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

In the matter of	)	
	)	
Revision of Part 15 of the Commission's Rules	)	ET Docket No. 98-153
	)	
Regarding Ultra-Wideband Transmission Systems	)	
	)	

PETITION FOR RECONSIDERATION OF THE SATELLITE INDUSTRY ASSOCIATION

SATELLITE INDUSTRY ASSOCIATION

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The Satellite Industry Association ("SIA"), pursuant to Section 1.429 of the Commission's rules, hereby seeks reconsideration of the Second Report and Order and Second Memorandum Opinion and Order ("2nd R&O") in the above-captioned proceeding.[1] This petition is limited to one element of the 2nd R&O: the rules that are required to prevent ultra-wideband ("UWB") devices from interfering with fixed satellite service earth station receivers operating on C-band downlink frequencies (*i.e.*, 3650-3700 MHz and 3700-4200 MHz).

The Satellite Industry Association is a U.S.-based trade association providing worldwide representation of the leading satellite operators, service providers, manufacturers, launch services providers, remote sensing operators, and ground equipment suppliers. SIA is the unified voice of the U.S. satellite industry on policy, regulatory, and legislative issues affecting the satellite business.[2]

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[1] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems,* Second Report And Order And Second Memorandum Opinion And Order, FCC 04-285 (Dec. 16, 2004).

[2] SIA includes Executive Members: The Boeing Company; Globalstar LLC; Hughes Network Systems, Inc.; ICO Global Communications; Intelsat; Iridium Satellite LLC; Lockheed Martin Corp.; Loral Space & Communications Ltd.; Mobile Satellite Ventures; Northrop Grumman Corporation; PanAmSat Corporation and SES Americom, Inc. and Associate Members Eutelsat Inc., Inmarsat Ltd., New Skies Satellites Inc., Stratos Global Corporation, and The DirecTV Group.

Introduction and Summary

A significant amount of new information has become available since the Commission established its interference standards for UWB devices. The new information calls into question both of the key parameters that the Commission relied on when examining compatibility between UWB and FSS, which are as follows:

(i) the interference-to-noise ("I/N") ratio that is needed to protect C-band FSS downlinks, based on which the required power density after the receive earth station antenna (P_d) can be calculated; and

(ii) the EIRP density limit (dBm/MHz) for UWB devices ($EIRP_{max}$) that will ensure that P_d is not exceeded.

Multiple studies within and outside the ITU have concluded that the 0 dB I/N ratio that underlies the Commission's standards is too high, and should be reduced by 20 dB or more. Similarly, multiple studies within and outside the ITU establish that the – 41.3 dBm/MHz $EIRP_{max}$ limit adopted by the Commission for UWB devices is way short of what is required to protect C-band downlinks. These studies demonstrate that, to provide adequate protection, the limit might have to be reduced by 30 dB or more.

The results of these studies are summarized in Sections I and II of this petition. On reconsideration, the Commission should revise its EIRP density limit of -41.3 dBm/MHz to take the new information into account.

Section III of this petition addresses an engineering study conducted by Alion Science and Technology on behalf of the Coalition of C-band Constituents. Although the Commission was able to replicate the result of the study, in the 2nd R&O it rejected the report's conclusions, finding that the assumptions underlying the conclusions were not realistic. For reasons that are discussed in Section III, however, the assumptions were rooted in sound engineering judgments and reasonable projections as to where the UWB market is headed. On reconsideration, therefore, the Commission should give credence to the report's findings.

In the 2nd R&O, the Commission stated that it could rely on its complaint procedures to ensure that UWB interference to C-band downlinks gets corrected. For reasons that are discussed in Section IV of this petition, however, complaint procedures are inadequate when interference is intermittent and could have originated from any one of a large number of devices that move from place to place. In a similar context involving radar detectors, the Commission acknowledged the futility of attempting to prevent interference once large numbers of interfering devices have entered the marketplace. It is essential, therefore, that the Commission have adequate UWB power limits in place.

The potential for interference to C-band downlinks is a matter of grave concern to the satellite industry. FSS operators use C-band frequencies to serve customers requiring a high degree of reliability. Among other things, these customers use C-band frequencies for program distribution to cable head-ends and radio/TV broadcast stations, broadband communications to U.S. Navy vessels, commercial weather data distribution to airlines and pilots, and position location and status for trucking fleets. UWB interference could jeopardize the billions of dollars that FSS operators, customers, and distributors have invested in FSS systems for commercial and national security purposes, and could interrupt vital FSS services. Given these stakes and the accumulating body of evidence showing that the rules currently expose C-band downlinks to serious levels of interference, the Commission should reexamine its UWB interference standards.

Discussion

I. The COMMISSION'S INTERFERENCE TO NOISE RATIO (I/N) OF 0 dB DOES NOT PROTECT FSS EARTH STATIONS

The Commission's initial power density analysis was based upon incorrect assumptions and data. The Commission derived the "power density after the receive earth station antenna" (P_d) that it believed was needed to protect FSS

downlinks based on an interference-to-noise ratio ("I/N") of 0 dB.[3] However, subsequent to the First Report and Order, information has come to light demonstrating that an I/N of 0 dB is inadequate. This information includes an official ITU recommendation; the findings of an ITU working party and an ITU task group; and the results of a study conducted by the European Conference of Telecommunications Administrations ("CEPT").[4] These studies show that an I/N on the order of -20 dB is needed to protect FSS downlinks from interference.

The Commission should reconsider its use of a 0 dB I/N in light of these new facts. In connection with its reconsideration, moreover, the Commission should reexamine its reliance on Appendix 7 of the 1998 edition of the ITU's Radio Regulations for the 0 dB figure. As is discussed below in greater detail, that appendix is no longer in force, and even when it was in force it had no relevance to the issue of the appropriate I/N level for UWB devices.

A. Based on Information That Was Not Before the Commission When It Adopted the 1st R&O, the 0 dB I/N Figure Should be Reduced Substantially.

The value for I/N should be reduced from 0 dB to -20 dB. Although some parties believe that I/N should be even lower (*e.g.,* -23 dB), a -20 dB protection level is supported by the majority view expressed in ITU and European meetings addressing this subject.[5] The findings of these ITU and European meetings are discussed below.

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[3] *See Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, First Report and Order, FCC 98-153 (Apr. 22, 2002) ("1st R&O"), Paragraph 140 and footnote 213; *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, Memorandum Opinion and Order and Further Notice of Proposed Rule Making, FCC 03-33 (March 12, 2003), Paragraph 127 and footnote 300.

[4] Citations to these documents are given in the discussion that follows.

[5] SIA previously proposed an I/N value of between -10 dB and -12.2 dB. *See* Petition for Reconsideration of the Satellite Industry Association, page 8 (May 22, 2003). In retrospect, this value was overly generous, because it corresponds to the standard allowance for *primary* services. Having reviewed the ITU and European papers, SIA is convinced that -20 dB is the appropriate figure.

i. Recommendation ITU-R S.1432

ITU-R S.1432 addresses the issues of allotting interference to different sources as a percentage of total noise.[6] In particular, "recommends 4" of this ITU Recommendation[7] sets the interference to be allotted to all non-primary sources at 1% of the total noise.[8]

An I/N of -20 dB means that the allotment of non-primary sources in the interference budget is 1% of the total noise as provided for in ITU-R S.1432. An I/N of 0 dB, on the other hand, corresponds to an allotment of 100% of the total noise to interference from all non-primary sources. The Commission's use of a 0 dB I/N, therefore, exposes C-band FSS downlinks to 100 times the level of interference from UWB devices than would be the case under Recommendation ITU-R S.1432 (*i.e.*, 100% of the total noise instead of 1% of the total noise).

FSS operators rely on Recommendation ITU-R S.1432, to develop their C-band link budgets, and they make contractual commitments to their customers based on these link budgets. Satellite links designed to have a certain amount of interference from non-primary sources (1% of the total noise) cannot be expected to work properly with an interference from non-primary sources that is 100 times larger than budgeted. For that reason alone, it is essential that the Commission reconsider its use of a 0 dB I/N.

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[6] Recommendation ITU-R S.1432 (2000), "Apportionment of the Allowable Error Performance Degradations to Fixed-Satellite Service (FSS) Hypothetical Reference Digital Paths Arising from Time Invariant Interference for Systems Operating Below 15 GHz".

[7] "that error performance degradation due to interference at frequencies below 15 GHz should be allotted portions of the aggregate interference budget of 32% or 27% of the clear-sky satellite system noise in the following way:

– 25% for other FSS systems for victim systems not practising frequency re-use;

– 20% for other FSS systems for victim systems practising frequency re-use;

– 6% for other systems having co-primary status;

– 1% for all other sources of interference"

[8] Some have proposed that a smaller I/N should be associated with UWB sources since other non-primary sources could also interfere with FSS downlinks. Then the aggregate from all non-primary sources would exceed 1%. For instance, an I/N=-23 dB would correspond to allotting half of the 1% allowance to UWB sources. Despite the solid grounds for using an I/N lower than -20 dB, most analyses conducted internationally have been based on I/N of -20 dB, in part due to the difficulties in apportioning this 1% allowance among several possible sources. SIA is not going to further dwell on this point and in what follows a -20 dB I/N value is accepted as a reasonable choice.

The United States Administration, moreover, contributed to and supported the development of Recommendation ITU-R S.1432 within Study Group 4 of the ITU Radiocommunication Sector. Absent exceptional circumstances, the Commission should not be basing its rules on standards that conflict with internationally-recognized principles.

ii. Questions With Respect to the Applicability of Recommendation ITU-R S.1432 Raised in a Document Submitted to the ITU by the United States

Despite the fact that the United States contributed to and supported the development of Recommendation ITU-R S.1432 within Study Group 4, it submitted a document to the ITU-R Working Party 4A ("Efficient Orbit Spectrum Utilization") meeting held in Geneva in October 2004[9] in which the applicability of Recommendation ITU-R S.1432 as a basis for defining the levels required to protect FSS systems was questioned. SIA strongly opposed submission of this document as formally detailed in the document included here as Exhibit 1 which was sent to the ITAC-R National Committee as on September 30, 2004[10].

As predicted in the SIA document, the suggestions in the United States document of exploring alternatives to the 1% allowance for all non-primary sources of interference did not receive support at the ITU meeting. As a result, Working Party 4A did not change its previous conclusion that, as per Recommendation ITU-R S.1432, the aggregate interference from all non-primary sources should not exceed 1% of the total noise (see discussion in the next section of this petition).

The detailed justification of why the 1% allowance in Recommendation ITU-R S.1432 is applicable to the current situation is given in Exhibit 1, where it is also emphasized why harmful interference cannot be used as standard in this case. This is an important point that is worth highlighting again here.

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[9] Document 4A/115 (6 October 2004), Response to Liaison Statement from TG 1/8 "Compatibility Between Ultra Wideband (UWB) and FSS Systems".

[10] In Exhibit 1, the United States submission to the ITU meeting is referred to as Document USWP4A/12 which was the document designation during the domestic preparation for the Geneva meeting.

As discussed above, satellite links operate with link margins that are set to guarantee availability levels that an operator is committed, under contract, to provide to a given customer. These margins will account for variations in propagation conditions (*e.g.* fading), equipment aging and other link degradations. An interfering emission may at a given point in time use up most of this margin without causing "harmful" interference, *i.e.*, without producing any noticeable degradation to the link. However, this does not mean that this interference is acceptable as it would put the link in a state in which a minimum variation in the conditions which the margin was intended to compensate for would (in the absence of such margin) severely degrade the link.

In the U.S. submission to ITU-R Working Party 4A (Document 4A/115), it was stated that in a typical link a 1% interference increase would be "practically immeasurable". But it should come as no surprise that the degradation associated with a 1% interference increase is small, given that the degradation is being caused by non-primary sources. In any event, as pointed out in Exhibit 1, no matter how small this degradation is, it represents what was budgeted for in the design of satellite links currently operating.

To illustrate this point, one can apply the "model analysis" proposed as an alternative in Document 4A/115, and included in its Annex 1, assuming that instead of I/N= -20 dB (1% allowance) we have I/N = 0 dB (100% allowance) as proposed by the Commission. The results, presented here as Exhibit 2, show that I/N = 0 dB would degrade the link by more than 2 dB. The margin of C-band links is usually of this order of magnitude or lower and therefore I/N = 0 dB would cause this link to collapse or eat up most of its margin.[11]

[11] Lower values of I/N could still eat significant portions of the link margin which, as noted above, are there to absorb propagation conditions, equipment aging and other link degradations. If significant portions of the margin are used to cope with interference sources producing more degradation than accounted for in the link design, the link becomes unprepared to deal with all the sources of degradation that the margin was supposed to cope with in the first place.

iii. Working Party 4A of the ITU Radiocommunication Sector Reaffirmed That Aggregate Interference From UWB Devices Should Be Smaller Than 1%

In a liaison statement to Task Group 1/8 (Compatibility Between Ultra-Wideband Devices (UWB) and Radiocommunication Services)[12], Working Party 4A stated the following as a result of discussions that took place in its April 2004 meeting:

"WP 4A confirms the allowable interference levels caused by UWB which were previously sent to TG 1/8. Recommendation ITU-R S.1432 contains the allowable degradations to the FSS below 15 GHz. The Recommendation states that for **all** sources of long-term interference that is neither from FSS systems, nor from systems having co-primary status, the allowable interference noise contribution is 1%.

For ease of calculation, 1% can be assumed on the uplink and 1% can be assumed on the downlink when assessing the long-term interference.

WP 4A notes that this 1% value is the total of all sources of interference that are not FSS or co-primary. TG 1/8 should note that only a portion of the total of 1% should be apportioned to UWB.

Short-term interference effects have not been considered by WP 4A."

This conclusion was supported by the vast majority of Working Party 4A participants.

iv. Task Group 1/8 of the ITU Radiocommunication Sector Has Incorporated the 1% Allowance in Several Texts Addressing Compatibility Between UWB and FSS Systems

Consistent with the protection requirements formulated by Working Party 4A, several texts generated at the last meeting of Task Group 1/8 (Geneva, November 2004), and addressing the compatibility between UWB and FSS, incorporate the 1% allowance prescribed by Recommendation ITU-R S.1432 as the protection criterion required by FSS systems. For instance, results of

[12] Annex 26 to Document 4A/78 (10 May 2004), Liaison Statement to Task Group 1/8, "Interference Caused by Ultra Wide-Band Devices Into the Fixed-Satellite Service below 30 GHz".

compatibility with FSS downlinks are expressed in terms of I/N values and the need for further interference mitigation is concluded on the grounds that these values exceed -20 dB[13]. Moreover, Recommendation ITU-R S.1432 is explicitly quoted as setting the "service protection requirement" for FSS[14].

In summary, in the ITU for addressing compatibility between UWB and FSS, an I/N = -20 dB is the consensus choice and, at a minimum, is endorsed by a vast majority of participants.

v. Studies Conducted Within the European Conference of Telecommunications Administrations (CEPT) Also Concluded That I/N = -20 dB Is the Appropriate Protection Requirement for FSS Systems

CEPT (European Conference of Telecommunications Administrations) has recently concluded a comprehensive study of the protection requirements of different radiocommunication services with respect to the interference generated by UWB devices. The results of these studies are contained in Report 64 of the Electronic Communications Committee (ECC)[15] and have concluded that the protection requirement should be based on Recommendation ITU-R S.1432, *i.e.*, should correspond to an I/N value of -20 dB[16]. This study contributes further to the international consensus favoring the -20 dB standard.

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[13] Attachment 3 to Annex 5 to Document 1-8/256 (17 December 04), Working Document Toward a Preliminary Draft New Report, "Studies on Impact of Systems Using UWB Technology on Systems Operating Within the Fixed-satellite Service", see Section A.3.3.1.2.1.

[14] Annex 5 to Document 1-8/256 (20 December 04), Structure of the Report on Impact of Devices Using UWB Technology on Radiocommunication Services, see Table in Section 7 (Conclusions) under A3.

[15] ECC Report 64, "The Protection Requirements of Radiocommunications Systems Below 10.6 GHz from Generic UWB Applications", Helsinki, February 2005. A link to Report 64 can be found at http://www.ero.dk/documentation/docs/doccategory.asp?catid=4&catname=ECC/ERC/ECTRA%20Reports.

[16] See, for instance, item 11 of the Table included in Section 8 (Overall Conclusions of the Report) or Section A11.2.3 of Annex 11(Fixed satellite Service – FSS)

B. The Portion of the ITU Radio Regulations Offered as a Basis for Choosing I/N=0 dB Is Not Applicable to the Situation Under Consideration and Since WRC-2000 Is Not In Force Anymore

The Commission has based its use of I/N=0 dB on Section 2.3.1 of Appendix 7 of the 1998 edition of the ITU Radio Regulations. It should be apparent from the foregoing discussion, however, that the ITU has not adopted a 0 dB standard for I/N. To the contrary, none of the ITU authorities that has addressed the I/N issue – Study Group 4 (Fixed-satellite Service) in Recommendation ITU-R S.1432, Working Party 4A of the ITU Radiocommunication Sector in its liaison statement to Task Group 1/8, and Task Group 1/8 of the ITU Radiocommunication Sector – either looked to Appendix 7 for guidance or even suggested that Appendix 7 is relevant to the I/N issue. The same is true of CEPT.

These circumstances dictate that the Commission reexamine its reliance on Appendix 7. In connection with its reexamination, the Commission also should consider SIA's prior demonstration, which SIA makes again here, that the Commission's reliance on Appendix 7 was misplaced.[17]

Among other things, the 1998 edition of Appendix 7 that was used by the Commission is no longer in force. Neither the subsequent 2001 edition nor the 2004 edition that is currently in force provides any basis for the Commission's use of a 0 dB I/N. Even were the 1998 version in force, the version would be inapplicable to the I/N issue for several reasons.

First, Appendix 7 concerns coordination between two primary services. As such, it has no relevance to situations in which one of the services does not have an allocation, and therefore lacks coordination status.

Second, as stated in footnote 300 of MO&O & FNPRM, the Commission relied on the value of the parameter J given in Table II of the 1998 version of Appendix 7 (J=0 dB for digital systems and -8 dB for analog systems). However,

[17] Although the Commission in the 2nd R&O (¶ 94) dismissed this showing as "repetitious," SIA needed to repeat the showing because the Commission never has addressed the merits of it. The issue of the appropriate I/N level, and the interference consequences that flow from it are fundamental and merit substantive consideration by the Commission.

J is just an intermediate parameter in the calculations and is used with the objective of determining an interference level that is exceeded only for a small percentage of time (short term allowable interference). That is not what we are looking for here because what has to be determined is the long-term interference corresponding to the aggregation of several UWB devices.

Finally, other assumptions associated with the analysis in Section 2.3.1 of Appendix 7 of the 1998 edition of the ITU Radio Regulations are inapplicable to the current situation (*e.g.* the number of interfering sources is n=3). These mismatches provide additional evidence that the superseded version of Appendix 7 was not intended to address the I/N issue.

II. SEVERAL NEW STUDIES CONCLUDE THAT, IN ORDER TO PROTECT FSS DOWNLINKS, THE EIRP DENSITY OF EACH UWB DEVICE WOULD HAVE TO BE MUCH LOWER THAN THE -41.3 dBm/MHz AUTHORIZED BY THE COMMISSION

The maximum EIRP density per UWB device that can be permitted consistent with protecting FSS earth stations can be expressed in terms of the value of $EIRP_{max}$ that will ensure that P_d (allowable power density after the receive FSS earth station antenna) is not exceeded. Several expert bodies recently have examined the question of what is the appropriate EIRP density limit. They uniformly have concluded that protection of FSS systems cannot be ensured unless the value of $EIRP_{max}$ for each UWB device is significantly lower than the – 41.3 dBm/MHz limit adopted by the Commission.

SIA recognizes that developing an EIRP density limit is a difficult exercise that is dependent on the assumptions that are made concerning various parameters.[18] These uncertainties, however, dictate that the Commission err on the side of caution. It is all too possible that the interference generated by UWB devices will exceed what is predicted because the devices will be deployed and

[18] Without pretending to be exhaustive, parameters that have to be defined include: density of UWB devices; average activity factor of UWB devices; geographic distribution of these devices with respect to the interfered-with earth station; percentages of devices that are indoors and outdoors; and propagation models associated with indoor and outdoor devices. The first two of these parameters can be condensed by multiplying them together to create a single parameter (number of simultaneously active UWB devices).

operated in a manner that deviates from the assumptions underlying the derivation of the EIRP density limit.

It is highly significant that multiple groups of experts, each examining this issue and applying its own set of assumptions, have determined that an EIRP density limit is needed that is well below – 41.3 dBm/MHz. This development is particularly significant given that, as discussed in Section 3 below in connection with the "Alion study"[19], the Commission never has developed a set of assumptions concerning parameters on which to base its EIRP density limit. Although in the case of the Alion study the Commission challenged several of the assumptions that had been made, it generally either did not provide an alternative proposal or, to the extent it did provide an alternative, it did not offer any justification for it.

In the remainder of this section, SIA summarizes the findings of several studies conducted in the ITU and in the CEPT. All these studies have initially assumed that each UWB device is radiating – 41.3 dBm/MHz and have concluded that for a wide range of values assigned to other parameters (e.g. UWB density and geographic distribution), the value I/N of -20 dB is significantly exceeded. If I/N of -20 dB is exceeded by 20 or 30 dB this means that in order to provide adequate protection to the FSS the permitted EIRP density should be reduced accordingly by 20 or 30 dB. The Commission needs to reconsider its rules in light of these findings.

A. Analysis Contained in United Kingdom Document Submitted to the June Meeting of Task Group 1/8

As an example of a study where assumptions are clearly stated, Exhibit 3 contains an analysis presented by the United Kingdom to the June 2004 meeting of the ITU-R Task Group 1/8[20]. The effect of outdoor and indoor UWB units is

[19] Evaluation of UWB and Lower Adjacent Band Interference to C-Band Earth Station Receivers, Alion Science and Technology, February 11, 2004.
[20] Document 1-8/152 (2 June 2004), "FSS/Ultra Wideband Compatibility – Aggregate Interference Studies in the Space-to-Earth Direction".

separately considered and a sensitivity analysis is conducted with respect to the density of active UWB devices, the FSS antenna height and elevation angle. For indoor devices a 10 dB building attenuation is included and after the attenuated signal leaves the building a combination of $1/r^2$, $1/r^3$ and $1/r^4$ models is used, depending on the distance from the building (*i.e.*, "r"). The modeling of the UWB density and distribution for the outdoor scenario is simply uniform. For the indoor scenario a detailed model including a certain number of "hot spots" and residential users is described in detail in Section 2 (page 4) of the document included here as Exhibit 3.

For a wide range of parameters characterizing the interference environment, the study determined that I/N significantly exceeds -20 dB for large percentages of time. Depending on the specific assumptions used, moreover, the I/N value of -20 dB can be exceeded by as much as 30 dB, even if only indoor UWB devices are considered. Therefore, in order to protect the FSS under the latter circumstances, $EIRP_{max}$ would have to be reduced to – 71.3 dBm/MHz.

B. Most Recent Conclusions of Task Group 1/8 on the Compatibility Between UWB and FSS

The most recent outcome from ITU-R Task Group 1/8 addressing the compatibility between UWB and FSS contains a summary of several analyses, including that in the UK document discussed in the preceding section[21]. All these analyses lead to values of I/N that exceed -20 dB by different amounts that can be as large as 33 dB.

One of the studies in the Task Group 1/8 document concludes that in order to protect FSS systems to the level corresponding to an I/N of -20 dB, the $EIRP_{max}$ for each UWB device should be limited to -53 dBm/MHz (rural area), -66 dBm/MHz (semi-urban area) and -77 dBm/MHz (urban area). These numbers

[21] Attachment 3 to Annex 5 to Document 1-8/256 (17 December 04), Working Document Toward a Preliminary Draft New Report, "Studies on Impact of Systems Using UWB Technology on Systems Operating Within the Fixed-satellite Service", see in particular Table 6.

have also been tentatively included in the conclusions of the Task Group 1/8 document (section A.3.3.1.2.3) but have not been officially adopted by the group since they appear between square brackets.

There is nothing in the Task Group 1/8 outcome that corroborates the value of -41.3 dBm/MHz proposed by the Commission for $EIRP_{max}$. On the contrary, even if the more extreme numbers are discarded, there is overwhelming evidence that in order to protect FSS systems this number has to be significantly reduced.

C. The Electronic Communications Committee (ECC) of the CEPT Has Recently Issued a Comprehensive Report On the Protection Requirements of Radiocommunication Services Including FSS With Respect to UWB

In February 2005, ECC completed an extensive report addressing the protection requirements of several radiocommunication services vis-à-vis UWB[22]. The conclusions of this report with respect to the protection requirements of FSS downlinks coincide with the tentative conclusions of Task Group 1/8 given in Section B above.

In particular, the $EIRP_{max}$ value of -53 dBm/MHz for rural areas is associated with a density of 5 active devices per km^2 and 100 m exclusion zone; the -66 dBm/MHz value for suburban areas is associated with a density of 50 active devices per km^2 and 50 m exclusion zone; while the -77 dBm/MHz value for a dense urban area is associated with a density of 500 active devices per km^2 and 10 m exclusion zone.

Once again, there is evidence here warranting a reexamination of the number -41.3 dBm/MHz adopted by the Commission for $EIRP_{max}$.

[22] ECC Report 64, "The Protection Requirements of Radiocommunications Systems Below 10.6 GHz from Generic UWB Applications", Helsinki, February 2005

D. ECC Task Group 3 (UWB Issues) Has Produced a Final Draft of the CEPT Report to EC (European Commission) In Response to EC Mandate on UWB

The European Commission has mandated the CEPT "to undertake all necessary work to identify the most appropriate technical and operational criteria for the harmonised introduction of UWB-based applications in the European Union"[23].

The associated studies were conducted within Task Group 3 and a draft of the final CEPT Report will be considered in a ECC meeting to be held from 14 to 18 March 2005. The executive summary of this draft final report is included here as Exhibit 4.

In an attempt to achieve a compromise between the views of UWB proponents and those of the incumbent services, Task Group 3 has proposed an interim solution based on a value of -55 dBm/MHz for $EIRP_{max}$ and proposed that further work be performed.

In any case, the following text is included in the executive summary: "The main conclusions of the CEPT studies in response to EC Mandate on UWB are:

- the FCC Indoor UWB mask does not by itself provide adequate protection from interference to the existing services,
- the majority of the radio services considered requires more stringent generic limits than defined in the FCC masks, indoor as well as outdoor,
- The solution could be the two step approach as described above."

Although no conclusion is reached with respect to a final value for $EIRP_{max}$, the CEPT studies unequivocally conclude that the -41.3 dBm/MHz would not protect the existing services. Moreover, by proposing an interim value of -55 dBm/MHz, these studies give an idea of what a compromise solution that takes into consideration the conflicting interests involved might look like.

[23] Annex 7 to draft "Final Report to EC in Response to the Mandate on UWB: Technical, Operational and Regulatory Criteria for the Harmonised use of Radio Spectrum for UWB-Based Applications", output of the Task Group 3 meeting held in Brest, France (1-3 March 2005)

III. THE COMMISSION SHOULD HAVE ACCEPTED THE ASSUMPTIONS OF THE ALION STUDY

In the 2nd R&O, the Commission addressed a study that had been submitted by the Coalition of C-band Constituents (the "Coalition"). The study, which was based on tests conducted by Alion Science and Technology ("Alion"), concluded that FSS receivers will experience "complete reception failure at currently regulated UWB power levels assuming emitter densities currently found in the environment of common wireless-based consumer units."[24]

The Commission "was able to duplicate the Alion study," and it obtained "similar results when using the same assumptions Alion employed."[25] The Commission, however, rejected the Coalition's assumptions as "not realistic,"[26] and based on alternative assumptions it concluded that there was "no justification to reduce the UWB emission levels in the FSS frequency band."[27]

For the reasons that are stated below, the Commission has misconstrued key elements of the Coalition's assumptions. On reconsideration, therefore, the Commission should adjust its UWB interference criteria to guard against the interference the Coalition has shown will be caused absent an adjustment.

A. Spatial Distribution of UWB Devices

In the 2nd R&O, the Commission criticized the Alion study for being "founded on the premise that a large number of UWB devices [would] be located near the FSS receiver"[28]. In fact, however, the study took into account three alternative scenarios, only one of which involved grouping of UWB devices near the FSS receiver.

The Alion study investigated the potential for interference to a number of FSS receivers/carriers under three statistical UWB device distribution scenarios: uniform, Gaussian and inverse Gaussian. With the uniform distribution, it was assumed that the UWB devices were uniformly distributed within a radius of 5

[24] 2nd R&O, ¶ 95.
[25] 2nd R&O, ¶ 99.
[26] 2nd R&O, ¶ 96.
[27] 2nd R&O, ¶ 99.
[28] 2nd R&O, ¶ 96.

kilometers of the FSS receive station. With the Gaussian distribution, the UWB devices were distributed such that most of the UWB devices were clustered in the near vicinity of the FSS receiver. With the inverse-Gaussian distribution, it was assumed that most of the UWB devices were located near the outer perimeter of study zone and away from the FSS receiver. These scenarios fairly accounted for all UWB distributions that could reasonably be expected.

B. UWB Exclusion Zone

In the 2nd R&O, the Commission characterized Alion as having assumed UWB transmitters would be located as close as or even "within 30 meters"[29] from the FSS receiver. To the contrary, the Alion study assumed that no UWB devices would be located closer than 30 meters from the FSS receiver. Given the size of C-band earth stations (i.e. the antenna and supporting infrastructure) an assumed 30 meter radius in which access by the general public would be restricted is reasonable and if anything is overly conservative.

C. UWB Distribution Density

In the 2nd R&O, the Commission faulted the Coalition for assuming that UWB devices would "replace all existing Part 15 cordless telephones, wireless security applications, and wireless data communications," including those "within and between vehicles, resulting in an estimated 64 UWB devices per acre or 1.24 million UWB devices, all operating continuously within 5 km of an FSS receiver"[30]. In fact, however, the Alion study took into account a number of cases in which much smaller (operational) UWB distribution densities resulted in unacceptable interference to FSS receivers. Specifically, for the 8-PSK FSS carrier analyzed by Alion, UWB device distribution densities of approximately 200 active devices/km^2 (0.8 active devices/acre) and 64 active devices/km^2 (0.25 active devices/acre) corresponding to uniform and Gaussian UWB distribution scenarios, respectively, resulted in unacceptable interference to an FSS receiver.

[29] *Id.* ¶¶ 96, 98.
[30] *Id.* ¶ 96

Similarly for a 47.2 Mbps, QPSK carrier, the Alion analysis showed that UWB device distribution densities of approximately 25 active devices/km^2 (0.1 active devices/acre) and 127 active devices/km^2 (0.5 active devices/acre) corresponding to uniform and Gaussian UWB distribution scenarios, respectively, resulted in unacceptable interference to an FSS receiver. These distributions are certainly achievable and reasonable, if not conservative, UWB distribution densities.

D. UWB Activity Factor

The UWB activity factor refers to the percentage of time that a UWB device is transmitting. In the 2nd R&O, although it did not specify what it considers to be a suitable activity factor range for UWB, the Commission faulted the Alion study for using a UWB "100% activity factor."[31]

In fact, Alion did not use a UWB 100% activity factor. Rather, Alion based its study on the number of simultaneously operating UWB devices at any given point in time. This is an appropriate course to follow given that it takes one unknown quantity out of the analysis. Moreover, the number of simultaneously active UWBs is one of the critical parameters needed in any aggregate interference analysis. Once the number of active devices that cumulatively cause unacceptable interference to an FSS receiver is determined, the true population of UWB devices (both active and inactive) can be easily calculated by dividing the number of active UWB devices by the activity factor. Accordingly, although the Commission may disagree with the values for the density of active devices assumed in the study, its implication that the Alion study is incorrect because it assumed a 100% activity factor for UWB devices is without merit.

E. UWB EIRP Density

In the 2nd R&O, the Commission disagreed with the Alion's assumption that all active UWB devices within the 5 kilometer study radius would produce "the maximum permissible power spectral density (PSD) level within the pass-

[31] *Id.* ¶ 96

band of the FSS receiver"[32]. Additionally, the Commission noted that not all UWB devices will operate with their emissions centered around 4 GHz[33].

The Commission provided no basis or justification in support of its position. Part 15 of the Commission's rules permit UWB devices to operate with up to a maximum EIRP density level of -41.3 dBm/Hz. It is essential, therefore, that C-band FSS earth stations be protected against that level.

F. Apportionment of Indoor and Outdoor UWB Devices

In the 2nd R&O, the Commission expressed its belief that only a small percentage of UWB devices, likely much less than 5 percent, will be operated outdoors. It based this belief on the fact that outdoor usage will be limited to hand-held, short range, peer-to-peer operations that will be of extremely short duration.

The Commission's position, however, conflicts with recent information about where the UWB market is headed. During a meeting of the Commission's Technological Advisory Council ("TAC") that took place on October 27, 2004 at the Commission, a number of commercial electronic device manufacturers indicated that they were investigating the incorporation of UWB systems in highly mobile units such as laptop computers and PCS telephones for the reception and transmission of pictures, video, data, etc. These applications, including PCS telephones, augur heavy use of UWB devices both indoors and outdoors. In the absence of evidence to the contrary, and the Commission has presented none, this market information is entitled to considerable weight.

G. Directional Antennas

The Commission assumes "that many UWB devices will employ directional patch antennas," as a result of which they "would not necessarily direct their signals toward the FSS site."[34] The Commission has not, however,

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[32] *Id.* ¶ 95.
[33] *Id.* ¶ 98.
[34] *Id.* ¶ 98.

provided any basis for its assumption, and a variety of factors point in a different direction.

All things being equal, one would expect a UWB manufacturer to prefer an omni antenna to a directional one because directional antennas burden the user with having to properly align its device in order to achieve the proper link and the fastest data transfer speeds. This would be especially true in the case of peer-to-peer UWB operations, which, if directional antennas are used, would require that two UWB units be aligned properly in order to achieve a successful link. Manufacturers of non-UWB mobile devices such as PCS telephones and laptop computers already favor the use of omni antennas for these reasons and it is reasonable to assume that UWB manufacturers, driven by the same considerations, will follow suit.

IV. RELYING ON COMPLAINT PROCEDURES TO ENSURE PROTECTION OF FSS EARTH STATION RECEIVERS FROM UWB INTERFERENCE IS INEFFECTIVE AS DEMONSTRATED BY PAST EXPERIENCE

In the 2nd R&O, the Commission assumed that interference to C-band earth station receivers could be redressed through its complaint procedures. It stated that it would "investigate any interference complaints from UWB devices to the authorized radio services,"[35] would take steps to ensure that the interference problem is corrected, and would take whatever enforcement actions may be deemed necessary.

Complaint procedures, however, are ineffective when it comes to interference from unlicensed UWB devices. Although the cumulative interference effect of UWBs on an FSS receiver may be quite large, the interference from a single UWB device will be brief and intermittent. It is not feasible in these circumstances for an FSS earth station operator to trace the source of interference from a UWB device, all of which are unlicensed and many of which are mobile. Even if the interference were traceable, moreover, preserving evidence that could be presented to the Commission is virtually impossible.

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[35] *Id.* ¶ 99.

The Commission's experience with radar detectors provides a cautionary tale about the dangers of relying on enforcement procedures once unlicensed equipment that causes interference has been deployed. In response to widespread cases of interference to FSS VSAT earth stations, the Commission adopted tighter emission limits for new radar detectors. It acknowledged, however, that its options were limited with respect to radar detectors that already were in the field.[36] Although it stated that such radar detectors would "continue to be subject to the non-interference requirement in Section 15.5 of the rules,"[37] the Commission conceded that the non-interference requirement could not be effectively enforced against them:

> [I]dentifying each individual source of interference from radar detectors is not practical for a satellite operator because these devices are mobile and therefore interfere intermittently. Further, these interference sources are not under the control of the satellite operator, so in most cases it is not possible for the satellite operator to remedy the interference even if the source could be identified.[38]

CONCLUSION

It is essential, based on the information presented in this petition, that the Commission reconsider the standards it has been applying to protect C-band FSS earth stations against interference from UWB devices. New information demonstrates that the current rules expose FSS C-band earth stations to interference that could have devastating consequences.

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[36] *See Review of Part 15 and Other Parts of the Commission's Rules*, First Report and Order, 17 FCC Rcd 14063 (2002), ¶ 15.
[37] *Id.* (footnote omitted).
[38] *Id.* ¶ 11.

The Commission has made a commitment to "continue to examine interference issues as UWB products develop" and to take "appropriate action" if there was "any indication that … [the FCC's] standards are not adequate to protect any of the authorized radio services from harmful interference."[39] The time to act on that commitment is now.

Respectfully submitted,

SATELLITE INDUSTRY ASSOCIATION

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March 11, 2005

[39] MO&O and FNPRM, ¶ 131.

September 30, 2004

SIA Comments on Document US WP 4A/12

1. Introduction

In 2003, the commercial satellite industry generated approximately US$90 Billion in revenues, enabled over US$1 Trillion in global economic activity, and facilitated hundreds of thousands of jobs. On a daily basis, our national economic activity depends on the voice, video, and data services provided by commercial satellites to fixed and mobile end users, corporations and governments in the U.S. and overseas. Commercial satellites deliver critical services for emergency responders and the armed forces – both mission critical and logistical. Satellites also provide the telecommunications backbone for domestic and international television, radio, and print media distribution. Over 20 million households in the U.S. and over 60 million households worldwide subscribe to direct broadcast satellite services for their television programming, while community cable systems receive nearly all their video feeds from satellite distribution.

The Satellite Industry Association (SIA)[1] has severe concerns with some of the concepts contained in Section 2 of Document USWP4A/12. In order to better understand these concerns, it is instructive to highlight here the trajectory followed by Document 12 within the US WP 4A preparations for the upcoming international WP 4A meeting to be held in Geneva from 13 to 21 October.

[1] The Satellite Industry Association (SIA) is a U.S.-based trade association representing the global commercial satellite industry on policy, regulatory, and legislative matters of common concern to its members. SIA Executive Members include: The Boeing Company; Globalstar LLC; Hughes Network Systems, Inc.; ICO Global Communications; Intelsat; Iridium Satellite LLC, Lockheed Martin Corp.; Loral Space & Communications Ltd.; Mobile Satellite Ventures LP; Northrop Grumman Corporation; PanAmSat Corporation; SES Americom, Inc., and Verestar Inc. SIA's Associate Members include Eutelsat, Inmarsat, and New Skies Satellites Inc.

This document was initially proposed by an FSS operator and labeled Document USWP4A/10. It received support from several FSS operators and had the following main objectives.

(i) Call the attention of TG 1/8 to the fact that the 1% interference allowance previously given by WP 4A was an aggregate value that included UWB and other interference sources (non-primary services, unlicensed devices; unwanted emissions). Therefore conclusions about technical parameters such as required "separation distances" should not be based on a 1% allowance but on a smaller value.

(ii) Agree with TG 1/8 statement that conclusions about uplink interference should at the moment be kept as tentative.

The edits suggested by the FCC so drastically reversed these initial objectives that the document was renumbered as Document 12, having Mr. Scott Kotler from the FCC as the author. In particular, rather than conveying the point that 1% is an aggregate and therefore the UWB allowance should be smaller than 1% (e.g. 0.5%), Document 12 states that the 1% "value is not an absolute threshold" nor "a maximum allowable interference level". This not only contradicts what WP 4A had previously communicated to TG 1/8 but goes against the views of all FSS operators participating the US WP 4A preparatory meetings.

SIA supports the 1% aggregate allowance for all non-primary sources of interference. The 1% is part of the overall interference allocation for FSS links, as codified in the internationally approved Recommendation ITU-R S.1432. UWB devices, which are not even allocated on a secondary basis, but simply operate on an unlicensed basis, should be apportioned a fraction of the 1% aggregate allowance. Challenging this interference allowance in international fora amounts to asking the FSS community to accept, on an international, worldwide basis, that UWB devices should be allowed to cause more interference than the amount that was allocated to this kind of interferers in the design of FSS links in accordance with Recommendation ITU-R S.1432.

Sensitive FSS receivers operate with limited margin, which must overcome all sources of propagation effects (e.g. rain fade) and other link degradations (e.g. equipment aging and implementation losses). Increasing the FSS noise floor beyond what was already accounted for in the link budget would, as a minimum, obliterate FSS link margins or, at worst – under any number of fading conditions – interrupt reception. Furthermore, it is not appropriate to ask WP 4A – the ITU-R group that represents the FSS community - to go

against the FSS interests and penalize all FSS operators that have designed their links based on the guidelines contained in a Recommendation originated by WP 4A itself.

In the text of Document USWP4A/12 initially submitted to the National Committee, the FCC had insisted that anything that does not produce harmful interference should be acceptable. After it was informally pointed out to the author of the document that such approach was flawed, an attempt has been made to fix the problem by substituting the words "unwanted interference" for "harmful interference". This hardly helps to improve the situation because introduction of a term ("unwanted interference") that is not anywhere in the ITU Radio Regulations can only increase confusion. Moreover, the term is questionable in itself since it seems to imply that some kinds of interference would be "wanted".

Actually, despite avoiding the term "harmful interference" in Document USWP4A/12, the misconception that assumes anything below harmful interference as acceptable is at the root of the UWB e.i.r.p. levels currently authorized by the FCC. Use of "harmful interference" as a benchmark in this kind of situation was vigorously challenged by several SIA members in their comments on a recent FCC NPRM[2]. More specifically, in comments provided in response to this NPRM[3], it was stated that:

"Clearly harmful interference cannot be used as a standard for authorizing new users under an interference temperature approach. Harmful interference is an extreme level of interference that "seriously degrades, obstructs or repeatedly disrupts" the operations of a communications system. Harmful interference is rarely seen when properly functioning radio equipment is used in a frequency band by services or systems that operate on a co-primary basis. At the same time, it is clear that just because interference between such services or systems in a band does not rise to the high level of "harmful interference" it cannot be reasonably concluded that the interference is subjectively acceptable or tolerable to the victim service or users."

One of the basic flaws in having harmful interference as a benchmark stems form the fact that satellite links operate with link margins that are set to guarantee availability levels

[2] In the matter of Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands, ET Docket No. 03-237.

[3] Comments of Globalstar, L.P., ICO Global Communications, Inmarsat Ventures Ltd., Intelsat Global Services Corp., Lockheed Martin Corp., Loral Space & Communications Ltd., New Skies Satellites, Northrop Grumman space Technology, PanAmSat Corporation and SES Americom, Inc. in ET Docket No. 03-237, April 5, 2004.

that an operator is committed, under contract, to provide to a given customer. These margins will account for variations in propagation conditions (e.g. fading), equipment aging and other link degradations. An interfering emission may at a given point in time use up most of this margin without producing any noticeable degradation to the link. However, this does not mean that this interference is acceptable as it would put the link in a state in which a minimum variation in the conditions which the margin was intended to compensate for would (in the absence of such margin) severely degrade the link.

2. Specific Problems with Statements Contained in Document USWP4A/12

We address below some specific concerns that we have with statements included in Document USWP4A/12.

2.1. *"… the 1% value specified in the above referenced liaison statement represents a small percentage of the maximum allowable interference that could potentially degrade the performance of an FSS system."*

This statement is not correct. The allowable interference degrades the performance of the FSS system, but still allows it to perform according to the required design objectives. If, however, the 1% allowance for other sources is exceeded, then the FSS performance will not meet the required performance objectives if all other sources of interference are present at their allowable level, and the performance of the FSS system <u>will be degraded</u>.

2.2. *"The 1% value is a contributing factor in an FSS system design objective that is used to establish system parameters and does not represent an interference criteria for establishing unwanted emission limits."*

This statement is correct only in the sense that any interference criterion for defining emission limits should allow less than 1% of noise increase due to UWB emissions and to the effect that there is no agreement on which fraction of the 1% allowance should be apportioned to UWB emissions.

2.3. *"… Annex 1 is an analysis, making certain assumptions, that considers C-Band Adjacent Satellite Interference in a 2 degree spacing environment and set the interference*

from "Other Sources" at 1%. This analysis illustrates that the overall C/(I+N) reduction due solely from "Other Sources" is only 0.026 dB. This amount is practically immeasurable."

Without going into the details of the calculations presented, we note that even if the C/(N+I) degradation is immeasurable, 1% is the number used in the determination of FSS link margins to achieve the required performance. Any interference from "other sources" that in its aggregate exceeds 1 % will eat up in the link margin and will have an impact on the link performance, as discussed above.

2.4. *"The 1% value is not an absolute threshold, that when exceeded, results in degradation to the desired signal."*

We disagree with this statement because, once the allowance for interference taken into account in the link budgets is exceeded, the availability objectives can no longer be met, and therefore degradation with respect to the intended quality of service will occur if all other interference entries are present at the allowable levels.

3. Conclusion

In view of the above, SIA strongly opposes that Document USWP4A/12 be submitted to the upcoming WP 4A meeting in Geneva. Not only it is detrimental to the FSS, but it will also be virtually impossible to defend it during the meeting.

Very truly yours,

David A. Cavossa
Executive Director
Satellite Industry Association

VICTIM Earth Station

Elevation Angle of Victim ES (degrees)	10
Calculated Slant Length (km)	40581
Spreading Loss (dB)	163.159
Conversion Factor from Degrees to Rads	0.01745
Frequency (MHz)	3700
Noise Temperature of Victim Receive ES (K)	100
EIRP Density of Victim Space Station Network (dBW/Hz)	-39.4
Victim ES Size (meters)	4.5
On-Axis Gain of Victim ES (dBi)	43.279

INTERFERING Networks

Number of Interfering Nets (one to the east/one to the west)	2	2	2	2	2	2
Geocentric Orbital Separation between Interfering and Victim Network	2	4	6	8	10	12
EIRP Density of interfering network (dBW/Hz)	-39.4	-39.4	-39.4	-39.4	-39.4	-39.4
Free Space Path Loss (dB)	196.001	196.001	196.001	196.001	196.001	196.001
Boltzman's Constant (dBW/K-Hz)	228.6	228.6	228.6	228.6	228.6	228.6
Off-Axis Victim Co-Pol ES Antenna Gain (dBi) (29-25LOG(THETA) (REC S.580)	20.439	12.914	8.511	5.388	2.965	0.986
Off-Axis Victim Cross-Pol ES Antenna Gain (dBi) 19-25LOG(THETA)	10.439	2.914	-1.489	-4.612	-7.035	-9.014
Include Contribution from Cross-Pol Source? (1=YES, 0=NO)	1	1	1	1	1	1

I/N (Co-Pol)	-6.362	-13.888	-18.290	-21.413	-23.836	-25.816
I/N (Cross-Pol)	-16.362	-23.888	-28.290	-31.413	-33.836	-35.816
Conversion to Delta-T/T (Co-Pol) in %	23.110%	4.085%	1.483%	0.722%	0.413%	0.262%
Conversion to Delta-T/T (Cross-Pol) in %	2.311%	0.409%	0.148%	0.072%	0.041%	0.026%
Conversion to Delta-T/T (Cross and Co-Pol) in % from Each Sat	25.421%	4.494%	1.631%	0.794%	0.455%	0.288%
Degradation [dB]	0.903	0.174	0.064	0.031	0.018	0.011
Agg I/N of both Interfering Networks	-2.938	-10.463	-14.866	-17.989	-20.412	-22.391
Agg Delta-T/T of both Interfering Networks	50.843%	8.988%	3.262%	1.589%	0.910%	0.577%

	Inside Coord Arc	Outside Coord Arc	OTHER Interference	TOTAL
I/N (dB)	-1.832	-22.391	0	2.205
Delta-T/T	65.59%	0.58%	100.00%	166.17%
Degradation (dB)	2.190	0.025	3.010	4.252

C/N based on Victim EIRP Density	16.478 dB
C/(I+N) Agg Inside Coord Arc (from 10 interfering sats)	14.288 dB
C/(I+N) Agg (from 12 interfering satellites)	14.272 dB
C/(I+N) Agg (from 12 interfering satellites & Other)	12.226 dB
Overall C/(I+N) Reduction due to OTHER Only	2.046 dB

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

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United Kingdom

FSS/ULTRA-WIDEBAND COMPATIBILITY – AGGREGATE INTERFERENCE STUDIES IN THE SPACE-TO-EARTH DIRECTION

1 Introduction

TG 1-8 considered a study of aggregate interference into the fixed satellite service at their meeting in October 2003. In particular, a static model indicated that interference into C-band earth station receivers in the FSS could potentially exceed permissible thresholds due to the aggregate effect from ultra-wideband (UWB) devices.

This paper describes a Monte Carlo approach to modelling this aggregate effect, and further examines the potential for interference to fixed satellite service earth station receivers.

2 Simulation Approach

In order to simulate the aggregate effect of a population of UWB devices into an FSS earth station receiver, a "Monte Carlo" simulator was used. The simulator allowed different densities of UWB transmitters to be modelled, both in indoor and outdoor environments, and the impact on an FSS earth station to be estimated.

The simulations are based on a number of Monte Carlo trials. In each trial, interference from a specified number of randomly positioned UWB transmitters was calculated at a victim receiver, assumed to be located in the middle of the simulation area.

Two variants of a propagation model were used to model path loss: For outdoor transmitters, path loss was calculated using a multi-slope model, with clutter loss added to simulate obstructions (represented by a log-normal distribution with a mean of 10 dB and a standard deviation of 10 dB). The multi-slope model can be summarised as follows:

- Path Loss = 20 log (4 π d / λ) *for* $d \leq 100$ *m*
- Path Loss = (Loss at 100 m) + 30 log (d / 100) *for* $100\ m < d \leq 2000\ m$
- Path Loss = (Loss at 2000 m) + 40 log (d / 2000) *for* $d > 2000$ *m*

For indoor transmitters, path loss was calculated using a multi-slope model above with building penetration loss added (represented by a log-normal distribution with a mean of 10 dB and a standard deviation of 5 dB).

Interference analysis results were reported in the form of a cumulative distribution function (CDF) specifying the occurrence probability of interference scenarios for which a given interference level is exceeded.

The simulator allowed different interference scenarios to be modelled by specifying:

- the UWB EIRP density
- the UWB transmitter density
- the number of buildings (for indoor use)
- the UWB transmitter height (above ground)
- the radius of the (circular) simulation area
- the victim receiver antenna height
- the victim receiver maximum antenna gain and elevation angle
- the victim antenna radiation pattern and receiver bandwidth.

In addition, the simulator allowed the area to be modelled as either a circular area (see Fig.1), or as an annulus with an inner ring or “exclusion zone” free of UWB devices (see Fig.2):

FIGURE 1

Circular simulation area

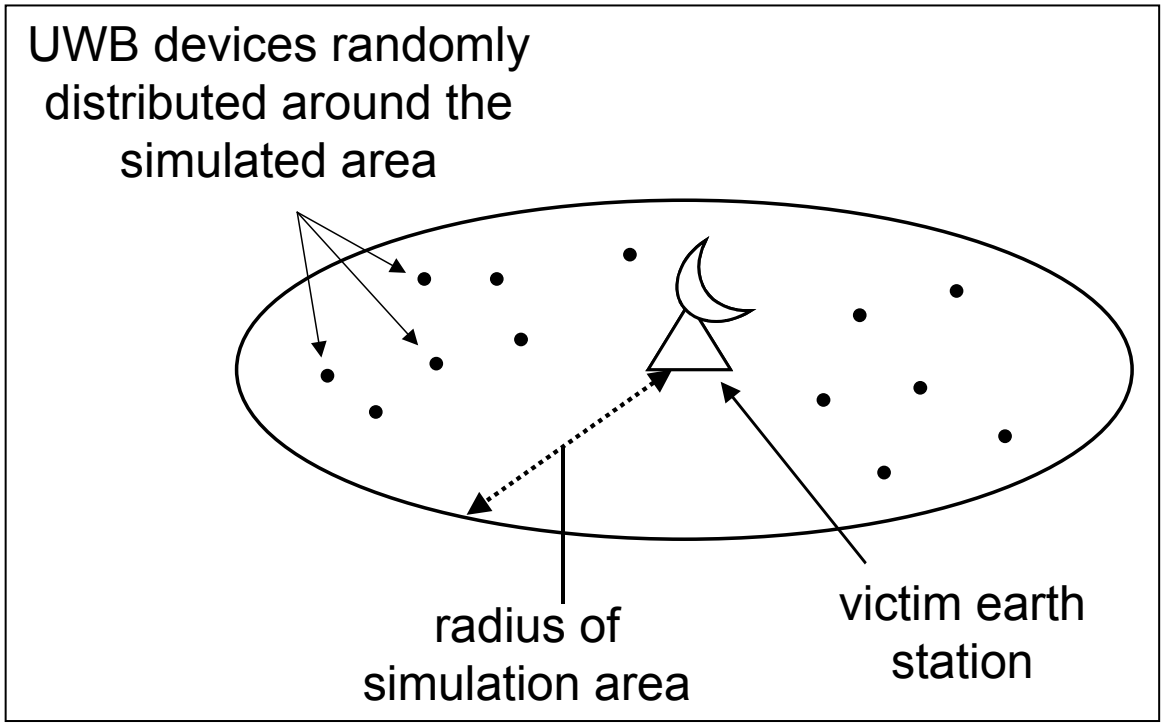
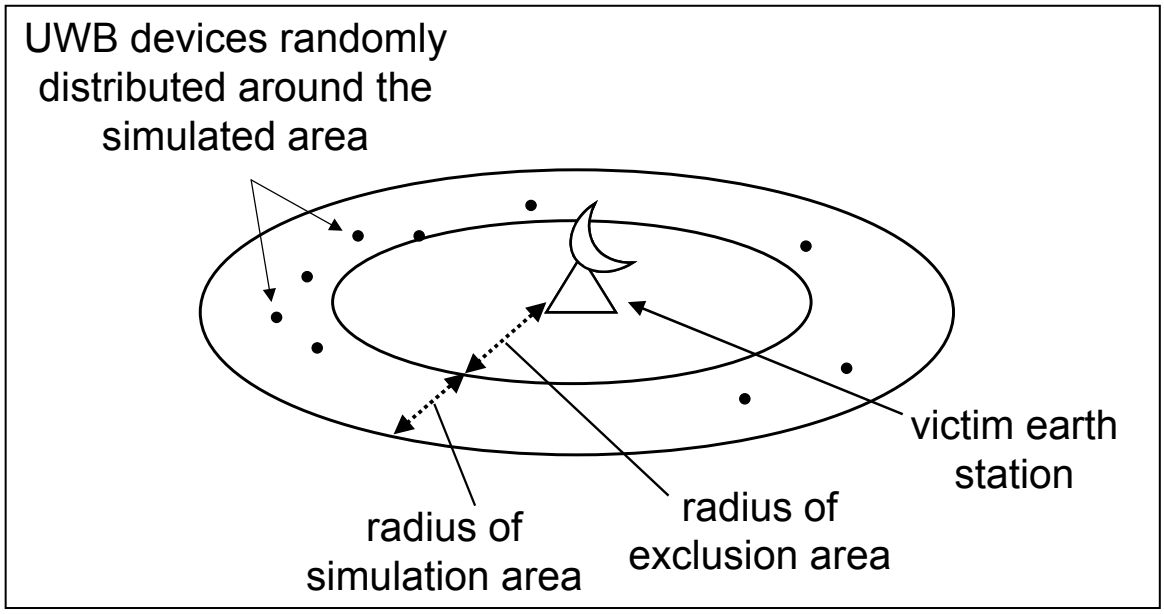


FIGURE 2

Circular simulation area with exclusion zone



The following characteristics were chosen to represent the victim earth station receiver:

Victim (earth station) receiver frequency	4 GHz
UWB EIRP (Average)	–71.3 dBW/MHz
Victim receiver bandwidth	50 MHz
Victim receiver noise Temperature	100 K
Victim receiver antenna gain	52 dBi
Victim receiver antenna elevation	5º – 25º
Victim receiver antenna pattern	Appendix 7
Victim receiver feeder loss	0 dB
Victim receiver antenna height (a.g.l.)	10m – 30m
UWB antenna height (a.g.l.)	2m
Simulation area radius	20 km
Interference criterion	–151.6 dBW/50 MHz (I/N = –20 dB)

Using the model described, and the characteristics above, two scenarios were studied:

- Outdoor interference. An area of radius 20 km around a receiving earth station was populated with active outdoor UWB devices. The aggregate impact of active UWB devices was modelled for densities from 0.01km^{-2} (12 active devices [1]) to 10 km^{-2} (125,000 active devices).
- Indoor interference. An area of radius 20 km around a receiving earth station was populated with 100 "hotspots" and 2 million residential dwellings. A hotspot was modelled as a five-storey building, of dimensions 20m high x 30m wide x 30m deep. In each trial, 100 hot spots are randomly distributed over the simulation area. Each residential building was modelled as two storeys with an attic, of dimensions 8m x 6.3m wide x 6.3m deep. A density of 0.005 active UWB devices per square metre was assumed in the hotspots (a total of 2250 active devices), and 0.0017 devices per square metre in the residential dwellings (a total of 404,838 active devices).

To investigate the sensitivity of the model to various parameters, the following variations on the indoor scenario were tested:

- Varying the height of the victim antenna from 10m to 30m above ground level;
- Varying the elevation angle of the victim antenna, from 5º to 25º (relative to the horizon);
- Varying the separation distance between the victim receiver and the population of UWB devices (i.e. the exclusion zone, see Fig.2);
- Varying the density of UWB devices contained within the simulated area.

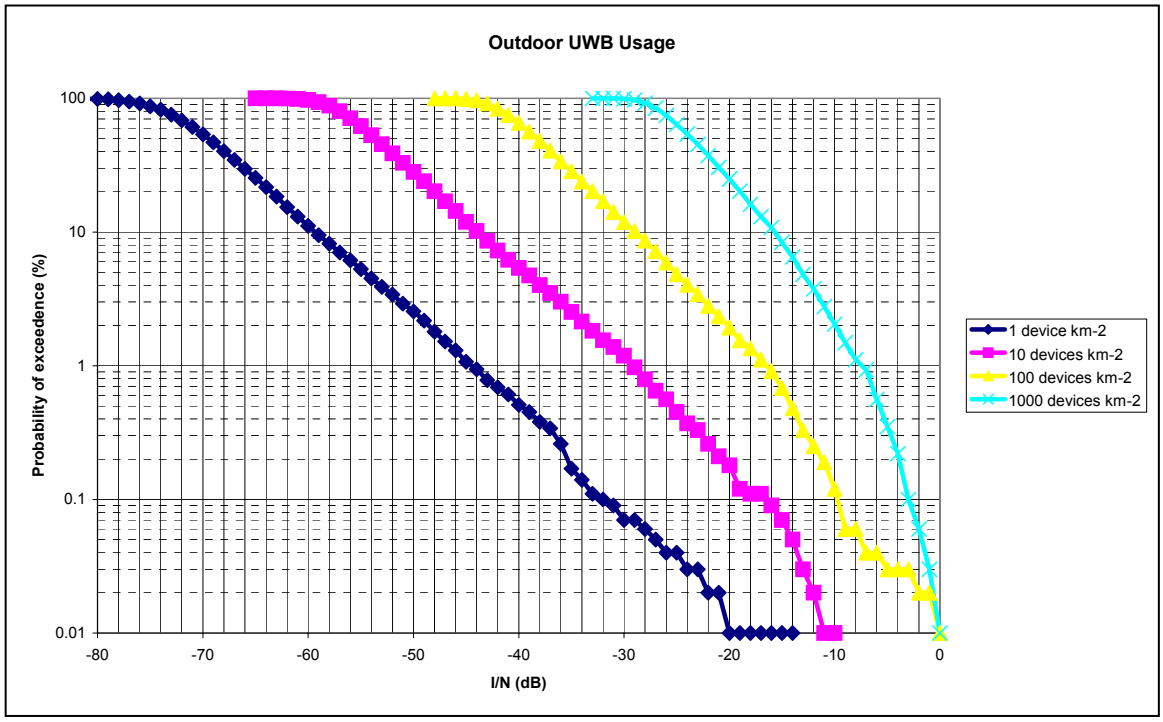
[1] Active devices: It was assumed that UWB devices have a 1% activity factor. Thus, in a large population of devices, it was assumed that 1% of the total population would be "active devices" at any given time. From this 1% activity factor, the total population of UWB devices would 100 times larger than the number of active devices.

3 Results

The simulation of the outdoor scenario produced the following results:

FIGURE 3

Simulation of outdoor UWB usage

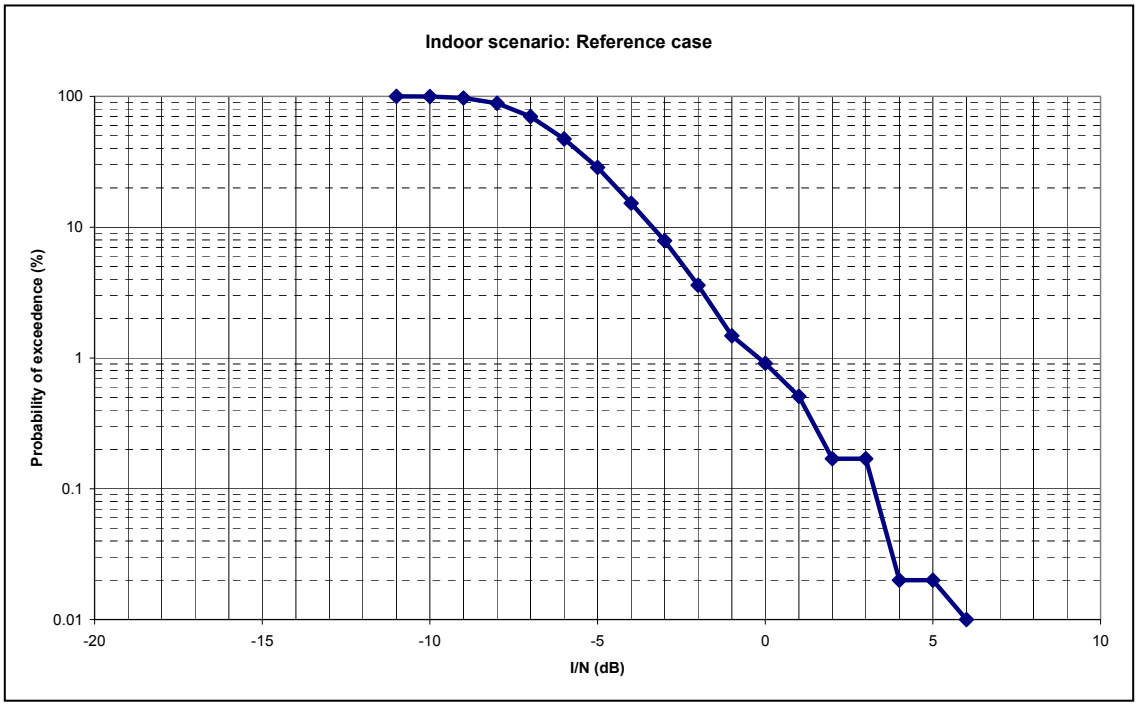


This demonstrated that aggregate interference is highly dependent upon the density of UWB devices. Furthermore, the -20dB Interference-to-Noise (I/N) threshold is exceeded for less than 1% of time for UWB densities of less than 10 devices per km^2. However, if the UWB density is 1000 devices per km^2, the probability of interference exceeds 20% at the -20dB I/N threshold.

For the simulation of indoor usage of UWB, a "reference case" was created to begin the study: The victim receiver was assumed to be located at the centre of the simulation area, at a height of 15m above the ground, and pointed with an elevation of 15º to the horizontal. Using the parameters for the indoor scenario described in section 2, the interference probability was calculated thus:

FIGURE 4

Indoor scenario reference case

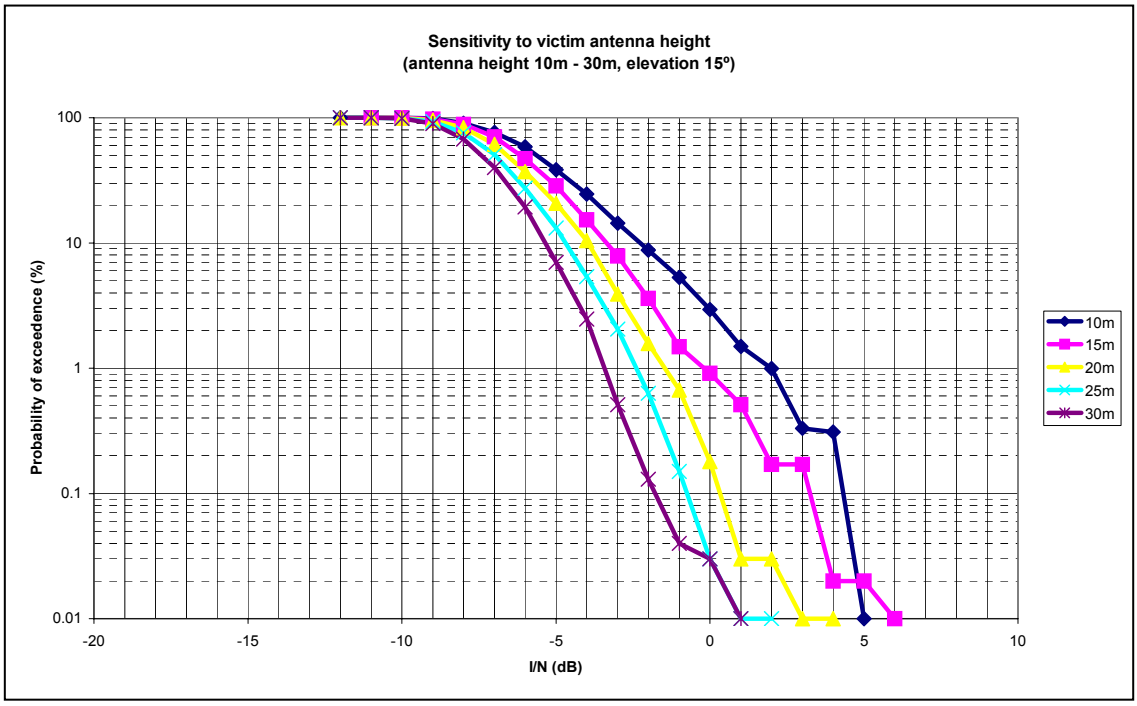


This indicates that the probability of an earth station experiencing an aggregate interference level in excess of the permitted -20dB Interference-to-Noise (I/N) threshold would be 100%, under the conditions simulated. Furthermore, the probability that I/N would exceed -3.5dB would be 10%.

However, it is recognised that earth stations are deployed in a wide variety of physical configurations and so a series of sensitivity analyses were conducted on the reference case, in order to identify the most critical parameters. Firstly, the sensitivity to antenna height was studied, from 10m to 30m above ground level (to simulate the location of an earth station on the rooftop of a commercial building, for example):

FIGURE 5

Sensitivity to Antenna Height



This demonstrated that the permitted threshold I/N is again exceeded in every case. The sensitivity to antenna height appears small but measurable: at the 1% exceedence level, it amounts to a decrease in interference of 1 – 2dB for every 5m of increased height.

Next, the sensitivity to antenna elevation was studied by running the same simulation for elevation angles of 5º and 25º:

FIGURE 6

Sensitivity at 5º antenna elevation

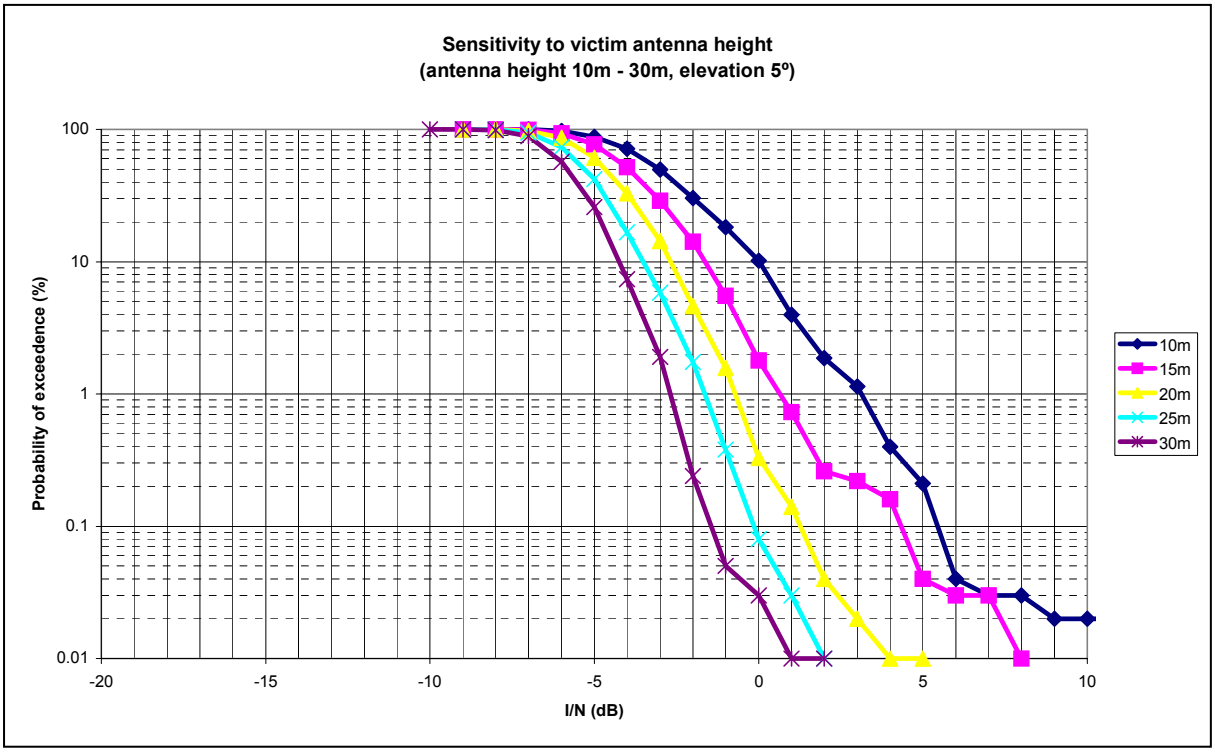
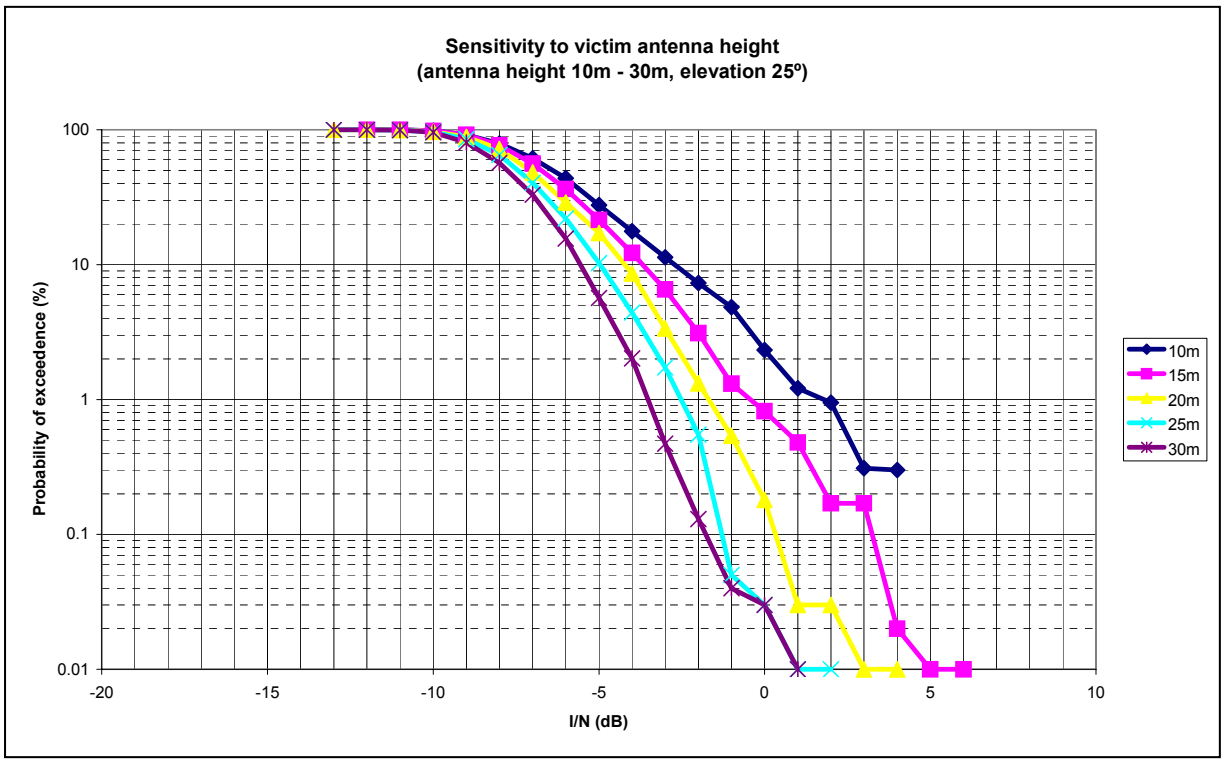


FIGURE 7

Sensitivity at 25º antenna elevation

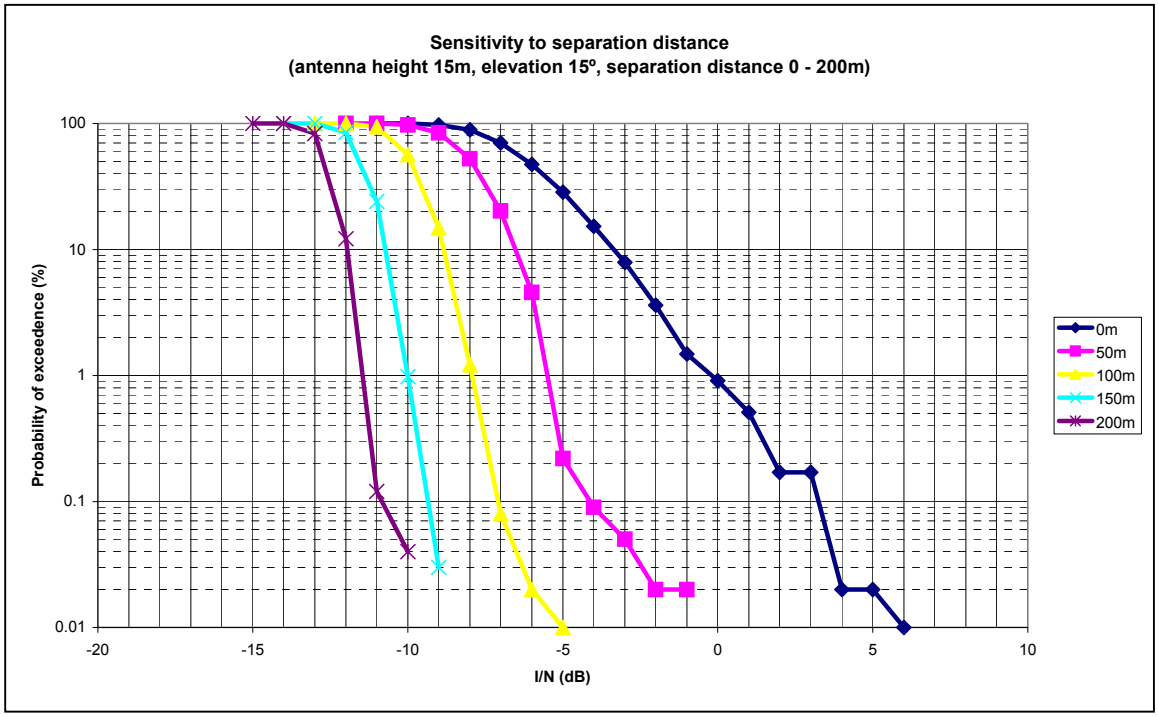


It can be seen that the sensitivity to antenna elevation is fairly limited: for an antenna mounted 30m above the ground, there is only 1dB improvement (at 10% exceedence) between 5º and 25º elevations. (This supports the theory that the main effect of the aggregate interference is via the antenna side-lobes, rather than the main beam).

Next, the sensitivity to separation of the earth station from the population of UWB devices was simulated. Noting that an earth station may be located some distance from the population of UWB devices, the simulation was repeated with different exclusion zones, up to 200m between the victim antenna and the nearest UWB device:

FIGURE 8

Sensitivity to separation distance

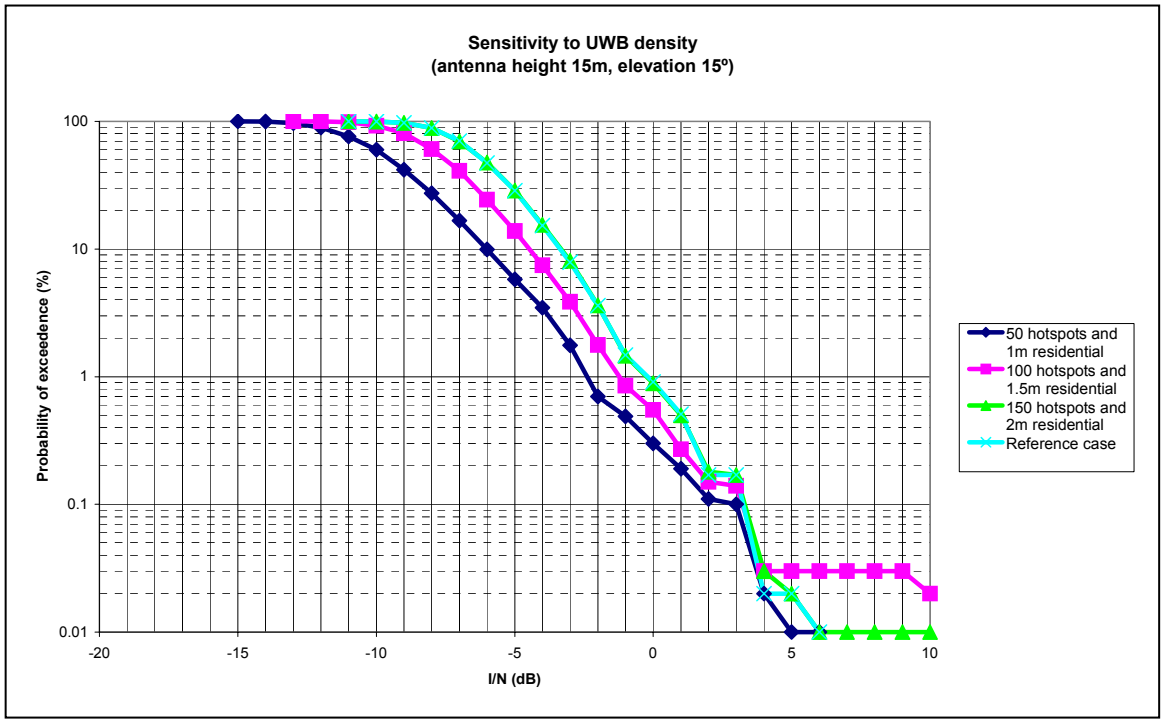


(The reference case is shown as zero separation). In all cases, the permissible I/N threshold is exceeded. However, it is noted that the separation distance decreases the degree of interference exceedence – for example, a 50m exclusion zone decreases the interference by more than 3dB at the 10% exceedence level.

Finally, the sensitivity of interference to the density of UWB devices was simulated. From the reference case of 100 UWB hotspots and 2 million residential dwellings, the following variations were modelled: 50 hotspots and 1 million residences; 100 hotspots and 1.5 million residences; 150 hotspots and 2 million residences:

FIGURE 9

Sensitivity to UWB density



Again, the permissible I/N thresholds were exceeded in every case. The simulation demonstrated that the density of UWB devices has only a small effect on the aggregate interference received by the victim. Note that the difference between the reference case (100 hotspots and 2 million residences) and the last case (150 hotspots and 2 millions residences) is almost nil – this indicates that the impact of hotspots may be small compared to the aggregate effect of the (more distributed) residential usage of UWB.

4 Conclusions

The simulations described here have demonstrated that the aggregate impact of UWB devices upon earth station receivers in the fixed satellite service may exceed the permitted allowance of 1% of noise (I/N = -20dB) by up to 30 dB. Although the likely degree of deployment of UWB is not yet known, the widespread usage of such devices could place serious constraints on the use of C-band receive earth stations.

Some potential mitigation factors have been identified here, such as exclusion zones around the victim antenna, but none appear sufficient to protect earth station receivers to the degree specified in ITU-R Recommendations. The analysis suggests that the key sharing parameters are the density of active UWB devices, and their physical proximity to the FSS earth station receiver.

The conclusions presented in this document are provisional. It is suggested that they be reviewed once Task Group 1/8 have reached agreement on a representative set of transmission parameters and usage characteristics of UWB devices for use in sharing studies. Given the ranges of such parameters indicated in contributions to TG1/8 to date, and the heavy use of the frequency bands concerned by existing applications of the Primary services, it is important to ensure that the parameters and characteristics selected do not underestimate the potential interference.

Final Report to EC
in response to the Mandate on UWB

"Technical, operational and regulatory criteria for the harmonised use of radio spectrum for UWB-based applications"

0 Executive summary

This Report has been developed by CEPT in response to the "Mandate to CEPT to harmonise radio spectrum use for ultra-wideband systems in the European Union" and provides the conclusions of the work undertaken towards developing the necessary regulatory provisions for the introduction of UWB in Europe.

A two-step approach is proposed in response to the mandate on UWB:
1) An interim solution should be developed on the basis of the Impact analysis of a -55 dBm/MHz PSD limit in the band 3.1-10.6 GHz for indoor equipment.
2) Future work should be performed based on latest UWB requirements and taking into account detailed mitigation techniques.

An overview is given of the status of UWB implementation both within Europe and outside Europe. Technical specifications of UWB devices and related relevant ETSI and IEEE standardisation are then described.

Possible regulatory framework in Europe based on the results of the studies presented ECC Report 64 is considered. The results of these studies are significantly lower than the FCC limits in terms of maximum UWB PSD.

Considerations are also given to the related regulatory provisions of ITU Radio Regulations such as No 5.340.

A possible monitoring and review process, for the proper implementation of UWB devices in Europe, is also considered together with a discussion on the experimental rights to use radio spectrum (or licences) for UWB applications which concludes that the mechanism for experimental use of radio spectrum already exists through national procedures for test and development licences.

The main conclusions of the CEPT studies in response to EC Mandate on UWB are:
- the FCC Indoor UWB mask does not by itself provide adequate protection from interference to the existing services,
- the majority of the radio services considered requires more stringent generic limits than defined in the FCC masks, indoor as well as outdoor,
- The solution could be the two step approach as described above.