BEFORE THE

# Federal Communications Commission

WASHINGTON, D.C.

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JUN 20 1996
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

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| In the Matter of | ) | |
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| Requested Amendment of the Commission's Rules to Allocate the 37.5-38.6 GHz Bands to the Fixed-Satellite Service and to Establish Technical Rules for the 37.5-38.6 GHz Band | ) | RM No. 8811 |

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**OPPOSITION OF**
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## SUMMARY

MOTOROLA'S PETITION SHOULD BE INCORPORATED INTO THE COMMISSION'S ONGOING 37-40 GHZ RULEMAKING:

- THE PETITION RAISES ISSUES INTEGRAL TO THOSE IN THE RULEMAKING
- RESOLUTION OF THE PETITION NECESSARILY IMPACTS UPON ISSUES BEING CONSIDERED IN THE ONGOING RULEMAKING

MOTOROLA'S PLAN TO SHARE THE 37-40 GHZ BAND BETWEEN FIXED SERVICES AND FIXED SATELLITE SERVICES RAISES SIGNIFICANT CONCERNS:

- SHARING IS POSSIBLE ONLY BETWEEN FSS DOWNLINKS AND FS RECEIVERS AND ONLY UNDER CERTAIN CONDITIONS
    - SHARING WOULD REQUIRE COSTLY PROCEDURES TO OVERRIDE INTERFERENCE
    - SHARING WOULD INCREASE INTERFERENCE TO FS RECEIVERS
- SHARING IS NOT POSSIBLE BETWEEN FS TRANSMITTERS AND FSS DOWNLINKS
    - FSS DOWNLINKS WOULD PRECLUDE FS SYSTEMS FROM OPERATING IN THE SAME GEOGRAPHIC AREA
    - THE CARRIER-TO-INTERFERENCE RATIOS NEEDED TO SHARE ARE DIFFICULT IF NOT IMPOSSIBLE TO ACHIEVE
    - ATTEMPTS TO AVOID HARMFUL INTERFERENCE WILL RESULT IN HOLES IN SERVICE AREAS

MOTOROLA MUST PROVIDE MORE INFORMATION ABOUT ITS SHARING PROPOSAL:

- MOTOROLA MUST JUSTIFY ITS NEED FOR THE 37-40 GHZ BAND
- MOTOROLA MUST FURNISH POWER FLUX DENSITY LIMITS
- MOTOROLA MUST SUPPLY ADEQUATE COORDINATION PROCEDURES
- MOTOROLA MUST ACCOUNT FOR EVOLVING SERVICES IN THE 37-40 GHZ BAND

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**OPPOSITION OF**
**WINSTAR COMMUNICATIONS, INC.**

WinStar Communications, Inc. ("WinStar"),[1] by its attorneys, hereby submits its opposition to the above-captioned Petition for Rulemaking filed by Motorola Satellite Communications, Inc. ("Motorola").[2]

## I. INTRODUCTION

Motorola has petitioned the Commission to institute a rulemaking to allocate the 37.5-38.6 GHz band to the Fixed-Satellite Service ("FSS") (space-to-earth) on a co-primary basis with the Fixed Service ("FS") and to establish power flux density

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1 WinStar is a licensee in the 38.6-40.0 GHz band.

2 See Requested Amendment of the Commission's Rules to Allocate the 37.5-38.6 GHz Bands to the Fixed-Satellite Service and to Establish Technical Rules for the 37.5-38.6 GHz Band, Public Notice, Rpt. No. 2132 (May 21, 1996).

limits for the FSS service.[3] Although this petition is ostensibly limited to the 37.5-38.6 GHz band, Motorola seeks the allocation in order to implement FSS service from 37.5-40.0 GHz: "If the 37.5-40 GHz bands are used exclusively for terrestrial services then it would be difficult, if not impossible, to implement certain types of satellite systems in this band as well as in adjacent bands."[4] As described below, Motorola's petition lacks sufficient information to permit an existing licensee or other interested parties to perform a meaningful analysis and, in any event, should be addressed (if at all) in the Commission's ongoing 37-40 GHz rulemaking, in which Motorola is a participant.[5]

## II. MOTOROLA'S PETITION SHOULD BE MADE PART OF THE COMMISSION'S ONGOING 37-40 GHz RULEMAKING

The Commission currently has before it a rulemaking proceeding concerning the 37-40 GHz band. Among other things, that proceeding is designed specifically to: (1) provide a channeling plan and licensing and technical rules to allow for microwave operations in the 37.0-38.6 GHz band and (2) amend the licensing and technical rules in the 38.6-40.0 GHz band.[6]

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3 Motorola Petition for Rulemaking (filed March 4, 1996).

4 Id. at 1-2.

5 See Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands, *Notice of Proposed Rule Making and Order*, FCC 95-500, ET Docket No. 95-183, RM 8553, (rel. Dec. 15, 1995) ("37-40 GHz Rulemaking").

6 See 37-40 GHz Rulemaking.

Motorola's petition raises issues going to the heart of the 37-40 GHz Rulemaking, such as the use of the spectrum, interference standards, etc. The issues raised in Motorola's petition are intertwined with those raised in the 37-40 GHz Rulemaking: resolution of issues in one proceeding will necessarily impact on resolution of issues in the other. For that reason, Motorola's petition must be addressed and resolved in the 37-40 GHz Rulemaking. In addition, consolidation in the ongoing proceeding would conserve scarce agency resources by eliminating the need to consider essentially the same issues in two separate proceedings.[7]

## III. WINSTAR'S PRELIMINARY ENGINEERING REPORT INDICATES SIGNIFICANT PROBLEMS WITH MOTOROLA'S REQUEST TO SHARE THE 37-40 GHz BAND

In a study prepared for WinStar and submitted with the instant opposition, Gene G. Ax and Dale N. Hatfield conclude that Motorola's proposal to share the 37-40 GHz band with incumbent licensees, such as WinStar, presents a number of significant problems.[8] Ax and Hatfield confirm that (1) under certain conditions, FSS downlinks would cause harmful interference to FS

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7 It would be profoundly inefficient and in a sense inappropriate for the Commission to grant rights to incumbent licensees in the 37-40 GHz Rulemaking -- thereby encouraging licensees and the public to invest and rely on the final order in that proceeding -- and then to alter substantially and fundamentally the manner in which the band can be used by granting Motorola's petition.

8 See Gene G. Ax and Dale N. Hatfield, Technical Considerations in Sharing Spectrum in the 37-40 GHz Band Between Fixed Satellite Service Downlinks and the Fixed Service ("Ax and Hatfield").

receivers and (2) FS transmitters will cause harmful interference to FSS downlink receivers. More importantly, they observe that attempts to avoid interference will severely limit the potential uses of the spectrum, impose extraordinary costs on licensees, and degrade service quality for end users. In short, sharing between FS licensees and FSS licensees in the 37-40 GHz band will dampen the efficient use of the spectrum to the ultimate detriment of both end users and licensees.

A. FSS Downlinks Cause Interference To FS Receivers

With respect to Motorola's petition, Ax and Hatfield note that sharing is possible "only as far as FSS downlink interference to FS receivers is concerned" and only under certain conditions.[9] Such conditions include: (1) maintaining FSS signals' angles of arrival above 10-15 degrees; (2) holding downlink power flux density levels at or below the levels proposed in Motorola's petition; and (3) increasing FS transmitter EIRP levels sufficiently above those needed to combat receiving system noise levels.[10] It is not clear from the face of Motorola's petition whether such conditions are achievable.[11] What is clear from Motorola's petition is that other facts are required for meaningful analysis.

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9 See id. at 3.

10 See id.

11 Indeed, Motorola did not submit any studies supporting the viability of its proposal.

In any event, Ax and Hatfield conclude that the methods needed to avoid interference into FS receivers from FSS transmitters would be costly,[12] would constrain available satellite elevation angles,[13] and most importantly, would exacerbate the harmful interference from FS transmitters into FSS downlink receivers.[14] Thus, while sharing between FSS downlinks and FS receivers is achievable, such sharing is impractical given the large financial costs to licensees and increased interference between FS transmitters and FSS downlink receivers.

B. FS Transmitters Interfere Into FSS Downlink Receivers

As pointed out by Ax and Hatfield, the more serious interference problem presented by Motorola's petition is the interference from FS transmitters into FSS downlink receivers. First, absent drastic measures, "wherever an FSS downlink earth station is located, FS systems would be 'frozen out' for an area around the earth station."[15] Second, to achieve the Carrier-to-

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12 See id. ("[T]he more powerful transmitters [used to override interference] would be more costly than otherwise needed and the range of the longest possible links would be compressed due to the Commission's proposed EIRP limit of 55 dBW.").

13 FS link paths are occasionally pointed substantially above the horizontal plane, creating additional interference problems and further constraining the available non-interfering satellite elevation angles. See Ax and Hatfield at 3 n.9.

14 See Ax and Hatfield at 3 ("[M]ore importantly, FS EIRP levels higher than otherwise needed would exacerbate the already extremely severe problem of limiting FS interference into FSS downlink receivers.").

15 Id. at 4 (noting that studies conducted in the 28 GHz negotiated rulemaking concerning shared use between FSS and

Interference ("C/I") ratio necessary to override interference, the required isolation under certain realistic assumptions would have to be over 100 dB above that for free space propagation.[16] Such levels are extremely difficult to achieve and are, in fact, impossible without restrictions on spectrum uses such as the provision of fixed, mobile, and point-to multipoint services.[17] Third, Ax and Hatfield conclude that attempts to avoid harmful interference from FS transmitters into FSS downlinks will lead to holes in service coverage even with achievement of high isolation levels and restrictions on spectrum use.[18] In light of the above, sharing (if it is possible at all) would impede efficient use of the spectrum.

Moreover, the Commission has previously rejected sharing attempts in circumstances similar to those here. For example, in the 28 GHz proceeding, the Commission, after much study and extensive comment, tentatively concluded that FSS and LMDS services cannot share the band: "it [is] not feasible for LMDS stations and the ubiquitous FSS user transceivers to share the same frequencies."[19] For that reason, the Commission proposed to

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LMDS services concluded either that sharing was not possible or was possible only if "severe constraints" were imposed upon both services).

16 See Ax and Hatfield at 5.

17 See id. at 7.

18 See id. at 6-7.

19 See Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz

segment that band.[20] Consequently, it would appear as both a technical and policy matter that sharing is infeasible.

## IV. MOTOROLA MUST PROVIDE MORE DETAILED INFORMATION ABOUT ITS PROPOSAL

Motorola devotes a mere three pages to its petition -- a petition that could eliminate incumbent licensees' ability to provide Fixed Services.[21] The Petition is notable for its failure to provide any technical information. The omission of substantive information precludes the detailed technical and economic analysis necessary for a serious evaluation. Thus, Motorola must supply the requisite information in order to enable meaningful comments to the Commission. Without such information, interested parties -- and the Commission -- will lack the ability to evaluate the petition. Without limiting the scope of relevant spheres of inquiry, WinStar describes below some of the information Motorola should provide.

### A. Motorola Must Justify Its Need For Spectrum

In its Petition, Motorola asserts that "[i]f the 37.5-40 GHz bands are used exclusively for terrestrial services then it would be difficult, if not impossible, to implement certain types of satellite systems in this band as well as in adjacent bands."[22]

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Frequency Band, 11 FCC Rcd 53, 68, ¶ 39 (1995)("28 GHz NPRM").

20 See id. at 68-70, ¶¶ 39-43.

21 WinStar has spent many millions of dollars developing, and plans to continue to invest substantially in, the 37-40 GHz band.

22 Motorola Petition at 2.

However, Motorola offers no justification for this sweeping statement nor does it indicate any present intention to do so. It should be required to provide justification and indicate a present realistic intention to deploy an FSS system utilizing this band. Further, if satellite systems cannot be implemented in the relevant band so long as the 37.5-40 GHz band is used exclusively for terrestrial services, Motorola should demonstrate why it cannot utilize other spectrum to avoid encumbering the currently active 38.6-40.0 GHz band licensees.

B. Motorola Must Furnish Power Flux Density Limits

Motorola recommends that "the Commission adopt the power flux density limits of the ITU Radio Regulations for the 37.5-40.5 GHz band."[23] However, Motorola fails to provide the power flux density limits that its system can withstand. Consequently, interested parties cannot determine the impact of Motorola's request. Thus, Motorola must indicate the levels of in-band and adjacent-band interfering power flux density ("PFD") which its satellite ground stations will accept. Further, Motorola should provide the full hemispheric sensitivity of the FSS earth stations so that Fixed Service licensees may predict the likely geographic constraints on FS system transmitters imposed by FSS systems. Likewise, Motorola should indicate the size and technical characteristics of its downlink receiving antennas as this will effect acceptable levels of interference from FS

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[23] Id. at 3.

systems. Without this information, estimating the necessary interference-avoidance mechanisms for co-primary sharing will be a futile exercise.[24] Further, the interfering PFDs which a satellite ground station is capable of enduring are an essential component to the development of effective spectrum sharing coordination procedures.

C. Motorola Must Supply Adequate Coordination Procedures

The development of reasonable coordination procedures is the responsibility of Motorola, an inactive co-primary prospective applicant in the relevant band. FS incumbents, such as WinStar, currently operate with tremendous flexibility in their service areas: they need not coordinate with other licensees prior to placing links in operation. Thus, if this band can feasibly be shared, Motorola, as the subsequent licensee, should be required to submit a sharing plan that preserves the flexibility of FS incumbents and permits both FS and FSS service providers to operate ubiquitously with seamless coverage and in a financially viable manner without degrading service quality for end users.

D. Motorola's Proposal Must Not Interfere With The Evolution of Service in the 37-40 GHz band

The Commission traditionally has been committed to the efficient utilization of spectrum.[25] To accomplish this goal,

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24 Licensees' inability to forecast appropriate interference-avoidance mechanisms could hinder significantly the full utilization of the band.

25 See Section 1 of the Communications Act, 47 U.S.C. § 151; see also Replacement of Part 90 by Part 88 to Revise the Private Land Mobile Radio Services and Modify the Policies Governing Them, 10 FCC Rcd 10076, 10079 at ¶ 5 (1995) ("PLMR

the Commission has proposed allowing licensees flexibility in the provision of wireless services to encourage the deployment of spectrum-efficient technologies.[26] Motorola's proposal for the provision of service in the 37.5-40 GHz band must not defeat this laudable goal of the Commission. Because sharing necessarily limits licensees' flexibility,[27] Motorola should explain whether and how the implementation of FSS systems in the 37.5-40 GHz band would allow for evolving services as contemplated by the 37-40 GHz Rulemaking.

For example, the severe interference-avoidance measures anticipated by WinStar's engineering report would preclude the use of the 37.5-40 GHz band for mobile services and severely hinder the provision of fixed, point-to-multipoint, and other

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Order")("This proceeding commenced . . . to promote the more effective and efficient use of the PLMR spectrum bands.").

26 See Amendment of the Commission's Rules To Permit Flexible Service Offerings in the Commercial Mobile Radio Services, 11 FCC Rcd 2445 (1996); see also Ax and Hatfield, at 7 ("In order for spectrum to be put to its most highly-valued uses in the marketplace, licensees should be allowed the flexibility to provide whatever services they choose to offer.").

27 See PLMR Order at 10132, ¶ 126 ("Where channels are congested with numerous licensees, implementing advanced technologies may be quite difficult. . . .[T]he introduction of exclusivity . . . will increase the efficient use of the spectrum through the introduction of more advanced technology and result in improved service."); see also Amendment of the Commission's rules to Provide Channel Exclusivity to Qualified Private Paging Systems at 929-930 MHz, 8 FCC Rcd 8318, 8319-20, at ¶ 6 (1993) (licensing on a non-exclusive basis discourages investment); See also Ax and Hatfield, at 7 ("[I]n order for this flexibility in service offerings to work, the use of the spectrum should not be encumbered by the necessarily severe constraints that such spectrum sharing imposes").

services.[28] While the Commission has not allocated the 37.5-40 GHz band to mobile services, the Motorola proposal may prevent the Commission from offering the flexibility to provide these services in the future. Motorola should provide detailed information on the effects of its proposal on the future provision of evolving services in the 37.5-40 GHz band.

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[28] See Ax and Hatfield at 8.

## V. CONCLUSION

The Motorola Petition fails to provide sufficient information for a meaningful evaluation of its proposal. WinStar recommends that the Commission request additional information from Motorola, consistent with the recommendations contained herein, which would enable a meaningful and serious engineering and economic analysis. Moreover, the Motorola Petition should be incorporated into the Commission's ongoing rulemaking proceeding concerning the 37-40 GHz band.

Respectfully submitted,

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Dated: June 20, 1996

# Opposition of

# WinStar Communications, Inc.

## Attachment 1

# Technical Considerations in Sharing Spectrum in the 37-40 GHz Band Between Fixed Satellite Service Downlinks and the Fixed Service

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June 18, 1996

**Technical Considerations in Sharing Spectrum in the 37-40 GHz Band Between Fixed Satellite Service Downlinks and the Fixed Service**

## I. Introduction

In ET Docket No. 95-183[1], the Federal Communications Commission ("FCC" or "the Commission") has undertaken an important proceeding that stands to have significant impact on the development of competition in the provision of local telecommunications services and on the efficiency with which the associated spectrum in the frequency range from 37.0 to 40.0 GHz is utilized. The purpose of this paper is to briefly analyze the technical feasibility of co-primary sharing of some of the 37.0 to 40.0 GHz band spectrum between downlinks in the Fixed Satellite Service ("FSS") and the Fixed Service ("FS"), as proposed by Motorola Satellite Communications, Inc. ("Motorola") in its Petition before the Commission.[2] The balance of the paper is divided into three parts. Section II is an analysis of FSS downlink interference into FS receivers; Section III is an analysis of FS transmitter interference into FSS downlink receivers; and Section IV summarizes our analyses and the conclusions we reach.

## II. Analysis of FSS Downlink Interference Into FS Receivers

It is useful to take a look at what would likely be a "worst case" interference situation. Specifically, this would be the case where an FS receiving antenna's boresight would be looking directly at a satellite with the FSS and FS both using co-polarized transmissions.[3] In its Petition, Motorola requested the Commission to adopt the Power Flux Density ("PFD") limits of the ITU Radio Regulations for the 37.5-40.5 GHz band.[4] These limits for FSS transmissions are as follows:

-115 dB (W/m$^2$)/MHz for angles of arrival between 0 and 5 degrees above the horizontal plane;

-115 dB (W/m$^2$)/MHz at 5 degrees linearly increasing to -105 dB (W/m$^2$)/MHz at 25 degrees;

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[1]Notice of Proposed Rulemaking and Order In the Matter of Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands, ET Docket No. 95-183 and Implementation of Section 309(j) of the Communications Act -- Competitive Bidding, PP Docket No. 93-253, FCC 95-500, Released December 15, 1995 ("the Notice").

[2]Petition for Rulemaking In the Matter of Amendment of Parts 2.106 and 25.202 of the Commission's Rules to Allocate the 37.5-38.6 GHz Band to the Fixed-Satellite Service and to Establish Technical Rules for the 37.5-38.6 GHz Band, dated March 4, 1996.

[3]How low elevation angles to satellites might go would likely depend on whether the satellite system is a Geostationary Orbit Satellite ("GSO") system or a NON-GSO system.

[4]See Radio Regulations, Art. 28 para. 4(6), RR 2578, 2582, 2583, 2584.

-105 dB (W/m$^2$)/MHz for angles of arrival between 25 and 90 degrees above a horizontal plane.

Consider an existing digital microwave radio for the 38 GHz band. This digital microwave radio uses 4FSK modulation and has a Receive Signal Level ("RSL") sensitivity of approximately -85 dBm per MHz of receiving bandwidth (i.e. -85 dBm/MHz or -115 dBW/MHz) for a Bit Error Rate ("BER") of $10^{-6}$ for a non-protected configuration where the signal out of the antenna goes directly without loss into the receiver. For a 0.5 m diameter parabolic dish antenna with a receiving efficiency of 55 percent, a co-polarized signal strength of -105.3 dB (W/m$^2$)/MHz produces an antenna output/receiver input of -85 dBm/MHz or -115 dBW/MHz corresponding to the RSL for a $10^{-6}$ BER. Note that, for a particular receiver technology and type of modulation, the PFD required for a given BER scales directly with receiving bandwidth, just as the allowed FSS downlink PFD level does.[5]

For this co-polarized, on-boresight receiving situation, the Carrier-to-Interference ("C/I") ratio at the FS receiver is equal to -105.3 -(-115) or 9.7 dB. This C/I ratio is far short of the theoretical C/N ratio of 17.6 dB required for a $10^{-6}$ BER.[6] Suppose the practical C/N ratio requirement is 18 dB. Then the receiver noise level in a bandwidth of 1 MHz would be equal to -85 dBm/MHz -18 dB or -103 dBm/MHz. If an interfering signal were to degrade the FS receiver's $10^{-6}$ BER RSL sensitivity of -85 dBm/MHz by 1 dB, the interfering FSS signal level would have to be approximately 6 dB below the noise level[7], i.e. at -109 dBm/MHz. This would require the co-polarized FSS downlink signal to have a PFD of -129.3 dB (W/m$^2$)/MHz. This is 14.3 dB below the limit of -115 dB (W/m$^2$)/MHz.

When interference is controlling, with essentially no contribution from receiver noise, increasing the gain of the FSS receiving antenna would have no effect on the level of FSS downlink interference. However, as cost-effective receiving system technology reduces the noise temperature and the required RSL levels, primarily noise-limited FS receiving system

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[5]However, increasing the gain of an antenna reduces the required PFD level for a given quality of reception in the presence of receiving system noise. Thus, if interfering signals are to degrade performance in the presence of only receiving system noise by a small amount, say 1 dB for a given BER, increasing antenna gain in the direction of an interfering signal results in additional loss of receiving system sensitivity. WinStar, for example, uses many 0.6 m diameter antennas, and this makes their receiving systems somewhat more sensitive to main beam interference than is the case for the 0.5 m diameter antennas used in the above discussion.

[6]"Interference Criteria for Microwave Systems," TIA/EIA Telecommunications Systems Bulletin, TSB10-F, Telecommunications Industry Association, June 1994, Annex B, p. B-5.

[7]In accordance with the method used in TSB10-F in setting interference thresholds. (See Annex B)

RSL sensitivity levels would require that the proposed FSS downlink PFD levels be even lower.[8]

One might argue that the FS systems could overpower the interference from the FSS downlinks by increasing transmitter EIRP levels above those needed to primarily combat receiving system noise levels. However, this has at least two negative effects. First, the more powerful transmitters would be more costly than otherwise needed and the range of the longest possible links would be compressed due to the Commission's proposed EIRP limit of 55 dBW. Second, and more importantly, FS EIRP levels higher than otherwise needed would exacerbate the already extremely severe problem of limiting FS interference into FSS downlink receivers.

Fortunately, antennas used in the 37-40 GHz band have relatively very-narrow half-power beamwidths; for example, a bit over 1 degree for 0.5 m diameter dishes. Such an antenna should have more than 20 dB of discrimination when off boresight by a couple of degrees. Thus, even when the arrival elevation angle of an FSS downlink earth station is as low as 5 or 10 degrees, not many FS links would have close to matching path elevation angles, so that a fair amount of discrimination would be expected with a 0.5 m diameter antenna for most FS system receiving paths. Antennas smaller than 0.5 m in diameter or equivalent area, would of course, have larger beamwidths but the required PFD for the desired signal would increase along with this decrease in antenna gain so that the FSS downlink PFD would tend to be decreased relative to the FS signal PFD.

Thus, it tentatively appears that spectrum sharing between FSS downlinks and the FS might be possible only as far as FSS downlink interference to FS receivers is concerned, if downlink angles of signal arrival from the satellites were kept above about 10 or 15 degrees and the FSS downlink PFD levels were kept at or below the level proposed by Motorola in its Petition.[9] Unfortunately, as discussed next, such spectrum sharing appears to be

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[8]If noise is to be controlling, and not interference, this means that acceptable FSS downlink PFD levels depend on the technologies used in both the FS and FSS. Thus, preset PFD levels could have the effect of limiting the usefulness of new technologies over time in these two services. And, the use of such technologies might be cost-effective in one service but not in the other. This technology interdependence is but one reason for not sharing spectrum by two different services.

[9]Of course, there would be situations where FS link paths would have elevation angles above the horizontal in the neighborhood 10 or 15 degrees or considerably more. Fortunately, most such paths would necessarily be reasonably short since the elevation differential for the two ends of the paths would increase at a rate close to 18 percent per mile for a 10 degree elevation angle. For example, for a 3 mile long path the differential elevation would be close to 2,800 feet. Except for generally causing more FS transmitter interference into FSS downlink receivers, FS systems might be able to overpower the FSS

extremely difficult for ubiquitous FSS and FS system deployments as far as controlling FS transmitter interference into FSS downlink receivers is concerned.

## III. Analysis of FS Transmitter Interference Into FSS Downlink Receivers

It strongly appears that wherever an FSS downlink earth station is located, FS systems would be "frozen out" for an area around the earth station unless drastic measures were taken to prevent this. The Commission recognized this severe problem in the LMDS Notice[10] where similar spectrum sharing was considered. In paragraph 39 of this LMDS Notice, the Commission stated with regard to the Negotiated Rulemaking Committee that was formed to analyze spectrum sharing possibilities, "The Committee concluded that it was not feasible for LMDS stations and the ubiquitous FSS user transceivers to share the same frequencies."[11]

There were conflicting results from the interference studies concerning the sharing of spectrum; however, it appears that at least most of those claiming that such sharing was possible proposed a number of sometimes severe constraints on the systems sharing the spectrum. The Commission tentatively concluded that the concerns about spectrum sharing were valid. This lead the Commission to state, in paragraph 44 of the LMDS Notice, "We propose a segmentation scheme for the 28 GHz band that we believe is equitable, allows licensees to operate viable systems, promotes competition within the band, allows the public to receive service as soon as possible, and provides for future growth of both satellite and terrestrial services "[12]

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interference. For the very short links with path elevation angles being more skyward, PFD levels could overpower the FSS downlink PFD with the use of low transmitter EIRPs. However, as already indicated, this would somewhat exacerbate the severe problem of adequately limiting FS transmitter interference into FSS downlink receivers.

[10]Third Notice of Proposed Rulemaking and Supplemental Tentative Decision 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, and Suite 12 Group Petition for Pioneer's Preference, CC Docket No. 92-297, Released July 28, 1995 ("the LMDS Notice").

[11]Ubiquitous or seamless coverage without holes can be a crucial element of communication service offerings. Just as has been the case with VSAT systems, for example, customers tend to want all of their locations served via the VSATs, and not by a collection of differing interconnected networks.

[12]As a side note, we believe the Commission stands to find bidders in any auctions for spectrum in the 37-40 GHz band willing to pay much more for spectrum that is not encumbered by the severe constraints that spectrum sharing would impose on both the FSS

The above shouldn't be particularly surprising given that the Commission's proposed EIRP limit for the FS of 55 dBW is quite comparable to the EIRPs of many communications satellites, including those that would operate under the FSS PFD limits proposed by Motorola, since the FS transmitters would be located many orders of magnitude closer to the FSS downlink earth stations than the earth stations' satellite transmitters would be to the satellite transmitter(s).

Suppose an FS transmitter was located one mile away from an FSS downlink earth station and that the communications satellite was located in geostationary orbit. The relative free space propagation loss between the satellite transmitter and the FS transmitter to the satellite downlink earth station is approximately 87 dB (20log(22,300+ mi/1 mi)). If the EIRPs and effective bandwidths of the two systems were the same and a 15 dB Carrier-to-Interference ("C/I") ratio[13] was necessary in order for the interference to be acceptable, the propagation loss between the FS transmitter and the FSS downlink earth station would have to be about 102 dB above that for free space propagation. This is obviously a level of interference suppression that is not always easily achieved.

Actually, the EIRP of a communications satellite producing Motorola's proposed PFD limit of -115 dB ($W/m^2$)/MHz, for a satellite elevation angle above the horizontal plane between 0 and 5 degrees, turns out to be over 47 dBW, which is, in fact, quite close to the Commission's proposed maximum EIRP limit for the FS of 55 dBW. For this satellite transmitter EIRP, the required interference suppression between the FS transmitter and the downlink earth station becomes equal to about 110 dB above that for free space propagation.

Suppose the effective bandwidth of the two systems was 10 MHz, instead of 1 MHz. This would allow the FSS EIRP to be increased to 57 dBW, compared with the 55 dBW for the FS transmitter. This would require the FS transmitter to FSS downlink earth station interference discrimination to still be 100 dB above that for free space.[14] And, if the effective bandwidth of the two systems was increased to 50 MHz the required discrimination above that for free space would still be equal to 93 dB. Of course, these estimated required interference suppression levels above that for free space scale at the rate of 20 dB/decade in distance, so that, for example, if the FS transmitter was located 0.1 mi (528 ft), instead of 1

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and FS systems.

[13]Obviously, a 15 dB C/I ratio would not be adequate for some systems. And, if the approach to acceptable interference taken in the TIA/EIA TSB10-F was followed, acceptable C/I ratios would almost assuredly be substantially higher.

[14]These calculations ignore the small, rather negligible, atmospheric propagation losses that have little bearing on this broad discussion of interference. Note that the required interference suppression levels remain extremely high even when the FS transmitter EIRPs are reduced below the 55 dBW maximum level.

mi, from the FSS downlink earth station, all of the above required interference suppression levels would be increased by 20 dB.

In the Notice the Commission proposes antenna standards in Part 94.75(b) for the 38.6 to 40 GHz frequency band. The Table therein provides minimum antenna radiation suppression vs. angle in degrees from the centerline of the main beam in decibels. Suppose these FS Rules were applied to the FSS downlink earth station's antenna performance requirements. For these category A antennas, the minimum antenna gain is 38 dBi, and the minimum radiation suppression vs. angle off antenna boresight is as follows (angle range in degrees/minimum radiation suppression in dB): (5 to 10/25), (10 to 15/29), (15 to 20/33), (20 to 30/36), (30 to 100/42), and (100 to 180/55).

Note that the required interference suppression values above that for free space propagation, calculated above, far exceed even the 55 dB of required antenna discrimination off the *back side* of an antenna. Even when the back side of an FS transmitting antenna is pointed towards the back side of an FSS downlink antenna the required line-of-sight separation distance for the 10 MHz bandwidth situation, discussed above, would be on the order of a third of a mile.

The discussion so far has assumed the angle of arrival above the horizontal for the satellite system downlink signals is between 0 and 5 degrees. For angles of arrival above 5 degrees Motorola's proposed PFD limit increases linearly, in dB, to -105 dB (W/m$^2$)/MHz at an elevation angle of 25 degrees and remains constant for angles above 25 degrees all the way to vertical. Note that the range of allowed PFD levels is only 10 dB. FS systems used in short range applications would be expected to use lower gain antennas with path elevation angles ranging from 0 degrees above the horizontal to angles certainly exceeding 25 degrees. One would expect to see a large range of path elevation angles used in high-density ubiquitous deployment of FS systems. The higher satellite downlink PFD levels at the higher elevation angles would not necessarily allow off-boresight downlink antenna discrimination to be useful in limiting the FS to FSS downlink interference.

The maximum increase of 10 dB in the allowed satellite downlink PFD discussed above, as the downlink signal angle of arrival above the horizontal increases, is not a very substantial improvement when the required FS to FSS downlink receiver interference suppression has to exceed that for free space propagation in the neighborhood of 100 dB in order to allow the separation between an FS transmitter and an FSS downlink receiver to be in the neighborhood of 1 mile, as covered above.

Obviously, some very substantial kinds of non-line-of-sight signal blockages are needed in order to adequately limit FS transmitter interference to FSS downlink receivers. In some cases, a combination of building and/or terrain signal blockage, interference shielding fences, high performance antennas--possibly with shrouds, etc. may be used to adequately limit interference to particular FSS downlink receivers; however, there would always be numerous situations in which FS transmitters could not be located at or near the

desired location. This would necessarily mean that there would be an extremely large number of "holes" in high-density ubiquitous seamless coverage for both the FSS and FS that would not need to be the case if spectrum sharing was not required.

In order for spectrum to be put to its most highly-valued uses in the marketplace, licensees should be allowed the flexibility to provide whatever services they choose to offer with any technical constraints only being those that are necessary to protect other systems/services. And, in order for this flexibility in service offerings to work, the use of the spectrum should not be encumbered by the necessarily severe constraints that such spectrum sharing imposes. As one moves from point-to-point to point-to-multipoint to mobile, etc., systems, spectrum sharing would result in more and more holes in the needed seamless coverage since interference possibilities to FSS downlink receivers increases substantially with this increased service flexibility. One can easily see that sharing of spectrum between the FSS downlinks and a terrestrial-based mobile service system would have extremely serious interference situations that would be intolerable unless the mobile service was not allowed to function in certain situations.[15] In particular, mobile units could not be allowed to transmit even when they are not within the main beam of the FSS downlink antennas for substantial distances around the downlink earth stations. As an example of the complete impracticality of FSS downlinks sharing spectrum with terrestrial-based mobile services, we note that a mobile with an EIRP of 1 W located off the back side of an FSS downlink receiving antenna could cause intolerable interference hundreds of feet away under line-of-sight conditions, and, of course, this rapidly gets much worse as the mobile moves around closer and closer to the main beam of the antenna. More importantly, however, even if very large numbers of holes in seamless coverage was acceptable, it strongly appears to be infeasible for a usable system to guarantee that mobiles would not be allowed to transmit whenever they could cause unacceptable interference.[16]

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[15]Although we have emphasized the problems raised by sharing spectrum between FSS and mobile, there are very severe problems in sharing spectrum between FSS and other services, such as point-to-point, point-to-multipoint, etc., on a seamless, ubiquitous basis.

[16]Under spectrum sharing arrangements between differing licensees, it is easy to see that cost-effective delivery of adequate quality services (if, indeed, certain services are possible at all) is likely to be substantially compromised. Examples of where this can occur include holes in desired coverage areas and inadequate control of interference between different licensees' systems. When a licensee has exclusive use of spectrum, the licensee can flexibly provide a more optimum mix of services with the desired quality much better than when the spectrum is shared. This is basically because a single licensee can independently control interference (that is then internal to the licensees's systems rather than between differing licensees' systems) than when some rather fixed rules have to be followed when spectrum is shared between different licensees. In addition, these rather fixed rules tend to pre-suppose a certain mix of technologies will be used in the systems sharing the spectrum. And, this makes it more difficult to make use of newly developing technologies to advantage when they

## Section IV Summary and Conclusions

As discussed above, we believe spectrum sharing in a portion of the 37 - 40 GHz band between FSS downlinks and the FS, as requested by Motorola, would be fraught with extremely difficult problems that we believe both the FSS and FS would both like very much to avoid. We believe that completely ubiquitous coverage by both the FSS downlinks and the FS would not be possible. Instead, as a practical matter, we believe large numbers of "holes" in coverage would be unavoidable. If given the required service flexibility , we also believe the licensees of the 37 - 40 GHz spectrum would put the spectrum to its most highly-valued uses. Sharing of spectrum between the FSS downlinks and the FS would not allow this needed flexibility.

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come along.