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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
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In the Matter of:)
)
Amendment of the Commission's Rules to)
Provide for Operation of Unlicensed NII)
Devices in the 5 GHz Frequency Range)

ET Docket No. 96-102
RM-8648
RM-8653

**WIRELESS INFORMATION NETWORKS FORUM
REPLY TO COMMENTS ON PETITIONS FOR RECONSIDERATION**

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SUMMARY

The Wireless Information Network Forum ("WINForum") urges the Commission to adopt both the changes suggested in its own petition for reconsideration and the increase in lower band power limit suggested by Hewlett-Packard Corp. ("HP"). In its own petition, WINForum proposed a series of technical revisions intended to comport with the spirit of the Commission's *U-NII Order* and to provide some additional flexibility for product designers. Significantly, the only opposition to WINForum's proposed changes related to an aspect of one of its proposals and then only with respect to one of the three bands. Specifically, the satellite commenters urged the Commission to reject WINForum's proposal to allow 3 dB of "headroom" in the 5.15-5.25 GHz band but, as discussed in WINForum's reply, their opposition fails to consider averaging effects that render the impact of the proposal on MSS feeder links negligible.

The satellite commenters also took issue with HP's proposal to raise the power output limits for the 5.15-5.25 GHz band to conform with HIPERLAN developments in Europe. In opposing the proposed power increase, however, the satellite commenters have misconstrued developments in Europe and failed to provide any technical analysis refuting WINForum's extensive studies demonstrating that the effect of authorizing U-NII devices at 250 mW transmitter output power in the low band would be virtually undetectable.

Under the circumstances, WINForum urges the Commission to adopt all of its proposed rule changes and the power increase requested by HP. With these changes, U-NII devices would be governed by the following power limits, where B is the 26 dB emission bandwidth in megahertz:

Band	Bandwidth	Total Power Limit	Power Spectral Density Limit	Operational Limits
5.15-5.25 GHz	$B \geq 20$ MHz	250 mW	25 mW/MHz	Indoor-only
	$B < 20$ MHz	11 dBm + 10 log (B)		
5.25-5.35 GHz	$B \geq 20$ MHz	250 mW	25 mW/MHz	Indoor/Outdoor
	$B < 20$ MHz	11 dBm + 10 log (B)		
5.725-5.825 GHz	$B \geq 20$ MHz	1 W	100 mW/MHz	Indoor/Outdoor
	$B < 20$ MHz	17 dBm + 10 log (B)		

These limitations are consistent with the overall intent of the Commission's *U-NII Order*, provide added flexibility to product designers, and should be adopted upon reconsideration.

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**WIRELESS INFORMATION NETWORKS FORUM
REPLY TO COMMENTS ON PETITIONS FOR RECONSIDERATION**

The Wireless Information Networks Forum ("WINForum") hereby respectfully submits its reply to comments on its Petition for Reconsideration and the Petition for Reconsideration filed by Hewlett-Packard Company ("HP") in the above-captioned proceeding.¹ With regard to WINForum's petition, the record largely supports adoption of all of the proposed modifications. Commenters, in fact, opposed only one narrow aspect of WINForum's requested changes and then only with respect to one of three bands, a proposal to permit 3 dB of flexibility in the power spectral density limits to accommodate power spectra that are not "flat." The opposition to this proposal, however, severely overstates the effects of the change, which does not alter the overall power limits for the band. Several satellite interests also challenge HP's request to raise the power limit for the low band to achieve parity with European developments, relying on procedural technicalities and analyses that ignore significant interference-limiting factors.

¹ Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range, ET Docket No. 96-102, FCC 97-5 (Jan. 9, 1997) ("*U-NII Order*"); Petition for Reconsideration and Clarification of the Wireless Information Networks Forum, ET Docket 96-102 (filed Mar. 3, 1997) ("*WINForum Petition*"); Petition for Reconsideration of Hewlett-Packard Company, ET Docket No. 96-102 (Mar. 3, 1997) ("*HP Petition*").

WINForum accordingly urges the Commission to adopt the full panoply of changes suggested in its petition and the modification suggested by HP on reconsideration.

I. WINFORUM'S PROPOSED MODIFICATIONS AND CLARIFICATIONS ARE SUPPORTED BY THE RECORD AND SHOULD BE ADOPTED BY THE COMMISSION ON RECONSIDERATION

On March 3, 1997, WINForum filed a Petition for Reconsideration and Clarification proposing changes that it believes are consistent with the intent of the Commission's rules. The large majority of these specific changes are either non-controversial or have been supported by the commenters in this proceeding. Specifically:

- *First*, no commenters took issue with WINForum's suggested clarification that would permit operation across the lower and middle band boundary at 5.25 GHz.²
- *Second*, no commenters opposed WINForum's suggestion that the Commission clarify and harmonize the out-of-band emissions limitations with the general "quiet band" limits of Section 15.209.³ WINForum notes, however, that it is continuing to work

² WINForum Petition at 5.

³ *Id.* at 5-7. Resound Corporation did file an "opposition," but the document does not appear to state any discernible opposition to the WINForum Petition. Nominally, Resound challenges the proposal to delete the first sentence of Section 15.407(b)(5), relating to "quiet band" compliance, but WINForum's proposal is merely editorial. Resound at ¶ 2. WINForum requested the deletion because its suggested modifications added similar language to its proposed 15.407(b)(1) (low band) and 15.407(b)(2) (middle band) clarifying the interaction between the quiet band limits and the out-of-band emissions limits for the 5.15-5.35 GHz band. While this language was not added to the proposed 15.407(b)(3) (upper band), the omission was intentional as the upper band is not adjacent to any designated quiet bands. Resound also appears to construe the revised language to mean that no out-of-band emissions limits would apply beyond 10 MHz from any U-NII band edge. Resound at ¶ 1. However, WINForum's changes to the language of Section 15.407(b)(3) are editorial and do not alter the out-of-band emissions rules originally adopted by the Commission. Resound's excerpt of the FCC's rules, in fact, erroneously implies that the existing 15.407(b)(3) imposes a 50 dB out-of-band attenuation requirement from the edge of the 5.725-5.825 GHz band. In fact, a 10 MHz shoulder exists next to the band edge where out-of-band emissions are required to be attenuated only by 40 dB. Thus, WINForum's restatement of the rule is functionally identical to the Commission's original formulation. Finally, Resound implies

(Continued...)

with NTIA on this issue and will apprise the Commission if such discussions require modification of the positions stated in its petition for rulemaking.

- *Third*, commenters foresee no difficulty with adopting WINForum's suggestion to eliminate the frequency stability requirements, since no band channelization has been adopted for U-NII devices.⁴
- *Fourth*, commenters did not, in large part,⁵ take issue with WINForum's suggestion to state the out-of-band emission limits relative to the inband power limits, including the required power reduction for systems with more than 6 dBi of antenna gain, rather than as relative to actual transmitted in-band power.⁶ In addition, commenters did not object to the proposal to allow 3 dB of tolerance in any given 1 MHz band, while maintaining the total power output as a function of bandwidth, in either the 5.25-5.35 GHz or 5.725-5.825 GHz bands.
- *Fifth*, commenters, including the satellite interests, affirmatively support WINForum's proposal to limit the total power for emissions bandwidths of less than 20 MHz as $X \text{ dBm} + 10 \log(B)$, where B is the 26 dB bandwidth in MHz and X is 4 dBm for the 5.15-5.25 GHz band,⁷ X is 11 dBm for the 5.25-5.35 GHz band, and X is 17 dBm for the 5.725-5.825 GHz band.⁸

(...Continued)

(Resound at ¶ 3) that devices operating above 5.85 GHz under Section 15.249 are entitled "quiet band" protection. This clearly is not the case; indeed, the entire band 5.725-5.875 GHz is an Industrial, Scientific, and Medical band.

⁴ *Id.* at 7.

⁵ Although AirTouch states that it opposes this change, the opposition to the revision of the out-of-band emissions limits centers around WINForum's proposal to permit 3 dB of "headroom" in the power spectral density limits, which, AirTouch theorizes, affect the out-of-band emissions limits commensurately if the proposed change is adopted. In fact, as stated in the WINForum Petition for Reconsideration, the suggested word changes related to the out-of-band emission rule states that the out-of-band emissions do "not includ[e] the 3-dB tolerance for power spectral density." WINForum Petition for Reconsideration at 10. In any event, AirTouch does not appear opposed *per se* to the concept of measuring out-of-band emissions relative to the maximum permitted inband power rather than as relative to the actual inband power of a device.

⁶ *Id.* at 9-10.

⁷ The change proposed by HP would result in the low band power limit becoming identical to the middle band power limit, *i.e.*, $11 \text{ dBm} + 10 \log(B)$, where B is the 26 dB emission bandwidth, up to a maximum of 250 mW. The indoor-only operating condition would continue to apply in the low band.

- *Sixth*, the record supports WINForum's request that the Commission specify the total power output in a manner that accurately represents the interference potential of U-NII devices by eliminating symbol-to-symbol envelope variations due to modulation.⁹
- *Seventh*, the comments do not oppose WINForum's proposed clarifications to the definition and measurement of power spectral density and peak power spectral density that avoid overstating the interference potential of U-NII devices due to the inherent randomness (noise-like variation) of a wideband signal measured with a narrowband filter.¹⁰
- *Eighth*, the comments appear to support WINForum's conclusion that special rule considerations are necessary for impulse transmission techniques.¹¹
- *Finally*, the record supports modifying the definition of U-NII devices, as suggested by WINForum, to require such devices to utilize digital modulation techniques.¹²

WINForum believes that these rule clarifications and changes, which no commenter has opposed, will enhance the utility of the U-NII bands without altering the interference potential of U-NII devices.

II. WINFORUM'S PROPOSAL TO PERMIT MINOR VARIATIONS IN THE POWER SPECTRAL DENSITY LIMITS SHOULD BE ADOPTED

In effect, commenters challenged only *one* aspect of WINForum's petition for reconsideration with respect to only *one* of three frequency bands¹³ – its proposal to allow 3 dB

(...Continued)

⁸ *Id.* at 7-9.

⁹ *Id.* at 11-15.

¹⁰ *Id.* at 15-19.

¹¹ *Id.* at 20-21.

¹² *Id.* at 21.

¹³ WINForum notes that its proposal to allow 3 dB of headroom in the middle and upper bands was unopposed and, at a minimum, should be adopted on reconsideration, since the MSS interests objected only to the headroom in the lower band.

of flexibility in the power spectral density rules to compensate for the pragmatic reality that the power spectra of most modulations are not "spectrally flat." In effect, under WINForum's proposal, while U-NII devices would be required to meet an overall band-specific power output limit or a band-specific limit determined by the use of the formula $X \text{ dBm} + 10 \log (B)$ (B is the 26 dB bandwidth in MHz), whichever is less, the power spectral density limits would allow 3 dB of variation in the power spectrum. That is, the maximum power in a 1 MHz band would be $X \text{ dBm} + 3 \text{ dB}$.

Thus, WINForum's proposal does not increase the overall power limit at all, *only* the power spectral density limits. Obviously, because *both* conditions must be met, a device could not double (increase by 3 dB) the power in *all* individual 1 MHz bands, as this would also double the overall power of the device and thereby violate the proposed rule on total power. Instead, WINForum's proposal merely allows some variation in the power spectral density, where the power in some 1 MHz bands might be increased and the power in others commensurately decreased to compensate for power spectra that are not "spectrally flat."

Because WINForum's proposal does not alter the maximum overall power output, the proposal will not "double the interference to MSS feeder links" as alleged by AirTouch.¹⁴ The WINForum proposal does not alter the total aggregate amount of power transmitted in the band for *all* devices, but rather how power is distributed across various 1 MHz sub-bands for *individual* devices, a factor that will make the effect negligible for MSS operators given the averaging effects over large numbers of devices.

¹⁴ AirTouch Comments at 5.

Although the Joint Commenters' and LQL's opposition to this proposal is somewhat more refined, it is, in effect, the same argument advanced by AirTouch concentrating on the effect of a single device in a 1 MHz band. Obviously, if there is 3 dB of "headroom" in the power spectral density limits, one device definitionally may generate up to 3 dB more power in a single 1 MHz band. However, the Joint Commenters fail to recognize that interference effects must be averaged over large numbers of devices and, for each device operating with a higher power in a particular 1 MHz band, there are other devices that are operating in the same 1 MHz band with less power than permitted under the power spectral density rules. Indeed, in the absence of mandated channelization and given the variations in peaking among different modulation schemes, there is no reason to believe that these "multiple U-NII carriers could 'pile-up' on the same frequency," as alleged by LQL.¹⁵ Even if such "pile ups" did occur on a theoretical basis, all of the calculations assessing the interference effect of U-NII devices assumed pathological "worst cases" and determined that the interference effect on MSS feeder uplinks is negligible in any event. Thus, whether one device operates with a slightly higher power in a single 1 MHz band is irrelevant to the larger inquiry at hand.

¹⁵ The only instance in which there may be systematic spectrum peaking in a particular 1 MHz segment is if all U-NII devices are designed to a single interoperability standard in which all transmitters not only operate with common center frequencies but also follow a single modulation specification. Any interoperability standard that might be developed will be for multi-media LAN operation for which such parameters as the duty cycle and deployment density will be highly predictable and controllable through technical standards. All analyses which have been presented by either party in this proceeding have been based on worst case values of these parameters because of the assumption that the applications are totally unpredictable. WINForum has shown that even when values of these parameters much higher than that which would be consistent with multi-media LANs are used, the effect on MSS systems is insignificant. Thus, if all systems are interoperable and operate as the industry now plans, the issue of spectral peaking is even of less significance.

Those parties opposing the WINForum's proposed change also neglect to assess the aggregate effects of *all* of WINForum's proposed rule changes. In particular, WINForum notes that the proposed change to a bandwidth-dependent power limit will have the effect of significantly reducing the potential for deployment of systems that concentrate energy in small bandwidths. WINForum believes the effect of its proposed changes to the rules should be taken as a whole, not an *à la carte* menu allowing certain parties to "pick and choose" only those proposals that favor their interests.

III. THE PROPOSAL TO ADOPT A HIGHER POWER LIMIT FOR THE LOW BAND IS CONSISTENT WITH INTERNATIONAL DEVELOPMENTS, WILL NOT CAUSE INTERFERENCE, AND SHOULD BE ADOPTED

In its petition for reconsideration, HP requested that the Commission adopt a power limit for the low (*i.e.*, 5.15-5.25 GHz) band of 1 W EIRP.¹⁶ WINForum, in its comments on HP's petition, noted that the proposed change would be in the public interest in that it would achieve consistency with international developments and provide additional design flexibility to manufacturers. WINForum also provided several technical papers relating to the effects of U-NII devices on MSS feeder uplinks ultimately concluding that any increase in energy in the band attributable to U-NII devices would not harm MSS operations. Under the circumstances, as HP

¹⁶ WINForum suggested, consistent with its proposal for the 5.25-5.35 GHz band in its petition for reconsideration, that the power limit for the lower band be $11 \text{ dBm} + 10 \log(B)$, where B is the 26 bandwidth in megahertz, up to a maximum of 250 mW. These power limits are stated for antenna gains of 6 dBi or less. As with other bands, any increase in antenna gain above 6 dBi would require a dB for dB reduction in transmitter output power.

argues, "[t]here is no reason for the Commission to defer authorizing U-NII devices at up to one watt of power."¹⁷

All of the satellite interests have filed in opposition to HP's request.¹⁸ In brief, the satellite interests argue that HP's proposal: (i) is procedurally defective; (ii) incorrectly states the current status of HIPERLAN developments in Europe; (iii) ignores that MSS systems cannot be designed to accommodate higher power devices; and, (iv) fails to address the impact of higher power U-NII devices on MSS feeder links.¹⁹ As detailed below, however, each of these arguments misstate relevant factors or rely on erroneous assumptions.

The satellite interests' argument on procedural grounds is specious. Without even considering that their reading of precedent would constrict the grounds for filing petitions for reconsideration in a draconian manner, the argument is all the more irrational in that the *U-NII*

¹⁷ HP Petition at 2.

¹⁸ AT&T Corp. also opposes the proposed change to the low band power limit, largely for competitive reasons. In effect, AT&T Corp. argues that raising the power will allow U-NII device technology to be competitive with systems operated by carriers that purchased spectrum at auctions. WINForum notes, however, that the proposed power limit change would render the low band limits identical to the middle band limits, which were determined by the Commission to allow deployment of devices "complementary to" – not competitive with – public network systems. *U-NII Order* at ¶ 88. WINForum also notes that the lower band is subject to an indoor-only operating condition (which HP has explicitly not requested to change, HP Petition at 2 n.7) that would preclude such devices from competing with wider area public networks.

¹⁹ LQL also asserts that the HP proposal "ignores the efforts of interested members of the satellite industry and equipment manufacturers to reach a compromise in this proceeding." LQL Comments at 3. While WINForum concurs that it participated in efforts to reach a compromise with the satellite interests, no agreement between these industries was ever reached. In any event, to the extent the FCC's order represents a "balancing of interests," implicit in that balancing is the potential for revisiting the lower band power limit based on European developments. While WINForum's petition for reconsideration did not pursue that issue, HP's petition merely accelerated a process that WINForum had always anticipated eventually undertaking, as contemplated in the *U-NII Order*.

Order explicitly contemplates that the Commission will revisit the issue of MSS/U-NII device sharing based on exactly the facts HP has alleged. Specifically, the *U-NII Order* states that the Commission would consider the technical standards governing operation in the low band "if European HIPERLAN systems proliferate and operate at more power than U-NII devices."²⁰ As discussed below, HP has correctly observed that the European nations are moving forward with HIPERLAN implementation at a maximum power of 1 Watt EIRP.

The satellite interests also attempt to argue that HP's characterization of the status of HIPERLAN in Europe is incorrect. LQL states, for example, that HP "concedes . . . the ETSI standard for HIPERLAN has not yet been finalized in Europe."²¹ This statement is simply incorrect and, for obvious reasons, no such concession can be found in HP's comments. The ETSI HIPERLAN specification is, in fact, a final standard and provides for operation of HIPERLAN devices at any of 3 receiver sensitivity-power level combinations, where the highest power level is 30 dBm or 1 Watt EIRP. These power levels are selectable by system and, among other things, permit a rudimentary adaptive power control to minimize unnecessarily high levels when devices are operated in close proximity. They are not intended as "implementation options" that can be selected by individual countries.

ICO/COMSAT, for their part, also state that "the CEPT Spectrum Engineering Working Group (WG-SE) Project Team SE-28 strongly supports regulations permitting only the operation of Class A HIPERLAN devices in the 5150-5250 MHz band, on an indoor-only basis, and with a

²⁰ *U-NII Order* at ¶ 96.

²¹ LQL Comments at 5.

peak EIRP of 1/100 watt of radiated power."²² It is WINForum's understanding, however, that the document referenced by ICO/COMSAT is a submission from ICO/COMSAT that has not been accepted by CEPT and that, in fact, considerable debate exists within CEPT on this subject.. Specifically, WINForum believes that parties have taken issue with the operational assumptions used for the study, which appear to exaggerate the impact of HIPERLAN devices on MSS feederlinks. It should also be pointed out that, during the public comment phase of the HIPERLAN Decision issued by CEPT in 1996, none of the satellite interests filed comments along the lines of the ICO/COMSAT proposal. At this time, representatives from ETSI RES 10 and SE-28 of CEPT are actively discussing the issue and a conclusion is not available at this time.

Even while admitting that second generation MSS systems could be designed to be immune from levels of interference the satellite interests hypothesize from 1 Watt U-NII devices, they continue to argue that their systems are too advanced in the design process to accommodate such higher powers at the present time. The Commission, however, should not base its spectrum policies on representations alleged without any supporting factual basis. Moreover, these systems *should* have been designed to tolerate any hypothetical levels of noise generated by 1 Watt EIRP radio networking devices, inasmuch as the HIPERLAN specification (including provisions for operation at 1 Watt EIRP) was underway and in circulation well before the allocation of spectrum in this band to MSS feederlinks at the 1995 WRC.²³

²² ICO/COMSAT Comments at 4-5.

²³ See, e.g., Sharing of Non-GSO MSS Feeder-Link Stations with HYPERLAN [sic] Mobile Services in the 5 GHz Range, ITU-R Study Groups Document 4-5/50-E (May 31, 1994) (Dated (Continued...))

Finally, and most importantly, the satellite interests once again allege that U-NII devices operating at 1 Watt EIRP will cause harmful interference to MSS feederlinks.²⁴ These claims, however, are based on outdated analyses that include faulty assumptions and have been refuted by WINForum's technical studies of December 6 and December 11, 1996, as detailed in Attachment 1. For example, AirTouch states that interference from U-NII devices "would reduce the capacity of its GlobalStar satellite system in the United States by over 27.4%, resulting in significant and unacceptable service degradation."²⁵ AirTouch neglects to mention that this result, provided in the AirTouch Reply Comments to the NPRM,²⁶ was based on the assumption that there are 50 million unlicensed devices operating in the 5.15-5.25 GHz band, all of which are either transmitting or receiving at all times (hence an average 50% duty cycle), and 60% of the devices are outdoors with an average antenna gain of 2 dBi as seen by the satellite. Moreover, AirTouch also neglects to mention that it subsequently filed an *ex parte* letter showing that 30 million indoor U-NII devices in the 5.15-5.25 GHz band operating with a 50% duty cycle

(...Continued)

prior to allocation of MSS feeder link spectrum in the 5 GHz band and citing "Co-Existence of Radio LANS with MLS," which assumes 0 dBW EIRP for HIPERLAN devices); *see also* "Harmonised Radio Frequency Bands For High Performance Radio Local Area Networks (HIPERLANs) In The 5 GHz And 17 GHz Frequency Range," Recommendation T/R 22-06 (Madrid 1992, revised at Nicosia 1994) (HIPERLAN specification dated prior to the allocation of MSS feeder link spectrum in the 5 GHz band, including provision for operation at 0 dBW).

²⁴ WINForum understood HP's proposal to be intended as a five-fold increase, not, as claimed by AirTouch (p. 4) and ICO/COMSAT (footnote 3), a twenty-fold increase in the allowed EIRP. The current EIRP limit is 200 mW (50 mW transmit power into a 6 dBi gain antenna). The HIPERLAN limit is 1 watt EIRP; there are no limits on combinations of transmit power and antenna gain used to achieve it.

²⁵ AirTouch at p. 2.

²⁶ AirTouch Reply Comments, ET Docket No. 96-102 (filed Aug. 14, 1996).

would cause a capacity reduction of less than one-half of one percent.²⁷ Thus, the results cited by AirTouch in its Comments are not only inappropriate given the indoor-only restriction in the *U-NII Order*, but have been superseded by AirTouch's own December 2 analysis.

There are also several major problems with AirTouch's use of the 27.4% figure to argue that HP's Petition should be denied. First, the *U-NII Order* requires all U-NII devices in the 5.15-5.25 GHz band to operate indoors. Clearly, since all devices in the 5.15-5.25 GHz band will operate indoors, the December 2 "indoor-only" results are more applicable and should have been cited by AirTouch instead of the earlier "60% outdoor" results. Second, even if there are someday 30 to 50 million U-NII devices deployed, they would not all be confined to the 5.15-5.25 GHz band, but distributed among the available 300 MHz of spectrum. Third, as was pointed out in WINForum's *ex parte* letter of December 6, 1996, AirTouch made a significant error in its assumed U-NII device antenna pattern. The assumed pattern creates energy, and a correction factor on the order of 4 dB (the exact correction depends on the assumed beamwidth) must be applied to yield a valid antenna pattern. Fourth, U-NII devices will on average be transmitting only a small fraction of the time. Indeed, frequency reuse considerations alone would prevent a 50% average transmit duty cycle in all but low-density areas (which are of little concern because they will account for only a small fraction of total deployment). A 1% overall average duty cycle is much more realistic. Accordingly, AirTouch's analysis severely exaggerates the potential interference from U-NII devices.

²⁷ The December 2 AirTouch *ex parte* letter is appended to these Reply Comments as Attachment 2.

In Attachment 1, these (and other) deficiencies in the AirTouch analysis are remedied, and the interference impact of U-NII devices on GlobalStar is calculated using the AirTouch model (but with correct parameters), assuming that the allowed transmit power in the 5.15-5.25 GHz band is $11 \text{ dBm} + 10 \log(B)$ (where B is the 26 dB bandwidth in MHz), which is identical to the power limit that WINForum has proposed in its Petition for operation in the 5.25-5.35 GHz band. Consistent with the *U-NII Order*, all U-NII devices are assumed to operate indoors. It is clear from this analysis that even at the proposed power level (which would result in a maximum EIRP of 1 Watt, as proposed by HP), the impact of the U-NII devices on MSS operation would be insignificant. For example, with a total of 30 million U-NII devices distributed evenly across the available 300 MHz and an overall average duty cycle of 10%,²⁸ the noise floor increase at the GlobalStar subscriber unit will be only 0.0008 dB ($\Delta T/T < 0.018\%$). For the same scenario, the AirTouch model gives a capacity decrease of only 0.017%.

In a similar vein, L/Q Licensee states that the MSS interests “have provided extensive analyses of the adverse impact of permitting higher-powered devices in the 5150-5250 [sic] on MSS feeder links, and *these studies remain an unrebutted part of the record in this proceeding.*”²⁹ WINForum believes that characterization of the MSS analyses as “extensive” is misleading. In fact, the AirTouch model discussed *supra* is the only technical analysis filed by MSS interests in this proceeding, of which WINForum is aware, which relates the number of U-NII devices to the

²⁸ The “duty cycle” used here is the activity factor (the fraction of devices that are actually powered-up and in use) multiplied by the actual duty factor of active devices. This aggregate average duty cycle is expected to be less than 1%, so assuming a 10% duty cycle greatly overstates the impact of the U-NII devices.

²⁹ LQL Comments at 6 (emphasis added).

capacity of a mobile satellite system. To WINForum's knowledge, L/Q has not provided such an analysis, but rather has proposed some arbitrary thresholds for the noise floor elevation at the spacecraft, without relating the threshold to any quantifiable service impact. Finally, L/Q must be well-aware that the AirTouch results have in fact been rebutted, since L/Q was a party to the January 2 letter from the MSS interests³⁰ that addressed the analysis provided in the December Apple/WINForum *ex parte*. The January 2 MSS letter raised several points criticizing the December Apple/WINForum analysis, although it does not rise to the level of a "new" interference analysis. Attachment 1 addresses those points and provides an updated interference analysis.

In summary, WINForum believes that it is entirely appropriate for the Commission to reconsider raising the power levels in the 5150-5250 MHz band, independent of the progress of the HIPERLAN discussions in Europe. WINForum has shown conclusively that even with the $11 \text{ dBm} + 10 \log(B)$ power limit, the effect on MSS will be immeasurable. None of the MSS interests have provided any realistic analysis that suggests otherwise.

IV. CONCLUSION

WINForum urges the Commission to reconsider the *U-NII Order* and implement both the changes proposed by WINForum and the power limit increase requested by HP. In other words, U-NII devices would need to meet the band-specific power limitations shown in Table 1 below, where *B* is the 26 dB emission bandwidth:

³⁰ January 2, 1997, ET Docket 96-102 *ex parte* letter from AirTouch Communications, Inc., COMSAT Corporation, ICO Global Communications, Inc. (ICO), and L/Q Licensee, Inc. (L/Q).

Band	Bandwidth	Total Power Limit	Power Spectral Density Limit	Operational Limits
5.15-5.25 GHz ³¹	$B \geq 20$ MHz	250 mW	25 mW/MHz	Indoor-only
	$B < 20$ MHz	11 dBm + 10 log (B)		
5.25-5.35 GHz	$B \geq 20$ MHz	250 mW	25 mW/MHz	Indoor/Outdoor
	$B < 20$ MHz	11 dBm + 10 log (B)		
5.725-5.825 GHz	$B \geq 20$ MHz	1 W	100 mW/MHz	Indoor/Outdoor
	$B < 20$ MHz	17 dBm + 10 log (B)		

Both WINForum and HP have requested modifications that are consistent with the Commission's twin goals of creating the most useful and diverse array of U-NII products and

³¹ The limit proposed in the band 5.15-5.35 GHz is the same as that proposed in WINForum's Petition for Reconsideration for the band 5.25-5.35 GHz. This same limit is also being proposed here for the 5.15-5.25 GHz band, reflecting WINForum's support of HP's Petition for Reconsideration. Note that with the limit proposed in the table for the band 5.15-5.35 GHz, the maximum EIRP is 1 watt, assuming a maximum antenna gain of 6 dBi without power backoff. In the event the HP proposal to raise the power limit for the lowest (5.15-5.25 GHz) band is not adopted, the maximum power limit for that band would then be 50 mW or 4 dBm + 10 log (B), whichever is less. The power spectral density limit for the band would be 5 mW/MHz, including the 3 dB headroom figure advocated by WINForum.

avoiding interference to co-channel spectrum users. WINForum urges the Commission to adopt these proposed changes on reconsideration.

Respectfully submitted,

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Attachment 1

INTERFERENCE FROM U-NII DEVICES TO THE MOBILE SATELLITE SERVICE IN THE 5150-5250 MHZ BAND: SUMMARY AND UPDATE

April 11, 1997

Introduction

The Report and Order in ET Docket 96-102 limits the power output of U-NII devices in the 5150-5250 MHz band to 2.5 mW/MHz, up to a maximum of 50 mW. If the antenna gain exceeds 6 dBi, these power levels must be reduced by the amount that the antenna gain exceeds 6 dBi.

In its Petition for Reconsideration, Hewlett-Packard Company ("HP") requested that the power limit in the 5150-5250 MHz band be increased to be consistent with that of HIPERLAN, for which the power limit is 1 watt effective isotropic radiated power ("EIRP").

In their Comments on HP's Petition, several MSS interests claimed that an increase in the allowed power level for U-NII devices in the 5150-5250 MHz band would create an unacceptable level of interference to mobile satellite systems which use feeder uplinks in the 5091-5250 MHz band. Those claims are based on erroneous or outdated assumptions, and in one case, calculations that are mathematically incorrect. The purpose of this paper is to address those errors and to provide a realistic and up-to-date interference analysis, based on parameters and limitations established in the *Report and Order*, to assess the impact of HP's proposal. Some components of this paper are reproduced from the December 11 *ex parte* presentation provided by Apple/WINForum, as well as the WINForum December 6 *ex parte* letter and attachments on average antenna gain of unlicensed devices, as seen by a satellite.

The AirTouch Model

In an Appendix¹ to its Reply Comments on the Notice of Proposed Rule Making ("NPRM") in ET Docket 96-102, AirTouch Communications provided a formula for the capacity reduction that would result to the GlobalstarTM system from unlicensed devices that share spectrum with the feeder uplink. That formula is:

$$\Delta C = \frac{10^{I_i/10}}{10^{I_{p15}/10} + 10^{I_i/10}}, \quad (1)$$

¹ That Appendix is entitled "Technical Analysis Regarding Interference to MSS Links by Part 15 Devices Using 5.15-5.25 GHz Frequency Band" [*sic*].

where ΔC is the ratio of the Globalstar capacity with NII/SUPERNet devices to that without them, $I_t = -202.86$ dBW/Hz is the total interference plus noise at the Globalstar subscriber unit excluding that from NII/SUPERNet devices, and I_{p15} is the aggregate power density from the Part 15 NII/SUPERNet devices, in dBW/Hz.

AirTouch calculates the U-NII device interference by assuming a total round-trip path loss of 193.9 dB, a transmitted power density per device of -80 dBW/Hz, a net building attenuation of 17 dB for indoor devices, and a bandwidth of 20 MHz for each U-NII device. Therefore, 20% of the total number of devices in the 5150-5250 MHz band affect a given Globalstar subscriber unit. With those assumptions, if all devices are indoors (as required in the new Subpart E of Part 15), $i_{p15} = 3.2 \times 10^{-4} N_M d i_t$, where $i_{p15} = 10^{I_{p15}/10}$, $i_t = 10^{I_t/10}$, N_M is the total number of U-NII devices (millions) in the 5150-5250 MHz band, and d is the average transmit duty cycle per device. ΔC then becomes:

$$\Delta C = \frac{1}{1 + 3.2 \times 10^{-4} N_M d} \quad (2)$$

The percentage capacity decrease as shown can be expressed as:

$$\Delta_{\%} = 100(1 - \Delta C) = 100 \left(\frac{3.2 \times 10^{-4} N_M d}{1 + 3.2 \times 10^{-4} N_M d} \right) < 0.032 N_M d \quad (3)$$

On December 2, 1996, AirTouch filed an *ex parte* letter (included here as Attachment 2). Attached to that letter are two sets of curves showing the percent U.S. capacity reduction for Globalstar vs. the number of unlicensed devices deployed in the 5150-5250 MHz band only. Although not stated in the December 2 letter, it is apparent from comparison of the curves with the original AirTouch model as summarized above that these curves were generated using that model. For example, the curves in the first figure are based on the assumption of indoor-only operation, and agree with equation (3) above. As can be seen, the upper bound in (3) is very tight for small $\Delta_{\%}$. The second AirTouch figure shows a curve for 5% outdoor use, but that is no longer relevant, since the FCC restricts operation of unlicensed devices in the 5150-5250 MHz band to indoor operation.

The Apple/WINForum Analysis and MSS Response

On December 11, 1996 Apple Computer and WINForum presented to the Commission a more detailed analysis of interference from unlicensed devices to MSS, using the basic AirTouch model and some of AirTouch's assumptions, but making minor changes to several parameters. In that analysis, 5% outdoor operation was assumed, consistent with AirTouch's second figure of December 2. The changes were:

- 3 dB was added to the path loss to account for the fact that the Globalstar feeder link uses circular polarization, while the polarization from the U-NII devices will be random.
- The average antenna gain for outdoor unlicensed devices was assumed to be 0 dBi, regardless of the gains of the individual antennas (this point will be discussed in more detail below).
- Unlicensed devices were assumed uniformly-distributed across the entire 350 MHz proposed in the NPRM.
- A noise figure of 2 dB was used for the MSS subscriber unit, rather than the 0 dB noise figure assumed in the AirTouch calculations.
- Unlicensed devices operation outdoors were assumed to reduce their average transmit power in accordance with the Apple/WINForum proposal submitted as an *ex parte* letter on November 1, 1996.

On January 2, 1997, a joint *ex parte* letter ("the MSS letter") was submitted by AirTouch Communications, Inc., COMSAT Corporation, ICO Global Communications, Inc., and L/Q Licensee, Inc. addressing the Apple/WINForum presentation of December 11, 1996. The MSS letter criticized the December 11 Apple/WINForum analysis on several points:

1. Since there are no standards for the unlicensed devices, actual devices will not necessarily use the technical parameters assumed in the analysis.
2. No explanation was given of how it would be assured that the unlicensed devices would be evenly-distributed across the entire 350 MHz.
3. The 2 dB noise figure was used rather than the 0 dB in the Globalstar link budget (however, the MSS letter provided no proof, nor even reaffirmation of a 0-dB noise figure).
4. There was no basis given for assuming 5% outdoor operation.

In the interest of completeness, those points are addressed here as follows:

1. The technical parameters assumed were based, as was clearly stated, on Apple/WINForum proposal of Nov. 1, 1996, for FCC Rules to apply to unlicensed devices in the 5150-5250 MHz band. Hence, the stated power limits were assumed to be the maximum allowed by the FCC.
2. The assumption of an even distribution of a large number (e.g., 30 million) of devices across all the available spectrum was viewed as more realistic than assuming that 30 million devices are confined to the 5150-5250 MHz band (as in the December 2 AirTouch curves). An even distribution was viewed as somewhat conservative, since the restrictions proposed on outdoor use for the 5150-5250 MHz band would tend to make that band less attractive than the middle (5250-5350 MHz) or upper (5725-5850 MHz). Given the FCC's subsequent prohibition on outdoor use for the 5150-5250 MHz band, it seems likely at this point that the deployment in that band will be somewhat less than the other bands, so an even distribution realistically represents a worst-case assumption.
3. Without some technical evidence (which the MSS interests have yet to provide), WINForum remains unconvinced that the subscriber unit (handset) noise figure is 0

dB. With a low-noise front-end amplifier, an aggregate noise figure of around 2 dB might be achieved with well-matched antenna system. However, WINForum is receptive to any evidence that the MSS interests might wish to provide regarding the actual measured noise figure of a mass-manufactured subscriber handset. That noise figure should include the effects of any losses, including mismatches and de-tuning (when hand-held) associated with the antenna system, which can be significant for small portable handsets.

4. The December 11 WINForum analysis assumed 5% outdoor operation for consistency with the December 2 AirTouch analysis. Now, however, it is a moot point, since the FCC has disallowed outdoor operation of unlicensed devices in the 5150-5250 MHz band, and no party has requested reconsideration of this restriction.

The Average Antenna Gain Issue

In its Reply Comments on the NPRM, AirTouch included an analysis of the average antenna gain of the unlicensed devices, as seen by a satellite. That analysis was based on an assumed antenna gain for the unlicensed devices given by:

$$G_{AT}(\alpha, \varepsilon) = \frac{27000}{B_\alpha B_\varepsilon} 10^{-\frac{1}{2} \left[\left(\frac{\varepsilon}{B_\varepsilon} \right)^2 + \left(\frac{\alpha}{B_\alpha} \right)^2 \right]} + 1, \quad (4)$$

where α and ε are the azimuth and elevation angles (degrees), respectively (see Fig. 1), and B_α and B_ε are the azimuth and elevation beamwidths.

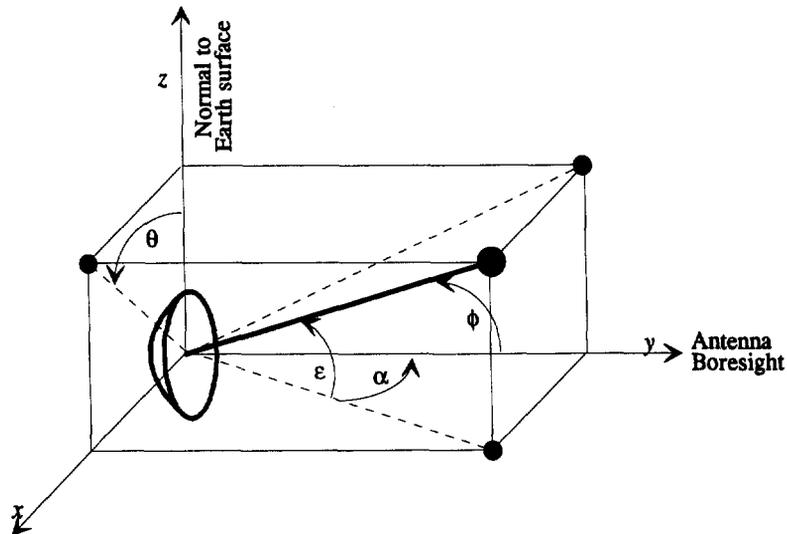


Figure 1: Antenna geometry and spherical coordinates²

² Figure 1 is reproduced from "Average Antenna Gain of Part 15 Devices as Seen by a Low Earth Orbit Satellite," attached to WINForum *ex parte* letter of December 6, 1996.

Based on this antenna model, AirTouch concluded that the average antenna gain would be about 2 dBi at maximum, with that maximum occurring at a beamwidth of about 60°.

MSS interests still seem to base their calculations and expectations of interference on that result. In fact, Exhibit 1 of the January 2 MSS letter states that "Globalstar considers the true average gain of the population of WDN [Wideband Data Network] devices, including those using antennas with gains greater than 6 dBi, to be between 1 and 2 dBi." Unfortunately, no technical data or analysis is provided by the MSS interests to support this view. Moreover, it seems to ignore the fact that on December 6, 1996, WINForum filed an *ex parte* letter with two detailed technical attachments providing extensive analysis of the average antenna gain of the unlicensed devices, as seen by the satellite.

As was explained in the second attachment to that letter, any antenna that neither dissipates nor creates energy must meet the condition:

$$\frac{1}{4\pi} \int_{-\pi}^{\pi} \int_{-\pi/2}^{\pi/2} G(\alpha, \varepsilon) \cos \varepsilon d\varepsilon d\alpha = 1. \quad (5)$$

It was shown in the Appendix to that attachment that for the AirTouch antenna pattern:

$$\begin{aligned} \frac{1}{4\pi} \int_{-\pi}^{\pi} \int_{-\pi/2}^{\pi/2} G_{AT}(\alpha, \varepsilon) \cos \varepsilon d\alpha d\varepsilon &\cong 1 + \frac{27000(\pi/180)^2}{2 \ln 10} e^{-B_e^2/2 \ln 10} \\ &= 1 + 1.786e^{-B_e^2/2 \ln 10}, \end{aligned} \quad (6)$$

where B_e is in radians. The AirTouch formula therefore has an excess gain (i.e., creates energy) that ranges from about 4.4 dB for small elevation beamwidths to about 3.8 dB for a 60° beamwidth. An energy-conserving antenna gain formula with the same relative gain as the AirTouch formula would be obtained by dividing the original AirTouch formula (4) by (6), so that (5) is satisfied.

Clearly, the AirTouch result for the average antenna gain is in error, because it is based on an antenna pattern that violates the laws of physics. The attachments to the December 6 WINForum letter provided analyses of average antenna gain for several different antenna types (including the corrected AirTouch antenna), and different distributions of unlicensed devices over the Earth's surface. It was concluded that the average gain is less than 0 dBi for antennas with any significant directivity, and that it is the actual transmit power (input to the antenna terminals) that determines the interference received by the satellite, not the average EIRP. It is important to note that these analyses did not assume any power backoff for high-gain antennas. Given the backoff required by the FCC rules for gains exceeding 6 dBi, use of a 0 dBi average antenna gain is conservative (may overestimate the actual interference).