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

In the Matter of	)	
	)	
Unlicensed Operation in the Band 3650-3700 MHz	)	ET Docket No. 04-151
	)	
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band	)	ET Docket No. 02-380
	)	
Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band	)	ET Docket No. 98-237

COMMENTS OF THE SATELLITE INDUSTRY ASSOCIATION

The Satellite Industry Association ("SIA") submits the following comments in response to the Notice of Proposed Rulemaking ("*NPRM*") in the above-captioned proceeding with respect to the 3650-3700 MHz band.[1] SIA is a U.S.-based trade association representing the leading U.S. satellite manufacturers, service providers, and launch service companies. SIA serves as an advocate for the commercial satellite industry on regulatory and policy issues common to its members. With its member companies providing a broad range of manufactured products and services, SIA represents the unified voice of the U.S. satellite industry.[2]

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[1] *Unlicensed Operation in the Band 3650-3700 MHz, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, and Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band*, Notice of Proposed Rulemaking, 19 FCC Rcd 7545 (2004) (FCC 04-100) ("*NPRM*"), summarized at *Unlicensed Operation of the 3650-3700 Band*, 69 Fed. Reg. 26790 (May 14, 2004) (proposed rule).

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

I. BACKGROUND AND SUMMARY

The 3500-3700 MHz band historically was used within the United States for government radiolocation services.[3] Decades ago, the ITU allocated the band to the fixed-satellite service ("FSS"),[4] and this band is heavily used by satellite networks throughout Europe, Africa and Asia. The FCC added a primary allocation in the 3600-3700 MHz band for non-government FSS downlinks in 1984, but restricted use to international intercontinental systems, subject to case-by-case electromagnetic compatibility analysis.[5] Now, many SIA member companies operate FCC-licensed satellite space and ground networks providing commercial services or critical tracking, telemetry and control ("TT&C") within this so-called "extended C-band."

More recently, Congress required Federal users to relinquish spectrum for reallocation to commercial use.[6] Ultimately, the 3650-3700 MHz band was among those bands NTIA and the FCC reallocated for "mixed-use."[7] As part of that transfer, the Commission deleted the government allocation in the band, excepting three government radiolocation stations (at

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[3] *NPRM*, ¶ 4. Later the band also was allocated for non-government radiolocation services on a secondary basis. *See* 47 C.F.R § 2.106, note US110 (2003).

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

[5] *See* 47 C.F.R § 2.106, note US245. *See also* Amendment of Part 2 of the Commission's Rules Regarding Implementation of the Final Acts of the World Administrative Radio Conference, Geneva, *1979;* 49 Fed. Reg. 2357 (Jan. 19, 1984) (Final Rule (2nd Report and Order)). The Report and Order also allocated the 5850-5925 MHz band for FSS (Earth-to-space).

[6] *See Spectrum Reallocation Final Report, Response to Title VI - Omnibus Budget Reconciliation Act of 1993*, NTIA Special Publication 95-3l2, released February 1995 (Final Report).

[7] "Shared use" means that a band of frequencies is generally available for both government and non-government use. *See* 47 C.F.R. § 2.105(b). "Mixed use" means that Federal government use is limited by geographic area, by time or by other means so as to guarantee that the potential use by Federal government stations is substantially less than the potential use to be made by non-government stations. *See NPRM,* ¶ 5 & n.8 (citing Section 113(b)(2)(B) of the Omnibus Budget Reconciliation Act of 1993, Pub. L. No. 103-66, 107 Stat. 312 (1993) ("OBRA-93")). *See also* 47 U.S.C. § 923(b)(2)(B) (Supp. IV 2004).

Pascagoula, Mississippi; Pensacola, Florida; and Saint Inigoes, Maryland) permitted to operate indefinitely.[8]

The FCC originally proposed to license fixed and mobile terrestrial services ("FS" and "MS," respectively) in the 3650-3700 MHz band.[9] In preparation for that, the Commission froze most existing FSS infrastructure in the band[10] and created two classes of licensed-FSS earth stations—grandfathered and secondary. Ultimately, the Commission indefinitely grandfathered most existing FSS earth stations (and those within 10 miles of stations on file prior to December 1, 2000) as primary,[11] but downgraded subsequently applied-for FSS earth stations as secondary to FS and MS.[12] The FCC then created a 200 km exclusion zone around each grandfathered earth station, where future mobile and fixed service licenses would be required to protect FSS earth stations. These grandfathered zones encompass most of the populous area in the co-terminus United States.[13] However, the comments filed by terrestrial entities on this proposal

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[8] *See Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band; The 4.9 GHz Band Transferred from Federal Government Use*, First Report and Order and Second Notice of Proposed Rule Making, 15 FCC Rcd 20488, 20504-05 (2000) ("*3650 MHz Allocation Report & Order*" and "*3650 MHz Service Rules Second Notice*", respectively). This restriction is codified in footnote US348.

[9] *Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band*, ET Docket No. 98-237, Notice of Proposed Rule Making and Order, 14 FCC Rcd 1295, 1296-97 (1998) ("*3560 MHz Allocation Notice*" and "*FSS Allocation Freeze Order*", respectively).

[10] Initially, the FCC ceased accepting applications for (1) new FSS earth stations, (2) major amendments to pending FSS earth station applications, or (3) applications for major changes in existing FSS earth stations.

[11] *Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band*, ET Docket No. 98-237, Memorandum Opinion and Order, 15 FCC Rcd 9340, 9341-42 (2000) ("*FSS Freeze MO&O*").

[12] *3650 MHz Allocation Report & Order*, 15 FCC Rcd at 20503.

[13] *See Comments of Satellite Industry Association*, ET Docket No. 02-380, FCC 02-328, at 21, App. G, Figure 5 (filed Apr. 17, 2003) ("*SIA Comments*").

reflected little interest in access to this band, while the existing FSS users remain subject to constraint.

In late 2000, several SIA members—alone and/or in coalition—requested reconsideration of the FCC's freeze and allocation,[14] and sought an immediate and urgent stay of the new rules.[15] Despite frequent status inquiries over the past three-and-a-half years, the agency has yet to address these requests and now proposes to "defer *further* action . . . pending our adoption of final rules concerning the allocation proposals herein."[16]

In addition, the Commission two years ago suggested layering yet another use in the band: unlicensed devices.[17] Without any relevant data supporting its tentative conclusion, the FCC's Notice of Inquiry speculated that unlicensed devices could operate co-frequency without interfering with either incumbent FSS operations or future FS/MS licensees.[18]

SIA's comments on the *NOI* contained a technical analysis demonstrating that—absent establishing larger exclusion zones—unlicensed devices of one watt or higher operating in the 3650-3700 MHz band would cause harmful interference to primary, grandfathered and secondary FSS downlinks. Unless unlicensed devices were limited to low power levels, co-frequency FSS operations would be put at risk given the potentially ubiquitous and uncontrolled nature of

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[14] Petitions for Reconsideration were submitted by Lockheed Martin Corporation, the Extended C-Band Ad Hoc Coalition and Inmarsat Ltd. (all filed Dec. 18, 2000).

[15] Extended C-Band Ad Hoc Coalition, *Emergency Motion for Stay Pending Reconsideration* (filed Nov. 28, 2000).

[16] *NPRM*, ¶ 27 (emphasis added).

[17] *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, Notice of Inquiry*, 17 FCC Rcd 25632 (2002) ("*NOI*").

[18] The *NOI* also speculated that unlicensed devices could operate at power levels even greater than one watt without causing harmful interference.

unlicensed operations in large portions of the country.[19] None of the comments to the *NOI* supplied engineering data or any technical analysis refuting SIA's demonstration.[20]

The instant *NPRM* abandons plans to license FS and MS at 3650-3700 MHz, proposing "the deletion of the existing terrestrial FS/MS allocations in any portions of the band in which unlicensed operation would be allowed."[21] The Commission now favors authorizing unlicensed devices—at relatively high powers—to "share" the band. Though the *NPRM* acknowledges more than once that unlicensed devices must not interfere with licensed services (whether primary or secondary),[22] it rejects SIA's demonstration of the separation distances required to protect FSS earth stations.[23] Instead, the Commission contends unlicensed devices could avoid interference provided that such devices are sufficiently separated from an FSS licensed earth station and, when they are non-fixed, are able to (1) listen-before-talk;[24] (2) compare a FSS licensee location database with its position calculated via an on-board GPS receiver ("geolocation");[25] or (3) avoid dedicated RF beacons established at protected FSS stations.[26]

The FCC's proposal falls well short of adequately protecting existing or future FSS operations in the 3650-3700 MHz band. Moreover, though the Commission acknowledges SIA's concern for the increased probability of *out-of-band interference* into conventional C-band

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19 *See SIA Comments* at 7-8.

20 *See Reply Comments of the Satellite Industry Association*, ET Docket No. 02-380, at 7 (filed May 16, 2003) ("*SIA Reply Comments*").

21 *NPRM*, ¶ 21.

22 *Id.*, ¶ 79.

23 *See id.*, ¶¶ 34-35, 58, 66.

24 *Id.*, ¶ 50-54.

25 *Id.*, ¶ 64-70.

26 *Id.*, ¶ 71-75.

downlinks above 3700 MHz, the *NPRM* recommends retaining only the present protection. Accordingly, SIA renews the objections set forth in its 2003 comments and reply comments, particularly with respect to the size and shape of any required exclusion zone, which are incorporated herein by reference.[27] Moreover, SIA seeks prompt decision on the overlapping requests for reconsideration and Emergency Stay, which have been pending—and ignored—for nearly four years.

In addition, SIA requests revocation of all remaining restrictions on FSS systems in the band (including both the "inter-continental" condition and the demotion of non-grandfathered extended C-band earth stations to "secondary" status). Finally, should the Commission nonetheless authorize unlicensed use of the extended C-band, it must: 1) revise the separation distances to provide adequate protection to primary and secondary licensees, 2) adopt an "exclusion zone" mechanism to protect earth station receivers in the adjacent band (above 3700 MHz), and 3) include, for non-fixed devices, a combination of all three possible avoidance techniques. These measures offer the only realistic potential to guarantee unlicensed devices operate on a non-interference basis to *all* FSS earth stations—primary or secondary, existing or prospective—as required by law and stated as a Commission objective.

II. THERE IS NO JUSTIFICATION FOR CURRENT CONSTRAINED STATUS AND OPERATIONAL LIMITS ON FSS LICENSEES, AND ALL SUCH LIMITATIONS MUST BE REPEALED

There is no remaining justification for limiting FSS earth stations in the 3650-3700 MHz band. The "international inter-continental" restriction codified in US245 was intended to protect primary government operations[28]—which, for the most part, have vacated the band. The

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[27] *See supra* notes 19-20.

[28] *See* 47 C.F.R § 2.106, note US245.

subsequent Section 25.202 two-tiered FSS licensing regime (grandfathered primary *vs.* subsequent secondary) was established to protect FS/MS licensees—which have never materialized, nor are likely to.[29] In fact, the *NPRM* explicitly contemplates deleting the FS and MS allocations from the band.[30]

Absent significant legacy government operations or FS/MS licensees in the band, all FSS earth stations in the extended C-band should enjoy unrestricted, primary status.[31] The elimination of most government systems in the 3650-3700 MHz band voids the sole justification for the FSS service/geographic limitations in footnote US245. Indeed, recognizing the footnote was both outdated and unnecessarily restrictive, four years ago the FCC itself suggested deleting the condition[32]—a proposal the SIA wholly supports.[33]

Heedless of history, the *NPRM* posits a new basis for US245:

> Although deletion of the footnote could provide more flexibility for FSS operations in the band, we also believe that more extensive FSS use could curtail the efficient use of this band by terrestrial operations, whether licensed or unlicensed; and, potentially, increase the costs associated with coordinating other co-primary

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[29] The record reflects that sharing between licensed FS/MS and ubiquitously deployed unlicensed consumer devices would be difficult or impossible. *See* SIA Reply Comments at 5-6; Comments of Motorola, Inc., ET Docket No. 02-380, at 9 (filed Apr. 17, 2003); Comments of IEEE 802.18, ET Docket No. 02-380, ¶¶ 7-10 (filed Apr. 17, 2003); Joint Comments of Intersil Corporation and Symbol Technologies, Inc., ET Docket No. 02-380, at 7 (filed Apr. 17, 2003).

[30] *See supra* text accompanying note 21.

[31] SIA acknowledges that FSS operations in extended C-band must continue to protect the remaining government radiolocation stations listed in footnote US348. *See* 3650 MHz Band Service Rules *NPRM,* 15 FCC Rcd at 20504-05.

[32] *Id.*, 15 FCC Rcd at 20508 ("We believe that deletion of this footnote restriction should be considered for the 3650-3700 MHz band in order to provide for flexible and efficient use of FSS earth station sites.").

[33] The Commission acknowledges, but does not resolve, pending Petitions for Reconsideration of the *3650 MHz Allocation Order* seeking exactly this relief. *NPRM,* ¶ 27.

> users of the band, thus inhibiting opportunities for such operation.[34]

This lagging logic is no substitute for due process.[35] Footnote US245 was tailored to protect sensitive government users that have since vacated the band—taking the justification for the restriction with them. Adding unlicensed devices does not automatically revive an obsolete regulation. Indeed, there is no conceivable link between the particular service/geographic limitations of the present policy and co-frequency unlicensed devices: the potential for interference to 3650-3700 MHz FSS operations is unrelated to the origin of the FSS transmission.

Similarly, there is no continuing basis for the Section 25.202 distinction between grandfathered, primary and secondary FSS extended C-band earth stations.[36] The FCC grounded that rule solely on the perceived need to protect future FS licensees[37]—and this justification

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[34] *NPRM*, ¶ 26.

[35] It is well known that an agency cannot rely on "*post hoc* rationalizations" to buttress unsupported decisions. *See Investment Co. Institute v. Camp*, 401 U.S. 617, 628 (1971); Burlington *Truck Lines v. United States*, 371 U.S. 156, 168-69 (1962). Here, the Commission cannot elide the original facts and concerns prompting footnote US245 through a newly minted justification of outdated policy.

[36] *See* 47 C.F.R. § 2.106, note NG169.

[37] *3650 MHz Band Service Rules NPRM*, 15 FCC Rcd at 20501 ("[B]ecause the new FSS facilities permitted by the *MO&O* could affect the use of the 3650-3700 MHz band by the terrestrial services, we now find it necessary to establish a limit on the acceptance of such applications and on the construction of FSS facilities.").

disappears upon deletion of that allocation.[38] Yet inexplicably, the Commission suggests new Part 15 devices might be *co-primary* with post December 2000 FSS earth stations.[39]

The Commission lacks any statutory basis to elevate Part 15 unlicensed devices to co-primary status; by definition, such devices must operate on a non-interference basis to any licensed service.[40] Any future unlicensed devices transmitting in 3650-3700 MHz cannot lawfully interfere with FSS earth stations regardless of whether such stations are "primary" or "secondary."[41]

In sum, preserving Footnote US245 and Section 25.202(g) is neither necessary nor permissible, and both rules must promptly be deleted.[42] Indeed, retaining either provision under wholly changed circumstances improperly "fail[s] to consider . . . important aspect[s] of the problem" and "offer[s] an explanation for its decision that runs counter to the evidence."[43] Thus, SIA requests that the FCC confirm that all FSS earth stations in the 3650-3700 MHz band—

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[38] Even the FCC recognized the impetus underlying prior rulings has since evaporated. In particular, allocations adopted in the *3650 MHz First Report & Order* were intended to fulfill Congress' mandate to transfer spectrum for non-Government use, but "[b]ased on intervening events, the passage of time, and subsequent Commission rulemakings, . . . it [is] reasonable to conclude that we do not have any remaining statutory obligations under Section 3002 of the BBA." *NPRM*, ¶¶ 30-31.

[39] *NPRM*, ¶ 25 ("[W]e seek comment on whether we should revise the 3650 MHz band's existing allocations to permit new FSS operations in the band on a co-primary basis with unlicensed devices.").

[40] *See, e.g.*, 47 C.F.R. §§ 15.05(b), 15.15(c). *Cf.* 47 U.S.C. § 302a(a) (2000).

[41] Elsewhere, the *NPRM* inconsistently acknowledges unlicensed devices must protect all FSS earth stations, whether grandfathered or new. *NPRM*, ¶¶ 60, 68.

[42] *Cf.* 5 U.S.C. §§ 706(2)(A), (E) (forbidding agency action "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law" [or] "unsupported by substantial evidence").

[43] *Motor Vehicle Mfg. Ass'n. v. State Farm Mut. Auto Ins. Co.*, 463 U.S. 29, 43, 50-51 (1983). *See also Brookings Mun. Tel. Co. v. FCC*, 822 F.2d 1153, 1169 (D.C. Cir. 1987); *Celecom Communications Corp. v. FCC*, 789 F.2d 67, 71 (D.C. Cir. 1986); *Telocator Network of Am. v. FCC*, 691 F.2d 525, 537 (D.C. Cir. 1982).

whenever licensed, however employed—should be entitled to full protection from interference throughout the exclusion zone of grandfathered FSS operations.[44]

III. THE NPRM'S PROPOSALS WILL NOT ADEQUATELY PROTECT FSS EARTH STATIONS IN THE 3650-3700 MHZ BAND

The *NPRM* tentatively concludes unlicensed devices will not interfere with co-frequency FSS operations in the 3650-3700 MHz band.[45] This finding is unjustified, both because it omits consideration of other Commission rulings that increase interference to FSS, and fails to account for emissions from its own expectations of numerous co-frequency unlicensed devices geographically adjacent to any given FSS earth station.[46] Further, the FCC seriously underestimates the geographic separation required to protect FSS earth stations. As a result, the proposed "exclusion zone" is much smaller than required.

Indeed, the record is replete with data showing that sharing FSS downlink spectrum is essentially impossible—evidence the agency sidesteps by shelving the nearly four-year old *Emergency Request for Stay*.[47] This "allocate first, investigate later" technique is the antithesis of reasoned decision making.[48]

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[44] In any case, even should the FCC authorize co-frequency Part 15 devices, all FSS extended C-band earth stations should be upgraded to primary status.

[45] *NPRM*, ¶ 33-39.

[46] *Cf. ITT World Communications, Inc. v. F.C.C.*, 725 F.2d 732, 754-55 (D.C. Cir. 1984) (FCC may not "resolve some issues. . .and defer the resolution of other issues when the issues decided were inextricably related to the issues deferred.").

[47] *See* text accompanying notes 14-16.

[48] *See Southern Company Services, Inc., v. FCC*, 313 F.3d 574, 580 (D.C. Cir. 2002) (FCC action "arbitrary and capricious if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise."); 5 U.S.C. § 555(b) (requiring the FCC to address matters "within a reasonable time").

A. The NPRM Significantly Underestimates the Protection Unlicensed Devices Must Afford FSS Earth Stations in the 3650-3700 MHz Band

The *NPRM* tentatively concludes co-frequency unlicensed devices would not interfere with FSS earth stations in the 3650-3700 MHz band. The FCC asserts this, in part, based on a calculation that would allow unlicensed devices (operating at or below the proposed power ceiling) to increase the FSS noise floor by as much as 10 percent.[49] This reasoning is both flawed and inconsistent with an existing ITU-R Recommendation[50] previously supported by the FCC and the U.S. government.[51]

First, the Commission mistakenly suggests *SIA itself* proposed the 10 percent figure.[52] This simply is not correct. Apparently, the Commission misunderstood SIA's May 16th comments, which presented an analysis of an "assumed" 10 percent noise floor increase on FSS receivers. However, this was a simple example, not a SIA-proposed interference ceiling.

Second, the FCC's reasoning bears no relation to actual operating conditions in the band. The most sensitive FSS receivers near 4 GHz operate with limited margin (as low as 0.5 dB), which must account for *all* sources of path loss (*e.g.,* rain fade, multipath). Increasing the 3650-3700 MHz noise floor by adding unlicensed devices would, as a minimum, obliterate FSS downlink margins or, at worst—under any number of fade conditions—interrupt reception. This

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49 *NPRM* at Appendix C.

50 *See infra* note 54.

51 *See Maximum Allowable Error Performance and Availability Degradations to Digital Fixed-Satellite Service Hypothetical Reference Digital Paths Arising From Interference For Systems Operating Below 15 GHz*, Delayed Contribution Document 4A/182-E (Oct. 2, 1998) (attached as Exhibit 5).

52 *NPRM* at Appendix C n.144 ("We note that in their comments, SIA assumed a I/N of -10 dB (*i.e.,* 10 log ($\Delta T/T = 0.1$ (10%)) = -10 dB). . . . Therefore, we used the same value in our analysis.").

could be particularly perilous for FSS networks utilizing extended C-band for critical satellite TT&C.[53]

Third, increasing C-band demand over the US arc (e.g., video distribution coupled with HDTV development) has spurred the use of more spectrum efficient techniques (higher-order modulation). Such approaches require more power and operate with tighter margins in those areas less prone to fading effects.

Finally and most importantly, the FCC's proposal ignores ITU-R Recommendation S.1432 adopted by the ITU Radio Assembly.[54] Recognizing the low link margins and the potential for increased interference to FSS downlinks,[55] Recommendation 1432 urges Administrations to take "all necessary precautions . . . to limit the degradation due to interference" by limiting "the maximum allowable interference from all sources (aggregate)" to 27 percent[56] for FSS networks employing frequency re-use, which is required by long-standing

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[53] Secure TT&C for commercial satellites is critical to the protection of commercial satellite infrastructure—an important element of national security and emergency preparedness ("NS/EP") communications. Indeed, the NSTAC Satellite Task Force recently emphasized the importance of further reductions in the vulnerability of commercial SATCOM command and control links to increase the robustness of Government communications. *See President's National Security Telecommunications Advisory Committee (NSTAC), Satellite Task Force Report, Fact Sheet* (Feb. 2004), *available at* http://www.ncs.gov/nstac/reports/2004/Satellite%20Task%20Force%20Fact%20Sheet%20(March%202004).pdf (last visited July 26, 2004).

[54] Apportionment of the Allowable Error Performance Degradations to Fixed-Satellite Service, ITU-R. S-1432 (adopted at ITU Radiocommunication Assembly 2000) (attached as Exhibit 4).

[55] *Id.* at *considering* b).

[56] *Id.* at *recommends* 1, 3.

FCC rules and policy.[57] Recommendation 1432 allocated the 27 percent aggregate interference budget (from the perspective of the victim FSS receiver) as follows:

- 20 % from other FSS systems
- 6 % from other systems having co-primary status; and
- 1 % *for all other sources of interference*.[58]

Any unlicensed devices allowed to transmit in extended C-band, by definition, would have inferior regulatory status vis-à-vis both primary and secondary FSS operations.[59] Thus, such devices fall within the last category—yet the FCC's rules would authorize increasing the FSS receiver noise floor by 10 percent, generating a 900 percent increase over the 1 percent noise floor increase endorsed in Recommendation S.1432. Moreover, the FCC ignores the *aggregate and cumulative effects* of other transmitters that both add to the noise floor and count toward the 1 percent cap. These include recently authorized, co-frequency users like ultra wide-band ("UWB") devices that plainly will raise the noise floor,[60] as well as out-of-band and spurious emissions. Indeed, if the FCC lawfully could approve unlicensed but co-primary devices (which it cannot), the *NPRM* would sanction an increase to the noise floor exceeding even the *combined* co-primary and "other" categories in Recommendation 1432.

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[57] *See* 47 C.F.R. § 25.210(f) (requiring U.S.-licensed C-band space stations to "employ state-of-the-art full frequency reuse either through the use of orthogonal polarizations within the same beam and/or the use of spatially independent beams.").

[58] ITU-R S.1432 at *recommends* 4 (emphasis added).

[59] *See supra* Section II.

[60] *See, e.g.*, 15 C.F.R. § 15.507 (authorizing UWB average radiated emissions of –41.3 dBm, measured with a 1 MHz resolution bandwidth). Recommendation 1432 classifies interference from any and all unlicensed sources (including UWB) within the "1 percent" category. *See* TG 1/8, *Working Document towards Revision of Doc 1-8/90 (Rev2)*, 1-8/TEMP/52-E (June 16, 2004) ("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%.") (emphasis in original).

In sum, the Commission proposes permitting a single unlicensed device to increase interference to FSS receivers in extended C-band. Yet this forecast both overlooks recent FCC rulings authorizing other interference sources and disregards ITU-R Recommendation 1432. The Commission rarely ignores, and typically conforms with, internationally developed and accepted ITU Recommendations,[61] especially those the United States supported. The *NPRM* neither challenges the technical basis behind the Recommendation nor justifies a radical departure from its previous position.[62] SIA urges the FCC to follow ITU Recommendation 1432 and confine *all* other sources of interference to 1 percent of the clear-sky satellite noise floor, appropriately allotting only a portion of any permitted increase to the proposed unlicensed devices.[63]

B. The Commission Underestimates the Aggregate Interference From Existing and Proposed Unlicensed Users of the 3650-3700 MHz Band

The *NPRM* also does not address adequately the increased probability of interference created by multiple and simultaneously transmitting Part 15 devices. The FCC predicts its proposal will foster a multiplicity of unlicensed devices.[64] It therefore correctly acknowledges that it must consider the aggregate effect of unlicensed devices in the 3650-3700 MHz band,[65] a central premise of ITU Recommendation 1432 as well.

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61 *Cf. Constellation Communications Holdings, Inc., Concerning Use of the 1990-2025/2165-2200 MHz and Associated Frequency Bands for a Mobile- Satellite System*, 16 FCC Rcd 13724, 13729 (2001) (requiring conformance with ITU Recommendations ITU-R S.1342 and ITU-R S.1340).

62 *Cf. Melody Music, Inc. v. FCC*, 345 F.2d 730, 732-33 (D.C. Cir. 1965); *Greater Boston Television Corp. v. FCC*, 444 F.2d 841, 852 (D.C. Cir. 1970), *cert. denied*, 403 U.S. 923 (1971).

63 For example, the FCC might set maximum power levels such that new unlicensed devices in the aggregate add no more than 0.5% to the noise floor of FSS receivers. Even at those levels, deployment of additional unlicensed devices will negatively affect FSS operations and constrain development of new FSS technologies and services.

64 *NPRM*, ¶ 2 (the proposed rules "should provide substantial opportunities for future, high-power, unlicensed devices").

65 *Id.,* Appendix C n.144.

However, the FCC's technical analysis assumes only a single interferer.[66] But obviously, multiple simultaneous unlicensed devices transmitting near a given FSS receiver generate greater interference than a single device. Curiously, the FCC never explains its failure to implement its own proliferation prediction. Such sunny assumptions are no substitute for the statutory endorsement, record evidence and reasoned explanation demanded by the Administrative Procedure Act.[67]

Exhibit 1, attached hereto, properly considers all currently authorized noise sources as well as the aggregate effects of multiple proposed unlicensed devices. SIA's analysis demonstrates that the FCC's proposed rules understate the consequences of new unlicensed emitters in the band. Put differently, the *NPRM* would sanction unlicensed devices likely to cause harmful interference to existing and planned FSS operations. Because the Commission lacks legal authority to sanction unlicensed devices other than on a non-interference basis, SIA submits that the Commission must reject the proposed rules.

C. The Commission Underestimates the Areas in which Unlicensed Devices Must Be Excluded

The *NPRM* also hinges on the FCC's estimate of the area in which unlicensed devices might interfere with nearby 3650-3700 MHz earth stations. Unfortunately, the FCC's "exclusion zone" methodology is flawed and would not prevent harmful interference to FSS receivers, for three reasons.

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[66] As described in Section III.A. above, Appendix C does not account for the aggregate interference of all permitted and proposed unlicensed devices in the band.

[67] 5 U.S.C. § 706(2).

First, the Commission discards SIA's technical analysis of the appropriate size of exclusion zones based on use of free space path loss.[68] Instead, for the fixed unlicensed devices, the Commission stated "[o]utside of the main beam, the required separation distance (or exclusion zone) of 25 kilometers assumes that a noise-to-interference ratio of 10 dB is acceptable to the FSS operators and that the ITU-R large FSS antenna roll-off gain pattern is appropriate."[69] As shown in Exhibit 1, SIA's analysis undeniably refutes this conclusion. At a separation angle of 15° from the main beam direction and a separation distance of 25 km, the 14 dBW maximum EIRP will result in an interference-to-noise ratio at the FSS receiver of 5.0 dB if the unlicensed device carrier bandwidth is 50 MHz.[70] This would be well above the interference-to-noise ratio necessary to protect the FSS, and could be even greater depending on the unlicensed device carrier bandwidth; interference necessarily will increase if there are multiple devices. Moreover, the proposed 25 km separation distance—erroneously calculated based on a single interfering unlicensed device—will not adequately protect sensitive FSS receivers.[71]

Second, the FCC presupposes unlicensed devices need protect only a narrow arc near the main beam of an FSS earth station receiver ("main beam arc"). Thus, the proposed rules draw a "keyhole" shaped exclusion zone of 180 km within 15 degrees of the main beam of the FSS

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[68] *NPRM*, ¶ 66 & n.86. Although the FCC describes SIA's free space path loss assumption as too conservative, it applies free space path loss in Appendix C to determine proper separation distances. *NPRM,* Appendix C n.146. As explained in Exhibit 1, free space path loss might be overly generous in that it fails to account for multipath signals ground-based unlicensed devices likely will generate.

[69] *NPRM*, ¶ 47. The assumed -10 dB I/N correspond to a 10 percent increase in the noise floor, an order of magnitude above the international standard 1 percent. *See* note 54 *supra*.

[70] *See infra* Exhibit 1, Section E.1 & Table 1-1.

[71] As described in Sections III.A and III.B above, Appendix C does not account for the aggregate interference of all permitted and proposed unlicensed devices in the band.

receiver and 25 km otherwise.[72] Exhibit 1 shows that the Commission's proposed exclusion zone near the FSS earth station main beam would be far too small. Even at the edge of the proposed exclusion zone, at 15 degrees off the main beam axis, the required exclusion zone would be between 158 and 250 km.[73] Closer to the main beam axis, an even larger exclusion zone is necessary. For example, Exhibit 1 shows that an exclusion zone of between 220 and 313 km is necessary for a 5-degree separation angle from the FSS earth station main beam.[74] The FCC's proposed zone also fails to account for the fact that most existing and planned earth stations in the band are "steerable" and can operate throughout the authorized satellite arc. Moreover, this simplistic assumption overlooks the agency's successful streamlining of the earth station licensing process that has permitted most earth stations to communicate with any FCC-recognized spacecraft in view.[75]

Limiting FSS earth stations to a single direction and a single satellite is inconsistent with the Commission's policy recently articulated in satellite and earth station licensing reform, which

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[72] The Commission noted that its proposed 180 kilometer separation distance, or exclusion zone would be 20 kilometers less than the 200 kilometer coordination zone proposed for licensed fixed point-to-point stations in the *3650 MHz Service Rules Second Notice*, but justified the difference because it proposed authorizing unlicensed devices at power levels on the order of 18 dB lower than previously considered for licensed fixed point-to-point facilities. *NPRM,* ¶ 47.

[73] *See infra* Exhibit 1, Section E.2 & Table 1-3.

[74] *Id.*

[75] This process permits an FSS earth station in the conventional C- and Ku-bands to repoint to and communicate with multiple satellites (either U.S. licensed or on the "Permitted List") without prior agency approval. This practice is common in the FSS business either for back-up purposes or to utilize ad-hoc capacity when and where available. *See Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Space Stations to Provide Domestic and International Satellite Service in the United States,* First Order on Reconsideration, 15 FCC Rcd 7207, 7210-11 (1999) ("*DISCO II First Reconsideration Order*"); *id.* at 7215-16.

increased licensee flexibility.[76] The FCC neither justifies so drastic a shift from its recently adopted policies[77] nor supplies any basis for changing the Commission's earth station rules.[78] Instead, the Commission should adopt an exclusion zone of 180 km throughout the arc for unlicensed devices.[79]

Third, the *NPRM's* standard for non-fixed unlicensed devices also is too generous. The FCC proposes a maximum allowed EIRP of 250 mW when the signal level received by the devices from the FSS earth station is –76 dBm/MHz. Under those circumstances, the interference-to-noise ratio at the FSS earth station will be in the order of 30.8 dB, generating huge excess interference to the FSS earth station.[80] SIA's analysis shows that the maximum interference-to-noise ratio necessary to protect FSS earth stations should not exceed -23 dB from all unlicensed devices, which would require a much lower detection threshold than the FCC proposes.

IV. THE NPRM UNDERESTIMATES POTENTIAL ADJACENT CHANNEL INTERFERENCE TO FSS EARTH STATIONS IN THE BAND 3700-4200 MHz

In addition to the unmistakable likelihood of harmful interference to co-frequency FSS receivers, deployment of unlicensed devices in 3650 - 3700 MHz also will disrupt FSS earth

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[76] *See, e.g., FWCC Request for Declaratory Ruling on Partial-Band Licensing of Earth Stations in the Fixed-Satellite Service That Share Terrestrial Spectrum*, 17 FCC Rcd 2002, 2006-08 (2002) (Second Report and Order) (rejecting proposed limits on full-band, full-arc licensing of C-band earth stations).

[77] *Cf. Melody Music, Inc. v. FCC*, 345 F.2d 730, 732-33 (D.C. Cir. 1965).

[78] *Cf. Greater Boston Television Corp. v. FCC*, 444 F.2d 841, 852 (D.C. Cir. 1970), *cert. denied*, 403 U.S. 923 (1971).

[79] At a minimum, the width of the main beam arc must be the authorized satellite arc plus the FSS receive antenna main beam width. Both the authorized satellite arc and the antenna beam width are available via the Commission's IBFS system and could be incorporated into the GPS geolocation database described above. Any updates to the geolocation database also should include any changes to the authorized satellite arc for a particular FSS earth station.

station receivers in the adjacent band. The 3700 - 4200 MHz spectrum—the conventional C-band—is the principal downlink allocation for C-band satellites. This spectrum is intensively used by satellite networks and *already* subject to coordination with (and thus, potentially, interference from) terrestrial microwave systems sharing the band.[81] Adding multiple unlicensed devices to the adjacent spectrum is certain to exacerbate interference, potentially disrupting thousands of FSS receivers—especially because the *NPRM* forsakes customary and effective sharing techniques such as "exclusion zones."

SIA's prior comments warned about out-of-band interference from unlicensed devices to sensitive FSS receivers, particularly given the trend toward smaller-dish "CSAT" operations in the band.[82] The Commission proposes retaining 3700-4200 MHz as a "restricted band," but contends the current 500 microvolts/meter (measured at 3 meters) field strength ceiling sufficiently protects FSS receivers.[83] The *NPRM* bases this tentative conclusion on the assertedly similar situation in the 2400-2483.5 MHz band.[84]

However, a closer look at C-band FSS suggests the cases are anything but parallel. As shown in Exhibit 2, out-of-band emissions from the proposed unlicensed devices are likely to cause harmful interference to FSS earth stations hundreds of meters away. For example, a single emitter with an arrival angle of 15 degrees with respect to the earth station main beam axis would exceed the required –23 dB interference-to-noise ratio[85] when within approximately 750

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80 *See infra* Exhibit 1, Section E.2 & Table 1-2.

81 47 C.F.R. § 25.203(a-c).

82 SIA Comments, at 10-11.

83 *NPRM*, ¶ 59 (citing 47 C.F.R § 15.209(a) (measurements assume 1 m bandwidth)).

84 *Id.*, ¶ 59 n.81 (citing 47 C.F.R § 15.247).

85 *See* Section III.A, *supra.*

m of the FSS receiver.[86] For an arrival angle of 5 degrees, the interference-to-noise ratio of –23 dB occurs for a single-emitter more than 2.1 km away.[87] The possibility of aggregate interference from multiple emitters has not been considered but larger separation distances actually would be required. The calculations supporting these conclusions are given in Exhibit 2.

Moreover, as set forth in Exhibit 3, a single unlicensed emitted can reach the low noise block-down-converter (LNB) of the earth station at levels more than 27 dB above the desired signal and potentially saturate the LNB. Operation near saturation could result in distortion of the received signal as well as trigger amplifier suppression effects, where the out-of-band emissions from unlicensed devices actually overcome weaker, desired satellite transmissions. The attached analysis shows that space-to-earth transmissions in conventional C-band would suffer severely degraded link performance by an adjacent-channel 25 W emitter within 600 meters, or even a 1 W emitter within about 115 meters.[88]

In sum, deployment of unlicensed devices in the extended C-band can be expected to interfere with the many earth stations receiving in the adjacent 3700-4200 MHz spectrum. But unlicensed devices are secondary to FSS operations, can generate no more than spurious emissions into the adjacent FSS downlink,[89] which—in any event—"shall be suppressed as much as practicable."[90] As a result, the unlicensed devices described in the *NPRM* cannot be authorized without thorough study of, and protection from, out of band interference. Accordingly, should the FCC open extended C-band to unlicensed devices, SIA suggests the

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86 *See infra* Exhibit 2, Table 2-1.

87 *Id.*

88 *See infra* Exhibit 3, Table 3-1.

89 47 C.F.R. § 15.205(a).

90 47 C.F.R. § 15.15(a).

Commission also adopt an "exclusion zone" mechanism to protect earth station receivers in the adjacent band.

V. NONE OF THE PROPOSED SHARING METHODOLOGIES IS ADEQUATE BY ITSELF TO PROTECT EXISTING AND FUTURE FSS STATIONS

A. The Proposed Listen-Before-Talk Mechanism Will Not Protect FSS Earth Stations From Harmful Interference

The proposed listen-before-talk mechanism is based on flawed logic. Scanning for the satellite uplink as proposed by the Commission is a poor substitute for listening directly for the satellite downlink that must be protected from harmful interference. The Commission erroneously assumes that a 6 GHz uplink always will be present when the FSS earth station is receiving.[91] This simply is not true. Rather, the *NPRM*'s listen-before-talk strategy can be expected to generate a "false negative" in several commonplace circumstances, thus permitting transmissions when an FSS earth station is receiving and susceptible to interference.

First, reliance on sensing alone will not prevent false negatives caused by varying signal strength resulting from blockage, multi-path fading and foliage attenuation. Second, the proposal assumes most FSS downlinks and uplinks are paired. But many FSS applications (e.g., video) are one-way—and scanning the uplink provides no assurance of the absence of an FSS downlink.[92] Also, the uplink and downlink signals may not be in the same relative locations in their respective bands, making it difficult for the unlicensed device to correlate the uplink it is

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[91] The 5.85-5.925 GHz band recently was allocated for the Dedicated Short Range Communication ("DSRC") Service. *See NPRM,* ¶ 51 & n.71. Because the DSRC band subsumes the FSS extended C-band uplink spectrum (5875-5925 MHz), unlicensed devices utilizing the proposed listen-before-talk mechanism must be able to "deconflict" between the DSRC signal and the FSS uplink signal.

[92] Indeed, the current intercontinental restriction on the FSS allocation encouraged asymmetric traffic between the 5850 and the 3650 bands. Hence, there might be long periods without any uplink transmission where the FSS earth station nonetheless is receiving a signal.

listening for with its corresponding downlink frequency band to determine on which frequency it is clear to transmit.[93]

Third, the Commission heavily relies on the nascent DFS sharing scheme with government radar systems in the 5 GHz band.[94] Yet, DFS-type sharing with radar has yet to be implemented, much less proven; in any event, DFS techniques are largely inapposite here. FSS downlinks operate at levels far below high-power radar and presuppose link margins unneeded by radar—making both signal identification and interference avoidance substantially more difficult.[95]

Finally, the FCC proposes to authorize unlicensed device transmissions even after detecting an uplink signal, albeit at reduced power.[96] In other words, the draft rules would allow multiple unlicensed devices to transmit on top of FSS receivers—rather than immediately ceasing transmission as required of all non-interference operations.[97] In sum, listen-before-talk

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[93] The FCC should not eliminate the flexibility satellite providers now enjoy when assigning uplink and downlink frequencies for a particular FSS earth station to any portion of their assigned frequency bands (including the use of cross strapping or one-way architectures). The current approach permits network operators to optimize use of the assigned spectrum while providing a variety of satellite services, including one-way video, to a diverse customer base.

[94] *See NPRM*, ¶ 50 & n.70 (applying Dynamic Frequency Selection Threshold approach similar to that used to protect government radar systems in 5 GHz band from unlicensed devices), citing *Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Report and Order, 18 FCC Rcd 24484 (Nov. 18, 2003) ("*Unlicensed Devices in the 5 GHz Band*")

[95] The differences between radar and FSS overwhelm any similarities, vitiating the putative value of the 5 GHz DFS model. For example, the proposed threshold for detecting FSS uplink transmissions is at least 12 dB below the rule adopted to identify 5 GHz radar emissions. *Compare NPRM* Appendix C (-76 dBm) *with Unlicensed Devices in the 5 GHz Band*, ¶ 23 (-62/-64 dBm). Moreover, FSS employs different transmit and receive frequencies and operates at receive powers not necessarily related to transmit power. Such characteristics make detecting, then sharing, FSS spectrum vastly more difficult than radar.

[96] *NPRM*, ¶ 51.

[97] *See* 47 C.F.R. § 15.15(c) ("operators of part 15 devices are required to cease operation should harmful interference occur to authorized users of the radiofrequency spectrum.").

devices can be expected to be tripped-up by environmental conditions and mismatches between uplink and downlink, resulting in frequent false negatives and harmful interference to licensed FSS earth stations.

B. GPS Geolocation Will Not Adequately Protect FSS Earth Stations With the Proposed Exclusion Zones

In order to avoid interference, GPS geolocation systems depend on an up-to-date and reliable licensee database, appropriately established exclusion zones, and safeguards to ensure automatic shutdown. Such a system also must account for the geolocation inaccuracy inherent in the device, and prevent end-users from tampering with or disabling of the shutdown mechanism. To protect against the case where a geolocation device is not working properly and yet the device continues to transmit, the system also must ensure unlicensed devices cease transmitting when not receiving positioning information.

A reliable and timely mechanism to update any geolocation database for new and relocated FSS earth stations should be in place before permitting unlicensed operation in the 3650-3700 MHz band. Any such database must include coordinates of all FSS earth stations, both grandfathered and new or relocated. COMSEARCH and similar entities already have such a database. The Commission therefore should require unlicensed devices to query COMSEARCH or other similar databases no less than monthly[98] to ensure that new or relocated FSS earth stations are properly protected.[99]

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[98] The FCC assumes, *NPRM,* ¶ 68, that new FSS earth stations operating in extended C-band will be constructed and licensed only infrequently. There is no evidence for this supposition. In any event, unlicensed devices bear the burden of avoiding interference. Thus, requiring any new co-frequency device to be capable of updating its internal database each month is the maximum interval that might appropriately protect higher-priority FSS receivers.

[99] The Commission should also implement its proposal to require fixed and mobile unlicensed devices to broadcast identification information at regular intervals. *NPRM,* ¶¶ 60-62. Such a signal should include both identification and contact information for the individual unlicensed device to permit prompt notification of actual interference to an FSS earth station.

C. The Proposed Dedicated RF Beacon Option Will Not Adequately Protect Sensitive FSS Receivers

Taken alone, SIA opposes beacon signals for interference avoidance as needlessly complex. The concept raises more questions than easily could be answered. Most importantly, who builds and operates the beacons? If the Commission requires a beacon, the costs of implementation, maintenance and operation must be borne by the device manufacturers, already primarily obligated to avoid interference. Yet many manufacturers are *not* service providers, and may have limited operational experience. And the FCC would be required to resolve the "free rider" problem: how could beacon costs be shared between "first mover" manufacturers and subsequent entrants?

In addition, the *NPRM* passes over the possibility that a dedicated beacon might fail, generating a "false negative." Indeed, if a beacon ceases, the draft rules guarantee an unlicensed device will erroneously assume it is free to transmit,[100] despite the clear non-interference and shutdown requirement.

Moreover, what signal characteristics should be required? Any beacon cannot itself interfere with FSS and thus must operate outside the FSS receive band—but wherever located, a beacon cannot impinge on other licensed services. The beacon frequency and bandwidth also must accommodate different satellites with varying frequency plans—a unique beacon may not be compatible with all FSS earth stations. A beacon must not cause the FSS operator any interference. These unresolved issues suggest that the concept of using an RF beacon requires further study, analysis and field trial.

Upon notification of such interference, the unlicensed operator must immediately cease transmissions.

D. Because of their Individual Inadequacies, the Commission Must Combine All Three Sharing Techniques to Minimize the Risk of Interference

Standing alone, none of the preceding mechanisms would guarantee that unlicensed devices—limited by rule and policy to non-interference operation—adequately protect sensitive FSS receivers. However, once the FCC revises the separation distances for the fixed unlicensed devices and the maximum allowed EIRP and corresponding detection thresholds for the non-fixed unlicensed devices, combining the strengths of the three mechanisms to minimize their respective weaknesses may offer a viable alternative.

First, GPS geolocation could supplement listen-before-talk to reduce the chance of false negatives. Because GPS geolocation is designed to inhibit all transmissions in exclusion zones, it could be used in conjunction with listen-before-talk to reduce the number of false negatives in exclusion zones. Second, listen-before-talk provides some protection for new and relocated FSS earth stations until unlicensed devices receive their first update including the new or relocated earth station location. Third, a dedicated beacon signal cannot serve as the sole protection, but could be a positive addition to both listen-before-talk and GPS. Provided that a dedicated beacon would always be transmitting when an associated FSS earth station is receiving, a beacon would reduce the incidence of false negatives (compared to listen-before-talk alone) caused by unpaired FSS uplink and downlink signals.

Though no single approach is sufficiently fool proof, a combination of techniques has the greatest potential to protect licensed services. Accordingly, to the extent the Commission permits unlicensed operation in the 3650-3700 MHz band, SIA urges the Commission to adopt

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[100] Unlike the GPS geolocation example, the unlicensed device looks for the absence (rather than the presence) of the beacon signal, and cannot distinguish between signals absent due to malfunction as opposed to signals absent because it might be clear to transmit.

listen-before-talk, GPS geolocation, and a dedicated beacon in conjunction to minimize the likelihood that FSS receivers will suffer harmful interference.

E. The Commission Must Develop Appropriate Enforcement Mechanisms

Regardless which sharing technique it adopts, the Commission also must establish how it will respond when unlicensed devices interfere with FSS earth stations. Each of the approaches outlined in the *NPRM* is fallible, underscoring the importance of *a priori* policies to ensure the Commission can, swiftly and surely, redress any harmful interference that may occur.

Traditionally, the FCC has regulated potential harmful interference through limitations on the power emitted by a transmitter. One of the main advantages of such an approach is that transmitted power is easily measurable, permitting straightforward determination of whether a given facility conforms to established standards.

By contrast, the necessity to consider and restrict *aggregate* interference—especially from anonymous users—makes validating compliance vastly more complicated. The *NPRM* provides little guidance. How will licensed operators be able to determine and establish that the new devices have exceeded authorized signal levels? If a licensed system experiences disruptive interference, how will that situation be remedied? In practice, how will *each* equipment manufacturer and individual user be held responsible for elimination of interference, especially were there thousands or millions of active, unlicensed and thus untraceable systems in operation, each contributing a component of the excessive interference?[101] Will the Commission demand satellite operators demonstrate extensive and repeated harm, though even infrequent or transient

[101] The FCC acknowledges this apprehension, but neither disputes the infirmity nor proffers any solution. *See NPRM,* ¶ 60 ("In the event that interference might be caused, it could be difficult for the operator of a licensed station to identify and locate an unlicensed device that may be causing interference.").

interference might interrupt FSS service? How much larger must any "shut-down" zone be, as compared with an exclusion zone, to ensure the Part 15 devices adhere to their duty of "non-interference?" How can *anyone* (the FCC or manufacturers) guarantee multiple untraceable, unlicensed devices will shutdown when the rules demand?

These critical questions are not merely rhetorical, but go to the core of the viability of the Commission's proposals. And the precedent for sharing satellite spectrum is decidedly unfavorable. Unlicensed radar detectors manufactured and distributed pursuant to Part 15 rules have caused serious interference disrupting the operations of licensed VSAT systems. Although the Commission adopted new forward-looking standards for detectors two years ago,[102] it conceded that its new policy could not be effectively enforced:

> [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.[103]

Nothing in the *NPRM* suggests that detecting and remedying disruptive interference will be any easier here. Yet, contrary to the requirements of the APA, the agency never acknowledges its previous conclusions, nor explains its change in policy.[104]

Absent robust and effective enforcement mechanisms, the Commission's proposals will subject licensed satellite operations in the extended C-band to unacceptable uncertainty and risk. Satellite signals must travel thousands of miles up and back from transmitter to in-orbit

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[102] *See Review of Part 15 and Other Parts of the Commission's Rules*, 17 FCC Rcd 14063 (2002) (First Report and Order) (footnote omitted). Under these rules, legacy equipment remains constrained solely by "the non-interference requirement in Section 15.5 of the rules," *id* at 14069, the same standard suggested in the instant *NPRM.*

[103] *Id.*, ¶ 11.

[104] *Cf. Greater Boston Television Corp. v. FCC*, 444 F.2d at 852.

spacecraft to receiver. As a result, satellite operations are particularly vulnerable to added interference. Small increases in the noise floor could exhaust planned margins, causing the link to fail, disrupting service to the customer. It's an all or nothing proposition, making effective enforcement of any limits essential.

The silence of the *NPRM* is unmistakable evidence that the FCC neither considered nor resolved how such enforcement would be accomplished. Absent more, SIA recommends the proposed rules await further research and review.

VI. CONCLUSION

For the reasons set forth above and in SIA's previous comments, permitting unlicensed devices to operate in the 3650-3700 MHz band likely would trigger harmful interference to co-frequency FSS receivers and also to FSS receivers operating in the adjacent conventional C-band. However, unlicensed devices cannot interfere lawfully with licensed operations. Therefore, SIA urges the Commission to review and rule on the long-pending reconsideration and stay motions and reject opening the extended C-band to unlicensed devices. Moreover, regardless of its decision on sharing in the band, both footnote US245 and Section 25.202(g)(1) are outdated and unjustified, and must promptly be repealed.

Respectfully submitted,

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EXHIBIT 1 - TECHNICAL ANALYSIS FOR COFREQUENCY OPERATION

The *NPRM* seeks comment on a number of technical issues that would be raised by authorizing unlicensed devices in the 3650-3700 MHz band. The *NPRM* provides little meaningful analysis of the aggregate interference threat from existing and proposed unlicensed uses of the 3650-3700 MHz band, and presupposes unlicensed devices would increase the noise floor ten times more than the permissible increase suggested by the ITU without causing harmful interference to licensed services. The following technical analysis evaluates the potential impact of the operation of unlicensed devices on FSS downlinks in the band.[105]

This analysis provides further support for SIA's contention that—based on the FCC proposed technical parameters—unlicensed devices operating in the 3650-3700 MHz band will cause harmful interference to grandfathered (and therefore primary) and secondary FSS downlinks. Such harmful interference could not be avoided absent relatively large exclusion zones that would effectively prohibit unlicensed operations in large portions of the country, or without further expanding the exclusion zones by limiting unlicensed devices to extremely low power levels.

A. Interference allowance

Recommendation ITU-R 1432 clearly specifies an interference allowance of 1% for all non co-primary sources of interference. The *NPRM* would allow unlicensed devices up to a 10 % noise floor increase. Moreover, the proposal does not consider other permitted uses of the band, such as UWB, and ignores out-of band and spurious emissions. SIA recommends that

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[105] This analysis is intended to supplement rather than supplant the Technical Analysis submitted with SIA's Comments to the *NOI*, which is incorporated herein by reference. *See SIA Comments* at 14-21.

calculations of interference into FSS earth station be made on the basis of 0.5% interference allowance from unlicensed devices, in order to account for all sources of interference.

B. Aggregate interference from multiple devices

Appendix C to the *NPRM* mentions in passing the need to consider aggregate interference from all unlicensed devices--but then analyzes the separation distances and detection thresholds to protect an FSS earth station from a single 250 mW unlicensed device.[106] The Commission predicts multiple unlicensed devices in the band. Hence any calculation must aggregate all of these interference sources to ensure that the cumulative effect does not cause harmful interference to FSS earth stations.

C. Propagation model

Although the FCC describes free space path loss assumption as too conservative at note 86, it applies free space path loss in Appendix C to determine proper separation distances. As clearly recognized in the NPRM, free space propagation is applicable for satellite links but not for terrestrial paths where multipath transmission is likely. Recommendation ITU-R P.452 specifies propagation models that are more appropriate and should be used for terrestrial paths propagation calculations. It is noted that though the free space path loss model yields more conservative results in some instances, it actually leads to less conservative results than the multipath model in other instances.

D. Miscellaneous losses

The calculation in appendix C assumes 10 dB miscellaneous losses, described in note 145 of the NPRM, but provides no clear explanation for the basis of choosing this value.

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[106] *NPRM*, Appendix C, note 144.

Clarification is sought on the basis for selecting this distance-independent value of 10 dB for miscellaneous losses (see note 145 of NPRM).

E. Exclusion zones for Fixed operations

1. Comments on the NPRM results

The exclusion zones proposed in the NPRM are based on overly optimistic assumptions. SIA's analysis indicates that a fixed unlicensed device EIRP of 14 dBW will result in unacceptably high interference levels at the Commission's proposed exclusion zone distance of 25 km outside the main beam of the FSS earth station receiver. As depicted in the table below, at a separation angle of 15° from the main beam direction, an exclusion zone distance of 25 km and an allowable EIRP the 14 dBW proposed by the Commission will result in an interference-to-noise ratio at the FSS receiver of 5.0 dB if the unlicensed device carrier bandwidth is equal to 50 MHz. This interference can be higher depending on the unlicensed device carrier bandwidth.

Table 1-1: Interference-to-noise ratios between fixed unlicensed devices operating at various bandwidths with respect to an FSS Earth Station (3650-3700 MHz)

Unlicensed Fixed device EIRP	14 dBW/50MHz	14 dBW/10MHz	14 dBW/5MHz	14 dBW/1MHz
FSL (25km @ 3650 MHz)	-131.6 dB	-131.6 dB	-131.6 dB	-131.6 dB
Miscellaneous Losses	10.0 dB	10.0 dB	10.0 dB	10.0 dB
FSL	-141.6 dB	-141.6 dB	-141.6 dB	-141.6 dB
Frequency	3650 MHz	3650 MHz	3650 MHz	3650 MHz
Distance	25 km	25 km	25 km	25 km
Gain of antenna at 15° (Note 1)	2.6 dBi	2.6 dBi	2.6 dBi	2.6 dBi
Interference level	-125.0 dBW/50MHz	-125.0 dBW/10MHz	-125.0 dBW/5MHz	-125.0 dBW/MHz
Interference level in dBW/Hz	-202.0 dBW/Hz	-195.0 dBW/Hz	-192.0 dBW/Hz	-185.0 dBW/Hz
Total system noise temperature	142.8 K	142.8 K	142.8 K	142.8 K
FSS Receiver Thermal Noise Floor	-207.05 dBW/Hz	-207.053 dBW/Hz	-207.05 dBW/Hz	-207.053 dBW/Hz
Interference-to-noise ratio at FSS receivers	5.0 dB	12.0 dB	15.0 dB	22.0 dB

Note 1 :
The antenna sidelobe pattern based on 32-25*log(theta) was used.

The calculations are made for an earth station system noise temperature of 100º K resulting in the total system noise temperature of 142.8º K.

2. Example revised Exclusion Zones calculations

Example calculations were performed assuming interference from 10 unlicensed devices. Furthermore a multipath propagation model based on Recommendation ITU-R P. 452 has been

assumed, though for the sake of comparison the results corresponding to a free space loss model have also been shown in the computation of the required separation distances.

In order to implement the multipath propagation model, it was necessary to assume the percentage of time for which the 0.5% noise interference allowance could be exceeded. Recommendation ITU-R S.1432 does not clearly define the time allowance corresponding to the interference noise allowance for all other sources of interference. However, for the purpose of this study, we have used the following three example values for the time allowance: 0.1%, 1%, and 10%. Considering that the analysis assumes 10 potentially interfering devices, the calculations are performed for cases where each of the devices are allowed to exceed the 0.5% noise interference threshold for 0.01%, 0.1%, and 1% of the time. Additionally, though Appendix C does not explain the rationale for presuming 10 dB of miscellaneous losses, the same assumption has been made in the present study.

The results of example calculations of required separation distances are given in Table 1-3 below. The example calculations show that the required exclusion zone would be between 220 km and 313 km in the case of a fixed unlicensed device with 5 degrees separation angle from the FSS earth station main beam direction using the multipath model, and would be in the thousands of km if the free space loss model were used. In the case of a device in the back lobe of the FSS earth station, the required exclusion zone would be between 86 km and 155 km. The distances would be larger if the miscellaneous losses are less that the assumed 10 dB.

F. Detection thresholds for non fixed operations

1. Comments on assumptions used in Appendix C of the NPRM

The Commission's analysis of detection thresholds for a listen-before-talk mechanism and separation distances for a GPS geolocation system in Appendix C to the *NPRM* does not

present an accurate picture of the true interference threat because the Commission has failed to adequately consider the aggregate interference from all potential unlicensed sources. In all of the points mentioned in paragraph C1 above are also applicable in this case. Additionally, the method used in computing the earth station EIRP in the backlobe is incorrect.

For non-fixed unlicensed device, the FCC has set the power switching thresholds too high to adequately protect FSS earth stations from harmful interference. The following analysis revises the interference-to-noise ratio at the FSS earth station when the non-fixed unlicensed device is located in the direction of the FSS earth station antenna backlobe gain. The analysis takes into consideration the allowed EIRP of 250 mW when the level of the signal received from the earth station will be equal to –76 dBm.

Table 1-2: Separation distance and interference-to-noise ratio for a fixed unlicensed device transmitting in the backlobe of an FSS Earth Station (3650-3700 MHz)

Earth station transmit EIRP (44 dBW/MHz)	74 dBm/MHz
Earth station peak antenna gain (assume 9m diameter antenna)	52.6 dBi
Transmit power at the antenna input	21.4 dBm/MHz
Earth station antenna gain (backlobe)	-10 dBi
Earth station EIRP (backlobe)	11.4 dBm/MHz
Miscellaneous losses	10 dB
Detection level as proposed by the FCC to allow a 250 mW EIRP	-76 dBm/MHz
Free space loss to be at detection threshold	**77.4 dB**
Corresponding separation distance between device and FSS earth station	0.03 Km
Proposed unlicensed device transmit EIRP (250mW)	24 dBm/50 MHz
Losses between unlicensed device and earth station @3650 MHz	73.3 dB
Miscellaneous losses	10 dB
Earth station antenna gain (backlobe)	-10 dBi
Interference level at the earth station	-69.3 dBm/50 MHz
Earth station thermal noise floor (-130.1 dBW/MHz)	-100.1 dBm/MHz
Interference-to-noise ratio at earth station	**30.8 dB**

2. Example revision of Separation Distances in Appendix C

The revised calculation of the required separation distances and detection threshold are given in Tables 1-4A and 1-4B below. These assume an FSS earth station with an EIRP of 44 dBW/MHz and an unlicensed device with an EIRP of 1 watt. The calculations consider 18 meter and 9 meter FSS earth stations, both of which are typical in the band.

The analysis demonstrates that the required detection threshold for non-fixed operation of unlicensed devices would be between -137 dBm and -132 dBm for an 18 m FSS earth station and between –131 dBm and -126 dBm for a 9 m earth station. This results in exclusion zones of between 220 and 313 km for fixed 25-watt devices and between 130 and 220 km for non-fixed 1-watt devices.

Table 1-3: Separation distances needed between fixed unlicensed devices operating at various angles with respect to the pointing direction of an FSS Earth Station (3650-3700 MHz)

	FIXED, Unlicensed Device (EIRP = 25 watts)		
ES angle to Unlicensed device (deg)	5	15	48
FSS ES Ant gain towards unlicensed device (dBi)	11.53	2.60	-10.00
Total System Noise temperature (K)	142.8	142.8	142.8
Thermal Noise power (dBW/MHz)	-147.1	-147.1	-147.1
Allowable Interference level if ΔT/T=0.5%	-170.1	-170.1	-170.1
Fixed unlicensed eirp (dBW/50MHz)	14	14	14
Interference path loss required (dB)	-168.60	-159.67	-147.07
Frequency of operation (MHz)	3675	3675	3675
(1m2) Ant gain (dBi)	32.75	32.75	32.75
Separation Distance assuming Free Space Loss model (km)	1748.3	625.5	146.7
Rec. 452 Smooth Earth Loss (dB)	-168.60	-159.67	-147.07
Required Separation Distance assuming multipath model (1%) (km)	220	158	86
Required Separation Distance assuming multipath model (0.1%)(km)	313	250	155
Required Separation Distance assuming multipath model 0.01% (km)	370	305	205

Table 1-4A: Separation distances needed between non-Fixed unlicensed devices operating at various angles with respect to the pointing direction of an FSS Earth Station (3650-3700 MHz)

	non-FIXED, Unlicensed Device EIRP = 1 watts)		
FSS ES angle to Unlicensed device (deg)	5	15	48
FSS ES Ant gain towards unlicensed device (dBi)	11.53	2.60	-10.00
Total System Noise temperature (K)	142.8	142.8	142.8
Thermal Noise power (dBW/MHz)	-147.1	-147.1	-147.1
Allowable Interference level if ΔT/T=0.5%	-170.1	-170.1	-170.1
Fixed unlicensed eirp (dBW/50MHz)	0	0	0
Fixed unlic. eirp incl. BW corr. (dBW/MHz)	-154.60	-145.67	-133.07
Interference path loss required (dB)	3650	3650	3650
Frequency of operation (MHz)	32.70	32.70	32.70
Separation Distance assuming Free Space Loss model (km)	351.2	125.6	29.5

Rec. 452 Smooth Earth Loss (dB)	-154.60	-145.67	-133.07
Required Separation Distance assuming multipath model (1%)(km)	130	70	35
Required Separation Distance assuming multipath model (0.1%)(km)	220	136	49
Required Separation Distance assuming multipath model 0.01% (km)	270	180	70

Table 1-4B: Detection threshold values to protect 9m and 18m FSS earth stations from a 1W unlicensed device

FSS ES angle to Unlicensed device (deg)	48	48
FSS ES antenna size (m)	9	18
FSS ES eirp (44 dBW / 1 MHz)	44	44
ES Ant Gain	53.00	59.02
Tx Pwr into Antenna (dBW/1.7 MHz)	-9.000	-15.015
FSS ES Antenna gain towards unlicensed device (dBi)	-10.00	-10.00
FSS ES eirp towards unlicensed device (dBW)	-19.00	-25.02
Interference path Separation distance assuming multipath model (1%) (km)	29.46	29.46
Interference Path loss (dB)	137.21	137.21
Frequency of operation (MHz)	5875	5875
Received signal at unlicensed device (dBW)	-156.21	-162.23
Detection threshold at unlicensed device assuming multipath model (1%) (dBm)	-126.21	-132.23

Interference path Separation distance assuming multipath model (0.1%) (km)	49.00	49.00
Interference Path loss (dB)	141.63	141.63
Frequency of operation (MHz)	5875	5875
Received signal at unlicensed device (dBW)	-160.63	-166.65
Detection threshold at unlicensed device assuming multipath model (0.1%) (dBm)	-130.63	-136.65

EXHIBIT 2 - TECHNICAL ANALYSIS OF ADJACENT BAND INTERFERENCE TO FSS DOWNLINKS IN 3700 – 4200 MHZ

Paragraph 59 of the NPRM would limit any out-of-band emissions from proposed new Part 15 devices to a maximum field strength of 500 microvolt/m measured at 3 m, which refers to a 1 MHz bandwidth. This is the same limit currently in the rules, see 47 C.F.R § 15.209(a). In considering the effects of such emissions on C-band satellite downlinks in the immediately adjacent 3700-4200 MHz band, this is equivalent to an interfering signal level of -25.6 dBm over a (typical) 36 MHz bandwidth transponder.

Table 2-1 computes the interfering signal level at the LNB flange for several distances between the unwanted emitter and the receive earth station. The calculations cover three different arrival angles off the boresight of the receive earth station antenna (5º, 8º and 15º). The table is based on free space path loss and assumes a sidelobe gain performance compliant with Part 25 25.209(a). The analysis allots the proposed new emitters half the noise floor increase ITU-R Recommendation 1432 reserves for non-co-primary services (i.e., 0.5 %).

The allotted 0.5% corresponds to an interference-to noise ratio of approximately –23 dB. Table 2-1 shows that for an arrival angle of 5º with respect to boresight, the adjacent band emission of a single emitter at 2.1 km from the earth station would exceed the I/N criterion, and potentially produce excess interference. For an arrival angle of 15º with respect to boresight, a single emitter would exceed the C/I criterion at distances of 750 m or closer.

Table 2-1 I/N Values Produced by a Single Emitter That Meets the Adjacent Band Limit Proposed in the NPRM (Interference Allowance of 0.5% of the Total Noise Corresponds to I/N = -23 dB)

Arrival Angle With Respect to Antenna Boresight (°)	Distance (m)	Interfering Signal Level at Victim Antenna (dBm/36MHz)	Interfering Signal Level at LNB Flange (dBm/36MHz)	I/N (dB)
5	50	-103.4	-91.9	9.6
	100	-109.4	-97.9	3.6
	200	-115.4	-103.9	-2.4
	400	-121.4	-109.9	-8.4
	600	-125.0	-113.4	-12.0
	800	-127.5	-115.9	-14.5
	1000	-129.4	-117.9	-16.4
	1400	-132.3	-120.8	-19.3
	1800	-134.5	-123.0	-21.5
	2100	-135.8	-124.3	-22.8
8	50	-103.4	-95.4	6.1
	100	-109.4	-101.4	0.1
	200	-115.4	-107.4	-5.9
	400	-121.4	-113.4	-12.0
	600	-125.0	-117.0	-15.5
	800	-127.5	-119.5	-18.0
	1000	-129.4	-121.4	-19.9
	1200	-131.0	-123.0	-21.5
	1400	-132.3	-124.3	-22.8
15	50	-103.4	-100.8	0.7
	100	-109.4	-106.8	-5.3
	200	-115.4	-112.8	-11.3
	400	-121.4	-118.8	-17.4
	600	-125.0	-122.4	-20.9
	700	-126.3	-123.7	-22.2
	750	-126.9	-124.3	-22.8

EXHIBIT 3 - TECHNICAL ANALYSIS FOR EARTH STATION LNB SATURATION

Most C-band earth stations in the United States, and around the world, utilize Low Noise Blockdownconverters (LNBs). After a reflector intercepts and magnifies the satellite signal, the LNB adds further amplification and downconverts the signal from 3.7-4.2 GHz to L-band (950-1450 MHz), in order to facilitate transporting the signal using coaxial cable.

The considerable installed base of legacy C-band earth stations in the 3.7-4.2 GHz band use LNBs that act as band pass filters that also pass the adjacent 3.65-3.7 MHz ban. LNBs are designed to "see" the full 500 MHz of C-band spectrum (3.7-4.2 GHz), and their filter response characteristics around the 3.7-4.2 GHz band hardly exhibit any attenuation. For all intents and purposes, the frequency response of LNBs in the 50 MHz below 3.7 GHz is identical to its pass band response. In fact, whether previously installed or recently manufactured, most LNBs have a pass band of approximately 3.625-4.2 GHz. Therefore, no C-band LNB will exhibit any rejection toward the 3.65-3.7 GHz band. Thus, C-band earth stations are as susceptible to interference in the adjacent extended C-band as they are to in-band interference in the 3.7-4.2 GHz band.

As a typical example, the case of a 4.5 m antenna used to receive a 36 MHz, fully saturated signal, is considered here. For a satellite saturation downlink EIRP of 39 dBW, a downlink free space loss of 196 dB and an antenna gain of 44 dBi, it follows that the desired signal within 36 MHz at the input of the LNB is -113 dBW, i.e. -83 dBm. If 12 satellite transponders are active, the total power at the input of the LNB will be -72.2 dB.

Typical LNBs have a range of operation that extends up to an input power of – 55 dBm. Beyond this level, saturation and non-linear effects start to occur. As expected, even in the case

of a satellite where 12 transponders are saturated, the LNB is still operating well within its normal range.

In Paragraph 43, the NPRM proposes to permit fixed unlicensed devices with EIRP levels up to 25 Watts, i.e. 14 dBW or 44 dBm, and that omnidirectional antennas would typically be used. For simplicity, it is assumed that the signal transmitted by the device is being received by the LNB directly (i.e., the LNB is in the line-of-sight of the device). This is not a worst case scenario since it is quite possible that the victim antenna will actually amplify the interfering signal by a value dependent on the angle of arrival of the interfering signal.

Table 3-1 calculates the interference-to-noise level at the input of the LNB. Calculations are made for the 25 W EIRP level for fixed unlicensed, as well as for a 1 W value for non-fixed unlicensed as proposed in the NPRM.

Table 3-1 shows that a typical LNB would start to saturate if a single 25 W emitter at about 600 m from the earth station has a direct path to the LNB. The saturation would occur at about 115 m from the earth station for a single 1 W emitter. When saturation starts to occur, each desired signal (single transponder carrier) is about 27 dB below the interfering signal and suppression effects associated with the non-linear operation of the device are likely to occur. This negative C/I, combined with the non-linear characteristics caused by saturation make it difficult—if not impossible—for the FSS receiver to distinguish the desired FSS downlink signal from the undesired unlicensed noise signal.

Table 3-1. Interference-to-Noise level at LNB Input for a Single Unlicensed Emitter (LNB Starts to Saturate at About -55 dBm Input Power) and Corresponding C/I Values for a Single Transponder Carrier

Unlicensed Device EIRP (Watts)	Distance (m)	Interfering Signal Level at LNB Flange (dBm/36MHz)	C/I (dB)
1	50	-47.7	-35.3
	100	-53.7	-29.3
	200	-59.7	-23.3
	400	-65.7	-17.3
	600	-69.2	-13.3
	800	-71.7	-11.3
	1000	-73.7	-9.3
	1500	-77.2	-5.8
	2000	-79.7	-3.3
	4000	-85.7	2.7
25	50	-33.7	-49.3
	100	-39.7	-43.3
	200	-45.7	-37.3
	400	-51.7	-31.2
	600	-55.3	-27.7
	800	-57.8	-25.2
	1000	-59.7	-23.3
	1500	-63.2	-19.7
	2000	-65.7	-17.3
	4000	-71.7	-11.2

EXHIBIT 4

RECOMMENDATION ITU-R S.1432

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

RECOMMENDATION ITU-R S.1432

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

(Questions ITU-R 73/4, ITU-R 75/4 and ITU-R 78/4)

(2000)

The ITU Radiocommunication Assembly,

considering

a) that emissions from radio transmitting devices may cause interference to victim receivers of the FSS and space stations;

b) that increasing use of the radio spectrum requires definition of the maximum allowable error performance degradations to satellite connections due to interference from various sources;

c) that error performance objectives for satellite digital paths are given in Recommendations ITU-R S.522, ITU-R S.614, ITU-R S.1062 and ITU-R S.1420;

d) that sharing considerations among FSS systems carrying digital traffic are given in Recommendations ITU-R S.523, ITU-R S.671, ITU-R S.735 and ITU-R S.1323;

e) that sharing considerations between FSS systems carrying digital traffic and fixed-service systems are given in Recommendation ITU-R SF.558,

recommends

1 that all necessary precautions should be taken in establishing digital satellite paths and connections to limit the degradation due to interference so that the error performance does not fall below that set in the performance objectives (see Recommendations ITU-R S.614, ITU-R S.1062 and ITU-R S.1420);

2 that the sources of interference to be taken into account may include:

– emissions from FSS systems operating in the same band;

– emissions from other radio services sharing the same frequency allocations on a primary basis;

– emissions from other radio services sharing the same frequency allocations on a non-primary basis;

– emissions from unlicensed devices;

– unwanted emissions (e.g. out-of-band and spurious emissions);

3 that, when sharing frequencies below 15 GHz, the maximum allowable interference from all sources (aggregate) should be limited to 32% or 27% for systems not practising and for systems practising frequency re-use, of the clear-sky satellite system noise;

4 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,

and that the sum of all of the interference sources should not cause violation of the error performance objectives (see Recommendations ITU-R S.522, ITU-R S.614, ITU-R S.1062 and ITU-R S.1420);

5 that Annex 1 should be used as guidance when applying this Recommendation.

NOTE 1 – This Recommendation neither replaces nor supersedes Recommendations ITU-R S.523, ITU-R S.671, ITU-R S.735, ITU-R S.1323 or ITU-R SF.558. The interference powers allowed under these Recommendations form portions of the maximum allowable interference.

NOTE 2 – In frequency bands allocated solely to the FSS, the maximum allowable interference is given by Recommendations ITU-R S.523, ITU-R S.671, ITU-R S.735 or ITU-R S.1323.

ANNEX 1

Basic considerations related to the maximum allowable error performance and availability degradations of digital satellite paths and connections arising from interference for systems operating below 15 GHz

1 Introduction

This Annex provides information on the apportionment of error performance and availability degradations due to interference into satellite communications systems carrying digital traffic.

2 Error performance and availability degradations due to frequency sharing among FSS systems

According to Recommendations ITU-R S.735 and ITU-R S.1323, digital satellite links should be designed to accommodate aggregate interference power from other FSS systems up to 25% of the total system noise power under clear-sky conditions. For systems utilizing frequency re-use, interference from other FSS systems is limited to 20% of the clear-sky system noise.

3 Error performance and availability degradations due to frequency sharing on a primary basis

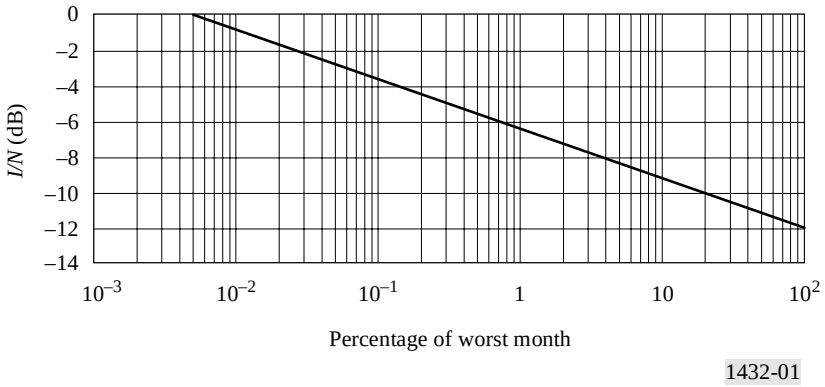
For the greatest number of allocations, the FSS shares frequencies with the fixed service and the mobile service. Recommendation ITU-R SF.558 deals with interference from fixed service systems into FSS systems and allows an interference level equivalent to 10% of the clear-sky satellite system noise that would give rise to a BER of 1×10^{-6} for not more than 20% of any month. There are currently no Recommendations dealing with interference from co-primary allocated mobile systems into FSS systems.

Recommendation ITU-R SF.558 goes on to indicate that interference from fixed service systems should not cause the BER to exceed 1×10^{-4} for more than 0.03% of any month nor cause the BER to exceed 1×10^{-3} for more than 0.005% of any month.

These interference allowances, in terms of percentage of system noise, can be converted into corresponding values of interference-to-noise ratio, I/N. Ten per cent of the system noise is equal to an I/N of –10 dB. If a conservative BER characteristic of 1 dB increase in noise yielding a tenfold increase in BER is assumed, I/N values for the other BERs are found to be I/N of –2.4 dB for 0.03% of any month and I/N of 0 dB for 0.005% of any month. This information is presented graphically in Fig. 1. Extrapolating the line from an I/N of –2.4 dB for 0.03% of any month to –10 dB I/N for 20% of any month on to 100% of any month yields an I/N of –12 dB. This I/N corresponds to 6% of the satellite system noise. Thus the interference from the fixed service which shares frequencies on a primary basis is equivalent to a single interference entry from another satellite system, according to Recommendations ITU-R S.735 and ITU-R S.1323.

FIGURE 1

Digital satellite path *I/N* due to fixed service interference



4 Error performance and availability degradations due to frequency sharing on a non-primary basis

There are no Recommendations pertaining to the amount of interference that a digital satellite circuit will receive from systems that share frequencies on a non-primary basis. Since, according to the RR, non-primary allocated services and all other emissions must operate on a non-interference basis, allotting 1% of the satellite system noise to these non-primary sources of interference should adequately accommodate these interferers.

5 Summary

As elaborated above, it is recommended that 32% or 27% of the satellite clear-sky system noise be allotted to interference. These allotments correspond to approximately 1.2 dB or 1.0 dB degradation in the carrier-to-thermal noise ratio for victim systems not utilizing and utilizing, respectively, frequency re-use. Interference from FSS systems, including non-GSO FSS systems, accounts for 25% of the clear-sky system noise (see Recommendations ITU-R S.735 and ITU-R S.1323), interference from the fixed service and other co-primary allocated services accounts for 6% of the clear-sky system noise, as derived in § 3 of this Annex, and interference from all other sources accounts for 1% of the clear-sky system noise.

EXHIBIT 5

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Delayed Contribution Document 4A/182-E

United States of America

WORKING DOCUMENT LEADING TO A DRAFT NEW RECOMMENDATION MAXIMUM ALLOWABLE ERROR PERFORMANCE AND AVAILABILITY DEGRADATIONS TO DIGITAL FIXED-SATELLITE SERVICE HYPOTHETICAL REFERENCE DIGITAL PATHS ARISING FROM INTERFERENCE FOR SYSTEMS OPERATING BELOW 15 GHZ

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Delayed Contribution
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United States of America

WORKING DOCUMENT LEADING TO A DRAFT NEW RECOMMENDATION

MAXIMUM ALLOWABLE ERROR PERFORMANCE AND AVAILABILITY DEGRADATIONS TO DIGITAL FIXED-SATELLITE SERVICE HYPOTHETICAL REFERENCE DIGITAL PATHS ARISING FROM INTERFERENCE FOR SYSTEMS OPERATING BELOW 15 GHz

1 Introduction

With the increasing number of fixed-satellite service systems has come an increased emphasis on the effective sharing of frequencies. More and more systems utilizing the same frequencies have led to whittling away at formerly comfortable link margins. The effects of interference on satellite system performance has become a topic of considerable importance with regard to the provision of digital services to customers whose satisfaction is guaranteed only by sufficient performance. Further, new global mobile-satellite service systems are sharing frequencies within FSS allocations for the provision of feeder links.

Error performance and availability requirements for digital satellite paths and connections have been and are continuing to be studied. Current Recommendations cover systems providing services utilizing constant rate connections and work is currently under way on requirements for systems utilizing Asynchronous Transfer Mode (ATM). These requirements must be taken into account in the design of digital satellite connections in order to guarantee sufficient performance. The purpose of this contribution is to provide an interference budget within a proposed Recommendation that will allow the operation of digital satellite connections within error and availability performance requirements.

2 Interference considerations

Interference among digital satellite systems is covered by ITU-R Recommendations S.735 and S.1323. Interference allowances are given in terms of percentage of system noise and range from 20% to 25%.

Interference from radio-relay systems is covered by ITU-R Recommendation SF.558. The Recommendation limits fixed service (FS) transmitters to 10% of the system noise that gives rise to a bit error ratio of 1×10^{-6} for a maximum of 20% of any month. Taking into account the interference levels for Bit Error Ratios (BERs) of 1×10^{-4} and 1×10^{-3} contained in the Recommendation and extrapolating these requirements to 100% of the time results in a continuous acceptable interference level from the FS of 5% of the system noise necessary to produce a 1×10^{-6} bit error ratio.

Fixed-satellite service systems are also vulnerable to interference from other sources which include emissions from non-co-primary allocated services, unlicensed devices and out-of-band emissions from services in adjacent bands. Although, hopefully, a small contribution to the overall interference level, it is none the less necessary to provide a limit for these types of interferers also. An allotment of 1% is suitable to provide protection for digital satellite links.

Based on information given above and in the attached proposed new Recommendation, the total interference budget is 31% of the system noise and is broken down as shown in the proposed new Recommendation.

A preliminary draft new Recommendation containing the criterion developed above is attached as Annex 1.

3 Conclusions

This contribution provides a proposed Recommendation on interference allotment among the FSS and other services sharing frequencies below 15 GHz. System designs based on the proposed Recommendation will allow efficient use of shared frequencies while adhering to error performance and availability requirements for digital satellite connections.

ANNEX 1

PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R S.IAL

MAXIMUM ALLOWABLE ERROR PERFORMANCE AND AVAILABILITY DEGRADATIONS TO DIGITAL FIXED-SATELLITE SERVICE HYPOTHETICAL REFERENCE DIGITAL PATHS ARISING FROM INTERFERENCE FOR SYSTEMS OPERATING BELOW 15 GHz

(Questions ITU-R 73/4,75/4 and 78/4)

The ITU Radiocommunication Assembly,

considering

a) that emissions from radio transmitting devices may cause interference to victim receivers of fixed-satellite service earth and space stations;

b) that increasing use of the radio spectrum requires definition of the maximum allowable error performance and availability degradations to satellite connections due to interference from various sources;

c) that error performance objectives for digital satellite digital paths are given in ITU-R Recommendations S.522, S.614, S.1062 and S.atm;

d) that availability objectives for satellite digital paths are given in ITU-R Recommendations S.579 and S.atm_av;

e) that sharing considerations among fixed-satellite service systems carrying digital traffic are given in ITU-R Recommendations S.523, S.671, S.735 and S.1323;

f) that sharing considerations between fixed-satellite service systems carrying digital traffic and fixed-service systems are given in ITU-R Recommendation SF.558,

recommends

1 that all necessary precautions should be taken in establishing digital satellite paths and connections to limit the degradation due to interference so as not to violate error performance and availability objectives (see ITU-R Recommendations S.614, S.1062 S.atm, S.579 and S.atm_av). Sources of interference may include:

a) emissions from fixed-satellite service systems operating in the same band;

b) emissions from other radio services sharing the same frequency allocations on a primary basis;

c) emissions from other radio services sharing the same frequency allocations on a non-primary basis;

d) emissions from unlicensed devices;

e) unwanted emissions (e.g. out-of-band and spurious emissions);

2 that, when sharing frequencies below 15 GHz, the maximum allowable interference from all sources should be limited to 31% of the clear sky satellite system noise;

3 that error performance and availability degradation due to interference at frequencies below 15 GHz should be allotted portions of the interference budget of 31% of the clear sky satellite system noise in the following way:

– 81% for other fixed-satellite service systems,

– 16% for other systems having co-primary status,

– 3% for all other sources of interference,

and that the sum of all of the interference sources should not cause violation of the error performance and availability objectives (see Recommendations S.522, S.614, S.1062, S.atm, S.579 and S.atm_av);

4 that Annex 1 should be used as guidance when applying this Recommendation.

ANNEX 1

Basic considerations related to the maximum allowable error performance and availability degradations of digital satellite paths and connections arising from interference for systems operating below 15 GHz

1 Introduction

This Annex provides information on the apportionment of error performance and availability degradations due to interference into satellite communications systems carrying digital traffic.

2 Error performance and availability degradations due to frequency sharing among fixed-satellite service systems

According to ITU-R Recommendations S.735 and S.1323, digital satellite links should be designed to accommodate aggregate interference power from other FSS systems up to 25% of the total system noise power under clear sky conditions. For systems utilizing frequency reuse, interference from other FSS systems is limited to 20% of the clear sky system noise. Satellite systems utilizing frequency reuse will necessarily have an interference contribution due to intra-system sources. This contribution can be looked upon as being a maximum of 5% of the clear sky satellite system noise. Thus a total of 25% of the system noise under clear sky conditions is allotted to interference from other FSS systems.

3 Error performance and availability degradations due to frequency sharing on a primary basis

For the greatest number of allocations, the fixed-satellite service shares frequencies with the fixed service and the mobile service. ITU-R Recommendation 558-2 deals with interference from fixed service systems into FSS systems and allows an interference level equivalent to 10% of the clear

sky satellite system noise that would give rise to a Bit Error Ratio (BER) of 1 x $^{10\text{-}6}$ for not more than 20% of any month. There are currently no Recommendations dealing with interference from co-primary allocated mobile systems into FSS systems.

ITU-R Recommendation 558-2 goes on to indicate that interference from fixed service systems should not cause the BER to exceed 1 x 10^{-4} for more than 0.03% of any month nor cause the BER to exceed 1 x 10^{-3} for more than 0.005% of any month.

These interference allowances, in terms of percentage of system noise, can be converted into corresponding values of Interference-to-Noise ratio (I/N). Ten per cent of the system noise is equal to an I/N of -10 dB. If a conservative Bit Error Ratio (BER) characteristic of 1 dB increase in noise yielding a tenfold increase in BER is assumed, I/N values for the other BERs are found to be I/N of 2 dB for 0.03% of any month and I/N of 3 dB for 0.005% of any month. This information is presented graphically in Figure 1. Extrapolating the line from an I/N of 2 dB for 0.03% of any month to -10 dB I/N for 20% of any month on to 100% of any month yields an I/N of -13 dB. This I/N corresponds to 5% of the satellite system noise.

4 Error performance and availability degradations due to frequency sharing on a non-primary basis

There are no Recommendations pertaining to the amount of interference that a digital satellite circuit will receive from systems that share frequencies on a non-primary basis. Since, according to the Radio Regulations, non-primary allocated services and all other emissions must operate on a non-interference basis, allotting 1% of the satellite system noise to these non-primary sources of interference should adequately accommodate these interferers.

5 Summary

As elaborated above, it is recommended that 31% of the satellite clear sky system noise be allotted to interference. This allotment corresponds to approximately a 1.2 dB degradation in the carrier-to-thermal noise ratio. Interference from FSS systems, including NGSO FSS systems, accounts for 81% of the total, or 25% of the clear sky system noise (see Recommendations S.735 and S.1323), interference from the fixed service and other co-primary allocated services accounts for 16% or 5% of the clear sky system noise, as derived in 2, and interference from all other sources accounts for 3% or 1% of the clear sky system noise.