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October 10, 1995

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

DOCKET FILE COPY ORIGINAL

Re: Reply Comments of Texas Instruments, Inc.

Dear Mr. Caton:

Transmitted herewith, on behalf of Texas Instruments, Inc. are an original and 4 copies of "Reply Comments of Texas Instruments, Inc."

Should any questions arise or should you need any further information, please contact me at the above telephone number.

Respectfully submitted,

Robert L. Pettit

Enclosures

No. of Copies rec'd 0+4
List ABCDE

Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of:	)	
Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services	)	CC Docket No. 92-297
and	)	
Suite 12 Group Petition for Pioneer's Preference	)	PP-22

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To: The Commission

REPLY COMMENTS OF TEXAS INSTRUMENTS, INC.

Texas Instruments, Inc. ("Texas Instruments") hereby submits its reply comments in response to the Third Notice of Proposed Rulemaking and Supplemental Tentative Decision ("Third Notice") in the above-captioned proceeding.

I. 28 GHZ LMDS IS A VALUABLE SERVICE IN THE PUBLIC INTEREST WHICH THE COMMISSION SHOULD IMPLEMENT EXPEDITIOUSLY

The record in this proceeding is replete with information showing the benefits that Local Multipoint Distribution Service ("LMDS") will bring to the American people and to the Nation's economy. LMDS will enable provision of broadband two-way video communications, including video distribution, teleconferencing, telemedicine, telecommuting,

and data services to American homes and businesses and will employ thousands of Americans directly and in related businesses.[1]

Texas Instruments submits that nothing in the comments to this proceeding substantially supports alteration of the compromise band plan outlined in the Third Notice. If anything, the comments indicate that the FCC's compromise plan represents a tremendous effort on the part of the Commission and the parties to balance the reasonable spectrum requirements of those services desiring to operate in the 28 GHz band.

This is not to say that all services were (or could have been) afforded all the spectrum that was requested. In fact, this is most particularly true of LMDS proponents, who have seen their request for spectrum cut in half: from the 2 GHz originally proposed by the FCC,[2] to 1 GHz of spectrum in the current notice. Even so, Texas Instruments believes that the Commission's compromise plan represents a reasonable accommodation of competing interests and supports the compromise band plan.

What is critical at this point is to get LMDS off the drawing board and into American homes and businesses.[3] It is ironic that American-developed 28 GHz LMDS technology is being implemented in other countries before in our own. Accordingly, Texas Instruments

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[1] See generally Ex Parte Presentation of Texas Instruments of May 1, 1995; see also Third Notice at ¶ 3.

[2] Notice of Proposed Rulemaking, CC Docket 92-297, 8 FCC Rcd 557 (adopted December 10, 1992) ("First Notice").

[3] The Commission's delay in authorizing LMDS was criticized in recent testimony before the Senate Commerce Committee. Budget Reconciliation, 1995: Hearing on Spectrum Auctions Before the Senate Comm. on Commerce, Science & Transportation, 104th Cong., 1st Sess., September 12, 1995 (statement of Thomas W. Hazlett).

urges the Commission to move expeditiously to adopt both the compromise band plan and LMDS service rules and to proceed expeditiously with spectrum auctions and licensing of the service for American users.[4]

The comments of two parties that do not support the frequency sharing compromise deserve some comment. First, the National Aeronautics and Space Administration -- undaunted by the support of satellite companies for the compromise -- continues to press the Commission to relegate LMDS to the 40.5-42.5 GHz band. Texas Instruments has already provided exhaustive evidence in this proceeding that LMDS is not currently viable at 40 GHz,[5] and will not burden the record further by repeating those arguments. Suffice it to say that if potential equipment manufacturers, like Texas Instruments, thought that LMDS were viable in some other frequency band, they would support LMDS in another band. In fact, however, the service area of LMDS operations would be greatly reduced at 40 GHz and would result in significantly increased operational and equipment costs.[6] Moreover, a move to 40 GHz, even if it were viable, would delay the introduction of LMDS for years since 40 GHz equipment would have to be developed and tested.

Second, the Telecommunications Industry Association complains that the Commission has not retained 28 GHz as an expansion band for point-to-point microwave users. It should be noted, however, there are no current point-to-point microwave operations in the 28 GHz

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[4] The FCC should reject requests for unnecessary and dilatory actions such as the NYNEX proposal to establish an industry advisory committee. *See* Section III.C.4, *infra*.

[5] *See, e.g.*, Texas Instruments ex parte submissions April 16, 1995, April 28, 1995, May 2, 1995, and May 19, 1995.

[6] See discussion at Section II, *infra*.

band, and the Commission has declined to adopt point-to-point microwave channelization plans for 28 GHz. Moreover, TIA has failed to show why its demands for spectrum cannot be accommodated in other bands. Indeed, TIA notes that "dozens of entities have already applied for microwave spectrum, particularly in the 38 GHz band" for use by PCS systems. TIA Comments at 3. Whatever the legitimate needs for expansion by microwave users, there is no indication that they must be accommodated at 28 GHz at this late date.

Accordingly, the Commission should reject TIA's claim that "the Commission's proposed rules are arbitrary and capricious." TIA Comments at 9. In support of this claim, TIA cites *State Farm*,[7] which stands for the proposition that an agency may not change a rule unless the change is based on reasoned decisionmaking, adequately explained. In effect, says *State Farm*, an agency is bound by its own rule until it acts in a reasoned way to depart from it. However, failure to act, administrative inaction, and petition dismissals are not regulations that, under *State Farm*, would subject a decision to adopt actual rules to a "reasonableness" review. Indeed, "an agency changing its course by rescinding a rule is obligated to supply a reasoned analysis for the change beyond that which may be required when an agency does not act in the first instance."[8] *State Farm* simply does not apply where there is no preexisting regulation. If it did, every Commission decision in a new area of regulation would be a reviewable change from earlier "inaction." Furthermore, even if at

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[7] *Motor Vehicle Mfgs. Ass'n v. State Farm Mutual Auto Ins. Co.*, 463 U.S. 29 (1983). In this case, the Supreme Court found an agency rescission of a regulatory requirement was arbitrary and capricious because the new rule did not consider the preexisting regulation.

[8] *Id.* at p. 42 (emphasis added).

this late date TIA were to challenge the denial of a formal petition, the scope of the court's review of the Commission's action would be very narrow.[9]

II. SPECTRUM ISSUES

A. The FCC should retain LMDS at 28 GHz

A number of commenters suggest that if the current 28 GHz band plan requires modification, then the Commission should reconsider moving LMDS to 40 GHz. *See, e.g.*, Comments of NASA. As noted above, however, such reconsideration would not be warranted given the record in this proceeding. Indeed, there are immutable technical realities that govern the FCC's choice of 28 GHz over 40 GHz for LMDS. In particular, the difference in signal attenuation due to rain between these bands results in significant differences in LMDS cell radii. The smaller cells diminish the subscriber base to the point where operation of a full wideband wireless 40 GHz system simply is not economical. Thus, the FCC should not reopen the 40 GHz issue that was resolved with the proposed 28 GHz band plan of the Third Notice.

B. Successful LMDS Requires 1 GHz

Earlier in this proceeding, 2000 MHz of spectrum was proposed for two LMDS providers. The Third Notice designates 1000 MHz of spectrum for LMDS in separate segments of 850 MHz and 150 MHz. It is possible, and Texas Instruments believes it is

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[9] *See Natural Resources Defense Council v. SEC*, 606 F.2d 1031 (D.C.Cir.1979).

necessary, to allow single providers to aggregate these two segments for a total of 1000 MHz. To not allow providers to operate with the full 1 GHz would prevent this new service from competing on a level playing field with existing cable operations.

This 1 GHz of spectrum would support a fully competitive LMDS system if the 29.1-29.25 GHz band were allowed to be used for the upstream return links from subscribers to hubs. Some commenters, however, have suggested that transmissions from subscriber locations should not be allowed; others have suggested reduction of the 27.5-28.35 GHz segment to less than the proposed 850 MHz per provider. Comments of Entertainment made Convenient at p. 6. Texas Instruments firmly believes that LMDS subscriber links can share with MSS feeder links. The appendix to these reply comments contains the results of an analysis, conducted by the major proponents of LMDS technology (Texas Instruments, CellularVision, Endgate Technology and Hewlett Packard), that show that subscriber link operations using these LMDS systems will not cause harmful interference to the Motorola Iridium MSS system.

Furthermore, TRW states that "there is no question but that Odyssey can share the proposed NGSO MSS feeder link allocation at 29.1-29.5 GHz with the other NGSO MSS system, as well as with the LMDS and with GSO/FSS uplinks." TRW Comments at p. ii. TRW clearly recognized that it "will be required to share spectrum in the 28 GHz band with . . . LMDS systems (most likely in the form of subscriber-to-hub transmissions). . .. *Id.* at 17.

Motorola has not offered any substantial analysis or comments on prior sharing analyses except to state that it does not want to operate in the 28 GHz band with any other

system. Hopefully, Motorola will carefully consider the recent sharing analyses conducted by the LMDS proponents and attached to these reply comments, and will be able to support co-frequency sharing with LMDS subscriber links.[10]

C. IF THE 29.1-29.25 GHZ BAND IS SHARED ON A CO-PRIMARY BASIS, THE COMMISSION'S PROPOSED BAND PLAN WILL ACCOMMODATE THE NEEDS OF ALL SERVICES INCLUDING LMDS

1. Proposed Band Plan

The FCC-proposed band segmentation plan does not provide everything that was requested for all services but does address the basic requirements of each of proposed service in a manner that allows the various industries to progress to the next stage of development for the 28 GHz band. The current plan will support FSS GSO and non-GSO gateways, MSS feeder links, and LMDS systems. The 1 GHz designated for LMDS will allow systems to be developed and deployed to bring the benefit of wideband wireless services to the public. Texas Instruments requests that the FCC respond to the majority of the commenters that support the band plan and proceed without further delay

[10] If Motorola is not willing to accept this analysis and continues to be concerned about possible interference, perhaps it should consider the use of satellite spot beams that only see their uplink sites.

2. Co-primary LMDS and MSS Feederlink Allocations

Prior to the current proposed band segmentation plan, LMDS frequency plans were designed around the FCC's plan to allocate 2 GHz to the service.[11] The Commission proposed that two 1 GHz segments would support two LMDS systems in each operating area. At the time, Texas Instruments suggested that the sub-band for each of the two systems' subscriber unit return links be accommodated at the "opposite end" of the LMDS band from the hub links. This arrangement produces a natural guard band and does not waste valuable spectrum for this purpose. With the flexibility to allocate LMDS uses -- either the hub to subscriber downlink or the subscriber to hub uplink -- within the 2 GHz block, it would have been easy to limit LMDS operations to downlinks in the portion of the band shared with MSS feederlinks.

Now that only 1 GHz of spectrum is available for LMDS, other considerations must prevail; the basis for the earlier agreements among LMDS proponents with the Motorola Iridium system no longer exist. Given the dissimilar sizes of the currently proposed LMDS band segments (850 MHz and 150 MHz), the spectrum is optimally matched to support an asymmetric frequency plan if the hub downlink, which will carry far more information in the common residential setting than the uplink, is in the 850 MHz segment, and the subscriber return link is in the smaller 29.1-29.25 GHz segment. Because this LMDS frequency plan does not require any of the limited LMDS spectrum to be used for guard bands, it is the most efficient and economically sound use of the limited LMDS spectrum.

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[11] *See* First Notice at ¶ 20.

Contrary to the claims of one commenter, Motorola Comments at p. 3, technical analysis shows that MSS and LMDS subscriber return link sharing is possible. To analyze this point, LMDS proponents met in Washington, DC, on September 6-7, 1995, to see whether the subscriber equipment from various LMDS manufacturers could use the 29.1-29.25 GHz band as the return link frequency to the LMDS hubs and share, on a co-primary basis, with Iridium MSS satellite receivers operating in this band. The typical subscriber equipment parameters were determined for four proposed LMDS systems from CellularVision, Endgate Technology, Hewlett Packard and Texas Instruments. These parameters were used in a statistical analysis model derived from the analysis program generated by the FCC during the Negotiated Rule Making Committee ("NRMC") in 1994, as well as in a direct beam interaction analysis. These analyses are provided as an appendix to these reply comments. The results using a statistical approach to subscriber distribution and transmission shows that the Iridium receiver carrier to interference ratio (C/I) requirement of 20.9 dB can be met by all of the LMDS systems with positive margin. In addition, the direct beam analysis shows that the power spectral density of -26 dBW/MHz-km^2 can be met by the various LMDS return links. The comments provided by TRW indicates that they also support MSS feeder links sharing with LMDS TRW Comments at p. 13. Thus, the FCC is urged to allow efficient use of the spectrum by the proposed LMDS systems and provide a full 1 GHz of spectrum for LMDS by allowing LMDS subscriber return link transmission in the 29.1-29.25 GHz frequency band.

III. THE COMMISSION SHOULD ENCOURAGE A ROBUST LMDS WITH MINIMAL SERVICE RULES AND ADEQUATE SPECTRUM.

A. The Commission Should Not Impose Any LMDS Ownership Restrictions

Virtually no commenting party supported the imposition of ownership restrictions for LMDS operators -- and for good reason. As the Commission acknowledges, the multichannel video programming distribution ("MVPD") market is becoming increasingly competitive. It soon will include providers of direct broadcasting satellite service, cable television, wireless cable, video dialtone, satellite master antenna TV ("SMATV") service, and individual stations of advanced television ("ATV") broadcasting. For many of these multichannel services, especially cable, DBS, wireless cable, and SMATV, the video program capacity of these systems can be expected to increase dramatically in the near future with the implementation of digital signal compression and transmission techniques.

Texas Instruments submits that there should be no ownership restrictions because no showing has been made that any potential LMDS provider will have market power in the MVPD market. As described above, LMDS service providers will face intense and increasing competition from several other MVPD providers. Even if, for example, a local exchange carrier owned an LMDS system in its video dialtone service area, it still would face intense competition from DBS, cable TV and, soon, ATV. *See, e.g.*, Comments of Ameritech, pp. 2-3, and BellSouth, p. 6. Cable operators would face similar competition

from alternative media in their service areas.[12] Comments of NCTA at pp. 4-5. And in any event, it would be difficult to possess market power with a given LMDS service area since BTAs (the geographic markets which the Commission has proposed for LMDS) are not coextensive with existing local exchange or cable franchise areas.

Likewise, due to the inherent competition from alternative media, there is no reason to require two LMDS providers per geographic service area as suggested by a few parties. *See* Comments of GTE at pp. 3-4. Ironically, as described in Section III.B. below, the balkanization of the proposed LMDS spectrum actually would *inhibit* competition because LMDS cannot effectively compete with cable and other MVPD services without 1 GHz per provider.

B. <u>The Commission Should Allot 1 GHz for Each LMDS Service Provider</u>

In order to succeed as a robust new service, LMDS must survive in the highly competitive MVPD market. If LMDS cannot compete effectively due to regulatory constraints, investors will not provide capital, auction prices will be unnecessarily low, systems will be implemented very slowly, if at all, and valuable spectrum will be used inefficiently or even lie fallow. In short, the myriad public benefits of LMDS video and non-video applications may be lost.

The ability of LMDS to compete is a function of its service-price combination which,

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[12] Texas Instruments concurs with the assessment that the cross-ownership ban of Section 613 of the Communications Act, 47 U.S.C.A. § 533(a)(2) (1994), applies only to MMDS. Comments of Cox, et al. at pp. 3-4.

in turn, is based on the capacity and cost of the underlying system hardware. Capacity, as system designer and builders including Texas Instruments are well aware, is a direct function of RF bandwidth. Cost, however, is not simply a function of capacity/bandwidth. Much of the cost of an LMDS system, including the expense of antennas, poles, amplifiers, and installation, is fixed relative to capacity/bandwidth. Thus, a reduction in capacity/bandwidth of a system will not proportionately decrease its cost.

Texas Instruments strongly believes that, in the vast majority of situations, LMDS operators each will need 1 GHz of primary spectrum to compete with other MVPD providers.[13] This assertion is supported by other experienced equipment manufacturers including Hewlett-Packard, Northern Telecom, and GHz Equipment.

A few commenters ignore these economic and technical realities and ask the Commission to reduce the bandwidth available to individual LMDS systems. One party, for instance, suggests licensing LMDS in blocks of 450, 450, and 150 MHz. Unexplained, however, is how the licensee with 150 MHz could -- after investing in LMDS infrastructure costing nearly the same as that of the two 450 MHz licensees -- compete with either the other LMDS providers with three times the capacity or the cable system with 1 GHz of

[13] As described at length in Section II above, this 1 GHz must be a true primary allocation to LMDS, even if part of it is shared with another primary service. Burdensome sharing restrictions placed on LMDS in the 29.1-29.25 GHz band could turn the ostensibly co-primary LMDS allocation into what is, for all practical purposes, a secondary allocation. In the relatively rare instances when less than 1 GHz capacity is needed, such as a sparsely populated rural area, the FCC's rules should permit disaggregation and or partitioning.

effective bandwidth.[14]

It is no answer to claim, as did GTE, that digital compression technology is improving and, thus, LMDS will need less bandwidth to compete in the near future. GTE Comments at pp. 4-5. To the contrary, future advances in compression will be applied to other MVPD services, as well. LMDS may only keep pace with, not necessarily surpass, its competitors by implementing future technological improvements. Likewise, it makes no sense to calculate the initial video channel capacity of the CellularVision Hye Crest system and forever lock LMDS to that level of service. See NYNEX Comments at p. 6. Channel capacity (which is expanding rapidly for other MVPD service technologies) is not the relevant constant. RF bandwidth is the equalizer among different services like cable and LMDS, because the benefits of increased channel capacity will enure to every MVPD provider.

Precluding LMDS licensees from using the entire 1 GHz allocation could very well cause the remarkable unintended consequence of *reducing* competition in the MVPD market. Simply stated, the competition from alternative media -- which would require each LMDS provider to have 1 GHz at its disposal -- would preclude multiple LMDS providers from competing against each other, because there would be no incentive to build any non-competitive new MVPD system.

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[14] Equally untenable is the suggestion that 150 MHz be set aside for "municipal" LMDS operators. Comments of Duncan Weinberg at p. 2.

C. Other Issues

1. LMDS Geographic Service Areas

BTAs are the appropriate geographic service areas for LMDS licensees. The majority of commenters supported the Commission's tentative decision to this effect. As summarized by one commenter, "BTAs will result in greater economies of scale, lead to participation by greater numbers of providers, lower inference coordination costs among LMDS providers, and increase capital returns due to the larger customer base." BellSouth Comments at p. 7. The FCC should affirm its tentative decision to designate BTAs as the LMDS service areas.

2. Spectrum Flexibility

The Commission should permit licensees in the satellite services in the 28 GHz band to use their spectrum assignments as flexibly as possible. Comments received from several parties in the satellite industry indicate that there is substantial uncertainty surrounding international acceptance of their services. *See, e.g.*, Comments of Loral, Airtouch, and Constellation. Coupled with the unknown domestic demand for these new satellite services, there is a chance that some of the proposed systems will never be built, even if after licensing by competitive bidding. The FCC's rules should permit other services authorized in the 28 GHz band to use the spectrum assigned to licensees in these satellite services if the satellite service licensee agrees to terms of lease or sale

3. Delay for WRC Results

Contrary to the FCC's well-informed decision to advance this lengthy proceeding with deliberate speed, some parties suggest that the Commission delay its work pending the outcome of the ITU's World Radiocommunication Conference ("WRC") this fall. Such a delay clearly is not necessary, for any substantive changes to the U.S. positions due to decisions at the WRC can be accommodated at a later date. There is absolutely no need to slow deliberations on the many issues in this NPRM unrelated to the WRC allocations decisions. The Commission should proceed without further delay to resolve this proceeding.

4. Technical Advisory Committee

The FCC should reject the suggestion of NYNEX that the Commission establish a technical advisory committee in order to "sift through industry materials and answer factually the specific questions put by the Commission." NYNEX Comments at p. 7. Citing as precedent the establishment of the FCC's Advisory Committee on Advanced Television Service ("ACATS"), NYNEX would have the Commission refer to this new advisory committee (1) the comments to the Third Notice, (2) the information before the 1994 Negotiated Rule Making Committee, and (3) "post-NRMC ex parte proposals." *Id.* This proposal has no merit whatsoever.

First, such an advisory committee will significantly delay the introduction of LMDS (and the benefits that LMDS will bring) for no particular benefit. As the Commission is aware, advisory committees tend to move very slowly ACATS itself is in its eighth year.

Second, the record of the NRMC has virtually nothing to do with the issues before the Commission now that a band segmentation plan -- as opposed to a co-frequency sharing arrangement -- is being pursued. Third, the principal task of the ACATS was to test hardware implementations of competing ATV system designs. Unlike the present discussion of the 28 GHz band, the ACATS task was well beyond the means of the FCC. Fourth, this proposed advisory committee would be subject to the same competing internal interests and "parochial presentations" that plagued the NRMC. By law, federal advisory committees must have balanced representation, must hold open meetings, and must give opportunity for alternative views to be heard. *See* 5 U.S.C. App. II. Finally, of course, the NRMC that NYNEX derides was itself a federal advisory committee Clearly, this ill-conceived idea, designed to delay the introduction of LMDS, should be rejected.

Respectfully submitted,

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October 10, 1995

APPENDIX

REPLY COMMENTS OF TEXAS INSTRUMENTS, INC.
CC Docket No. 92-297
October 10, 1995

LOCAL MULTIPOINT DISTRIBUTION SERVICE CUSTOMER PREMISE EQUIPMENT TRANSMISSION AND IRIDIUM SATELLITE RECEIVER COMPATIBILITY ANALYSIS

SEPTEMBER 12, 1995

INTRODUCTION

Local Multipoint Distribution Service proponents met September 6-7, 1995, to conduct analysis to determine the feasibility of the various LMDS customer premise equipment (CPE) to use the 29.1 to 29.25 GHz band as the return link frequency to the LMDS hubs and demonstrate compatibility with the Iridium satellite receiver operating in this band. The typical CPE parameters were determined for four proposed LMDS systems from CellularVision, Endgate Technology, Hewlett Packard and Texas Instruments. These systems all make use of narrow beam antennas (2.5 to 4 degree beamwidth), return link power control to adjust the transmit power for rain attenuation and/or range (0.1 km to 2.0-5 km) from the CPE to the system hub and low EIRP density at maximum range(-44.6 dBW to -52 dBW). These parameters were then used in a statistical analysis derived from the program generated by the FCC during the Negotiated Rule Making Committee for 28 GHz in 1994 and in a direct beam interaction analysis. These analyses are presented in the following sections of this report.

SUMMARY OF RESULTS

The results of the analysis using a statistical approach to CPE distribution and transmission shows that the Iridium receiver carrier to interference ratio (C/I) requirement of 20.9 dB can be met with positive margin. In addition the direct beam analysis shows that the power spectral density of -26 dBW/MHz-km^2 can be met by the various LMDS CPE return links. Thus, the LMDS CPEs are capable of using the 29.1 GHz to 29.25 GHz band for return links without harmful interference to the Iridium satellite receiver. Table one is a summary of the C/I ratios provided by each of the LMDS systems and Table two provides a summary of the power spectral density for dense and sparse populated LMDS systems.

Table One: C/I Ratio Analysis Summary

System	Total C/I	Main Beam C/I
CellularVision	36.7	37.1
Endgate Technology	27.6	28.1
Hewlett Packard	41.9	43.1
Texas Instruments	35.4	36.0

Table Two: Power Density Summary

System	200 X 400 km, dBW/MHz-km^2	2000 X 400 km, dBW/MHz-km^2
CellularVision	-42.65	-46.65
Endgate Technology	-26.2	-30.2
Hewlett Packard	-34.56	-38.56
Texas Instruments	-39.67	-43.67

STATISTICAL ANALYSIS

Overview

The aggregate power density from LMDS subscriber transmissions directed toward the Iridium satellite vehicle is calculated for four LMDS systems, Texas Instruments, Hewlett Packard, Endgate Technology and CellularVision. The aggregate power density is compared to the satellite feeder power density to provide a C/I ratio. The satellite C/I for each of 4 LMDS system ranges from 27.6 to 41.9 dB with a desired C/I of 20.9 dB.

System Parameters

The satellite parameters used as inputs to the analysis program are as follows.

SV altitude=780.0 Km.
SV half power beamwidth (HPBW) =5.0 degrees
SV elevation angle to the edge of the HPBW = 7.5 degrees
SV feeder EIRP density = -21.1 dBW/Hz
SV antenna pattern for Iridium

LMDS system parameters that were used for the four different LMDS systems in the analysis program are listed below.

Table Three: Typical LMDS System Parameters

Parameter	TI	HP	EG	CV
Transmitter Power per RF channel (dBW)	-17	-19.6	-13	-23
Modulation Type	QPSK	QPSK	4FSK	QPSK
Bandwidth of RF channel (MHz)	2.5	1.0	24	1.0
Antenna Gain (dBi)	34	35	39	31
EIRP density (dBW/Hz)	-47	-44.6	-47.8	-52
Minimum hub-CPE range (Km)	0.1	0.1	0.1	0.1
Maximum hub-CPE range (Km)	5	2	2.2	5
Tower height (meters)	30	15	20	30
Hub spacing in HPBW (Km)	17	17	17	17
Hub spacing out of HPBW (Km)	68	68	68	68
Maximum look angle for 50% blocking (Deg)	5	5	5	5

CPE Antenna pattern envelope is specific for each LMDS supplier
(Frequency reuse is included in the hub spacing density for a reuse factor of 4)

As noted above, LMDS system specific parameters are included. A common hub spacing is used for each LMDS system. This is equivalent to CPE spacing for simultaneous transmissions based on a frequency reuse factor of 4. Adjustments are made in the results for variations to these parameters for each LMDS system.

Analysis Results

Outputs resulting from the program are listed below. Adjustments are made for different frequency reuse and hub densities for each LMDS system. The number of simultaneous hub receiving frequencies is equivalent to the number of CPEs transmitting simultaneously.

Table Four: Statistical Analysis Results

Data Output and Adjustments	TI	HP	EG	CV
CPEs in SV HPBW (frequency reuse 4x)	896	896	896	896
CPEs outside the SV HPBW	3940	3940	3940	3940
C/I for CPEs within the SV HPBW (dB)	36.0	41.4	35.1	37.1
C/I for all CPEs as an aggregate (dB)	35.4	40.2	34.6	36.7
Frequency reuse adjustment (dB)	-	-	-7.0 (4/20)	-
Concentration factor (dB)		1.7 (6/4)		
Resulting Total Aggregate C/I (dB)	35.4	41.9	27.6	36.7

Adjustments for frequency reuse and concentration factors effect the number of CPEs transmitting in the calculation of density and therefore are converted to a dB value. The dB value is used to adjust the program results. HP plans on a circuit concentration of 6x which would reduce the number of hubs. Endgate plans a frequency reuse factor of 20 rather than a value of 4 that was used in calculations. It should be noted that the hub spacing derived from the population density is valid for the Endgate Technology deployment which is based primarily on business applications. The resultant C/I ratio is conservative since the hub densities should be based on business distributions instead of general population distributions.

With worst case population density, worst case subscriber density area, LMDS suitability factor of 100% and fully loaded busy hour circuits, this analysis indicates the lowest LMDS supplier aggregate C/I created by subscriber transmissions is within the required Iridium C/I limit.

DIRECT BEAM INTERACTION

The statistical analysis approach presented above provides a snapshot of the total interference into the Iridium satellite by typical LMDS CPEs for four different LMDS systems. It includes interference from CPE antenna side lobes and possibly interference from main beam interaction between the CPE antennas and the satellite. However it is a statistical model and as such does not provide an indication of what the interference could be under certain worst case conditions. Therefore an analysis was performed to provide an estimate of the worst-case interference caused by LMDS CPE main beam interaction with the main beam of the Iridium satellite.

Overview

The computer model was exercised over many different geometries with different initial conditions. Although the results indicate that the expected interference from LMDS CPEs into the Iridium satellites is low, concern has been expressed that the model may not provide information about the interference under certain worst-case geometries and CPE operations. Therefore a separate model was developed to analyze the interference into the Iridium satellite by CPE transmitters when the parameters are adjusted for worst-case conditions. This model does not provide any estimate of the probability of this result, but only establishes an upper bound on the interference based on the worst-case conditions for direct main beam interaction.

The first step is to define the worst case scenario. Although a "worst-case" could be defined for all CPE antennas coupling into the Iridium satellite, this would be completely unrealistic because of the CPE distributions. Therefore we should define the worst-case scenario as one which is realistic, although highly improbable. The worst-case scenario will be defined based on the design parameters of the different LMDS systems and the expected deployment scenario. The analysis will be performed for the various LMDS

system implementations and for two satellite footprints. The worst-case earth-satellite geometry is assumed to be one which places the satellite antenna 2.5 degrees above the horizon. All CPE antennas are assumed to be pointed at the horizon. Therefore the Iridium satellite "sees" all CPE antennas pointed in the direction of the satellite. Although the CPE antenna-satellite distance varies over the satellite footprint, this distance is assumed to be equal to the distance between the Iridium gateway and the satellite in each case. The analysis calculates the total LMDS CPE power spectral area density in the satellite footprint for this worst-case scenario and shows a range of -30.2 to -46.65 dBW/MHz-km^2 for the large satellite footprint.

System Parameters

There may be numerous LMDS system implementations. Therefore the analysis was performed for four typical LMDS system implementations which represent a broad range of system parameters and distribution geometries. The analysis was also performed for different system operating parameters. The LMDS system parameters used in the analyses are shown in Table Five. The satellite parameters are shown in Table Six. The parameters are based on maximum capacity and assume the full 150 MHz return bandwidth is utilized. The satellite elevation angle and subscriber antenna elevation angles are adjusted to provide maximum interference on the horizon..

Table Five: Direct Beam LMDS System Parameters

System Parameter	(TI) Sys 1	(CV) Sys 2	(HP) Sys 3	(EG) Sys 4
1. Number of Subscriber Channels in 150 MHz BW	60	150	150	6
2. Number of Subscribers per Node in 150 MHz BW	5760	14400	3600	120
3. Subscriber Distribution	----------Uniform----------			
4. Subscriber Duty Cycle, %	4	4	4	100
5. Subscriber Antenna Elevation Angle, degrees	2.5	2.5	2.5	2.5
6. Subscriber Antenna Gain, dB	34	31	35	39
7. Antenna 3 dB Beamwidth, degrees	2.5	4.0	3.0	2.5
8. Subscriber TX bandwidth, MHz	2.5	1.0	1.0	24
9. Subscriber TX Power, Clear Air, dBW	-17	-23	-19.6	-13
10. Hub Density (Actual No. Hubs/Maximum No. Hubs)				
a. In 200 km X 400 km footprint	0.25	0.25	0.25	0.25
b. In 2000 km X 400 km footprint	0.1	0.1	0.1	0.1
11. Cell (hub) spacing, km	5	5	2	2.2

Table Six: Direct Beam Satellite Parameters

1. Satellite Footprint	
a. Small	200 km X 400 km
b. Large	2000 km X 400 km
2. Allowed Power Spectral Density	- 26 dBW/MHz-km^2
3. Receiver Bandwidth	6.25 MHz
4. Satellite Elevation angle, degrees	2.5

In addition to these parameters, a number of assumptions about the system were used in the calculations. These assumptions are:

Percent of CPE signals having same polarization as satellite	50%
Percent of CPEs having clear LOS path to satellite	50%
Percent of CPEs simultaneously active	50%

Direct Beam Interaction Analysis Results

The system parameters for the four systems were used to analyze the expected interference level radiated from within the satellite footprint. Two footprints were used: 200 X 400 km and 2000 X 400 km. The total interference was calculated in terms of dBW/MHz-km^2. The analysis procedure and equations are described in the following paragraphs and summarized at the end.

The first step is to calculate the Effective Isotropic Radiated Power (EIRP) from any CPE. This is calculated as follows:

$$P_{EIRP} = P_{TX} + G_{TX\ ANT}$$

The EIRP Power Spectral Density is then calculated, based on the channel bandwidth for the particular system:

$$PSD_{EIRP} = P_{EIRP} - 10 \log (BW)$$

Since Adaptive Power Control is used at each CPE to normalize the received power at the node or hub antenna, the average power of the CPE transmitter can be used. The average power is taken to be the power averaged over all CPE transmitters associated with a hub. Since the CPEs are uniformly distributed in area about the hub, the average power is the power radiated by a CPE located on the boundary of a circle which equally divides the