned

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[29] SES/Intelsat Comments at 7, *citing Utilities Telecom Council and Winchester Cator, LLC Petition for Rulemaking to Establish Rules Governing Critical Infrastructure Industry Fixed Service Operations in the 14.0-14.5 GHz Band,* Order, DA 13-1093 (OET, WTB and IB rel. May 15, 2013).

[30] Commissioner McDowell's statement in support of the Notice cited estimates that "775 million wirelessly-connected devices will be used by Americans in 2017." *See* Notice at 53, Statement of Commissioner Robert M. McDowell (footnote omitted). In addition, the Wi-Fi Alliance has cited studies projecting that 1.5 billion chipsets utilizing both 802.11n and 802.11ac protocols will ship by the end of 2014. *See supra* n.6.

[31] Comments of the American Association of State Highway and Transportation Officials, ET Docket No. 13-49, filed May 28, 2013 ("AASHTO Comments") at 8.

[32] Alliance/Global Comments at 30.

about the aggregate interference potential of these devices going forward, given the Commission's current predictions of expanded U-NII operation."[33]

Thus, evaluating whether U-NII devices can be introduced in the 5.9 GHz band without harming licensed services requires an examination of aggregate interference from U-NII operations. With respect to 5.9 GHz FSS uplinks, this requires consideration of the cumulative interference levels of all devices within a satellite's footprint. SES and Intelsat have commissioned an analysis of this cumulative effect, and it demonstrates that even small numbers of simultaneously-operating U-NII devices would result in unacceptable aggregate interference to FSS receivers.[34] Specifically, the calculations demonstrate that, even if the widest bandwidth for U-NII operations is used, only 5,200 U-NII devices would by themselves create a 1% rise in the satellite receive system interference noise temperature – an increase that would consume the entire allowance under the ITU regulations for all non-primary services in the spectrum band.[35] Because there are other non-primary operations in the band, however, U-NII devices should be allocated only a fraction of that allowance.[36] Applying such a reduction shrinks the number of U-NII devices that could operate without exceeding the threshold still further – to 2,600 if U-NII is allotted half of the 1% allowance or to 1,720 if a more reasonable allocation of one-third of the 1% allowance is used.[37]

The results of these calculations stand in stark contrast to U-NII proponents' desire to deploy hundreds of millions or even billions of devices capable of operating in the

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[33] Comments of ARRL, the National Association for Amateur Radio, ET Docket No. 13-49, filed May 28, 2013 ("ARRL Comments") at 6.

[34] *See* Technical Annex.

[35] *See id.* at Section 1.3 and Table A.3-1.

[36] *See id.* at Section 1.3.

[37] *See id.*

5.9 GHz band. As noted above, Commissioner McDowell referred to estimates that "775 million wirelessly-connected devices will be used by Americans in 2017,"[38] and the Wi-Fi Alliance has predicted that more than 1.5 billion dual-band U-NII chipsets utilizing 802.11n and 802.11ac protocols will ship by the end of next year.[39]

Clearly there is a disconnect between the U-NII industry's desire to ubiquitously deploy equipment capable of operating in the 5.9 GHz band and the reality that a relative handful of such devices would impermissibly interfere with licensed satellite operations. Furthermore, no way to resolve that disconnect is evident. Even if the Commission were able to devise and enforce limits on the number of simultaneously-operating U-NII devices in the 5.9 GHz band, those restrictions would render the band useless for the purposes identified by U-NII proponents. In short, given the Commission's obligation to protect FSS uplinks and other licensed 5.9 GHz systems from cumulative harmful interference, U-NII operations cannot realistically be permitted in the band.

IV. NO FEASIBLE METHOD OF MITIGATING INTERFERENCE TO LICENSED 5.9 GHZ OPERATIONS HAS BEEN PROPOSED

The comments discuss a number of possible approaches to reduce the threat of interference from U-NII devices, but there is no analysis showing that the methods would be effective in preventing interference from U-NII devices into satellite receivers. Furthermore, the comments of Wi-Fi proponents make clear that implementation of many of the methods suggested would be inconsistent with the contemplated usage of U-NII spectrum.

Cambium Networks summarizes the situation as follows:

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[38] *See supra* n.30; *see also* Cisco Comments at 12 & n.31 (the "number of mobile devices in the United States is expected to skyrocket from 424 million in 2012 to 775 million in 2017").

[39] *See supra* n.6.

> it appears to us that a very great amount of work remains to be done to demonstrate that . . . spectrum sharing techniques will provide effective and robust protection for licensed users and a practical framework within which operators can deploy unlicensed devices. . . . At this early stage, it is somewhat difficult to be confident that acceptable co-existence solutions will be identified.[40]

SES and Intelsat agree that no technique has been identified that will ensure effective protection of 5.9 GHz band licensed services while allowing use of the spectrum for ubiquitously-deployed U-NII devices.

In a prior proceeding, the Commission considered how to prevent U-NII devices from interfering with satellite service uplinks. Specifically, in order to protect MSS feeder links in the U-NII-1 band, the Commission restricted U-NII operations to indoor locations and imposed power limits more stringent than in other U-NII bands.[41] These constraints had the effect of decreasing the total signal power from co-channel U-NII devices received at the MSS spacecraft.

Applying similar restrictions to mitigate interference to FSS operations in the 5.9 GHz band, however, does not appear to be practical. Commenting parties who seek access to 5.9 GHz spectrum for U-NII devices emphasize their desire to use the spectrum to expand outdoor WiFi services and therefore oppose making the band subject to either an indoor-only restriction or strict power limits. For example, Cablevision argues that the indoor-only restrictions that currently apply to the U-NII-1 band "are unnecessary and impede one of the

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[40] Comments of Cambium Networks Ltd., ET Docket No. 13-49, filed May 28, 2013 ("Cambium Comments") at 5.

[41] *See* Notice at ¶ 36 (the "Commission adopted technical rules for U-NII devices in [the U-NII-1 band] to protect the nascent NGSO/MSS industry," limiting peak transmitter output power to 50 mW and restricting U-NII devices to indoor operation).

most effective and growing applications for WiFi – outdoor use."[42] Cablevision opposes extending those restrictions to the 5.9 GHz band.[43] Moreover, Cablevision advocates applying a 1W power level to the 5.9 GHz band, claiming it is "needed to support reliable outdoor links."[44] Comcast agrees, stating that it currently uses only the U-NII-3 channels in its Xfinity WiFi deployments because restrictions such as those in the U-NII-1 band make using that spectrum "impossible, impractical, or uneconomical."[45] Like Cablevision, Comcast supports removing the indoor-only restrictions on U-NII devices throughout the 5 GHz band and argues that the Commission should apply a 1W power level in the 5.9 GHz band,[46] and other parties express similar views.[47] Thus, imposing in the 5.9 GHz band the restrictions the Commission applied to protect uplinks to MSS spacecraft in the U-NII-1 band would appear to render the 5.9 GHz spectrum unworkable to meet the stated requirements of WiFi providers.

Moreover, even if the Commission were to adopt an indoor-only rule in the 5.9 GHz band, such a rule would not effectively address interference to FSS networks.

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[42] Comments of Cablevision Systems Corporation, ET Docket No. 13-49, filed May 28, 2013 ("Cablevision Comments") at 6.

[43] *See id.*

[44] *See id.* at 5.

[45] Comcast Comments at 2.

[46] *See id.* at 25, 27-28.

[47] *See* Comments of Google Inc. and Microsoft Corporation, ET Docket No. 13-49, filed May 28, 2013 ("Google/Microsoft Comments") at 5-6 (the Commission should authorize outdoor use and increase power levels across the U-NII bands, to the extent possible); Comments of the National Cable & Telecommunications Association, ET Docket No. 13-49, filed May 28, 2013 ("NCTA Comments") at 18 ("Applying the U-NII-3 rules, including a 1W maximum allowed power limit for indoor and outdoor operations, to U-NII-4 will make U-NII-4 equally attractive for unlicensed broadband operations."); Comments of Time Warner Cable, ET Docket No. 13-49, filed May 28, 2013 ("TWC Comments") at 10 (to expand outdoor Wi-Fi deployment capability, TWC encourages the Commission to adopt rules for the U-NII-1 and U-NII-4 bands that are comparable to those of the U-NII-3 band to make the bands equally functional for robust outdoor Wi-Fi networks).

Alliance/Global appropriately questions whether an indoor-only rule would be enforceable, claiming that the Commission "would not be able to exercise the necessary oversight to ensure that the rule was followed," because a "U-NII device user could simply walk outdoors," eliminating the protective effect of the rule.[48] Even if U-NII devices could be limited to indoor use, the number of U-NII devices that would trigger interference to FSS uplinks would be relatively low. If one assumes that building walls would attenuate the transmissions of a U-NII device by 20 dB (*i.e.*, a factor of 100), then the number of such devices operating simultaneously that would create an unacceptable increase in the noise temperature of the receiving satellite system would grow by a factor of 100 as well.[49] However, the resulting number of U-NII devices that could operate without negatively affecting a receiving GSO satellite would still be a small fraction of the deployment numbers predicted by U-NII proponents.

Other approaches that have been used or suggested to control interference in existing U-NII bands simply are not workable when applied to protecting FSS in the 5.9 GHz band. The SES/Intelsat comments explain that using a database incorporating geo-location information to ensure a minimum separation distance is not useful because managing aggregate interference, not ensuring minimum separation distances, is the central issue in preventing interference into FSS uplinks.[50] Similarly, using spectrum sensing and dynamic frequency

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[48] Alliance/Global Comments at 30. *See also* IEEE 802 Reply Comments at 18 ("personal portable devices cannot, as a practical matter, be restricted to indoor use").

[49] For example, using the widest proposed U-NII bandwidth, the number of U-NII devices that would create a 0.33% increase in satellite receiver noise temperature would increase from 1,720 to 172,000.

[50] SES/Intelsat Comments at 11.

selection ("DFS") is not a workable approach to protecting a receiver on a GSO satellite from the cumulative interference of multiple U-NII devices within the satellite's coverage area.[51]

Commenters who favor U-NII operations in the 5.9 GHz band also question whether the approaches discussed to mitigate interference would be feasible and cost-effective. Ericsson, for example, expresses doubts about spectrum sensing and dynamic frequency selection, noting that "[r]eliable detection at low signal levels is difficult to guarantee and false detection causes undue link stability problems for U-NII equipment."[52] Motorola Solutions cautions that enhanced spectrum sensing and other new techniques intended to mitigate interference "would add cost and complexity to 5 GHz U-NII devices."[53] Cambium observes that relying on geo-location "might be problematic where incumbent systems are nomadic or mobile, where there are security-related objections to revealing the location of the incumbent operator, or where the unlicensed terminal cannot access the public Internet."[54] Cisco notes that even if geo-location capability was incorporated in U-NII devices, "there is no means to track which U-NII device belongs to who."[55] Cisco concludes that "to require U-NII devices to transmit identifying information and geolocation data that might be meaningful for tracking interference would require that the very nature of U-NII operations in the 5 GHz band be materially changed at substantial cost."[56]

U-NII proponents also generally oppose applying dynamic frequency selection requirements to the 5.9 GHz band. Cablevision, for example, argues that:

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[51] *See id.* at 11-12.

[52] Comments of Ericsson, ET Docket No. 13-49, filed May 28, 2013 ("Ericsson Comments") at 3.

[53] MSI Comments at 10.

[54] Cambium Comments at 6.

[55] Cisco Comments at 40.

[56] *Id.*

> DFS causes a host of problems that make it incompatible with WiFi. Most significantly, the need to scan for signals, move channels if a protected user is detected, and then rescan greatly increases the time necessary to secure a link – resulting in either a negative user experience or no experience at all, because the consumer believes the delay is due to the network not being available.[57]

Parties that express confidence that the potential for interference to satellite receivers in the 5.9 GHz band can be easily resolved rely on a misunderstanding of satellite network structure. For example, CEA states that "FSS systems operate in relatively few fixed, identified locations that can be registered in a database, marked with a beacon signal, or subject to other similar mitigation measures."[58] Similarly, TWC suggests that interference from U-NII operations in the 5.9 GHz band can be avoided "by coordinating with incumbent users and avoiding their operations."[59] As discussed above, however, the location of an FSS earth station on the ground is not relevant to the potential for interference to an FSS receiver on a geostationary satellite. As a result, avoiding U-NII operations in the vicinity of FSS uplink earth stations will not address the aggregate interference threat from very large numbers of U-NII devices into FSS satellites.

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[57] Cablevision Comments at 7. *See also* Comcast Comments at 26 ("DFS requirements increase equipment costs and delay commercialization timelines while undermining the Wi-Fi user experience."); NCTA Comments at 22 ("any bands where DFS is imposed" are rendered "unsuitable for the development of widespread consumer Wi-Fi networks like those built by cable companies"); TWC Comments at 13 ("TWC believes it is feasible to achieve interference protection without incurring the burdens that DFS requirements impose on Wi-Fi providers and end users").

[58] CEA Comments at 16. *See also* Google/Microsoft Comments at 10 (5.9 GHz FSS earth stations are "at known, stationary locations that could be protected using geolocation database technology"); Comments of the Wireless Internet Service Providers Association, ET Docket No. 13-49, filed May 28, 2013, at 8 (arguing that the Commission should establish "protection zones" around 5.9 GHz FSS uplink facilities "and adopt professional installation requirements so that unlicensed facilities are not constructed inside of the protection zones").

[59] TWC Comments at 12.

Similarly, no reliable method has been proposed for ensuring that U-NII devices in the 5.9 GHz band would not interfere with safety-critical DSRC systems being developed for use in the U.S. and around the globe. Qualcomm expressly acknowledges that "it is virtually impossible to completely eliminate interference from the wide deployment and use of Wi-Fi devices throughout the DSRC band, especially because Wi-Fi usage within vehicles via mobile hotspots and vehicle cellular connectivity is growing every day."[60] Qualcomm's suggested approach to this problem – the only concrete proposal on the record – is to segment the band between DSRC and U-NII.[61] This suggestion seems to concede that U-NII devices cannot co-exist with DSRC deployment in the 5.9 GHz band.

The history of disruptions to the Federal Aviation Administration ("FAA") Terminal Doppler Weather Radar ("TDWR") network discussed in the Notice[62] demonstrates the persistence of interference concerns and the difficulty in enforcing Commission-prescribed mechanisms for protecting authorized services in the band. As Baron Services observes, the Commission has been actively attempting to eliminate interference to TDWR for four years, but has not fully succeeded.[63] One reason for the difficulty is that interference resulting from multiple devices operating at relatively low powers is almost impossible to identify and correct.[64] The fact that measures the Commission adopted to prevent interference in other U-NII bands

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[60] Comments of QUALCOMM Incorporated, ET Docket No. 13-49, filed May 28, 2013 ("Qualcomm Comments") at 6.

[61] *Id.* at 8.

[62] Notice at ¶¶ 8-10 & 42-47.

[63] Comments of Baron Services, Inc., ET Docket No. 13-49, filed May 28, 2013 ("Baron Comments") at 5.

[64] *Id.* at 8.

have been circumvented[65] also raises significant concerns. Given the huge number of ubiquitously-deployed U-NII devices that will be in the hands of users, disruptive interference can occur even if only a very small percentage of those users make unauthorized changes to their devices' operation.

The Commission clearly cannot just proceed on the assumption that interference issues will be able to be resolved as they come up, especially when the problem is one of aggregate interference. Satellite operators have experience with interference due to proliferation of unlicensed devices that do not meet Commission standards, such as radar detectors.[66] Other commenters agree that "once consumer equipment is in the field, correcting interference problems after they arise is impossible."[67] The Commission simply cannot responsibly pursue possible introduction of U-NII devices in the 5.9 GHz band unless and until it identifies measures to mitigate interference from U-NII devices that are effective, enforceable, and consistent with the stated requirements of U-NII network proponents.

V. ADJACENT BAND CONCERNS MUST BE ADDRESSED

The SES/Intelsat Comments also raise concerns about the possibility of adjacent band interference from U-NII devices into conventional C-band services.[68] Because FSS capacity in the conventional C-band is extensively used for a wide range of services, including video distribution and contribution, government networks, and communications to ships at sea

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[65] *See* Notice at ¶ 9 (in many cases, "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").

[66] *See* SES/Intelsat Comments at 12 & n.35.

[67] AASHTO Comments at 10.

[68] SES/Intelsat Comments at 9-10.

and remote areas where terrestrial infrastructure is limited,[69] any disruption of conventional C-band uplinks would have serious and far-reaching repercussions.

These concerns are intensified by the history of U-NII interference into federal TDWR networks. The Commission has acknowledged that U-NII devices have been modified by users, resulting in exceedances of emission limits for both in-band and out-of-band operations.[70] Baron observes that even U-NII devices that comply with current Commission rules can cause both co-channel and adjacent channel interference to weather radar systems.[71]

The DSRC community also highlights the potential for adjacent band effects that could harm intelligent transportation services. For example, the Alliance of Automobile Manufacturers and Association of Global Automakers submit an analysis of the threat of adjacent channel and out-of-band interference into DSRC devices.[72] The Alliance/Global analysis concludes that:

> U-NII devices have the potential to cause harmful interference to DSRC transmissions due to unwanted out-of-band emissions. This harmful interference could come from a U-NII device located in the same vehicle as the DSRC receiver, or in an adjacent vehicle. Furthermore, in the scenarios without an intervening channel between the U-NII device and the DSRC transmission, the harmful interference could come from a U-NII device located in a building nearby the vehicle with the DSRC receiver.[73]

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[69] *Id*. at 4-5.

[70] Notice at ¶¶ 42 & 59.

[71] Baron Comments at 2.

[72] Alliance/Global Comments, Technical Appendix at 15-28. *See also* Comments of Ford Motor Company, ET Docket No. 13-49, filed May 28, 2013, at 3 ("U-NII use of the 5.9 GHz band could cause harmful co-channel, adjacent channel, and out-of-band interference to DSRC services in numerous ways.").

[73] Alliance/Global Comments, Technical Appendix at 27.

Qualcomm similarly recognizes that stringent restrictions on U-NII out-of-band emissions will be needed to protect DSRC operations.[74]

The Commission is obligated to fully explore adjacent band issues in order to ensure that critical licensed services are protected. The Commission cannot consider permitting U-NII devices in the 5.9 GHz band until it has both implemented and verified the efficacy of steps to prevent unauthorized emissions into the conventional C-band.

VI. THE 5.9 GHZ BAND SHOULD BE EXCLUDED FROM FURTHER CONSIDERATION IN THIS PROCEEDING

In short, there is no evidence that U-NII operations in the 5.9 GHz band can feasibly co-exist with licensed services in the band. As a result, the SES/Intelsat Comments argue that the Commission should exclude the 5.9 GHz band from any reallocation of 5 GHz spectrum for U-NII devices.[75]

Other parties agree that the record does not support proceeding with the proposed reallocation of the 5.9 GHz band. ARRL observes that:

> a decision in the near term with respect to the addition of U-NII devices to the 5.85-5.925 GHz band would be premature. The present allocation status of this band is quite complicated due to the presence of important Federal systems, safety-based DSRC applications, . . . fixed-satellite applications and fixed and mobile Amateur radio facilities. An additional overlay of unlicensed, high-use density mobile applications requires careful planning.[76]

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[74] Qualcomm Comments at 9-10.

[75] SES/Intelsat Comments at 12-13.

[76] ARRL Comments at 10.

ARRL argues that "a full and complete investigation" of the possibility for sharing must "be conducted in an open, transparent manner" prior to any further Commission deliberations relating to the 5.9 GHz band.[77]

The automotive industry and other proponents of DSRC similarly argue that further consideration of expanding U-NII into the 5.9 GHz band is highly premature given the lack of any testing to date. These commenters emphasize the need for extensive, real-world analysis and study to confirm that U-NII devices will not disrupt DSRC systems and thwart their ability to perform critical safety-of-life services.[78] The Alliance of Automobile Manufacturers and Association of Global Automakers cautions that the "Commission should not take premature action now regarding shared use of 5.9 GHz spectrum, as doing so would involve incomplete,

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[77] *Id*.

[78] *See, e.g.*, Comments of American Honda Motor Company, ET Docket No. 13-49, filed May 28, 2013, at 4 (the 5.9 GHz band "has already been reserved for public safety since 1999," and any "change in the current course must be based on thorough and detailed studies proving that no interference or loss of benefit will occur"); Comments of General Motors Company, ET Docket No. 13-49, filed May 24, 2013, at 3 (the Commission can "only consider 5.9 GHz spectrum sharing after non-interference with DSRC has been objectively demonstrated through proper testing, and after all relevant stakeholders have been afforded the opportunity to weigh in"); Comments of the Intelligent Transportation Society of America, ET Docket No. 13-49, filed May 28, 2013, at 40 (the Commission cannot act based on the record to date given the "complex issues raised and the critical development of DSRC for safety services"); Comments of Mercedes-Benz USA, LLC, ET Docket No. 13-49, filed May 28, 2013 ("Mercedes-Benz Comments") at 3 (showing that U-NII devices can co-exist with DSRC requires "rigorous bench and field tests"); Comments of OmniAir Consortium, ET Docket No. 13-49, filed May 28, 2013, at 2 (the Commission should not "act on this topic of sharing spectrum in the 5.9 GHz range until substantial testing has been completed that proves that additional non-licensed use of this space will not interfere with soon to be deployed live saving technologies"); Comments of Savari Networks, ET Docket No. 13-49, filed May 28, 2013, at 35 (the "proposal to share spectrum allocated for safety of life services with unlicensed devices faces a high burden of demonstrating that DSRC will not be compromised" and requires careful evaluation using a robust testing protocol); Comments of Volkswagen Group of America, Inc., ET Docket No. 13-49, filed May 28, 2013, at 3.

inconclusive data regarding the grave risks posed by 5.9 GHz U-NII use to life-saving DSRC technologies."[79]

Both the National Transportation Safety Board ("NTSB") and the Department of Transportation also emphasize that further study is needed. NTSB notes that the National Telecommunications and Information Administration ("NTIA") has identified risk factors that could affect DSRC and argues that additional analysis is required to determine how those risk factors might be mitigated.[80] The Department of Transportation agrees:

> in considering the extent to which new technologies or users will be permitted in the 5.9 GHz band, the FCC should ensure that this portion of the spectrum remains available on a co-primary basis for the purpose for which it was allocated in the Commission's 1999 decision, the Intelligent Transportation Systems radio service. . . . The NTIA has not completed its statutorily mandated study to evaluate spectrum sharing in the 5.9 GHz band. Consequently, it would appear untimely for the FCC to move forward prior to the conclusions of such an evaluation.[81]

Even parties who favor exploring use of the 5.9 GHz band for U-NII devices acknowledge that the groundwork for such action has not occurred.[82] Instead, these commenters urge the Commission to focus its short-term efforts on other proposals in the Notice that are less

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[79] Alliance/Global Comments at 33.

[80] Comments of the National Transportation Safety Board, ET Docket No. 13-49, filed May 28, 2013, at 4 (NTIA's analysis "should be conducted before safety-sensitive frequencies are opened up to UNII devices").

[81] Letter of John D. Porcari, Deputy Secretary of Transportation, to Lawrence E. Strickling, Assistant Secretary for Communications and Information, dated May 16, 2013, at 5, submitted by NTIA in ET Docket No. 13-49 with cover letter dated June 10, 2013.

[82] *See, e.g.,* Cisco Comments at 64 ("a substantial amount of technical exchange, analysis and testing will be necessary to determine the efficacy" of measures necessary to avoid interference to DSRC networks); Comments of IEEE 802, ET Docket No. 13-49, filed May 28, 2013, at 31 (recognizing that the technical parameters for U-NII devices to operate in a manner that would not cause harmful interference with DSRC devices must be developed).

controversial.[83] The Telecommunications Industry Association, for example, recognizes that designating new spectrum for U-NII devices "poses unique challenges given the wide range of incumbent services already in the band" and therefore the issues associated with the 5.9 GHz band will not be ripe for decision until well after other matters raised in the Notice.[84]

As the SES/Intelsat Comments and other parties observe, there is no reason for rushing ahead here.[85] The Commission is under no legislative obligation to take action with respect to the 5.9 GHz band.[86] Indeed, the Notice and proposed rules do not demonstrate adequate analysis of the interference issues in the 5.9 GHz band, nor does the record to date suggest that these interference concerns can be easily resolved.

In short, the record supports removing the 5.9 GHz band from further consideration in this proceeding.[87] If in the future a more concrete proposal for co-existence of U-NII with 5.9 GHz licensees is developed, the Commission must seek public comment on that

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[83] *See, e.g.*, Ericsson Comments at 4 (suggesting that the Commission can make determinations regarding existing U-NII bands in the near term); Comments of the Wi-Fi Alliance, ET Docket No. 13-49, filed May 28, 2013, at 7-8 (urging the Commission to act quickly on matters as they can be resolved but acknowledging that the 5.9 GHz band "presents new and novel questions and requires additional study with regard to how U-NII devices might share spectrum with . . . DSRC operating in the Intelligent Transportation radio service").

In contrast, Comcast and NCTA suggest that the Commission should move ahead on the 5.9 GHz band now because DSRC systems have not yet been deployed. *See* Comcast Comments at 30; NCTA Comments at 19. These arguments ignore the fact that FSS and other incumbent services are already present in the 5.9 GHz band.

[84] TIA Comments at 12.

[85] SES/Intelsat Comments at 12-13.

[86] *See id.;* ARRL Comments at 7; SAE International Comments at 3; Comments of Toyota Motor North America, Inc., ET Docket No. 13-49, filed May 28, 2013, at 5.

[87] Reply Comments of the Arizona Department of Transportation, ET Docket No. 13-49, filed June 18, 2013, at 2.

proposal.[88] Any future proceedings must be undertaken in a balanced manner, without prejudging the ultimate outcome.[89]

VII. CONCLUSION

The record in this proceeding provides no evidence that it would be possible for the Commission to both meet its obligation to protect licensed 5.9 GHz systems from interference and satisfy requests for use of the 5.9 GHz band for ubiquitously-deployed unlicensed devices. Accordingly, the Commission should terminate its consideration of the 5.9 GHz band for U-NII pending further detailed study of the interference threat to C-band FSS operations and other authorized services.

Respectfully submitted,

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[88] *See* SES/Intelsat Comments at 12; Alliance/Global Comments at 33; Mercedes-Benz Comments at 3.

[89] *See* Comments of the European Automobile Manufacturers' Association, ET Docket No. 13-49, dated May 24, 2013, at 3.

Technical Annex

Analysis of Uplink Interference from Proposed U-NII Devices in the 5.9 GHz Band into the Fixed-Satellite Service

A.1 Introduction

This technical annex presents an analysis of interference that would occur from the proposed U-NII (Unlicensed National Information Infrastructure) devices in the 5.85-5.925 GHz band, described in the FCC's NPRM,[1] into existing geostationary FSS (Fixed-Satellite Service) satellites that are already operating uplinks from US territories in this same band. Both the NPRM and commenters anticipate that U-NII devices using the Wi-Fi IEEE 802.11 family of standards would be deployed in this band.

A.2 Existing FSS operations in the 5.85-5.925 GHz band

Currently, there are at least 12 geostationary satellites operated by SES and Intelsat that provide service in the US with uplinks operating in the 5.85-5.925 GHz band. These are listed in Table A2-1 below. This table also provides the uplink sensitivity of these satellites in their beams operating in this band that provide coverage of US territory – expressed in terms of the beam peak and "average" G/T performance.[2]

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[1] See FCC Notice of Proposed Rulemaking in the matter of "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, 20 February 2013.

[2] The "average" G/T is intended to represent the average G/T performance across the footprint of that beam, which in many cases covers a large portion of CONUS where U-NII devices would potentially operate. The average is conservatively estimated to be 2 dB below the beam peak G/T value, which allows for the roll-off of the beam towards the edge of the beam.

Table A.2-1: Existing operational satellites of Intelsat and SES providing service to the US in the 5.85-5.925 GHz band, showing G/T performance levels

Satellite Operator	Satellite Name	Beam Name	Beam Peak G/T (dB/K)	Average G/T over Beam (dB/K)
Intelsat	IS-10-02 @ 1W	West Hemi	2.66	0.66
		East Hemi	-1.53	-3.53
		NE Zone	3.75	1.75
		SE Zone	0.93	-1.07
	IS-901 @ 18W	West Hemi	-3.3	-5.3
		East Hemi	-3.6	-5.6
		NW Zone	2.6	0.6
		SW Zone	-3	-5
		NE Zone	2.3	2
		SE Zone	3.2	1.2
	IS-905 @ 24.5W	West Hemi	-4.3	-6.3
		East Hemi	-4.4	-6.4
		NW Zone	2.5	0.5
		SW Zone	-3.7	-5.7
		NE Zone	1.9	-0.1
		SE Zone	-2.1	-4.1
	IS-907 @ 27.5W	West Hemi	-4.3	-6.3
		East Hemi	-4.4	-6.4
		NW Zone	2.5	0.5
		SW Zone	-3.7	-5.7
		NE Zone	1.9	-0.1
		SE Zone	-2.1	-4.1
	IS-903 @ 34.5W	West Hemi	-4.3	-6.3
		East Hemi	-4.4	-6.4
		NW Zone	2.5	0.5
		SW Zone	-3.7	-5.7
		NE Zone	1.9	-0.1
		SE Zone	-2.1	-4.1
		CA Zone	0.1	-1.9
	IS-801 @ 29.5W	WHUL	-0.5	-2.5
		EHUL	-3	-5
		NWUL	5	3
		NEUL	1.5	-0.5
		SWUL	2	0
		SEUL	2.5	0.5
	IS-805 @ 55.5W	Hemi A	-3.5	-5.5
		Hemi B	-4.0	-6.0

Satellite Operator	Satellite Name	Beam Name	Beam Peak G/T (dB/K)	Average G/T over Beam (dB/K)
SES	NSS-7 @ 20W	West Hemi	-2.3	-4.3
		East Hemi	-2.1	-4.1
		NE Zone	3.8	1.8
		SE Zone	1.7	-0.3
	SES-4 @ 22W	West Hemi	1.4	-0.6
		East Hemi	0.4	-1.6
	NSS-806 @ 40.5W	Hemi A/B	-3.1	-5.1
	SES-6 @ 40.5W	Hemi	-2	-4
	NSS-9 @ 177W	East Hemi	-0.9	-2.9
		West Hemi	-1.6	-3.6

Note that the average G/T performance (right hand column in Table A.2-1) ranges from +3.0 dB/K to -6.4 dB/K. The simple arithmetic average (in dB) of the average G/T values (right hand column of Table A.2-1) is -2.62 dB/K. In the interference analysis below we have conservatively assumed an average satellite G/T performance of -3 dB/K. This is 0.38 dB below the average of the average G/T values set forth above, 6.0 dB lower than the highest average G/T value, and 3.4 dB higher than the lowest average G/T value. It is thus a conservative assumption to make to simplify the uplink interference analysis.

A.3 Description of the interference analysis

The interference analysis is given in Table A.3-1 below. This analysis computes the impact of the uplink interference in terms of increased satellite receive system noise temperature, the so-called $\Delta T/T$ method.

The starting point of this analysis is the transmit power and antenna gain of the U-NII devices. The FCC's NPRM proposes that the maximum power of the proposed U-NII devices that would operate in the 5.85-5.925 GHz band would be 1 Watt per device (i.e., 0 dBW or 30 dBm). The antenna gain of these devices is a variable but, according to the NPRM, would be typically +6 dBi but with provision for higher gain for point-to-point devices. For this interference analysis, it is not the peak gain that is important but the gain in the direction of the geostationary orbit ("GSO"). There is nothing in the existing or proposed FCC rules relating to U-NII that

addresses the performance of the U-NII devices in this respect. Therefore we must make certain assumptions for the purposes of this analysis, which are described below.

U-NII devices with a peak gain of +6 dBi are presumably intended to radiate over a wide range of horizontal azimuth directions, but not intentionally in vertical directions, either downwards or upwards. However, such antennas would be low-cost and therefore would likely provide very little gain discrimination in the upwards direction towards the GSO. We have therefore tentatively assumed an average of 6 dB gain discrimination for the universe of such devices towards the GSO. Coupled with the maximum transmit power of 0 dBW, this would give an average radiated EIRP towards the GSO of 0 dBW (i.e., 0 dBW power + 6 dBi peak gain – 6 dB gain discrimination).

For U-NII devices with higher antenna gain, such as those for point-to-point applications, we tentatively assume that these devices also radiate the same EIRP towards the GSO, which may well be a very optimistic assumption. Such devices are unlikely to be the most popular compared to the near-omnidirectional ones, but they will almost certainly be installed outdoors. This assumption is unlikely to significantly impact the overall interference analysis.

In the analysis that follows, a direct line of sight is assumed between the interfering U-NII devices and the victim satellites, which implies that the U-NII devices are operating outdoors. It is recognized that not all U-NII devices will in fact be operated outdoors, so the results below should be interpreted only in relation to the outdoor U-NII devices. Indoor U-NII devices would produce a correspondingly lower level of interference to the GSO satellites, depending on the building blockage effects.

The interference analysis below, which computes the $\Delta T/T$ impact on the satellite uplink, is based on a spectral density approach. Therefore, we need to make certain assumptions concerning the occupied bandwidth of the power radiated by the U-NII devices. This is variable over a very wide range, based on the discussion in the NPRM, with a minimum value of 500 kHz and ranging up to 160 MHz. Therefore we have kept this as a variable parameter in the analysis below, showing the results for each of the following U-NII operating bandwidths: 500 kHz, 20 MHz, 40 MHz, 80 MHz and 160 MHz.

The analysis shown in Table A.3-1 computes the number of co-frequency U-NII devices that would cause various levels of ΔT/T degradation to the satellite link. The ΔT/T degradation levels considered are 0.33%, 0.5% and 1.0%. ITU-R Recommendation S.1432 budgets 1% of an FSS satellite system noise for all non-primary allocated services and other emissions that operate on a non-interference basis.[3] However, there are already non-primary allocations and emitters allowed in 5850-5925 MHz.[4] This suggests that unlicensed U-NII devices should contribute only a portion (say one-third or one-half) of the allotted 1%, and the analysis below therefore considers the reduced ΔT/T thresholds of 0.33% and 0.5%.

The results of the interference analysis show the following:

a. For U-NII devices operating in the minimum bandwidth (500 KHz) even a very small number of such devices (ranging from five to 16), operating outdoors anywhere in the US that falls within the beam footprint of the GSO satellites, would cause interference that exceeds the threshold levels.
b. Even for U-NII devices operating at the wider bandwidths contemplated by the IEEE 802.11ac standard (20 MHz to 160 MHz), the number of such outdoor devices that will cause interference exceeding the threshold levels is still very low compared to the numbers of devices foreseen by the U-NII proponents. The numbers range from only 215 for the 20 MHz operating bandwidth (for the ΔT/T level of 0.33%) to only 5,200 for the 160 MHz operating bandwidth (for the ΔT/T of 1.0%). By comparison, the Commission has suggested that there could be hundreds of millions of such U-NII devices across the US in the near future,[5] and the Wi-Fi Alliance has cited projections that global shipments

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3 *See* ITU-R Recommendation S.1432, *recommends* 4 and Annex 1, Section 4.

4 *See* 47 C.F.R. § 2.106, Part 18 (ISM equipment) and Part 97 (Amateur Radio).

5 In his statement in support of the NPRM, Commissioner McDowell cited estimates that "775 million wirelessly-connected devices will be used by Americans in 2017." *See* Notice at 53, Statement of Commissioner Robert M. McDowell (footnote omitted).

of dual-band Wi-Fi chipsets – including both 802.11n and 80.211ac – will exceed 1.5 billion by the end of 2014.[6]

A.4 Conclusions

In conclusion, this interference analysis shows that only a very modest number of U-NII devices operating in the 5.85-5.925 GHz band will cause unacceptable interference into the existing operational GSO FSS satellites that currently provide service to the US. If past and predicted Wi-Fi deployments are any guide, the deployment of U-NII devices in this band (if authorized) can be expected to very quickly exceed the thresholds for unacceptable interference. If the numbers of actual U-NII devices were to approach the current predictions for Wi-Fi deployments, the interference levels into the GSO FSS satellites would be many orders of magnitude higher than the threshold levels discussed here, and the satellite service would be completely incapable of operating.

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[6] *See* WiFi Alliance, Press Release, *Wi-Fi CERTIFIED™ ac takes Wi-Fi® performance to new heights*, http://www.wi-fi.org/media/press-releases/wi-fi-certified%E2%84%A2-ac-takes-wi-fi%C2%AE-performance-new-heights (last visited July 22, 2013).

Table A.3-1: Analysis of uplink interference from proposed U-NII devices operating in the 5.85-5.925 GHz band into existing co-frequency FSS satellites serving the USA

		Operating Bandwidth of U-NII Devices														
		500 kHz			20 MHz			40 MHz			80 MHz			160 MHz		
Frequency	GHz	5.900			5.900			5.900			5.900			5.900		
EIRP (max) for a single U-NII device	dBW	6.0			6.0			6.0			6.0			6.0		
U-NII device operating bandwidth	MHz	0.5			20.0			40.0			80.0			160.0		
Assumed gain discrimination of U-NII Tx antenna towards the GSO	dB	-6.0			-6.0			-6.0			-6.0			-6.0		
EIRP for a single U-NII device towards GSO	dBW	0.0			0.0			0.0			0.0			0.0		
# of U-NII devices simultaneously operating in same spectrum across operating bandwidth within satellite beam	#	**5**	**8**	**16**	**215**	**325**	**650**	**430**	**650**	**1300**	**860**	**1300**	**2600**	**1720**	**2600**	**5200**
Aggregate EIRP of multiple U-NII devices towards GSO	dBW	7.24	9.08	12.10	23.32	25.12	28.13	26.33	28.13	31.14	29.34	31.14	34.15	32.36	34.15	37.16
Aggregate EIRP density of multiple U-NII devices towards GSO	dBW/Hz	-49.75	-47.90	-44.89	-49.69	-47.89	-44.88	-49.69	-47.89	-44.88	-49.69	-47.89	-44.88	-49.69	-47.89	-44.88
Space loss to GSO orbit at 37,000 km	dB	199.2			199.2			199.2			199.2			199.2		
Polarization mismatch factor	dB	-1.5			-1.5			-1.5			-1.5			-1.5		
Typical GSO satellite receive G/T (averaged over satellite beam footprint)	dB/K	-3.0			-3.0			-3.0			-3.0			-3.0		
Resulting $\Delta T/T$ at GSO satellite Rx	%	**0.33%**	**0.50%**	**1.00%**	**0.33%**	**0.50%**	**1.00%**	**0.33%**	**0.50%**	**1.00%**	**0.33%**	**0.50%**	**1.00%**	**0.33%**	**0.50%**	**1.00%**

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this supplement, that I am familiar with the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this supplement and that it is complete and accurate to the best of my knowledge and belief.

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