EX PARTE OR LATE FILED

ORIGINAL

WILEY, REIN & FIELDING
1776 K STREET, N.W.
WASHINGTON, D.C. 20006

ERIC W. DESILVA
(202) 828-3182

FACSIMILE
(202) 429-7049

December 23, 1996

RECEIVED
DEC 23 1996
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.; Room 222
Washington, D.C. 20554

Re: Notification of *Ex Parte* Contact in ET Docket No. 96-102

Dear Mr. Caton:

It has recently come to our attention that the following ex parte material may not have been filed with the Commission in the proper docket. On December 12, 1996, Eric W. DeSilva, counsel to the Wireless Information Network Forum ("WINForum"); Henry Goldberg, counsel to Apple Computer, Inc.; Jay Padgett from Lucent Technologies, Inc.; Donald Johnson from Lucent Technologies, Inc., Jim McDonald from Motorola, Inc.; and Kwai Lum, from Industry Canada, met with Bruce Franca and Michael Marcus from the Office of Engineering and Technology and Karl Kensinger from the International Bureau to discuss spectrum sharing between wireless local area networks and mobile satellite services in the 5.15-5.25 GHz band. A copy of the following documents, prepared by WINForum, were left with the meeting participants.

Should you have any questions regarding this notification, please contact the undersigned at (202) 828-3182.

Respectfully submitted,

Eric W. DeSilva

Encl.

No. of Copies rec'd 0+1
List ABCDE

ATTACHMENT 1

EFFECT OF NII/SUPERNET DEVICE DEPLOYMENT ON GLOBALSTAR™ CAPACITY

Introduction and Abstract

In ET Docket 96-102, the Federal Communications Commission has proposed to allow the operation of unlicensed "NII/SUPERNet" devices in the bands 5150-5350 MHz and 5725-5875 MHz, under Part 15 of its Rules. The band 5150-5250 MHz is also used for the feeder uplink in the Mobile Satellite Service (MSS). The feeder uplink from the terrestrial gateway plus the associated downlink to the subscriber unit (i.e., a portable handset) constitute the forward link. Concerns have been raised by MSS interests about the potential for interference from the NII/SUPERNet devices to the MSS forward link. Specifically, AirTouch Communications has analyzed the capacity reduction to the Globalstar system that might occur due to transmissions from the NII/SUPERNet devices.

On November 1, 1996, Apple Computer and WINForum jointly proposed a set of Part 15 rules to regulate operation of NII/SUPERNet devices in the 5150-5250 MHz band which would prevent the NII/SUPERNet devices from causing harmful interference to the MSS. In this paper, the AirTouch capacity reduction formula is used to calculate the effect on Globalstar of the NII/SUPERNet devices, assuming that the Apple/WINForum proposal is adopted. The AirTouch assumptions on outdoor deployment and building attenuation are used in the calculations. From these calculations, it is clear that the effect of the NII/SUPERNet devices on Globalstar would be insignificant, even with unrealistically aggressive assumptions about the transmit duty cycle of NII/SUPERNet devices. For example, 30 million NII/SUPERNet devices, each operating at a duty cycle of 50% (i.e., every unit is always either transmitting or receiving), would cause a reduction in the baseband signal-to-noise ratio of only about 0.003 dB, and a capacity reduction (according to the AirTouch formula) of less than one-tenth of one percent. With more realistic assumptions about NII/SUPERNet operation (e.g., a 1% average duty cycle), the impact would be vanishingly small. Considering that the Globalstar forward link includes more than 13 dB of margin, it is clear that the NII/SUPERNet devices will not have any significant impact on the operation of Globalstar.

It is concluded that it would be in the public interest for the Commission to adopt the Apple/WINForum proposal, which would allow the NII/SUPERNet devices adequate flexibility, while protecting MSS from the possibility of harmful interference. Restrictions more severe than those proposed by Apple and WINForum are unnecessary to protect MSS, and would undermine the viability of NII/SUPERNet devices.

The AirTouch Analysis

On November 27, 1996, AirTouch Communications filed an *ex parte* document (Attachment 2) which included two figures showing the capacity degradation to the Globalstar mobile satellite system that would reportedly result from various numbers of NII/SUPERNet devices in the 5150-5250 MHz band, which is used for the Globalstar

feeder uplink. Although the basis for these curves was not provided, they seem to have been derived using the formula on page 4 of the Appendix to the AirTouch Reply Comments in ET Docket 96-102.[1] That formula is:

$$\Delta C = \frac{10^{I_t/10}}{10^{I_{p15}/10} + 10^{I_t/10}}, \tag{1}$$

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

AirTouch calculates the NII/SUPERNet 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 NII/SUPERNet 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 assumed in the first AirTouch figure in Attachment 2), $i_{p15} = 3.2 \times 10^{-4} N_M d\, i_t$, where $i_{p15} = 10^{I_{p15}/10}$ W/Hz, $i_t = 10^{I_t/10}$W/Hz, N_M is the total number of NII/SUPERNet devices (millions) in the 5150-5250 MHz band, and d is the average duty cycle per device. Substituting into (1), ΔC then becomes:

$$\Delta C = \frac{i_t}{i_{p15} + i_t} = \frac{1}{1 + 3.2 \times 10^{-4} N_M d}, \tag{2}$$

The percentage capacity decrease as shown on the figures in Attachment 2 is:

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

The bound is tight for small $\Delta_{\%}$, and it can be seen that it agrees with the curves in the first figure in Attachment 2.

In the second figure of Attachment 2, AirTouch assumes that 5% of the devices are operating outdoors. If G is the effective average antenna gain of the outdoor devices, then the effective number of indoor devices is:

$$N_{M,eff} = N_M\left(0.05 \cdot 10^{(G+17)/10} + 0.95\right). \tag{4}$$

[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*].

If $G = 2$ dBi as AirTouch assumes, then $N_{M,eff} = 4.9N_M$ and $\Delta_{\%} < 0.16N_M d$. The upper bound is slightly above the upper curve for the higher values of $\Delta_{\%}$, as would be expected.

Globalstar Capacity Degradation under the Apple/WINForum Proposal

On November 1, 1996 Apple Computer and WINForum jointly filed a proposal for rules governing NII/SUPERNet devices operating in the 5150-5250 MHz band, which would impose the following restrictions:

1) For devices operated indoors and in the 5.15-5.25 GHz band, a maximum burst-average transmit power of 10 dBm + 10 log B or 24 dBm (250 mW), whichever is less, where B is the 20-dB emission bandwidth in MHz.
2) A provision for outdoor operation in the 5.15-5.25 GHz band with a maximum 60-second average transmit power of 0 dBm + 10 log B or 14 dBm (25 mW), whichever is less.
3) In both cases, reduction of these maximum power limits by the amount by which the antenna gain exceeds 6 dBi (as in 47 CFR 15.247).

The AirTouch formula will be used here to calculate the impact on Globalstar's capacity, with several minor changes in parameters:

- 3 dB will be added to the path loss, to account for the fact that the Globalstar feeder link uses circular polarization, and the polarization of the signals from the NII/SUPERNet devices will be random.
- The average antenna gain for outdoor NII/SUPERNet devices will be assumed to be 0 dBi, regardless of the gains of individual antennas, based on extensive analysis by members of WINForum (see WINForum's *ex parte* letter of December 6, 1996). During the course of that analysis, an error of roughly 4 dB in the AirTouch antenna gain analysis was discovered. This error was partially offset by an error in AirTouch's assumed distribution of NII/SUPERNet devices over the Earth's surface.
- The total number of NII/SUPERNet devices will be assumed to be evenly-distributed over the entire 350 MHz of the proposed spectrum allocation: 5.15-5.35 GHz and 5.725-5.875 GHz. The bandwidth per device will be assumed to be 20 MHz, consistent with the AirTouch analysis.
- The value of I_t used by AirTouch will be increased to reflect a realistic receiver noise figure. The value used by AirTouch was based on a receiver noise temperature of 293° K (room temperature) for the subscriber unit.[2] Even a low-noise receiver front-end will have a noise figure greater than 0 dB. A 2-dB noise figure will be used, which equates to a noise temperature of about 460° K. With that change, $I_t = -201.2$ dBW/Hz (the full 2 dB increase is not reflected here because the other components of I_t are assumed unchanged).

[2]This was taken from the February 29, 1996 Globalstar "Applications for Modification to Order and Authorization for GLOBALSTAR™ 19-DSS-P-91(48) and CSS-91-014, tables 3 and 4.

The 17-dB building attenuation and the 5% outdoor usage assumed by AirTouch will remain the same, as will the AirTouch expression for capacity degradation in (1).

With these parameters, $i_{p15} = 3.1 \times 10^{-5} N_M d i_t$ and the percentage capacity decrease, assuming all devices operate indoors, becomes:

$$\Delta_{\%} = 100\left(\frac{3.1\times 10^{-5} N_M d}{1+3.1\times 10^{-5} N_M d}\right) < 0.0031 N_M d. \tag{5}$$

Under the Apple/WINForum proposal, outdoor devices would be limited to a 60-second average transmit power that is 10 dB less than the "instantaneous" (burst-average) limit for indoor devices. Hence, if an outdoor device is transmitting with duty cycle d, the power limit is:

$$P_{out} = \begin{cases} P_{in}, & d \le 0.1 \\ 0.1 P_{in}/d, & d > 0.1 \end{cases} \tag{6}$$

where P_{in} and P_{out} are the transmit power limits for indoor and outdoor devices, respectively. It will be assumed here that all devices are transmitting the maximum allowed power, so outdoor devices transmit at the highest level allowed by the duty cycle. This clearly is a worst-case assumption.

From (6), the effective number of indoor devices $N_{M,eff}$ is related to the total number of devices by:

$$N_{M,eff} = \begin{cases} N_M\left(0.05\cdot 10^{17/10} + 0.95\right) & d \le 0.1 \\ N_M\left(0.05\cdot 10^{17/10}\cdot 0.1/d + 0.95\right) & d > 0.1 \end{cases} \tag{7}$$

Therefore,

$$N_{M,eff} d = \begin{cases} 3.45 N_M d & d \le 0.1 \\ (0.25 + 0.95d) N_M & d > 0.1 \end{cases} \tag{8}$$

Substituting $N_{M,eff} d$ per (8) for $N_M d$ in (5) gives $\Delta_{\%}$ for the mix of indoor and outdoor devices. Figure 1 shows the resulting Globalstar capacity degradation vs. the number of NII/SUPERNet devices for various duty cycles. The upper bound is:

$$\Delta_{\%} < \begin{cases} 0.01 N_M d & d \le 0.1 \\ \left(7.75\times 10^{-4} + 2.94\times 10^{-3} d\right) N_M & d > 0.1 \end{cases} \tag{9}$$

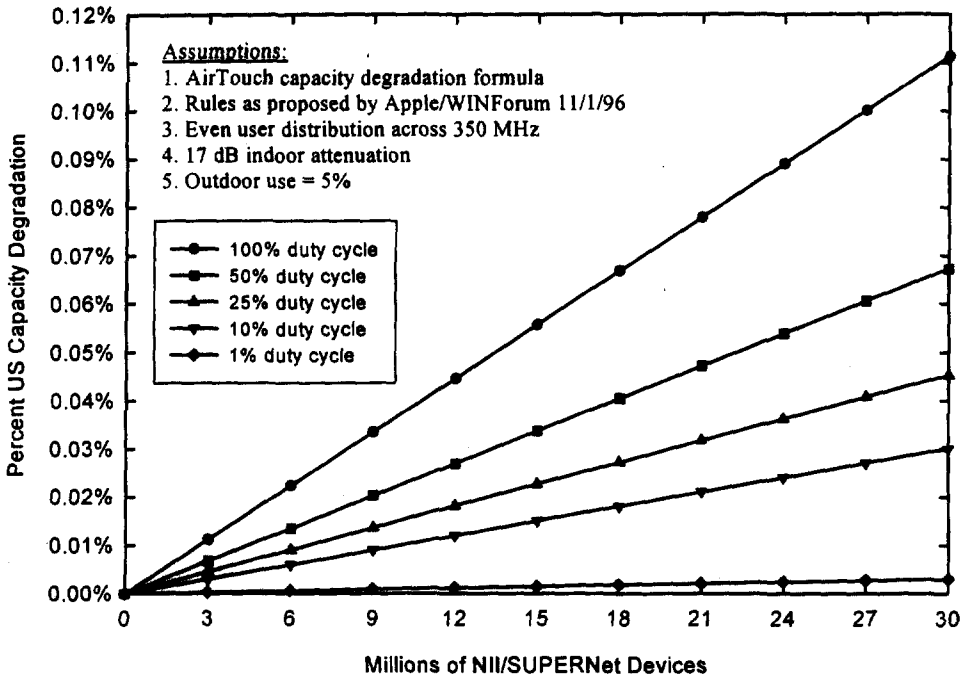


Figure 1: *Globalstar US capacity degradation from NII/SUPERNet devices using the AirTouch formula.*

The average NII/SUPERNet duty cycle is projected to be 1% or less.[3] In that case, the Globalstar capacity degradation with 30 million NII/SUPERNet devices is less than 0.003%. However, other duty cycles are shown for reference and comparison with the AirTouch results. Note that in the pathological case in which all devices are always either transmitting or receiving, the duty cycle is 50% and even then, the capacity reduction is about 0.07%. It is clear from this that even if NII/SUPERNet device deployment approaches that of cellular service in the U. S., and all devices are always active, the impact on Globalstar is negligible. With more realistic deployment and duty cycle assumptions, the impact is essentially nonexistent.

Another useful way of assessing the impact of the NII/SUPERNet devices is to calculate the reduction in E_b/N_0, the baseband signal-to-noise ratio, at the subscriber unit, given (in dB) by:

[3]See Exhibit A of WINForum's September 12, 1996 letter to Warren Richards, Chair, U.S. National Committee, International Communications and Information Policy, U.S. Department of State, filed as *ex parte* in ET Docket 96-102 on October 21, 1996.

$$\Delta(E_b/N_0) = 10\log\left(\frac{E_b/(i_{p15}+i_t)}{E_b/i_t}\right) = 10\log\left(\frac{i_t}{i_{p15}+i_t}\right) \approx -\frac{10}{\ln 10}\left(\frac{i_{p15}}{i_t}\right)\text{dB}, \tag{10}$$

with

$$\frac{i_{p15}}{i_t} = \begin{cases} 10^{-4} N_M d & d \le 0.1 \\ \left(7.75\times10^{-6} + 2.94\times10^{-5} d\right) N_M & d > 0.1 \end{cases}. \tag{11}$$

The approximation in (10) uses the first term in the Taylor series for $\ln x$. Figure 2 shows $\Delta(E_b/N_0)$ vs. N_M for various values of d (computed using the exact expression, not the approximation).

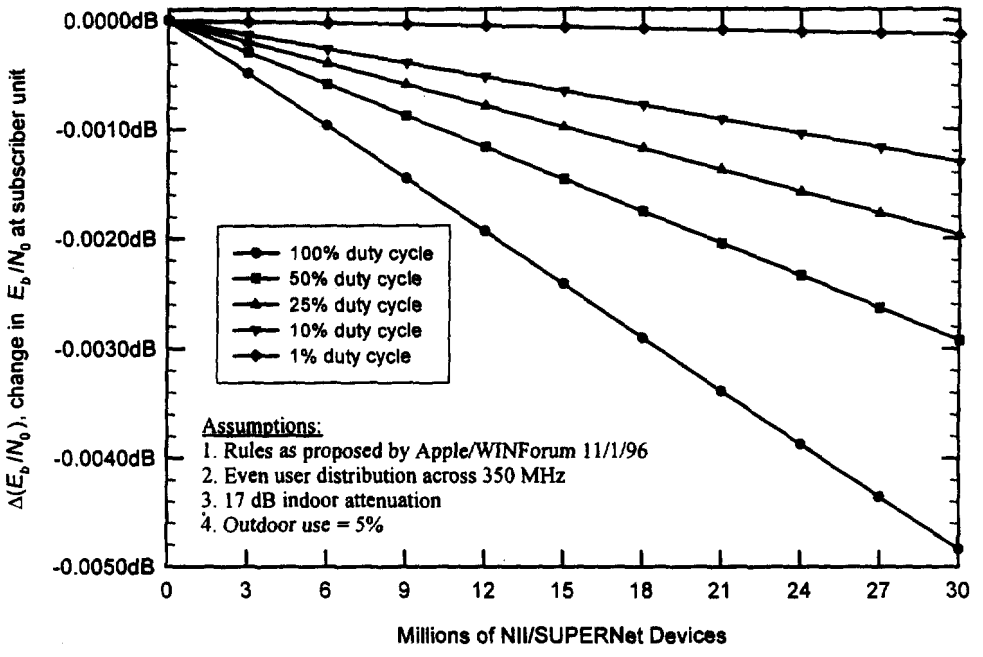


Figure 2: *Reduction in E_b/N_0 at the Globalstar subscriber unit due to NII/SUPERNet devices.*

Substituting (11) into the approximation of (10) gives:

$$\Delta(E_b/N_0) \approx \begin{cases} -4.65\times10^{-4} N_M d\,\text{dB} & d \le 0.1 \\ -\left(3.37\times10^{-5} + 1.28\times10^{-4} d\right) N_M\,\text{dB} & d > 0.1 \end{cases} \tag{12}$$

For 30 million NII/SUPERNet devices and a 1% duty cycle, E_b/N_0 at the Globalstar subscriber unit is reduced only 0.00014 dB. Even with the pathological 50% duty cycle, the reduction is only about 0.003 dB. Considering that the available link margin is 16 dB

with diversity and both paths clear, and 13.5 dB with one path fully blocked,[4] the negligible amount of degradation that could be caused by NII/SUPERNet devices would not impact service.

Conclusion

The Globalstar capacity reduction that would result from NII/SUPERNet devices has been analyzed, using the AirTouch formula and assumptions regarding building attenuation and percentage of outdoor operation, and assuming that the Apple/WINForum proposal of November 1, 1996 is adopted. In addition, the impact on the baseband signal-to-noise ratio E_b / N_0 has been analyzed. It is clear that if the Apple/WINForum proposal is adopted, the effect of NII/SUPERNet devices on the operation of the Globalstar system will be insignificant. The Part 15 rules proposed by Apple and WINForum will allow NII/SUPERNet devices adequate flexibility, while protecting the services to be provided by Globalstar. Restrictions on NII/SUPERNet devices operation more severe than those proposed by Apple and WINForum are unnecessary, and would only serve to undermine the usefulness of NII/SUPERNet devices.

[4]See Tables 3 and 4 of Globalstar, Feb. 29, 1996, *op. cit.*

SHARING BETWEEN MSS AND NII/SUPERNET IN THE 5150-5250 MHZ BAND

- MSS interests have expressed concerns about the potential for interference from NII/SUPERNet to the feeder uplink.
- Specifically, AirTouch has calculated the capacity reduction to Globalstar™ vs. NII/SUPERNet device deployment.
- Apple and WINForum have proposed (11/1/96) operating restrictions for NII/SUPERNet devices, intended to protect MSS.
- Application of the AirTouch capacity reduction formula and assumptions demonstrates that the Apple/WINForum proposal will protect MSS as intended.

THE AIRTOUCH ANALYSIS OF GLOBALSTAR™ CAPACITY REDUCTION

- Calculates additive interference from NII/SUPERNet devices at the subscriber unit (handset).
- Assumes 17 dB building attenuation, 20 MHz NII/SUPERNet bandwidth with 200 mW transmit power (i.e., 10 mW/MHz), 2 dBi average gain for outdoor devices.
- With no outdoor use and 30 million devices operating in the 5150-5250 MHz with 10% duty cycle AirTouch calculates a capacity reduction of less than 0.1%.
- With 5% outdoor use, 30 million devices with 10% duty cycle would reduce capacity less than 0.5%, according to the AirTouch formula.
- The actual average duty cycle is expected to be much lower (less than 1%).

THE APPLE/WINFORUM NOVEMBER 1 PROPOSAL

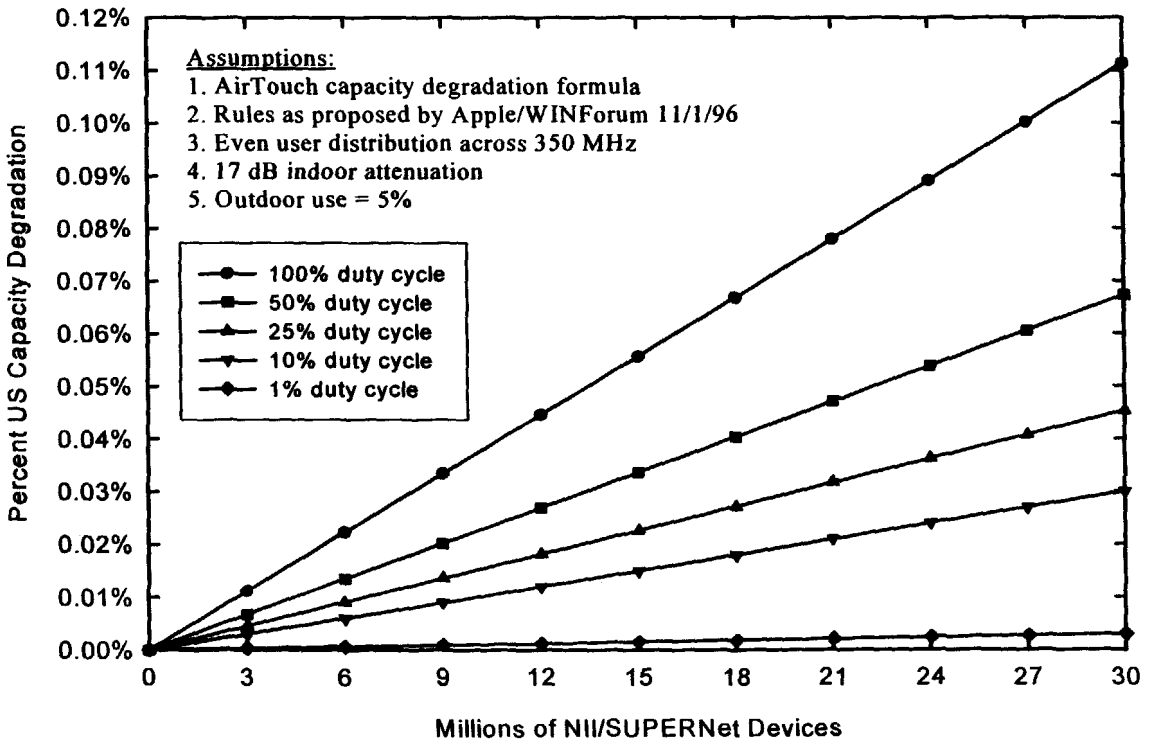
1. For devices operated indoors and in the 5.15-5.25 GHz band, a maximum burst-average transmit power of 10 dBm + 10 log B or 24 dBm (250 mW), whichever is less, where B is the 20-dB emission bandwidth in MHz.
2. A provision for outdoor operation in the 5.15-5.25 GHz band with a maximum 60-second average transmit power of 0 dBm + 10 log B or 14 dBm (25 mW), whichever is less.
3. In both cases, reduction of these maximum power limits by the amount by which the antenna gain exceeds 6 dBi (as in 47 CFR 15.247).

APPLICATION OF THE AIRTOUCH FORMULA ASSUMING THE APPLE/WINFORUM PROPOSED RULES

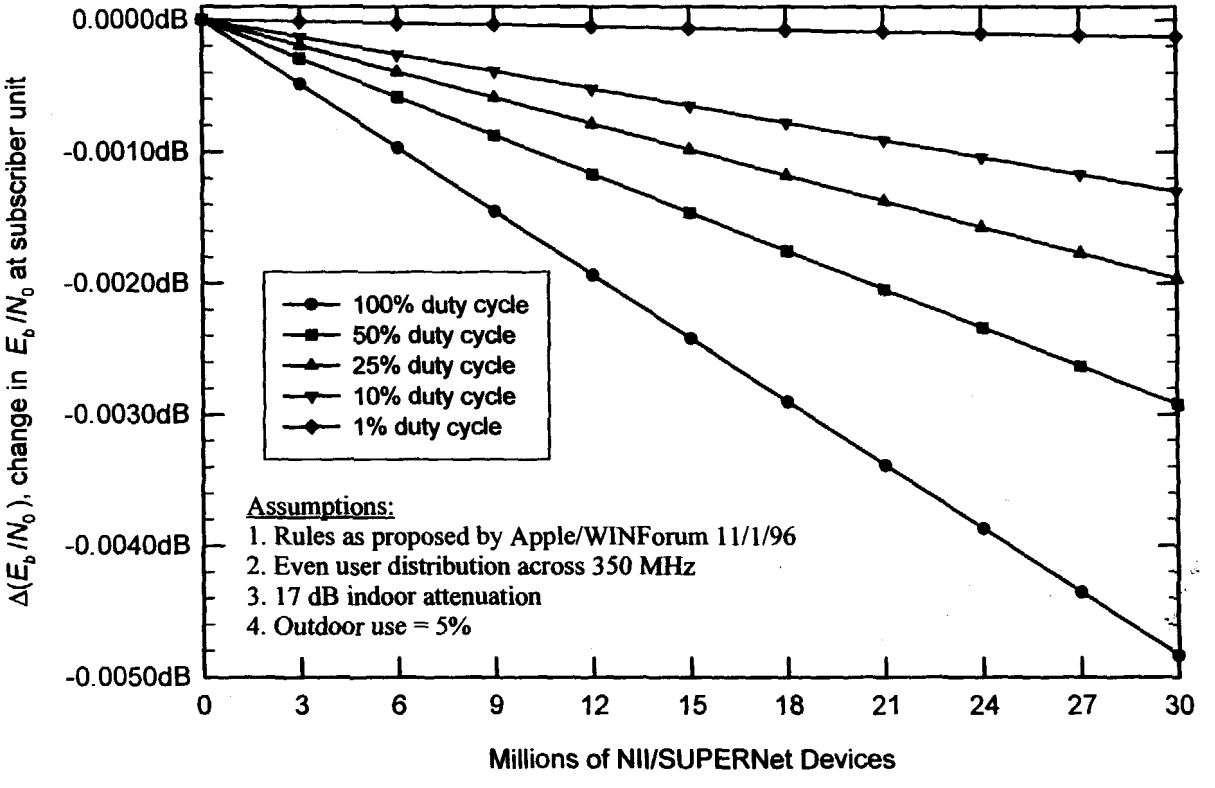
Assumptions

- **17 dB building attenuation, 5% outdoor use.**
- **20 MHz NII/SUPERNet device channel bandwidth.**
- **Even distribution of devices across 350 MHz.**
- **0 dBi average antenna gain for NII/SUPERNet devices (see the WINForum December 6 *ex parte*).**
- **3 dB polarization loss between NII/SUPERNet devices and the satellites due to random polarization of NII/SUPERNet transmissions.**
- **2 dB receiver noise figure for Globalstar™ subscriber unit.**

RESULTS FROM THE AIRTOUCH FORMULA ASSUMING THE APPLE/WINFORUM PROPOSED RULES



REDUCTION OF E_b/N_0 AT THE SUBSCRIBER UNIT ASSUMING THE APPLE/WINFORUM PROPOSED RULES



Note: the Globalstar™ forward link has over ~~14~~ 13 dB of margin