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September 24, 1997

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

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

Re: RM 9005, Ka-Band Blanket Licensing

Dear Mr. Caton:

On behalf of Comm, Inc. and Motorola Global Communications, Inc. ("Motorola"), enclosed please find for filing an original and nine copies of Motorola's Comments in the above-reference rulemaking proceeding. See Public Notice, IN Report No. 97-27, September 5, 1997.

If there are any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

James M. Talens

Philip L. Malet
James M. Talens

Counsel for Comm, Inc. and
Motorola Global Communications, Inc.

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EXECUTIVE SUMMARY

Comm, Inc. and Motorola Global Communications, Inc. (collectively, "Motorola"), licensee and applicant in the Fixed-Satellite Service ("FSS") in the Ka-band, hereby submit these Comments in response to the Commission's Public Notice of September 5, 1997, IN Report No. 97-27, which seeks to refresh the record in this proceeding. Motorola supports blanket licensing in certain portions of the Ka-band and urges the Commission to move quickly to develop rules in those bands where satellite services do not share the same spectrum with the fixed services ("FS"). Motorola favors the use of industry meetings to develop any necessary interservice sharing rules and other technical criteria to facilitate blanket licensing.

Successful implementation of the FSS in the Ka-band requires distribution of earth terminals to geographically diverse users. The only practical means for achieving such broad earth terminal distribution is through blanket licensing. Blanket licensing would permit the routine grant of large numbers of small antenna earth stations for use with FSS systems, permitting earth terminals to be sold and installed with the same ease that cellular telephones are marketed and used today.

Motorola proposes that a new Section 25.138, entitled "Licensing Provisions for Ka-band Earth Stations in the Geostationary Fixed-Satellite Service Operating in the 19.7-20.2 GHz, 28.35-28.6 GHz, and 29.5-30.0 GHz Bands," be offered for public comment in this proceeding. This Rule sets forth the technical and procedural requirements to permit routine GSO/FSS blanket earth station processing by the Commission.

Motorola believes that the matter of FS-NGSO/FSS mutual interference in the 18.8-19.3 GHz band can be resolved through technical discussions between the FS and NGSO/FSS

communities. Motorola urges the Commission to encourage and support the use of industry meetings to develop the appropriate technical sharing criteria that can be used for granting blanket licenses for earth terminals using this band.

TABLE OF CONTENTS

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

In the Matter of	)	RM No. 9005
Routine Licensing of Large Numbers of Small Antennas Operating in the Ka-Band	)	

To: The Commission

COMMENTS OF MOTOROLA

1. Comm, Inc. and Motorola Global Communications, Inc. (collectively, "Motorola"), licensee and applicant in the Fixed-Satellite Service ("FSS") in the Ka-band, hereby submit these Comments in response to the Commission's Public Notice of September 5, 1997, IN Report No. 97-27 ("Public Notice"), which seeks to refresh the record in the above-captioned proceeding. Motorola supports blanket licensing in portions of the Ka-band and urges the Commission to move quickly to develop rules in those bands where satellite services do not share the same spectrum with the fixed services ("FS"). Motorola favors the use of industry meetings to develop any necessary interservice sharing rules and other technical criteria to facilitate blanket licensing.

Introduction

2. On December 23, 1996, Lockheed Martin Corporation, AT&T Corp., Hughes Communications, Inc., Loral Space & Communications, Ltd., and GE American Communications, Inc. (collectively "Petitioners"), submitted a petition to the Commission to commence a rulemaking proceeding to revise Part 25 of the Commission's Rules to provide for the routine licensing of large numbers of small antenna earth stations in the Ka-band for the Geostationary Orbit/Fixed Satellite Service ("GSO/FSS"). Petitioners argued that blanket licensing in the 19.7-20.2 GHz, 28.35-28.6 GHz and 29.5-30.0 GHz bands is both feasible and essential, subject to the sharing principles specified in the 28 GHz First Report and Order.[1/] Petition at 6. Petitioners also supported separate development of sharing criteria, licensing and registration procedures for GSO/FSS and FS terminals operating in the 17.7-18.8 GHz band.

3. In its Comments, Teledesic Corporation ("Teledesic"), then an applicant for a non-GSO/FSS ("NGSO/FSS") license in the Ka-band, expressed its support the Petition, but urged the Commission to include consideration of blanket licensing in the 17.7-19.3 GHz and 28.6-29.1 GHz sub-bands.[2/] In its Reply, Petitioners did not object to Teledesic's request that the NGSO/FSS and GSO/FSS bands shared with FS be included in this proceeding. They did ask, however, that "separate Industry Working Groups be formed as quickly as possible to address the

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[1/] Rulemaking to Amend Parts 1, 2, 21, and 25 of Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, and to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, First Report and Order, 11 FCC Rcd 19005 (1996)

[2/] The International Bureau (the "Bureau") subsequently issued Teledesic a license to provide NGSO/FSS operations in portions of the Ka-band. See In the Matter of Teledesic Corporation Application for Authority to Construct, Launch, and Operate a Low Earth Orbit Satellite System in the Domestic and International Fixed Satellite Service, 12 FCC Rcd 3154 (International Bur., Mar. 14, 1997), recon. pending.

unique sharing issues of each sub-band in a timely fashion, and that the requested rulemaking proceeding be structured to permit the earliest possible adoption of blanket licensing procedures, by sub-band or service, as appropriate." Reply at 3.

4. Since these pleadings were filed, two developments have occurred in the Ka-band which the Bureau feels necessitate additional public comment in this proceeding. In March 1997, the Bureau issued a license to Teledesic for its proposed NGSO/FSS system in the 18.8-19.3 GHz and 28.6-29.1 GHz bands. Also, in May 1997, the Bureau authorized thirteen FSS companies to construct, launch, and operate their proposed GSO/FSS systems in the Ka-band on a primary basis.[3/] In view of these developments, the Bureau now seeks comment on the appropriateness of instituting blanket licensing procedures for the Ka-band. It further asks whether co-frequency sharing can be achieved between FS and satellite services in the 17.7-19.7 GHz band.

Discussion

5. Motorola is the licensee of the Millennium System, a constellation of four GSO satellites assigned orbital locations in the Ka-band suitable for serving North America, Central America and South America.[4/] The Millennium System will provide point-to-point and point-to-multipoint communications services on a virtual real-time basis using asynchronous

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[3/] See Authorizations of: Comm, Inc. (DA 97-968); GE American Communications, Inc. (DA 97-970); EchoStar Satellite Corporation (DA 97-969); Hughes Communications Galaxy, Inc. (DA 97-971); KaStar Satellite Communications Corp. (DA 97-972); Lockheed Martin Corporation (DA 97-973); Loral Space & Communications Ltd. (DA 97-974); Morning Star Satellite Company, L.L.C. (DA 97-975); NetSat 28 Company, L.L.C. (DA 97-976); Orion Atlantic, L.P. (DA 97-979); PanAmSat Licensee Corp. (DA 97-978); and VisionStar, Inc. (DA 97-980) (International Bureau May 9, 1997).

[4/] Comm, Inc., the licensee of Millennium, is a wholly-owned subsidiary of Motorola.

transfer mode. It will be capable of transmitting data to users at rates ranging from 384 kps (or lower) to 51.84 Mbps. Motorola is also the licensee of the IRIDIUM® System, an NGSO system that will soon be offering Mobile-Satellite Service ("MSS") to handheld terminals throughout the world. The IRIDIUM System will operate its feeder links in a portion of the Ka-band.

6. Motorola also has two applications pending before the Commission for satellite systems that will operate in the Ka-band. The first of these is the Celestri™ Multimedia LEO System, an NGSO/FSS network consisting of 63 satellites that will provide real-time broadband FSS to virtually all of the populated land masses in the world. The second application is for the Celestri™ GEO System, a constellation of five GSO satellites that will complement the Millennium System to provide global broadband broadcast, multicast and other data distribution services at extremely high data rates.[5/] Thus, Motorola is poised to enter the Ka-band with no fewer than three major satellite systems. Each of these systems will operate with hundreds of thousands of small earth terminals. Together, they will revolutionize global high capacity, high speed data transport to provide services currently unavailable and far too costly for the foreseeable future by any other medium.

7. Successful implementation of the FSS in the Ka-band requires distribution of earth terminals to geographically diverse users. The only practical means for achieving such broad earth terminal distribution is through blanket licensing. Blanket licensing would permit the routine grant of large numbers of small antenna earth stations for use with FSS systems,

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[5/] The Celestri LEO System and Celestri GEO System applications have not yet appeared on public notice.

permitting earth terminals to be sold and installed with the same ease that cellular telephones are marketed and used today.

8. In order to qualify for blanket licensing, FSS licensees would have to demonstrate that their terminals comply with certain minimal technical standards that protect against harmful interference to other primary users. As Petitioners correctly note, blanket licensing is currently used for certain Very Small Aperture Terminal ("VSAT") stations in the Ku-band pursuant to Section 25.134 of the Rules, 47 C.F.R. § 25.134. Also, the Commission has issued blanket licenses for a GSO MSS system, a Little LEO system and Big LEO systems.[6/] Any other terminal equipment licensing approach, requiring prior coordination would unnecessarily burden the Commission and industry, delay the introduction of Ka-band satellite services, and inhibit competition among satellite communications networks. Motorola therefore supports blanket licensing in the Ka-band and urges the Commission to move forward as quickly as possible to implement it. To that end, Motorola recommends that the Commission look to industry forums to develop the necessary sharing criteria that will provide the threshold technical standards to support blanket licensing. Given the lead time needed for industry to develop these standards

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[6/] Petition at 3. See also Rockwell International Corporation Blanket Licensing Authority for 15,000 Mobile Earth Terminals, 7 FCC Rcd 942 (1992), modified (to 30,000 terminals) in 10 FCC Rcd 10924 (1995); American Mobile Satellite Corporation Blanket Authorization for 200,000 Voice Mobile Earth Terminals, 10 FCC Rcd 9507 (1995); American Mobile Satellite Corporation Blanket Authorization for 30,000 Data Mobile Earth Terminals, 10 FCC Rcd 10458 (1995); American Mobile Satellite Corporation Reconsideration of 30,000 Mobile Earth Terminal Authorization to Operate Additional 12,000 Data Mobile Earth Terminals, 11 FCC Rcd 5527 (1995); see also Orbcomm Blanket Authorization for 200,000 Mobile Earth Terminals, 10 FCC Rcd 6572 (1995); U.S. Leo Services, Inc., Order and Authorization for 200,000 Portable Handheld Earth Terminals for Use with IRIDIUM, 11 FCC Rcd 20474 (1996).

and for the Commission to promulgate rules, it is imperative that these activities commence immediately.[7/]

9. In response to the Teledesic (NGSO) and Ka-band GSO licensing decisions, the Bureau has enlarged this proceeding from its original focus on GSO blanket licensing to include sharing and blanket licensing in all of the FSS portions of the Ka-band. This expansion of the scope of this proceeding not only increases the range of issues that must be addressed by the Commission but it also obfuscates the original focus of the Petition. In those bands where GSO/FSS operations have been designated as primary without co-primary FS, i.e., in the 19.7-20.2 GHz and 29.5-30.0 GHz bands, blanket licensing can be readily achieved based on standards developed by the current community of Ka-band GSO licensees. Thus, while Motorola is amenable to pursuing blanket licensing in some other segments of the Ka-band, the Commission's initial focus should be on accommodating blanket licensing of GSO earth terminals operating in the 19.7-20.2 GHz and 29.5-30.0 GHz bands.

10. In some segments of the Ka-band, notably those in which there is interservice sharing on a co-primary basis, sharing criteria must be established that permit operation without mutual harmful interference. For example, the many FS terminals currently in use in the 17.7-18.8 GHz band may create an environment of potential interference to FSS networks. Under these circumstances, it may be necessary for FSS networks to "accept" a limited level of interference from existing FS terminals. However, by using a combination of interference mitigation techniques, and with reasonable cooperation of the FS industry, Motorola believes

[7/] A preliminary series of industry meetings are currently being held to develop the technical criteria for blanket licensing in the 19.7-20.2 GHz and 29.5-30.0 GHz bands.

that sharing among such co-channel, co-primary services can be accomplished. Motorola further believes that industry working groups, operating with Commission guidance, constitute the most efficient vehicle for achieving consensus on spectrum sharing standards and developing blanket licensing rules.

11. In the paragraphs that follow, Motorola offers its views on sharing and earth terminal blanket licensing in several segments of the Ka-band. In all cases, Motorola believes that industry meetings represent the best means for developing consensus on relevant technical sharing criteria.

12. 19.7-20.2 GHz, 28.35-28.6 GHz and 29.5-30.0 GHz Bands. In the U.S., the 19.7-20.2, 28.35-28.6 and 29.5-30.0 GHz bands are designated as "primary" for GSO/FSS operation.[8/] There are no FS stations in those bands, nor are there any MSS terminals. Therefore, the only technical issue in these bands involves sharing among GSO satellite systems and terminals.[9/] Motorola urges the Commission to support resolution of issues associated with sharing and blanket licensing in these bands independently of the more complex sharing issues endemic to other portions of the Ka-band.

8/ The 29.25-29.5 GHz band is designated in the U.S. as co-primary between GSO/FSS and MSS feeder links. However, it would not be possible to coordinate MSS feeder link operation with GSO/FSS earth stations if blanket licensing were used in this band. Therefore, Motorola opposes any consideration of blanket licensing in the 29.25-29.5 GHz band.

9/ The 28.35-28.6 GHz band is similar to the 19.7-20.2 GHz and 29.5-30.0 GHz bands in the U.S. in that there is no FS designation. Therefore, for purposes of blanket licensing in the U.S., the 28.35-28.6 GHz band should be handled in the same way as the 19.7-20.2 GHz and 29.5-30.0 GHz bands. However, Mexico and Canada have allocated the 28.35-28.6 GHz band for FS as well as FSS operation. As Petitioners have indicated, it may be appropriate to apply specific technical requirements for terminals operating within a defined distance of the Mexican or Canadian border, to assure cross-border protection. See Petition at 5-6. This issue should be addressed in industry meetings once the U.S. standards are established.

13. As a starting point toward developing blanket licensing standards in these sub-bands, it is important to note that the Commission's GSO licensing in the Ka-band is predicated on two-degree orbital spacing. In this regard, it is necessary to establish threshold downlink power flux density ("PFD") and threshold uplink transmit power ("EIRP") density limits for all GSO systems in order to avoid mutual harmful interference. Motorola recommends a downlink threshold PFD limit of -122 dBw/m^2/MHz and an uplink EIRP limit of 15 dBw/MHz at an off-axis angle of 2.2 degrees. Satellites networks complying with these standards could share the Ka-band every two degrees without causing or receiving harmful off-axis interference.[10/] Moreover, these sharing criteria would establish threshold signal limits below which coordination would not be necessary and blanket licensing could be readily implemented.[11/]

14. Codifying these standards into a Commission rule would create a streamlined procedure under which GSO/FSS earth terminals operating in the 19.7-20.2 GHz, 28.35-28.6

10/ The analysis supporting these findings was submitted by Motorola in ITU Task Group ADHOC WP-4A, Document No. ADHOC US WP-4A/04 rev. 2, August 11, 1997 ("Optimum use of the band 29.5-30.0/19.7-20.2 GHz band by GSO VSAT networks") and is refined in Document No. ADHOC US WP-4A/04 rev. 3, September 22, 1997 (Efficient use of the band 29.5-30.0/19.7-20.2 GHz band by GSO VSAT networks"). This approach is based on a "thermal limited" analysis, which looks strictly to the link budgets and antenna gain characteristics of antennas to arrive at an appropriate PFD or EIRP values. See Attachment A to these Comments (Document No. ADHOC US WP-4A/04 rev. 3).

11/ Threshold limits permit blanket licensing, but they do not preclude use of earth stations operating at higher power levels if they are successfully coordinated. Such coordination should be completed with all Ka-band licensees potentially affected prior to operation because, directly or indirectly, all are impacted. A surrogate for this process is imposition of a hard limit, one that serves as both the criterion for blanket licensing and the maximum signal level. While a hard limit arguably could prevent future technological innovations that require higher power levels, it seems more likely that technology would move in the direction of enhanced receivers and improved antenna designs, both of which would require lower power levels for comparable transmission reliability.

GHz, and 29.5-30.0 GHz bands could be quickly licensed and distributed, without the need for time-consuming technical coordination for each installation and with assurance of interference-free operation.

15. Motorola proposes that a new Section 25.138, entitled "Licensing Provisions for Ka-band Earth Stations in the Geostationary Fixed-Satellite Service Operating in the 19.7-20.2 GHz, 28.35-28.6 GHz, and 29.5-30.0 GHz Bands," be offered for public comment in this proceeding. This Rule sets forth the technical and procedural requirements to permit routine GSO/FSS blanket earth station processing by the Commission.[12/] Motorola offers this proposal based on the analyses contained in Attachment A hereto, which reflect a minimum terminal antenna diameter (0.7 m) that can be used with orbital spacing of two degrees to permit shared Ka-band GSO/FSS operation.

16. 18.8-19.3 GHz and 28.6-29.1 GHz Bands. As noted, Teledesic has been licensed to operate an NGSO network in the Ka-band, using the 18.8-19.3 GHz band for its primary downlink operations and 28.6-29.1 GHz for its primary uplinks. Motorola's Celestri LEO System also proposes to use these same bands. NGSO operation in this downlink band has been designated co-primary with FS.[13/] Motorola believes that sharing is possible between FS and NGSO/FSS in the 18.8-19.3 GHz band, and that a separate industry working group should develop the technical criteria needed to support earth terminal blanket licensing in this band.

12/ See Attachment B to these Comments.

13/ The uplink NGSO band of 28.6-29.1 GHz is not designated for FS use in the U.S. The focus of the Commission's Public Notice is on interservice sharing between FS and FSS. GSO-NGSO and NGSO-NGSO sharing, including sharing in the 28.6-29.1 GHz band, is being discussed in a variety of industry forums and is not the subject of this proceeding. For a full technical discussion of NGSO-GSO and NGSO-NGSO sharing, however, see Celestri LEO System Application, File No. 79-SAT-P/LA-97 (filed June 13, 1997), Appendix B.

17. The nominal elevation angle for the Celestri LEO System earth terminal reception will be about 25°. This constraint obviates the need for mitigation of interference from FS transmissions because most of the energy from such transmissions lies in lower elevation angles . Nevertheless, additional interference mitigation techniques can be applied, such as antenna sidelobe control and general shielding, to further assure interference avoidance. With regard to interference into FS terminals, the Celestri LEO System downlink PFD level complies with the limits defined in Section 25.208(c) of the Commission's Rules in any 1 MHz bandwidth, at all elevation levels.[14/] Studies in the ITU-R have indicated that the PFD limits of Section 25.208(c) are adequate to protect FS from harmful interference due to NGSO constellations similar to the Celestri LEO System.[15/]

18. Accordingly, Motorola believes that the matter of FS-NGSO/FSS mutual interference in the 18.8-19.3 GHz band can be resolved through technical discussions between the FS and NGSO/FSS communities.[16/] Motorola urges the Commission to encourage and support the use of industry meetings to develop the appropriate technical sharing criteria that can be used for granting blanket licenses for earth terminals using this band.[17/]

[14/] Id.

[15/] See WRC-97 CPM Report, Chapter 4.3.4.

[16/] In order to prevent further complications in developing interservice sharing criteria, the Commission may want to impose a temporarily freeze on the issuance of FS licenses in the 18.8-19.3 GHz band.

[17/] It should be noted that in this band and in other bands failure to comply with a threshold criterion for blanket licensing does not mean that an earth terminal cannot be installed and used. It simply means that coordination procedures must be followed to assure that harmful interference to existing FS systems will not occur. Future FS systems, of course, are not

(continued ...)

Conclusion

19. Motorola favors commencement of a rulemaking proceeding to establish blanket licensing procedures in the Ka-band based on threshold sharing criteria developed through industry working groups.[18/] Motorola also favors industry development of sharing criteria and blanket licensing standards in the 19.7-20.2 GHz, 28.35-28.6 GHz, and 29.5-30.0 GHz bands separately from consideration of such issues in other parts of the Ka-band. Motorola requests

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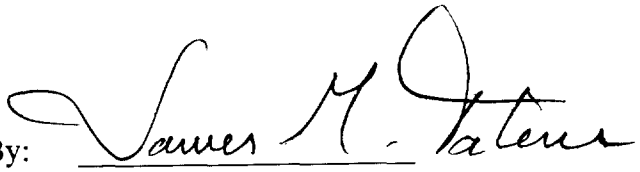
17/ (... continued)
necessarily protected by a prior coordination because they will bear the burden of coordinating with the earlier-coordinated FSS station. Under a blanket licensing process, on the other hand, there is no need to coordinate if the newly installed equipment complies with threshold technical standards specified in the blanket licensing rules.

18/ But see n. 8, supra.

that its proposed Section 25.138, which contains blanket licensing procedures, be included as a specific proposal in any Notice of Proposed Rulemaking issued by the Commission.

Respectfully submitted,

Comm, Inc.
Motorola Global Communications, Inc.

By: 

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Dated: September 24, 1997

CERTIFICATE OF SERVICE

I hereby certify that the foregoing Comments were sent, by hand, to the following persons:

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Attachment A

Radiocommunication Study Group Fact Sheet

Task Group: ADHOC WP-4A	Document No: ADHOC US WP-4A/04 rev 3
Reference: Recommendation SG 4/67 rev 1	Date: Sept. 22, 1997
Document Title: Efficient use of the band 29.5-30.0/19.7-20.2 GHz band by GSO VSAT networks	
Author: Ken Engle SATCOM Group Motorola Corp.	Phone: 602-732-2080 Fax: 602-732-2305 Email: ken_engle@email.mot.com

Purpose/Objective: This contribution is to analyze a set of critical VSAT GSO network parameters that would allow sharing of the band by networks with only 2 degree spacing of the satellites along the arc with the minimum sized VSAT aperture.

Abstract: This band is quite attractive for use by GSO/VSAT networks with high frequency reuse through multiple spot beams. Most of the new proposed networks for this band are for two way broad band data either point to point or point to multipoint to a user facility. The lack of the ubiquitous FS in this band facilitates deployment of large numbers of VSATs even in urban areas with no coordination difficulty.

The new recommendation document SG4/67 performed sharing studies between GSO VSATs and GSO FSS high data rate point to point networks who were characterized in recent AP3 submissions. It concluded that with reasonable link margins and high performance VSAT antennas with a minimum size of 0.7 meter, that sharing of the arc is feasible with as low as 2 degree spacing.

A more detailed analysis was performed which established limits, strategies for power control and sidelobe levels which in fact make it practical for VSATs with 0.7 meter antennas to share the arc every 2 degrees with acceptable link margins.

CEPT has prepared proposals for limits on NonGSO FSS in these bands for WRC-97. It is not possible to evaluate these proposals until the envelope of GSO network characteristics is established for a particular band. This contribution establishes such an envelope for the 29.5-30.0/19.7-20.2 GHz band in the form of GSO limits at the arc and GSO limits on the ground. It appears that these GSO limits could be extended to the total band 27.5-30.0/17.8-20.2 as well to promote use of the arc every 2 degrees by larger terminals.

In rev 2 the basic link assumptions were reviewed for errors and validity on assumptions on the future characteristics. The Io/No for each beam was calculated on the assumption there were four adjacent satellites all with co-frequency earth terminals located in the peak of the victim beam. Original conclusions unchanged about the minimum size and characteristics of VSATs that would allow sharing of the arc every two degrees.

Rev 3 is only editorial changes.

1.0 Introduction

The band 29.5-30.0/19.7-20.2 GHz is most attractive for use by GSO VSATs because FS is not allocated to these bands. While in Region 2, GSO MSS is co-primary for this same band, as of this date, no MSS GSO networks have been communicated to the ITU Radio Bureau. This contribution examines the possibility of establishing criteria to insure sharing of the arc every two degrees by GSO VSAT networks with the smallest size earth terminal antennas possible.

2.0 VSAT 20/30 GHz Network Characteristics

The maximum orbital efficiency, in this band, would be achieved with: (1) two degree spacing; (2) frequency reuse through satellite spot beams; and (3) regenerative transponders for point to multipoint networks. To achieve this utilization, certain network parameters must be established as a baseline. Table 1 summarizes the key parameters needed for the analysis.

In Table 1, a satellite is assumed to have spot beams with approximately 1° beam width with a beam and frequency reuse pattern that minimizes adjacent beam interference. The penalty for this method of frequency reuse is the large gain variation over a single spot beam. Therefore, the gain variation was selected to be 4 dB to the edge of the beam. With point to multi-point operation, the down link must have a fixed link margins but the FDMA up link can utilize adaptive power control to combat rain induced fades. The static up link margin must be sufficient to correct minor fluctuations in C/N and mitigate the necessity for precision up link power control. The up and down link data rates are consistent with a typical point to multipoint operation planned by many networks.

The initial values of single entry permissible levels of Io/No from an adjacent satellite network is assumed to be around 6 to 12%. The Appendix 29 trigger level value of 6% was developed for lower frequency bands with minimal link margins and global beams. Further, it is assumed there can be one interfering network which has a earth terminal located in the peak of the victims spot beam separated by 2 or 4 degrees on either side. The static link margin is defined as the difference between C/(N+I) and minimum link C/N.

Table 1
Generic 20/30 GHz VSAT Technical Characteristics

Parameter	Up link	Down Link
Transponder	regenerative	regenerative
Modulation	QPSK	QPSK
Coding	some	heavy
Access	FDMA	TDMA
Min. Link C/(N+I)	8	6
Typ/ Data Rate (Mbps)	0.38	100
Satellite Antenna	45 dBi (1°)	45 dBi (1°)
Edge of Beam	41 dBi	41 dBi
Noise Temp	575°K	250°K
Adaptive Power Control	yes	no
Static Link Margin	3-5 dB	5-10 dB
Io/No per Spot Single entry	6%-12%	6%-12%

3.0 VSAT sharing analysis

The baseline analysis assumed that the earth terminal antenna has the characteristics of the highest performance reported for a small aperture (0.7 meter) KaBand system. (The topocentric 2.2 degree gain discrimination is -25 dB for the down link and -30 dB for the up link) The feasibility of using such a small antenna with 2 degree spacing is examined in the link equations contained in Table A1 , Appendix A. These links assumed no atmospheric or pointing losses and the transmitter power was adjusted to keep the Io/No from an adjacent single network to reasonable limits with adequate link margins. The Io/No from four adjacent satellites assumes the earth terminal antenna sidelobes roll off an additional 5 dB at 4.4° from the main beam. Therefore the aggregate Io/No rises to 36.2% on the down link which does not significantly affect the beam availability with link margins of 4.7 to 8.7 dB.

Table 2 summarizes the key parameters from these Appendix A link calculations. The column labeled 0.7 meter, low side lobes, is the link analysis for the high performance terminals assumed as a baseline. The pfd values were calculated at the adjacent position in the arc for the up link and on the surface of the earth for the down link. In order to obtain reasonable down link margins for the baseline system, the single entry Io/No from an adjacent satellite was allowed to grow to 12%. Respectable link margins on the up link is achieved with Io/No of about 6%. With adaptive power control there will be short periods when the up link interference may increase from an adjacent satellite which is powering up to overcome a rain fade. This is one reason for maintaining a static single entry Io/No of about 6% on the up link.

In Table A.2, the links are analyzed for a VSAT also with 0.7 meter antenna but with typical side lobes as described in the Table of Characteristics shown in Document 4/64 from SG4 for VSATs this size. If the same pfd limits which were developed for the baseline network are maintained, the down link Io/No is degraded to a level of 48% for a single entry and 128% when 4 adjacent satellites are considered, which degrades the link margins to unacceptable levels. However, the up link edge of beam static link margin is not even above zero. This definitely would be unacceptable. Antennas apertures as small as 0.7 meters clearly need better side lobes than this case.

The link performance for earth stations with apertures of 1.5 meters are analyzed in Table A.3 and are also summarized in Table 2. Since the antenna has a D/>100 , it is assumed the sidelobes conform to 29-25log (dBi) in the region 1-48 degrees. Again, using the baseline 0.7 meter pfd limits, the total down link Io/No increases to 81% which is acceptable with the corresponding 5 dB increase in net link margin and the single entry up link Io/No remains at 6%.. The 1.5 meter antenna has substantially improved link margins and availability as compared to the baseline 0.7 meter and therefore could better serve certain classes of customers.

Table 2
Comparison of VSAT performance with fixed pfd limits (1° spot)

	0.7 meter low side lobes		0.7 meter avg. side lobes		1.5 meter low side lobes	
	UP	**DOWN**	**UP**	**DOWN**	**UP**	**DOWN**
pfd @ rec. antenna dBW/m^2/MHz	-147	-122	-147	-122	-147	-122
Io/No adjacent sat Single Entry /beam %	6	12	7	48	6	30
Io/No adjacent sat Four Entry /beam %	16	36	19	128	19	81
Static Link Margin Edge/peak of Beam dB	4.7/8.7	4.6/8.6	-0.7/3.2	4.8/8.8	6.2/10	11/14.7
ET off axis gain discriminant 2.2° dB	-30	-25	-23	-19	-30	-27

In Appendix B, the sharing of the base line VSAT network with larger trunking networks is analyzed by examining the associated off axis pfd limits when sharing with other large satellite networks. These networks are characterized by point to point service, with bent pipe transponders, high data rates, half degree spot beams, large fixed margins, and up to 4 meter earth terminals which conform to 29-25log in dBi. Table 3 summarizes the performance and interference levels between these large terminals.

Table 3
Sharing among Large Terminals with 4 meter antennas (0.5° spot beams)

	DOWN	UP fixed pwr	UP adaptive
pfd @ rec. antenna dBW/m^2/MHz	-123	-141	-147
Io/No adjacent sat Single Entry /beam %	20	40	10
Io/No adjacent sat Four Entries /beam %	52	106	26
Static Link Margin Edge/peak of Beam dB	13/17	6.8/9.0[1]	1/3[1]
ET off axis gain discriminant 2.2° dB	-37	-40	-40

1. This is the margin defined to maintain an up link C/N of 20 dB.

The down link pfd value of -123 dBW/m^2/MHz is slightly less than the base line VSAT system but the up link off axis pfd value is 6 dB higher as a consequence of the large fixed up link margins. If these networks practiced up link adaptive power control, then they could also share with the VSATs every 2 degrees of the arc as the pfd value on the arc would drop to the same or less than the baseline VSAT. With fixed up link margins , a spacing of 4 degrees is required to protect the up link of a VSAT or another large terminal from excessive interference.

4.0 Conclusions

It is feasible and practical to deploy GSO VSATs with antennas as small as 0.7 meter in the bands 29.5-30.0/19.7-20.2 GHz for use as point to point or point to multipoint moderate date rate networks with two degrees spacing along the arc. To realize this high density use, it is necessary for each network to conform to these two technical guidelines.

- Power Control for Rain
  - Adaptive Power Control on the up link
  - Fixed Power Control on the down link
- Maximum steady state clear air levels
  - Down Link: -122 dBW/m^2/MHz at the earth's surface
  - Up Link pfd at the arc: -147 dBW/$m^2$2/MHz for topocentric angle of 2.2°
    -152 dBW/$m^2$2/MHz for topocentric angle of 4.4°