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

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum and Adopt Service Rules and Procedures to Govern the Use of Vehicle-Mounted Earth Stations in Certain Frequency Bands Allocated to the Fixed-Satellite Service	)	IB Docket No. 07-101

NOTICE OF PROPOSED RULE MAKING

Adopted: May 9, 2007 **Released:** May 15, 2007

Comment Date: 30 days after Federal Register publication
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By the Commission:

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I. INTRODUCTION

1. In this Notice of Proposed Rulemaking ("*Notice*" or "NPRM"), we seek comment on whether to license Vehicle-Mounted Earth Stations ("VMES") as an application of the fixed-satellite service ("FSS") in the conventional and extended Ku-band frequencies.[1] We initiate this NPRM in response to a petition for rulemaking ("Petition") filed by General Dynamics SATCOM Technologies, Inc. ("General Dynamics").[2]

2. General Dynamics asks the Commission to amend Parts 2 and 25 of the rules to allocate spectrum for use with VMES in the FSS in the Ku-band uplink at 14.0-14.5 GHz and Ku-band downlink at 11.7-12.2 GHz on a primary basis, and in the extended Ku-band downlink at 10.95-11.2 GHz and 11.45-11.7 GHz on a non-protected basis, and to adopt Ku-band VMES licensing and service rules modeled on the Commission's rules for Ku-band Earth Stations on Vessels ("ESVs"). General Dynamics asserts that a VMES allocation and regularized service and licensing rules would facilitate the

[1] For purposes of this *Notice*, the "conventional" Ku-band refers to frequencies in the 11.7-12.2 GHz (downlink) and 14.0-14.5 GHz (uplink) bands and excludes the so-called "extended Ku-band" at 12.75-13.25 GHz, 13.75-14.0 GHz, 10.7-10.95 GHz, 10.95-11.2 GHz, 11.2-11.45 GHz, and 11.45-11.7 GHz. The conventional Ku-band frequencies are allocated on a primary basis to the FSS. *See generally* 47 C.F.R. § 2.106. Co-primary systems generally are obligated to coordinate with each other on a first-come, first-served basis, whereas a system operating under a secondary allocation must not give interference to, and must accept interference from, systems operating with primary status. *See* 47 C.F.R. § 2.105(c). The FSS is a radiocommunication service between earth stations at given positions, when one or more satellites are used; the given position may be a specified fixed point or any fixed point within specified areas; in some cases this service includes satellite-to-satellite links, which also may be operated in the inter-satellite service; the FSS also may include feeder links for other space radio-communication services. 47 C.F.R. § 2.1.

[2] Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum in the Ku- and Extended Ku-Bands to the Vehicle Mounted Earth Station Satellite Service ("VMES") on a Shared Primary Basis and to Adopt Licensing and Service Rules for VMES Operations in the Ku- and Extended Ku-Bands, Petition for Rulemaking, RM No. 11336 (filed May 24, 2006).

U.S. military's training needs with respect to advanced VMES technologies and increase the potential that advanced communications capabilities will be made available for various emergency preparedness and commercial purposes where high-bandwidth, mobile communications capabilities are beneficial.[3]

3. We seek to promote innovative and flexible use of satellite technology while ensuring avoidance of interference and efficient use of the spectrum. The primary goal of the NPRM is to develop a record on the capability of VMES terminals, or classes of VMES, to meet the interference avoidance requirements of the Ku-band FSS, such that any VMES rules for the Ku-band frequencies would protect existing FSS operators and their customers from harmful interference. We also seek to promote spectrum sharing with certain secondary operations in these frequency bands, including government space research service ("SRS") and radio astronomy service ("RAS") stations. Finally, we consider licensing methods that may simplify and speed the licensing process for VMES, while addressing our core regulatory concern with avoiding harmful interference.

4. Today, earth stations on mobile vehicles operate as land mobile satellite service ("LMSS") systems in the 14.0-14.5 GHz (Earth-to-space) and 11.7-12.2 GHz (space-to-Earth) bands.[4] LMSS licensees operate on a secondary allocation basis in the uplinks and on a non-conforming basis in the downlink frequencies. Therefore, LMSS licensees must protect primary FSS operations in the Ku-band against interference and cannot claim interference protection from primary FSS licensees. There are no specific service rules for LMSS in the Ku-band. As noted, General Dynamics asks the Commission to allocate the conventional Ku-band to VMES as an application of the FSS on a co-primary basis, similar to the allocation for ESVs that communicate with FSS satellites, and to expand the ESV rules to include VMES. General Dynamics states that its VMES terminals, Satcom-on-the Move™ ("SOTM"), can meet the relevant ESV technical requirements under both on-road and off-road conditions. The NPRM seeks the views of the satellite industry concerning the development of Ku-band FSS licensing and service rules for VMES for applications that also could be viewed as LMSS uses in a predominantly FSS frequency band.

5. Although the impetus behind the Petition is a desire to facilitate the U.S. military's training needs within the United States, the Petition suggests that non-military applications are likely to follow adoption of regularized licensing procedures for VMES.[5] Comments received on the Petition demonstrate that there also is commercial interest in even broader applications of VMES, involving use, by the general public, of ultra-small antennas on cars and trucks. The NPRM observes that these broader applications raise additional technical questions with respect to compliance with the Commission's Ku-band interference avoidance requirements. The NPRM therefore seeks comment on whether the broad commercial use, by the general public, of ultra-small antennas on vehicles traversing throughout the

[3] Petition at ii, 13.

[4] The LMSS is a mobile-satellite service ("MSS") in which mobile earth stations are located on land. 47 C.F.R. § 2.1. The MSS is a radio-communication service between mobile earth stations and one or more space stations, or between space stations used by this service, or between mobile earth stations by means of one or more space stations. 47 C.F.R. § 2.1. A mobile earth station is an earth station intended for use while in motion or during halts at unspecified points. 47 C.F.R. § 25.21. A land mobile earth station is a mobile earth station in the LMSS capable of surface movement within the geographic limits of a country or continent. 47 C.F.R. § 25.201.

[5] Petition at iii-iv, 4, 6-7. The Petition states that VMES is ideally suited for homeland defense and disaster recovery applications to supplement or replace disabled terrestrial communications systems. *Id.* at 6. The Petition also states that permitting broader VMES operations, under carefully prescribed conditions, would make the technology available for commercial uses such as satellite news gathering, weather services, mineral/fossil fuel exploration and extraction, and large-scale construction projects. *Id.* at 7.

United States raises the potential for harmful interference to other FSS licensees or Federal Government SRS and RAS operations, and, if so, whether there are technical rules that the Commission could adopt to mitigate against such harms.

6. As the Petition urges, the NPRM seeks comment on the proposed adoption of a co-primary allocation for VMES applications in the conventional Ku-band frequencies, and also seeks comment on service rules for VMES, possibly modeled on the current ESV rules. The NPRM discusses and seeks comment on rules and procedures to license VMES networks for operation only over geostationary satellite orbit ("GSO") FSS satellites in the Ku-band.

7. The record established in this proceeding will facilitate the development of allocation decisions and of any future rules. If the decision is made to go forward with VMES rules and allocations, we would seek to ensure that VMES terminals operate within the interference avoidance requirements of the Commission's two-degree satellite spacing environment for the Ku-band and not create the potential for undue interference to existing and future FSS operations in the Ku-band FSS frequencies.

II. BACKGROUND

A. Current LMSS/VMES Use

8. Earth stations on mobile vehicles currently operate as LMSS applications in the conventional Ku-band. In 1989, the Commission authorized Qualcomm, Inc. to construct and operate a two-way satellite-based narrowband data communication network of mobile and transportable transmit/receive earth stations and to operate a fixed transmit/receive earth station serving as a hub for the network communicating with FSS satellites in the 12/14 GHz frequencies bands.[6] The Commission noted that the 14.0-14.5 GHz band was allocated domestically and internationally to the LMSS on a secondary basis, and that the 11.7-12.2 GHz frequency band contained no allocation for MSS.[7] The Commission concluded that LMSS was permissible in both the uplink and downlink frequency bands, and permitted Qualcomm, Inc. to operate on a secondary basis in the uplink frequencies and as a non-conforming use in the downlink frequencies.[8] The Commission granted Qualcomm, Inc.'s request for a blanket authorization for over 20,000 technically identical very small antenna mobile earth stations operating in the 12/14 GHz band.[9] Today, the U.S. Table of Frequency Allocations ("U.S. Table" or "Table") more broadly defines the domestic U.S. secondary allocation in the 14.0-14.5 GHz frequency band as covering all MSS.[10] There are pending applications asking the Commission to authorize broadband LMSS earth stations on vehicles as a secondary MSS application in the 14.0-14.5 GHz uplink bands.[11]

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[6] *Qualcomm, Inc., Application for Blanket Authority to Construct and Operate a Network of 12/14 GHz Transmit/Receive Mobile and Transportable Earth Stations and a Hub Earth Station*, Memorandum Opinion, Order and Authorization, FCC 89-24, 4 FCC Rcd 1543 (1989) ("*OmniTracs Licensing Order*").

[7] *OmniTracs Licensing Order*, 4 FCC Rcd at 1543, ¶ 3. Since 1989, the LMSS allocation in the 14.0-14.5 GHz band has been expanded to include all MSS applications. *See* 47 C.F.R. § 2.106.

[8] *OmniTracs Licensing Order*, 4 FCC Rcd at 1544, ¶¶ 11-13.

[9] *OmniTracs Licensing Order*, 4 FCC Rcd at 1545, ¶ 20.

[10] *See* 47 C.F.R. § 2.106.

[11] *See, e.g.*, RaySat, Inc., Application for Authority to Operate 4,000 In-Motion Mobile Satellite Antennas in the 14.0-14.5 GHz and 11.7-12.2 GHz Frequency Bands, File No. SES-LIC-20060629-01083 (filed June 29, 2006) (seeking to use secondary MSS allocation in uplink and requesting waiver of section 2.106 for non-conforming use (continued....)

9. General Dynamics, a manufacturer of satellite earth station equipment, has developed its SOTM system consisting of a fixed earth station serving as one endpoint of a link and various mobile earth stations mounted on combat vehicles, each serving as the other endpoint.[12] The fixed earth station utilizes a standard 2.4 meter or larger earth station antenna that complies with the Commission's regulations and includes standard downlink and uplink equipment with a small, power-controlled transmitter.[13] Each mobile terminal contains a custom-designed, sub-meter diameter, high-performance antenna and tracking system that makes use of both active radio frequency tracking and predictive-tracking technologies that utilize sophisticated inertial navigation systems and Global Positioning Satellite ("GPS") receivers.[14] General Dynamics states that the sub-meter mobile terminals use a "stabilized" antenna mounted on a vehicle such as a military High-Mobility Multipurpose Wheeled Vehicle ("HMMWV") that is capable of both on-road and off-road travel.[15]

10. General Dynamics has been operating the SOTM system since November 24, 2004 pursuant to special temporary authority ("STA") and subsequently-granted regular experimental authority to access the Intelsat 707 satellite at 53° West Longitude ("W.L.").[16] On July 25, 2005, the Commission, on delegated authority, granted General Dynamics an STA to modify its experimental authorization to allow for domestic testing, demonstration, and training operations via six additional satellites from contiguous U.S. locations.[17] On November 21, 2005, General Dynamics received authority to further modify its experimental authorization to operate three additional 2.4 meter hub stations, and to operate smaller 0.45 and 0.50 meter (that is, 17.7 and 19.7 inch diameter, respectively) mobile earth station antennas, in place of the 0.60 meter (23.6 inch) mobile antennas originally used, from all locations in the United States, including Alaska and Hawaii.[18]

B. Petition for Rulemaking

11. The Petition asks the Commission to initiate a rulemaking to amend Parts 2 and 25 of the Commission's rules to allocate spectrum for use with VMES in the FSS in the Ku-band uplink at 14.0-14.5 GHz and Ku-band downlink at 11.7-12.2 GHz on a primary basis, and in the extended Ku-band downlink at 10.95-11.2 GHz and 11.45-11.7 GHz on a non-protected basis, and to adopt licensing and

(Continued from previous page)
in downlink, to provide two-way high-speed data communications, primarily to government and commercial enterprise customers, aboard vehicles in motion).

[12] Petition at 2.

[13] *Id.*

[14] *Id.* The system is designed to ensure a continuously stabilized mobile terminal to deal with the intense gyrations occurring as the vehicles move over rough terrain. The SOTM system uses Time-Division Multiple Access ("TDMA") technology and commercial Ku-band transponders to provide full-duplex, high data rate (tens of Mbps downlink and in excess of two Mbps uplink) communications, including voice and full-motion video, to coverage areas that are large and well defined. *Id.* at 2-3.

[15] Petition at 2-3, 5. The HMMWV is a light, highly mobile, diesel-powered, four-wheel-drive vehicle equipped with an automatic transmission. *See* http://www.army.mil/fact_files_site/hmmwv/index.html.

[16] *See* File Nos. 0640-EX-ST-2004, 0123-EX-PL-2005. *See also* Petition at 3 n.2.

[17] *See* File No. 0390-EX-ST-2005 (authorizing use, in addition to Intelsat 707 at 53° W.L., of the following satellites: AMC-9 at 83° W.L., Horizons 1 at 127° W.L., IA-5 at 97° W.L., IA-6 at 93° W.L., IA-7 at 129° W.L., and IA-8 at 89° W.L.). *See also* Petition at 3 n.3.

[18] *See* File No. 0117-EX-ML-2005. *See also* Petition at 3.

service rules for VMES operations in the Ku-band.[19] General Dynamics asserts that its current experimental authority has permitted the testing and demonstration of the VMES technology but provides insufficient authority to meet the military's requirements for domestic training with SOTM and other VMES technologies that may be acquired.[20] In seeking to expand the ESV regulatory framework to cover VMES, General Dynamics states that the Commission, in developing the rules for ESVs, engaged in a comprehensive study of mobile satellite operations in the Ku-band and adopted carefully prescribed requirements to ensure that ESV operations would adequately protect existing operators in the band from harmful interference.[21] General Dynamics asserts that its SOTM system is able to meet the operational rules applicable to ESVs.[22]

12. On July 20, 2006, the Commission placed the Petition on public notice.[23] Six parties filed comments by the August 21, 2006 comment date.[24] General Dynamics filed a reply by the September 5, 2006 reply due date.[25] Following the formal comment cycle, the Commission received additional pleadings.[26] On November 21 and December 18, 2006, General Dynamics filed responses to an information request from the International Bureau.[27]

[19] Petition at 15.

[20] Petition at ii-iii, 10-11.

[21] Petition at iii, 11.

[22] Petition at 11.

[23] Public Notice, Report No. 2780, Consumer & Governmental Affairs Bureau, Reference Information Center, Petition for Rulemakings Filed, RM No. 11336 (July 20, 2006).

[24] Comments of AvL Technologies Incorporated, RM No. 11336 (filed Aug. 21, 2006) ("AvL"); Comments of Maritime Telecommunications Network, Inc., RM No. 11336 (filed Aug. 21, 2006) ("MTN"); Comments of QUALCOMM Incorporated, RM No. 11336 (filed Aug. 21, 2006) ("Qualcomm"); Comments of the Satellite Industry Association, RM No. 11336 (filed Aug. 21, 2006) ("SIA"); Comments of SES Americom, Inc. and Americom Government Services, RM No. 11336 (Aug. 21, 2006) ("SES Americom"); Comments of ViaSat, Inc., RM No. 11336 (filed Aug. 21, 2006) ("ViaSat").

[25] Reply Comments of General Dynamics Corporation, RM No. 11336 (filed Sept. 5, 2006).

[26] Letter from Andrew D. Cotlar, Associate General Counsel, Association of Public Television Stations, to Marlene H. Dortch, Secretary, Federal Communications Commission, RM No. 11336 (filed Sept. 7, 2006) ("Request to Accept Late-Filed Comments"), attaching Letter from Lonna M. Thompson, Vice President and General Counsel, and Andrew D. Cotlar, Associate General Counsel, Association of Public Television Stations, and Katherine Lauderdale, Senior Vice President and General Counsel, Public Broadcasting Service, to Julius P. Knapp, Deputy Chief, Office of Engineering and Technology, Federal Communications Commission, RM No. 11336 (filed Sept. 7, 2006) ("APTS"); *see also* Letter from McLean Sieverding, Counsel for General Dynamics Corporation, to Marlene H. Dortch, Secretary, Federal Communications Commission (filed Nov. 14, 2006); Letter from McLean Sieverding, Counsel for General Dynamics Corporation, to Marlene H. Dortch, Secretary, Federal Communications Commission (filed Jan. 30, 2007). We grant the Request to Accept Late-Filed Comments and therefore accept the APTS pleading into the record.

[27] Letter from McLean Sieverding, Counsel for General Dynamics Corporation, to Marlene H. Dortch, Secretary, Federal Communications Commission (filed Nov. 21, 2006) ("November 21 Response to Information Request"); Letter from McLean Sieverding, Counsel for General Dynamics Corporation, to Marlene H. Dortch, Secretary, Federal Communications Commission (filed Dec. 18, 2006) ("December 18 Response to Information Request").

C. Related Proceedings

13. The issues raised in the Petition are interrelated with four other pending proceedings, three that address service and licensing rules for earth stations in the Ku-band FSS frequencies, and one that addresses the broader question of Federal government use of non-Federal spectrum.[28] In the Discussion section, below, the NPRM seeks comment on how these proceedings might be relevant to rules for VMES.

III. DISCUSSION

14. As noted, the Petition asks the Commission to initiate a rulemaking to amend Parts 2 and 25 of the Commission's rules to allocate spectrum for use with VMES terminals in the FSS in the Ku-band uplink at 14.0-14.5 GHz and Ku-band downlink at 11.7-12.2 GHz on a primary basis, and in the extended Ku-band downlink at 10.95-11.2 GHz and 11.45-11.7 GHz on a non-protected basis, and to adopt licensing and service rules for VMES operations in the Ku-band.[29] General Dynamics asks the Commission to add the following footnotes to the U.S. Table:

> NGXXX: In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), Vehicle Mounted Earth Stations (VMESs) are an application of the fixed-satellite service (FSS) and may be authorized to communicate with space stations of the FSS on a primary basis.
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> NGXXX: In the bands 10.95-11.2 GHz and 11.45-11.7 GHz, Vehicle Mounted Earth Stations (VMESs) may be authorized to communicate with U.S. earth stations through space stations of the fixed satellite service but must accept interference from terrestrial systems operating in accordance with the Commission's Rules.[30]

15. We ask for comment on the allocations requested by General Dynamics, that is, a primary allocation in the conventional Ku-band that would be modeled on the existing primary allocation for

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[28] *See Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service*, IB Docket No. 05-20, Notice of Proposed Rulemaking, FCC 05-14, 20 FCC Rcd 2906 (2005) ("*AMSS NPRM*") (proposing service rules and procedures for Aeronautical Mobile Satellite Service ("AMSS") systems communicating with FSS networks in the Ku-band); *Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands*, IB Docket No. 02-10, Report and Order, FCC 04-286, 20 FCC Rcd 674 (2005) ("*ESV Report and Order*") (petitions pending for reconsideration/clarification of ESV rules); *2000 Biennial Regulatory Review – Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by, Satellite Network Earth Stations and Space Stations*, IB Docket No. 00-248, Sixth Report and Order and Third Further Notice of Proposed Rulemaking, FCC 05-62, 20 FCC Rcd 5593 (2005) ("*Sixth Report and Order and Third Further Notice*") (proposing off-axis power-density envelopes for the FSS); Amendment to the National Table of Frequency Allocations to Provide Allocation Status for Federal Earth Stations Communicating with Non-Federal Satellites, Petition for Rulemaking of the National Telecommunications and Information Administration, RM-11341 (filed Aug. 4, 2006) ("NTIA Petition") (seeking primary status protection for some Federal government earth stations communicating with non-Federal satellites in several frequency bands, including the FSS Ku-bands) ; *see also* Public Notice, Consumer & Governmental Affairs Bureau, Reference Information Center, Petition for Rulemakings Filed, Report No. 2789 (Aug. 17, 2006) (placing NTIA Petition on public notice).

[29] Petition at 15. Part 2 of the rules includes the U.S. Table. *See* 47. C.F.R. § 2.106. Part 25 sets out the Commission's rules for the licensing of FSS earth and space stations. *See* 47 C.F.R. Part 25.

[30] Petition at 10.

ESVs. A primary allocation for VMES would provide protection from interference to VMES terminals, which are land-mobile and not fixed in nature, as well as give VMES equal status in coordinating emissions from VMES terminals with adjacent FSS systems, as if VMES terminals were FSS earth stations. Based on the comments received on the Petition, it is clear that certain commenters would propose to promote VMES terminals that use smaller antennas and less accurate antenna pointing systems than those that General Dynamics uses for its SOTM system. We have concerns that some classes of proposed VMES terminals would not operate compatibly in the Commission's Ku-band two-degree spacing environment for the FSS. We seek comment on how to differentiate compatible and non-compatible VMES terminals. In addition, certain applicants for systems providing earth stations on mobile vehicles may not be able to meet the VMES requirements that we would adopt, but otherwise might be able to engineer their systems to meet the Ku-band FSS interference avoidance requirements. We invite comment on whether we should, in that case, treat these as applications for LMSS systems and license them under the existing secondary LMSS allocation in the 14.0-14.5 GHz FSS uplink band and as non-conforming in the 11.7-12.2 GHz FSS downlink band, with specific license conditions to protect FSS licensees and their customers from harmful interference.[31] Should the Commission conclude that an applicant's proposal would not protect incumbent FSS operations or Federal Government SRS and RAS operations from harmful interference, the Commission may deny the application as ineligible for either primary FSS or secondary MSS.

16. We also seek comment on licensing and service rules for operating VMES terminals if they are granted primary allocation status. The Petition asks the Commission to extend the ESV Ku-band service and licensing rules to VMES by simply modifying section 25.222 to include "and [/or] VMES" after each reference to ESVs. Commenters on the Petition seek modifications to the technical requirements of section 25.222, as applied to VMES. We seek comment on the proposed set of rules set out in Appendix B to this NPRM. Additionally, we seek comment on the modifications proposed by commenters to the Petition. As discussed below, we view Appendix B as a starting point for developing VMES rules that would be designed to protect FSS systems or Federal Government SRS and RAS operations from harmful interference.

17. Authorizing VMES terminals in the Ku-band presents the challenge of protecting primary status FSS satellites from potential harmful interference. We intend that, if adopted, such a licensing program would support the deployment of VMES terminals to the benefit of the U.S. public while ensuring that existing FSS services are protected against harmful interference. At the same time, we need to ensure that providing protection to the VMES on a primary basis will not create an undue burden on existing FSS systems.[32] To that end, we seek comment from individual operators of incumbent radio

[31] This alternative assumes that the LMSS operator provides a technical study demonstrating that the proposed system could protect other FSS licensees and their customers from harmful interference through other means. We also note that the Petition seeks a proposed regulatory framework for VMES only to test and train U.S. military personnel on VMES technologies within the United States, with the intent that the U.S. military's operational use of VMES would occur outside of the United States and subject to regulations issued by the relevant administration. November 21 Response to Information Request Attachment at 4-6. We ask whether the availability of secondary status and non-conforming use licenses, STAs, or experimental licensing for domestic testing and training activities within the United States might permit General Dynamics to develop the type of record it anticipates it will need to demonstrate to other administrations, at some future point, the compatibility of VMES operations with other existing Ku-band FSS uses. *See id.* at 5-6.

[32] The use of ultra-small antennas, as proposed by some commenters, would reduce the available antenna gain isolation in the direction of other FSS satellite systems, potentially increasing the VMES interference vulnerability. Therefore, incumbent and future FSS systems would be in the position of having to provide protection to VMES antennas that are more susceptible to interference than traditional FSS antennas.

services in the Ku-band, including both Federal and non-Federal users. We request comments on the proposals addressed in this *Notice*. Further, we encourage all commenters to address any other issues concerning VMES operations in the Ku-band. The record established in this proceeding will allow the Commission to determine the impact of modifying the conventional Ku-band FSS allocations, authorizing VMES terminals, and facilitating the development of any future rules. Establishing a licensing procedure for VMES could advance our continuing effort to maximize the flexible use of the radiofrequency spectrum for earth station operations.[33]

A. Basis for VMES Operations and U.S. Table of Frequency Allocations Issues in the Ku-Band

18. Earth stations on mobile vehicles communicating with Ku-band FSS space stations historically have been licensed as LMSS systems; that is, as MSS systems with earth stations that are located on land.[34] General Dynamics proposes, instead, to treat these systems as an application of the Ku-band FSS. That is, the earth stations would communicate with Ku-band FSS satellites, receive primary protection against interference in the Ku-band, and have status allowing them to contribute to the noise received by nearby FSS satellites, as if they were traditional FSS earth stations. The Petition asks the Commission to treat VMES as co-primary in the Ku-band under the assumption that VMES terminals can meet the ESV technical rules, as applied to VMES.[35] We disagree that the ability of new mobile services to meet the ESV rules necessarily would require the Commission to grant the new mobile services the same primary status. A central question to be asked in the NPRM is whether the VMES should be granted primary status in the Ku-band FSS. As discussed below, General Dynamics asserts that VMES terminals are similar to ESVs and therefore merit primary status. However, there are significant differences between VMES (or, at least, some classes of VMES) and ESVs. At the same time, the lack of co-primary shared services in the conventional Ku-band could permit the Commission to consider associating VMES with the primary FSS service and provide VMES with the allocation status requested by General Dynamics, without the complicating requirements needed to protect primary non-

[33] *See Principles for Reallocation of Spectrum to Encourage the Development of Telecommunications Technologies for the New Millennium,* Policy Statement, FCC 99-354, 14 FCC Rcd 19868, 19870, ¶ 9 (1999) ("In the majority of cases," the Commission noted in 1999, "efficient spectrum markets will lead to use of spectrum for the highest value end use" and "[f]lexible allocations may result in more efficient spectrum markets."). *See also Amendment of the U.S. Table of Frequency Allocations to Designate the 2500-2520/2670-2690 MHz Frequency Bands for the Mobile-Satellite Service*, First Report and Order and Memorandum Opinion and Order, FCC 01-256, 16 FCC Rcd 17222, 17223, ¶ 2 (2001) (finding that investing incumbent licensees with more flexibility in the use of their assigned spectrum would foster the introduction of new services, promote competition, and permit market forces to determine the best use for the spectrum).

[34] 47 C.F.R. § 2.1 (defining MSS and LMSS).

[35] The Commission previously has authorized various mobile systems to operate with FSS space stations in the Ku-band. In doing so, the Commission has required that the various mobile systems meet the interference avoidance requirements applicable to the FSS, just as VSATs and other traditional FSS systems must avoid interference. For example, in 2005, the Commission authorized ESVs, establishing operational rules that are consistent with the VSAT rules and granting ESVs primary protection in the Ku-band FSS. The Commission added a footnote to the U.S. Table to recognize the allocation status of ESV systems as a mobile application of the FSS in both the 14.0-14.5 GHz uplink and 11.7-12.2 GHz downlink frequencies. 47 C.F.R. § 2.106 Footnote NG183 ("In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), earth stations on vessels are an application of the fixed-satellite service (FSS) and may be authorized to communicate with space stations of the FSS on a primary basis."). Additionally, the Commission has licensed individual AMSS and LMSS systems to operate in the Ku-band FSS. These individual systems operate with non-conforming use licenses that require them to protect primary Ku-band FSS licensees.

FSS systems. We seek comment and advice from the FSS industry on granting primary status to VMES. If VMES is granted primary status, the FSS industry will have to accept the increased noise-power from the VMES, as if VMES terminals were FSS earth stations, and will have to provide primary status protection to the VMES. At the same time, the FSS industry might benefit by supplying satellite capacity, services and equipment to VMES systems. The FSS industry therefore is in a good position to provide comment on the various tradeoffs resulting from a grant of primary status to VMES as an application of the FSS.

19. In asking for comment on whether we should grant primary status to VMES, or classes of VMES, in the conventional Ku-band, we observe that VMES, like ESV, is a mobile system, but with significant differences. We seek comment on these differences in the context of evaluating whether VMES, or classes of VMES, can operate compatibly in the FSS two-degree spacing environment. The significant identified differences include:

- Antenna Size. The Petition suggests that, although General Dynamics proposes to provide VMES for U.S. military applications, there will be commercial applications for this technology.[36] Commenters suggest that the Commission should develop rules that would permit large-scale deployment of mobile broadband systems to the public using ultra-small antennas.[37] Both military and commercial VMES applications would use antennas smaller than those typically found on VSATs or ESVs.[38] The original two-degree FSS VSAT interference rules were predicated on the use of antennas with a diameter of 1.2 meters or greater (*i.e.*, 3.9 feet or larger), operating from fixed locations. ESVs typically use antennas with a diameter on the order of 1.2 meters. General Dynamics currently is using antennas as small as 0.45 meters (17.7 inches) and supporters of the commercial applications of VMES are in favor of licensing even smaller antennas. The ultra-small antennas operating in a mobile environment envisioned for large-scale commercial deployment of VMES have a greater potential of causing interference to adjacent satellites than the antennas currently authorized for the band and would lack the interference rejection qualities of the larger antennas.

- Antenna Tracking Systems. ESV operators are required to use antenna systems that accurately track the wanted satellite as the ship moves, pitches and rolls. General Dynamics uses very precise, and very expensive, tracking systems for its military VMES antennas. Some proponents of commercial applications would lower the pointing accuracy requirements for VMES, resulting in lower-cost tracking systems and, potentially, increasing the level of interference to other FSS satellites.

- Ubiquity. ESVs are likely to be used only by relatively large vessels, capable of carrying the large ESV dishes, and are geographically limited to operating on waterways and in port. VMESs have been placed on vehicles capable of off-road travel and would have access to practically all of the United States.

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[36] Petition at 6-7; November 21 Response to Information Request Attachment at 6-7.

[37] *See, e.g.*, ViaSat at 3 (urging the Commission to propose rules that would allow the operation of small, low-profile antennas that consumers affordably could install on standard vehicles) and at 9 (stating that commercial success depends in part on ability to use small, low-profile antennas mountable on standard cars and trucks).

[38] A "VSAT," or very small aperture terminal, is a two-way satellite earth station with an antenna that is smaller than 3 meters in diameter. VSATs most commonly are used to transmit credit card or other data for point-of-sale transactions and to provide satellite Internet access to remote locations.

- Tracking Accuracy. Because of the size of the vessels on which ESVs are mounted, ESVs undergo smaller accelerations than earth stations on mobile vehicles, making it easier for the ESV antenna tracking system to track the wanted satellite. In fact, General Dynamics concedes that it is impossible to construct a VMES antenna tracking system that will meet the 0.2 degree antenna pointing requirement under all possible conditions.[39]

- Quantity. If applications of VMES are permitted for use by the general public, the number of VMES terminals that potentially could be operated is significantly larger than the number of ESV systems.

We seek comment on the relevance of these differences between VMESs and ESVs to the question of whether we should grant primary status for VMES as an application of the FSS. Additionally, we ask commenters to consider other factors, not listed, that may be relevant.

20. As stated above, if the Commission grants primary status to VMES, existing FSS systems will be required to accept the increased noise-power from VMES, as if VMES terminals were traditional FSS earth stations, and will be required to provide primary status protection to VMES. At the same time, the FSS industry may benefit by supplying satellite capacity, services and equipment to VMES systems. The FSS industry therefore is in a good position to provide comment on the pros and cons of associating VMES with FSS and providing primary status to VMES, or any given class of VMES. We therefore seek comment on General Dynamics' proposal to grant VMES primary allocation status by making VMES an application of the FSS.

21. We note that there is international recognition for MSS, including LMSS, as a secondary allocation in the 14.0-14.5 GHz band, as well as international recognition for ESVs as a primary service and AMSS as a secondary service.[40] We observe that there currently is no comparable international

[39] December 21 Response to Information Request Attachment at 9 (stating that "The design of a VMES terminal that could accurately track the desired satellite under any and all conditions would result in a terminal that is both too heavy and too expensive for virtually any user." and "General Dynamics has demonstrated that it is possible for the VMES antenna to be unable to move "fast enough" to satisfy extreme environments. Fortunately, we have also demonstrated that our transmitter mute function performs well enough to eliminate potential interference effects.").

[40] The Commission adopted a primary allocation for ESVs in an order released early in 2005, by adding footnotes to the U.S. Table to recognize ESVs as an application of the FSS with primary status. *ESV Report and Order*, 20 FCC Rcd at 676, ¶ 3. In doing so, the Commission implemented, in part, the decision reached at the 2003 World Radiocommunications Conference ("WRC-03") of the International Telecommunications Union ("ITU"), which had added a footnote to the International Table of Frequency Allocations stating that, among other things, ESVs may communicate with FSS space stations in the 14.0-14.5 GHz bands. *See ESV Report and Order*, 20 FCC Rcd at 676, ¶ 3. WRC-03 also added a worldwide secondary AMSS allocation in the 14.0-14.5 GHz band used for satellite uplinks. *See Final Acts WRC-03 World Radiocommunication Conference* (Geneva, 2003) at 34-38; *see also* 47 C.F.R. § 2.106 Footnote 5.504A. AMSS is a component of the MSS. 47 C.F.R. § 2.1. In 2003, the Commission conformed the U.S. Table to the international allocation. *Amendment of Parts 2, 25, and 87 of the Commission's Rules to Implement Decisions from the World Radiocommunication Conferences Concerning Frequency Bands Between 28 MHz and 36 GHz and to Otherwise Update the Rules in this Frequency Range*, ET Docket No. 02-305, Report and Order, FCC 03-269, 18 FCC Rcd 23426, 23454, ¶ 76 (2003) ("*Above 28 MHz Order*") (adopting secondary allocation for MSS, including LMSS and AMSS, in 14.0-14.5 GHz band). *See also* 47 C.F.R § 2.106 Footnotes 5.504A, 5.504B, 5.504C and 5.509A (international footnotes stating, among other things, that, in the band 14.0-14.5 GHz, aircraft earth stations in the secondary AMSS also may communicate with space stations in the FSS). In 2005, the Commission proposed to adopt a footnote to the U.S. Table to make aircraft earth stations in the AMSS an (continued....)

recognition in the conventional Ku-band for VMES as an FSS application.[41] General Dynamics states that it would be impractical to gain ITU recognition for VMES before operating such terminals within the United States under Commission regulation.[42] Further, General Dynamics states its belief that implementation of broader, international VMES rules will be easier to accomplish after other administrations recognize the compatibility of VMES with other existing FSS Ku-band users.[43] Additionally, General Dynamics states that it anticipates that VMES operations abroad, unlike ESVs operating on the high seas, will require a form of licensing pertinent to the administration with jurisdiction over the foreign soil on which the terminals would operate.[44] As General Dynamics asserts, international recognition may be less relevant for VMES operating solely within the United States than for ESV and AMSS systems, which, once licensed by the Commission, operate both domestically and internationally. In this regard, we note the current international allocation for MSS, including LMSS, at 14.0-14.5 GHz. Further, we note that, even in the absence of ITU agreement on a VMES allocation, we would design any proposed VMES rules to ensure that other countries' communications systems would not receive interference from VMES terminals operating within the United States. We seek comment on this analysis and ask for comment on the relevance, if any, of the current international recognition of LMSS, ESV, and AMSS to our consideration of a domestic allocation status for VMES.

22. The majority of commenters support General Dynamics' request to initiate a rulemaking proceeding.[45] SES Americom, a supplier of Ku-band satellite transponder capacity, states that it has been

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application of the FSS on a secondary basis in the 11.7-12.2 GHz and 14.0-14.5 GHz bands, except that reception from GSO space stations in the FSS in the 11.7-12.2 GHz band would be protected in the United States on a primary basis, provided that the aircraft earth stations operated under the same parameters as earth stations in the FSS. *See AMSS NPRM*, 20 FCC Rcd at 2924, ¶ 31. At this time, the proposal remains pending.

[41] Additionally, despite the general international acceptance of ESVs, several administrations currently do not recognize ESVs, much less VMES, because they have allocated the 14.0-14.5 GHz band to the Fixed Service ("FS") on a primary basis. *See* 47 C.F.R. § 2.106 Footnotes 5.505, 5.508. Other administrations treat ESVs as secondary mobile systems in the MSS. *See* 47 C.F.R. § 2.106 Footnote 5.457B.

[42] November 21 Response to Information Request Attachment at 5. General Dynamics states that its proposal is intended to urge the Commission to provide a regularized licensing mechanism and service rules for VMES operations within the territory regulated by the Commission, through technical standards that render VMES terminal transmissions no different than those of ESVs, VSATs, and other FSS Ku-band terminals. *Id.* at 5-6.

[43] *Id.* at 6.

[44] *Id.* at 4. General Dynamics states that it has supplied SOTM terminals to ND-Satcom, a German satellite communications modem and system manufacturer and integrator, which in turn has supplied these systems to the German army. It states that the German administration has licensed the terminals and that the terminals currently are in operation in Germany. November 21 Response to Information Request Attachment at 5.

[45] Some commenters offer strong support. *See, e.g.*, SES Americom at 2 (strongly supporting the General Dynamics proposal); ViaSat at 1 (ViaSat has strong interest in proceeding because it is developing antenna and modulation technology for high-speed data communications in moving vehicles). Other commenters support the proposal if properly implemented. SIA, for example, supports the initiation of a rulemaking proceeding to address the orderly implementation and use of earth stations on moving land-based platforms, noting that, if properly implemented, such expanded use of the FSS will promote spectrum efficiency, improved access to spectrum by services with mutually compatible technical characteristics, and expanded broadband deployment. SIA at 3, 6. *See also* MTN at 2-3 (supporting rulemaking on implementation and use of earth stations on moving vehicles and land-based platforms; if properly implemented, expanded use of the FSS will promote spectrum efficiency, improve access to spectrum by services with mutually compatible technical characteristics, and contribute to broadband deployment); Qualcomm at 2 (as a general matter and as discussed in its comments, Qualcomm supports the Petition and believes that its adoption will promote greater flexibility in spectrum use). *See also* AvL at 1 (unpaginated) (General Dynamics' (continued....)

approached by other prospective providers of new terrestrial-based mobile satellite services, confirming *"strong and growing" customer interest in the provision of terrestrial mobile communications using the* FSS.[46] SES Americom says that these prospective providers recognize that satellite-based broadband service to vehicles can meet important communications requirements such as supplying mobile broadband service immediately to the public safety community in a time of crisis when terrestrial service may not be available.[47] SES Americom asserts that satellites are not likely to be an efficient solution where terrestrial mobile broadband is available.[48] At the same time, SES Americom states that the Commission should ensure that mobile service is available to governmental and commercial users where terrestrial service cannot reasonably be deployed, or where terrestrial service temporarily is unavailable due to natural disaster, terrorist attack, or other catastrophic event.[49] ViaSat adds that an allocation consistent with ESV would ensure access to multiple satellites and facilitate interoperability among ESV, VMES, VSAT and other FSS services having a primary allocation and that this primary allocation would provide the interference protection that ViaSat claims is needed to satisfy the growing demand for two-way broadband for vehicles in motion.[50]

23. Finally, as noted above, if the Commission concludes that the terminals proposed by VMES applicants (or subclasses of the proposed terminals) might not be able to meet the ESV rules, or modifications of the ESV rules, as modified for VMES, the Commission could continue to grant individual licenses to LMSS operators. Such licenses would need to contain appropriate technical conditions to ensure that the licensed systems were compliant with the FSS interference avoidance environment. The Commission could license such LMSS systems under the existing secondary MSS allocation in the 14.0-14.5 GHz uplink band. Of course, if the Commission concludes that the terminals proposed by a VMES applicant (or subclasses of the proposed terminals) would not meet the VMES rules or otherwise protect incumbent FSS operations from harmful interference, the Commission may refuse to license the proposed system as either primary FSS or secondary LMSS. We ask for comment on the regulatory treatment of VMES. We do not think it is useful or necessary to adopt Qualcomm's suggestion that we allocate the conventional Ku-bands to VMES as an MSS on a primary basis; that is, by upgrading the secondary MSS allocation in the 14.0-14.5 GHz band to primary and adding a co-primary allocation for VMES as an MSS in the 11.7-12.2 GHz band.[51] This is because, with a decision to

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request to apply ESV rules to VMES is logical, technically sound, and in best interest of satellite communications industry). *But see* APTS at 2-3 (APTS and Public Broadcasting Service voice concern that expanding limited military use of conventional and extended Ku-bands for VMES might create harmful interference that could affect their members' ability to deliver noncommercial educational programming using these bands).

[46] SES Americom at 4. *See also* ViaSat at 2 (stating that ViaSat has interests in both governmental and commercial applications and urging Commission to consider importance of commercial deployment in addition to U.S. military and governmental uses.

[47] SES Americom at 4. *See also* SIA at 5 (agreeing that potential commercial uses would include homeland security/national defense and disaster recovery to supplement or replace disabled terrestrial systems, satellite news gathering and weather services, mineral/fossil fuel exploration and extraction, and large-scale constructions projects, citing to Petition at 6-7); MTN at 3 (same).

[48] SES Americom at 4.

[49] SES Americom at 4.

[50] ViaSat at 4.

[51] *See* Qualcomm at 3, 5. With respect to the extended Ku-bands, 10.95-11.2 GHz and 11.45-11.7 GHz, Qualcomm observes that the FSS allocation currently is shared on a co-primary basis with the FS, requiring coordination among these stations. Qualcomm asserts that, as VMES is mobile, it is possible for VMES to receive interference from fixed, point-to-point microwave systems. Qualcomm at 3. Because of these difficulties, Qualcomm concurs that (continued....)

permit VMES to operate as a primary service with FSS satellites in the Ku-band, we would propose to add a footnote that, similar to that adopted for ESVs, would make VMES an application of the FSS with primary status, and thus a co-primary status for VMES as an MSS system would be unnecessary. We seek comment on this analysis.[52]

1. Ku-band Downlink: 11.7-12.2 GHz Band, and 10.95-11.2 GHz and 11.45-11.7 GHz Bands

24. The allocations and operating conditions for portions of the Ku-band downlink spectrum differ based on several factors, including the fact that non-Federal and Federal facilities currently operate in portions of the Ku-band downlink frequencies. We discuss each band separately below.

a. 11.7-12.2 GHz Band

25. The 11.7-12.2 GHz band is allocated to the FSS for downlink operations on a primary basis and is used extensively for VSAT downlinks.[53] In the *ESV Report and Order*, we added a footnote to the U.S. Table stating that ESVs are an application of the FSS in the 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space) bands.[54]

26. There is no U.S. Table allocation for MSS, including LMSS and AMSS, in the 11.7-12.2 GHz downlink band.[55] As noted, in 1989 the Commission licensed Qualcomm, Inc. to operate a

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VMES operations in the extended Ku-bands must be secondary in nature and in accordance with footnote NG182, developed for ESVs. *Qualcomm* at 3 (noting consistency, in this regard, with the Petition). *See also* 47 C.F.R. § 2.106 Footnote NG182. Qualcomm also believes that any rulemaking should be applied equally to both the Federal and non-Federal portions of the U.S. Table. Qualcomm at 3. Including co-primary MSS allocations, as Qualcomm suggests, in both the Federal and non-Federal portions of the U.S. Table would open the commercial Ku-band FSS frequencies to use by Federal government agencies with primary allocation status. This is a subject that is broader in scope than the General Dynamics Petition. *See, e.g.*, NTIA Petition, RM-11341, *supra* note 28.

[52] We also note that, in a recent petition, NTIA is seeking to authorize, on a primary, protected basis, some Federal government earth stations that communicate with non-Federal satellites in several frequency bands, including the FSS Ku-bands. NTIA Petition at 1-2. Because Federal earth stations operating with non-Federal satellites generally operate on a non-interference basis, and Federal policy promotes the use of commercial communication satellite systems, the NTIA Petition seeks to promote greater Federal use of non-Federal satellites. Because the Commission will address the NTIA Petition separately, we ask, for present purposes, that commenters only address those effects that they would envision that a grant of the NTIA Petition might have on the General Dynamics proposal to adopt an allocation and licensing scheme for VMES.

[53] *See* 47 C.F.R. § 2.106.

[54] *ESV Report and Order*, 20 FCC Rcd at 706, ¶ 79. In the *ESV Report and Order*, we also removed a mobile (except aeronautical mobile) allocation under which the Commission had licensed Local Television Transmission Service ("LTTS"). *ESV Report and Order*, 20 FCC Rcd at 709-710, ¶¶ 82-84. As of March 1, 2005, we no longer consider LTTS license applications for the 11.7-12.2 GHz band, although we did "grandfather" pre-existing LTTS licensees to operate as a secondary mobile service in the 11.7-12.2 GHz band with the understanding that there will be no expectation of renewal. *ESV Report and Order*, 20 FCC Rcd at 710, ¶ 84.

[55] Qualcomm notes that MSS is allocated in the 14.0-14.5 GHz FSS uplink but that the corresponding downlink, in the 11.7-12.2 GHz band, needed for two-way communications, does not contain an MSS allocation. Qualcomm at 3. The lack of an MSS allocation, according to Qualcomm, requires that applicants seek a waiver of the Commission's rules, which, Qualcomm states, adds uncertainty and risk to the launch of commercial mobile operations. Qualcomm at 3. As noted above, Qualcomm suggests that the Commission treat VMES as an MSS and add an MSS allocation to the 11.7-12.2 GHz FSS downlink band. Qualcomm at 3. Qualcomm asserts that ESV terminals and mobile earth (continued....)

narrowband land mobile service on a non-conforming basis in the 11.7-12.2 GHz FSS downlink.[56] In the *AMSS NPRM*, the Commission proposes to establish a new non-Federal footnote for the 11.7-12.2 GHz band to indicate that Aeronautical Earth Station ("AES") terminals in the AMSS may operate with FSS space stations, so that parties will be aware that mobile receivers might be operating in the band.[57] Currently, domestic downlink signals operate under ITU Radio Regulation 4.4 in the 11/12 GHz band.[58]

27. We seek comment on whether to establish a new non-Federal footnote for the 11.7-12.2 GHz band to reflect that VMES terminals may operate with FSS space stations. We believe our rules should reflect clearly the various types of operations that use a spectrum band.

b. 10.95-11.2 GHz and 11.45-11.7 GHz Bands

28. The frequency band 10.7-11.7 GHz is allocated internationally for FSS on a primary basis. Within the United States, this band is referred to as the "extended" Ku-band,[59] and FSS use of this band is reserved for international systems by footnote NG104.[60] In the United States, these bands also are used by the FS for LTTS, Microwave Business, Microwave Public Safety, and Common Carrier Fixed Point-to-Point. Our regulatory treatment of ESVs in these bands requires ESV operators to accept interference from all current and future FS operations in these bands.[61] Within the United States, we do not anticipate that unprotected receive-only operations in the extended Ku-band would interfere with or restrict other authorized operations in the band.[62] We seek comment on whether VMES operations in the 10.95-11.2 GHz and 11.45-11.7 GHz bands should be permitted on a non-protected basis with respect to the FS.

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stations are indistinguishable to satellite networks, yet ESVs are licensed expeditiously and afforded co-primary status in the U.S. Table. Qualcomm at 3. We note that the ESV footnote allocations were modeled after the international footnotes developed at WRC-03. *See* ITU-R Footnote 5.457A ("In the bands 5 925-6 425 MHz and 14-14.5 GHz, earth stations located on board vessels may communicate with space stations of the fixed-satellite service. Such use shall be in accordance with Resolution 902.").

[56] *See supra* note 6.

[57] *AMSS NPRM*, 20 FCC Rcd at 2915, ¶ 15. As noted, current AMSS operations in the 11.7-12.2 GHz FSS band are on a non-conforming use basis pursuant to grant of a rule waiver. *AMSS NPRM*, 20 FCC Rcd at 2910-11, ¶ 5.

[58] *See* ITU Radio Regulation 4.4, which permits operation in any band on a non-interference and non-protection basis. The full text of ITU Radio Regulation 4.4 reads as follows: "Administrations of the Member States shall not assign a station to any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations."

[59] Within the "extended" Ku-band downlink, the 10.7-10.95 GHz and 11.2-11.45 GHz bands are authorized for use in accordance with ITU-R Appendix 30 B, which provides for the planned use of the GSO FSS. The rules we propose today only would apply to extended Ku-band downlink operations at 10.95-11.2 GHz and 11.45-11.7 GHz.

[60] *See* 47 C.F.R. § 2.106 Footnote NG104, which states that "[t]he use of the bands 10.7-11.7 GHz (space to Earth)...by the fixed satellite service in the geostationary-satellite orbit shall be limited to international systems, *i.e.*, other than domestic systems."

[61] *ESV Report and Order*, 20 FCC Rcd at 710, ¶ 86.

[62] VMESs, like ESVs, would use these portions of the Ku-band for reception only. *See ESV Report and Order*, 20 FCC Rcd at 710, ¶ 86. Because Ku-band ESV downlink operations will not interfere with current or future FS operations, and because ESVs will not receive protection from the FS in these bands, the Commission determined (continued....)

2. Ku-Band Uplink: 14.0-14.5 GHz Band

29. The U.S. Table for the 14.0-14.5 GHz band includes a primary allocation for non-Federal FSS uplink operations.[63] This band is used heavily by VSATs for uplinking to geostationary satellites. A single GSO FSS authorization can cover several thousand VSAT earth station terminals, which provide video and data communications and are widely deployed at business locations, ranging from the largest corporate headquarters to the smallest convenience stores. In 2001, the Commission also permitted non-geostationary orbit ("NGSO") FSS gateway and user terminal uplinks to operate in the 14.0-14.5 GHz band.[64] The 14.0-14.5 GHz band also is allocated for MSS uplinks on a secondary basis for non-Federal use.[65] As noted, this MSS allocation presently is used by OmniTracs, a satellite-based land mobile communications and tracking system that provides real-time messaging and position reporting between trucking fleets and their operations centers.[66] As noted above, the *ESV Report and Order* added a footnote to the U.S. Table stating that ESVs are an application of the FSS in the 14.0-14.5 GHz band (for satellite uplinks).[67] The ITU, at WRC-03, recognized that the use of the 14.0-14.5 GHz band for AMSS on a secondary basis is compatible with current FSS systems, and the *AMSS NPRM* proposes to add a footnote making AMSS an application of the FSS.[68] There are no primary FS allocations in any portion of the 14.0-14.5 GHz band.

30. A proposal to recognize VMES as a functional equivalent of conventional FSS operations in the 14.0-14.5 GHz band would rely on our two-degree spacing policy to protect existing and future FSS operations from harmful interference.[69] Accordingly, recognition of VMES as an FSS application would

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that the intent of NG104 would not be undermined by allowing ESVs to operate domestically in these bands. *Id.* at 711, ¶ 86. We would propose to make the same determination with respect to VMESs operating domestically in these bands.

[63] 47 C.F.R. § 2.106.

[64] *See Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, ET Docket No. 98-206, First Report and Order and Further Notice of Proposed Rule Making, FCC 00-418, 16 FCC Rcd 4096 (2000). The Commission, on delegated authority, recently authorized an NGSO applicant to construct, but not launch or operate, a system of NGSO satellites designed to use, among other bands, the 14.0-14.5 GHz FSS uplink band, but the licensee subsequently surrendered its license. *See Application of Virtual Geosatellite, LLC for Authority to Launch and Operate a Global Fixed-Satellite Service System Employing Non-Geostationary Satellites in Sub-Geosynchronous Elliptical Orbits*, Order and Authorization, DA 06-2560, 21 FCC Rcd 14687 (Int'l Bur. 2006) ("*Virtual Geo Order*"); *see also* note 154, *infra*.

[65] *See* 47 C.F.R. § 2.106.

[66] In 2005, OmniTracs processed more than nine million transactions daily. *See* OmniTracs Keeps on Trucking, Dec. 1, 2005 at http://www.wirelessweek.com/article/CA6287997.html?spacedesc=Features (visited Jan. 26, 2007).

[67] *ESV Report and Order*, 20 FCC Rcd at 706-07, ¶ 79.

[68] *See AMSS NPRM* at 2924, ¶ 31.

[69] In 1983, the Commission established a two-degree orbital spacing policy to maximize the number of in-orbit satellites serving the United States in either the C-band or the Ku-band. *See Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations*, CC Docket No. 81-704, Report and Order, FCC 83-184, 54 Rad. Reg. 2d (P & F) 577 (1983) ("*Two-Degree Spacing Order*"); *summary printed in Licensing Space Stations in the Domestic Fixed-Satellite Service*, 48 Fed. Reg. 40233 (Sept. 6, 1983), *on recon., Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations*, CC Docket No. 81-704, Memorandum Opinion and Order, FCC 84-487, 99 FCC 2d 737 (continued....)

allow VMES terminals to communicate with FSS space stations in the 14.0-14.5 GHz band on a primary basis.

a. 14.0-14.2 GHz Band

31. The 14.0-14.2 GHz portion of the Ku-band is allocated on a primary basis in the United States to FSS for non-Federal operations.[70] Space research services (for both Federal and non-Federal use) are allocated to the 14.0-14.2 GHz sub-band on a secondary basis.[71] The only currently authorized non-FSS facilities in this portion of the Ku-band uplink are two National Aeronautics and Space Administration ("NASA") space research Tracking and Data Relay Satellite System ("TDRSS") receive facilities (located in Guam and in White Sands, New Mexico), which operate with frequency assignments in the 14.0-14.05 GHz band.[72] We note that the filtering associated with the existing TDRSS facilities leaves them vulnerable to interference to varying degrees. The White Sands facility, for example, has some filtering across the entire 14.0-14.5 GHz band, while the Guam facility is somewhat better protected above 14.2 GHz.[73] We also note that NASA plans to establish another TDRSS receive facility on the east coast of the United States, with several mid-Atlantic region sites under consideration. As discussed in the *ESV Report and Order*, we would expect NASA to equip any future facilities operating in this band with state-of-the-art interference filtering.[74]

32. We recognize the importance of protecting these space research facilities from receiving harmful interference. With this is in mind, if we should adopt primary status for VMES in the 14.0-14.5 GHz bands, we seek comment on the feasibility of allowing VMES operations within a 125 kilometer protection zone around operational NASA TDRSS sites, particularly if the Commission were to allow large numbers of VMES to be operated under a blanket license. We propose, as a condition of the license, to prohibit VMES operators from operations in the 14.0-14.2 GHz band within 125 kilometers of the NASA TDRSS sites at Guam or White Sands. However, we solicit comment on whether we should allow VMES operators that wish to operate in the 14.0-14.2 GHz band and plan to travel within 125 kilometers of the NASA TDRSS sites at Guam or White Sands to coordinate their proposed operations to resolve any potential harmful interference concerns regarding space research facilities. Such coordination would be a condition to licensing, as opposed to a prerequisite to licensing and, thus, we

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(1985). At that time, the Commission began assigning adjacent in-orbit satellites to orbit locations two degrees apart in longitude, rather than the three-to-four degrees longitude previously used.

[70] *See* 47 C.F.R. § 2.106. In WT Docket No. 01-289, the Commission removed a secondary non-Federal radionavigation allocation from the 14.0-14.2 GHz band because the record demonstrated no existing or anticipated need to use Ku-band spectrum for radionavigation. *See Review of Part 87 of the Commission's Rules Concerning the Aviation Radio Service*, WT Docket No. 01-289, Second Report and Order and Further Notice of Proposed Rule Making, FCC 06-148, 21 FCC Rcd 11582, 11595-96, ¶ 19 (2006).

[71] *See* 47 C.F.R. § 2.106.

[72] *See Amendment of Parts 2, 25 and 73 of the Commission's Rules to Implement Decisions from the World Radiocommunication Conference (Geneva, 2003) (WRC-03) Concerning Frequency Bands Between 5900 KHz and 27.5 GHz and to Otherwise Update the Rules in this Frequency Range*, ET Docket No. 04-139, Notice of Proposed Rulemaking, FCC 04-74, 19 FCC Rcd 6592, 6609, ¶ 42 n.74 (2004).

[73] For information on the filtering capabilities at the White Sands and Guam facilities, see Letter from Robert E. Spearing, Deputy Associate Administrator for Space Communications, Office of Space Flight, NASA, to Craig Holman, Regulatory Counsel, The Boeing Company, at Figure 2 (Dec. 18, 2001), *cited in ESV Report and Order*, 20 FCC Rcd at 712 n.233.

[74] *See ESV Report and Order*, 20 FCC Rcd at 712, ¶ 89.

would not require a Ku-band VMES operator to complete this coordination prior to receiving a Commission VMES license.[75] Should NASA seek to provide similar protection to future TDRSS sites, the National Telecommunications and Information Administration ("NTIA") should notify the International Bureau that the TDRSS site was nearing operational status. The Bureau then would issue a notice requiring all Ku-band VMES operators to cease operations in the 14.0-14.2 GHz band within 125 kilometers of the new TDRSS site until they have coordinated with the new site. After coordination, VMES operators again would be permitted to operate within 125 kilometers of the new TDRSS site, subject to any operational constraints developed in the coordination process.[76] Additionally, we solicit comment on what technical measures should be incorporated into terminals to assist VMES operators in meeting any coordination obligations, such as GPS-related software technology.

33. We seek comment on how the coordination process should work, as this would be different from the more traditional Federal Government pre-licensing coordination process between the Commission and NTIA.[77] Specifically, should VMES licensees go directly to NASA or should they work through the Commission? If the former, Ku-band VMES operators would be required to notify the International Bureau once they had completed this coordination, and, upon receipt of such notification, the Bureau would release a public notice stating that operations within the new coordination zone might commence in 30 days if no party had opposed such operations.[78] Even if we accord VMES primary status, in deference to the U.S. assets operated by NASA, we would expect the coordination to be conducted on an equal basis between NASA and the VMES operator, even though the SRS is a secondary allocation in the 14.0-14.2 GHz portion of the 14.0-14.5 GHz FSS uplink band.[79]

34. As NASA will have a limited number of space research earth stations that will be receiving from the government data relay satellites, we believe that coordination between VMES and TDRSS operations is possible and will not prove to be a burden for VMES operators. In addition, the TDRSS sites provide an important service, we do not anticipate that the number of TDRSS sites will increase significantly, and, in any event, future expansion of the SRS could be severely curtailed if VMES operators have no obligation to protect future TDRSS sites. For these reasons, we believe that protection of future sites is warranted. This is the general approach the Commission adopted for ESVs accorded primary status in this band. We seek comment on applying this approach to VMES, should we accord VMES similar primary status in this band.

[75] This is the same approach the Commission took for ESVs. *ESV Report and Order*, 20 FCC Rcd at 712-13, ¶ 90.

[76] If necessary, the Commission might be required to invoke section 316 of the Communications Act to modify an authorization in order to protect TDRSS stations. *See* 47 U.S.C. § 316.

[77] NTIA is responsible for managing the Federal portion of the U.S. Table. In bands shared between Federal and non-Federal services, the Commission and NTIA operate under a long-standing coordination agreement. *See* NTIA Manual, Basic Coordination Arrangement Between IRAC and the FCC, *available at* http://www.ntia.doc.gov/osmhome/redbook/8.pdf, at Chapter 8.3.1 (visited Mar. 16, 2007).

[78] This comports with the Commission's treatment of ESVs in this band. *ESV Report and Order*, 20 FCC Rcd at 713, ¶ 91.

[79] *See ESV Report and Order*, 20 FCC Rcd at 713, ¶ 91.

b. 14.2-14.4 GHz Band

35. The 14.2-14.4 GHz segment is an exclusive non-Federal use band that is allocated on a primary basis to FSS for uplink operations and on a secondary basis to the MSS.[80] We seek comment on whether to allow VMES operations to communicate with FSS space stations in the 14.2-14.4 GHz band on a primary basis.

c. 14.4-14.5 GHz Band

36. In addition to the non-Federal primary FSS and secondary MSS allocations in the 14.4-14.5 GHz segment, the Federal government has secondary fixed and mobile allocations in the band. Our records indicate that there are several fixed point-to-point operations and a limited number of fixed stations used by the Federal government for terrestrial telecommand. There also are several Federal government aeronautical mobile stations, land-based aeronautical mobile stations, and land mobile stations in the band. Furthermore, there are several Federal government surface telemetering mobile stations in the band that are used to send telemetry information to other stations on the ground. The 14.4-14.5 GHz band appears to be used predominantly by fixed, mobile, and transportable telemetry microwave systems. The band also is used to transmit air traffic control video links, closed circuit television, and range test data (including airborne downlink data transmissions). We seek comment on how the VMES operators would propose to protect the Federal fixed and mobile operations in the band.[81]

37. RAS operations in the 14.47-14.5 GHz band, although important, are carried out at a relatively small number of geographic locations and require limited exclusion zones to protect them from interference. We note that in the past, radio observations in the 14.47-14.5 GHz band were not performed on a continuous basis and usually were scheduled in advance.[82] As telescope time becomes more valuable due to costs and oversubscription, and switching feeds for observing various bands becomes easier, radio telescopes are increasingly scheduled dynamically, particularly for observations above 10 GHz. As a result, current observations can be scheduled with only a few hours lead time. Therefore, coordination between VMES and RAS sites could possibly be based on a combined time and distance basis. If we should adopt primary status for VMES in the 14.0-14.5 GHz bands, we seek comment on the feasibility of coordination between VMES and RAS operations to preclude harmful interference to the RAS as observations currently are performed, and particularly if the Commission were to allow large numbers of VMES to be operated under a blanket license. Specifically, we seek comment on requiring VMES operators proposing operations in the 14.47-14.5 GHz band and planning to travel in the vicinity of the radio observatories listed in US203 and of Arecibo, Puerto Rico, Mauna Kea, Hawaii, and St. Croix, Virgin Islands to coordinate their proposed operations to resolve any potential interference concerns. Such coordination would be a condition to licensing, as opposed to a prerequisite to licensing,

[80] Similar to the 11.7-12.2 GHz band, the 14.2-14.4 GHz band had, until recently, a secondary mobile allocation for LTTS for television pickup and television non-broadcast pickup stations under Part 101 of our rules. *See ESV Report and Order*, 20 FCC Rcd at 713-14, ¶ 93; *see also* 47 C.F.R. § 101.147, note (24). As of March 1, 2005, no new LTTS applications will be considered for this band, although pre-existing licensees have been grandfathered to operate as a secondary mobile service in the 14.2-14.4 GHz band with the understanding that there will be no expectation of renewal. *See ESV Report and Order*, 20 FCC Rcd at 714, ¶ 94.

[81] In the *ESV Report and Order*, the Commission noted that it had received no comment on secondary Federal mobile, fixed and transportable use of the 14.4-14.5 GHz band, and concluded that the standard primary/secondary sharing environment applies. *See ESV Report and Order*, 20 FCC Rcd at 714-15, ¶ 95.

[82] *See ESV Report and Order*, 20 FCC Rcd at 715, ¶ 97.

and thus, we would not require a Ku-band VMES operator to complete this coordination prior to receiving a Commission VMES license.[83]

38. We seek comment on how the coordination process should work, as this would be different from the more traditional Federal Government pre-licensing coordination process between the Commission and NTIA.[84] Specifically, should VMES licensees go directly to the National Science Foundation ("NSF") or should they work through the Commission? If the former, Ku-band VMES operators would be required to notify the International Bureau once they had completed coordination. Upon receipt of such notification, the Bureau would release a public notice stating that operations within the new coordination zone might commence in 30 days if no party had opposed such operations.[85] We also seek comment on what technical measures should be incorporated into terminals to assist VMES operators in ensuring that the results of the coordination agreements can be implements, *e.g.*, GPS-related software technology or a VMES control center. Lastly, we seek comment if unwanted emissions from VMES terminals need to be regulated to protect RAS stations.

3. Proposed Footnotes

39. If we permit VMES terminals in the 10.95-11.2 GHz and 11.45-11.7 GHz bands, we propose to add the following non-Federal footnote **NGxxx** to the U.S. Table for those bands:

> **NGxxx** In the bands 10.95-11.2 GHz and 11.45-11.7 GHz (space-to-Earth), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 may be authorized to communicate with space stations of the fixed-satellite service but must accept interference from stations of the fixed service operating in accordance with the Commission's Rules.

40. If we permit VMES terminals in the 11.7-12.2 GHz and 14.0-14.5 GHz bands to communicate with space stations of the FSS on a primary basis, we propose to add the following non-Federal footnote **NGyyy** to the U.S. Table for these bands:

> **NGyyy** In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 are an application of the fixed-satellite service and may be authorized to communicate with space stations of the fixed-satellite service on a primary basis.

We seek comment on the footnotes proposed above.

B. Technical and Operational Requirements for VMES in the Band 14.0-14.5 GHz (Earth-to-Space)

41. The Communications Act mandates that transmitting radiocommunication facilities must be licensed before they can operate.[86] The rules governing transmit-only and transmit/receive earth stations are contained in Part 25 of the Commission's rules. The rules primarily are intended to ensure that satellite networks of space and earth stations can operate without harmful interference with respect to

[83] This is the same approach the Commission took for ESVs. *ESV Report and Order*, 20 FCC Rcd at 715, ¶ 96.

[84] *See supra* note 77.

[85] This comports with the Commission's treatment of ESVs in this band. *ESV Report and Order*, 20 FCC Rcd at 715, ¶ 96.

[86] 47 U.S.C. § 301.

each other and to other telecommunications services. The regulatory framework of the Commission's *two-degree satellite spacing environment established technical rules to govern earth stations* communicating with Ku-band satellites, to ensure that the earth stations' operations do not cause unacceptable interference to adjacent satellite systems.[87] Primarily, earth station technical requirements for routine licensing consist of an antenna diameter of minimum size and maximum power level limits.

42. The antenna diameter is important because it affects the antenna gain.[88] The antenna gain at various off-axis angles, combined with the power-density fed to the antenna, provides a measure of the interference potential of that earth station to other in-orbit satellites. The combination of power-density and gain is the equivalent isotropically radiated power-density ("E.I.R.P.-density"), which is at its maximum in the direction of the antenna main beam. In directions other than the main beam, the E.I.R.P.-density is directly related to the antenna gain pattern. For example, the antenna gain in the vicinity of two degrees off-axis, or two degrees measured from the main beam of the antenna, provides a measure of the potential of that earth station to cause interference to satellites located two degrees away in orbit from the satellite with which the earth station is communicating. The emission of any earth station antenna must fall within the limits defined by equations in the Commission's rules. Because decreasing the antenna diameter produces wider main beams and higher side lobes, the allowable antenna gain pattern envelope effectively creates a minimum earth station antenna diameter because at some point the main beam will become wide enough to cause unacceptable interference to adjacent satellites.

43. The Commission "routinely" licenses Ku-band earth station facilities that meet the two-degree orbital spacing technical requirements set forth in Part 25 of the Commission's rules. The Commission's routine earth station standards include minimum antenna sizes. Those sizes are related to the Commission's antenna gain pattern requirements. The smallest antenna routinely licensed in the Ku-band is 1.2 meters (3.9 feet) in diameter.

44. In the *ESV Report and Order*, the Commission combined the antenna performance and input power density rules in Part 25 to adopt off-axis E.I.R.P.-density rules for ESV earth station transmitters.[89] In adopting ESV rules, as set out in section 25.222 for Ku-band ESV use, the Commission combined the ESV mobile environment with the FSS and provided ESV operators with the option of using smaller antennas that may not meet the two-degree spacing antenna pattern specified in section 25.209 of the

[87] *See generally Two-Degree Spacing Order*, 54 Rad Reg. 2d (P&F) 577 (adopting 2° orbital spacing policy to maximize the number of in-orbit satellites operating in the Ku- and C-bands).

[88] Antenna gain is the ratio of the power required at the input of a loss-free reference antenna to the power supplied to the input of a given antenna to produce, in a given direction, the same field strength or the same power flux-density at the same distance. When not specified otherwise, the gain refers to the direction of maximum radiation. 47 C.F.R. § 2.1 (Gain of an Antenna). In other words, gain refers to an antenna's ability to collect, concentrate, and direct energy in a particular fashion, *i.e.*, a beam. Many antennas are shaped like parabolas, or large curved bowls. The "axis," or boresight, is the line running through the center of the bowl and perpendicular to the plane of the edge of the bowl. The majority of the energy is transmitted along the boresight in what is called the main beam of the antenna. The "off-axis" angle is the angle formed by the axis and any other line running through the center of the bowl. The energy transmitted from an antenna forms "ripples," alternately increasing and decreasing in magnitude as the off-axis angle increases. These ripples are called "side lobes."

[89] *ESV Report and Order*, 20 FCC Rcd at 682, ¶¶ 13-14, 716, ¶ 99.

rules, as long as the power-density into the antenna is reduced to the point that the off-axis E.I.R.P.-density limits set out in section 25.222 are met.[90]

1. Use of ESV Rules as Model for VMES

45. General Dynamics urges the Commission to expand the ESV regulatory framework to cover VMES.[91] General Dynamics states that the Commission, in developing the rules for ESVs, engaged in a comprehensive study of mobile satellite operations in the Ku-band and adopted carefully prescribed requirements to ensure that ESV operations adequately would protect existing operators in the band from harmful interference.[92] General Dynamics states that its SOTM system is able to meet the off-axis E.I.R.P.-density limits and other operational rules applicable to ESVs.[93] Therefore, General Dynamics asserts that the Commission can be confident in adopting regularized service and licensing rules for VMES operations in the Ku-band.[94]

46. Of course, the operation of VMES will differ significantly from the operation of ESVs because of the potential ubiquity of VMES terminals. ESVs, by their very nature, are restricted to operation within navigable waters and associated ports, whereas VMES terminals are capable of traveling just about anywhere in the land area of the United States. In addition, the accelerations experienced by a ship will tend to be significantly less than the accelerations of an off-road vehicle, making the antenna tracking mechanism of the VMES more complex than that on the ESV.[95] Still, we concur with General Dynamics and the majority of commenters that the ESV rules are the appropriate starting point for developing VMES rules that would be designed to protect adjacent FSS systems from harmful interference.

47. We therefore seek comment on whether, given the significant differences between ESVs and VMES, the ESV rules, as applied to VMES, would provide sufficient protection to the FSS. In Appendix B, we have included what we think are the appropriate portions of the Ku-band ESV rules, as a starting point for our analysis. Principally, these requirements are set out in section 25.222 of the Commission's rules.[96] Section 25.222 includes three principal types of rules pertaining to interference protection of adjacent FSS satellites: (1) off-axis E.I.R.P.-density limits and associated conditions; (2) antenna

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[90] *ESV Report and Order*, 20 FCC Rcd at 682, ¶ 14. *See also* 47 C.F.R. §§ 25.222 (Ku-band ESV rules), 25.209(a)-(b) (antenna gain patterns).

[91] Petition at 10-12. In this regard, General Dynamics proposes that the Commission include the text "and[/or] VMES" after most references to ESVs in section 25.222. *Id. See also* 47 C.F.R. § 25.222.

[92] Petition at iii, 11. *See also* November 21 Response to Information Request Attachment at 7 (asserting that adoption of the Petition would permit increased efficiency in the use of FSS Ku-band spectrum because it would encourage the use of somewhat larger antennas than those previously licensed for use on land mobile and air mobile platforms, and would mandate that they be pointed and tracked effectively).

[93] Petition at 11.

[94] Petition at 11-12.

[95] *See, e.g.*, December 18 Response to Information Request Attachment at 1 (stating that, as compared to ships and aircraft, the ground vehicle environment is considered the most challenging from a pointing accuracy viewpoint).

[96] 47 C.F.R. § 25.222, Blanket Licensing Provisions for Earth Stations on Vessels (ESVs) Receiving in the 10.95-11.2 GHz (Space-to-Earth), 11.45-11.7 GHz (Space-to-Earth), 11.7-12.2 GHz (Space-to-Earth) Frequency Bands and Transmitting in the 14.0-14.5 GHz (Earth-to-Space) Frequency Band, Operating with Geostationary Satellites in the Fixed-Satellite Service.

pointing accuracy requirements; and (3) a requirement to cease, or mute, transmission if the antenna strays from its intended satellite.[97] These rules are intended to control possible interference from ESV terminals to FSS satellites stationed near the intended satellite.[98]

48. We seek comment on applying section 25.222 and related rules to VMES terminals communicating with FSS networks. As stated by SIA, a decision to adopt rules to expand access to Ku-band and extended Ku-band FSS spectrum for this new service will need to be designed to ensure that VMES systems will access FSS satellites under conditions that apply to the U.S. two-degree spacing environment and account for and prevent the occurrence of any potential mispointing of antennas that could produce interference in excess of that defined in the existing Ku-band FSS rules.[99] The commenters generally support using section 25.222 of the rules as a starting point for deliberations.[100]

49. Currently, the smallest antenna routinely licensed in the Ku-band is 1.2 meters (3.9 feet) in diameter.[101] VMES terminals employ stabilized antennas that are small enough to mount on wheeled vehicles. General Dynamics describes the use of antennas as small as 0.45 meters (17.7 inches) in diameter on military vehicles.[102] Commenters advocating other commercial applications of VMES would

[97] 47 C.F.R. § 25.222(a)(1)-(5), (6), (7)-(8). In addition, the ESV service rules for Ku-band contain provisions that provide for protection of certain Federal stations operating in the Ku-band. *See* 47 C.F.R. § 25.222(d)-(e).

[98] ESVs are mobile transmitters operating in spectrum allocated for the FSS. To protect adjacent satellites from interference, the rules require that the off-axis power emitted by any single ESV antenna fall within a specified E.I.R.P.-density envelope pattern. The E.I.R.P.-density envelope pattern defines the level of power-density that is permitted to be emitted from an ESV antenna as a function of the angle measured from the main axis of the antenna. The ESV envelope patterns set out in section 25.222 of the rules are the same as those used generally for VSATs that operate in conjunction with the Commission's two-degree satellite spacing. These off-axis E.I.R.P-density limits are combined with the two other main requirements (the antenna pointing error allowance and the requirement to cease transmissions if an ESV antenna strays from its intended target) to keep the power emitted from the ESV transmitter at or below a level that will prevent harmful interference.

[99] *See* SIA at; *see also Two-Degree Spacing Order*, 54 Rad. Reg. 2d (P&F) 577 (1983), *on recon.*, 99 FCC 2d 737 (1985).

[100] *See* SES Americom at 5 (ESV rules the "logical framework" and "with limited exceptions, ESV rules make sense as template for VMES rules because of operational similarities between land mobile and maritime mobile systems); ViaSat at 5 (generally agreeing with proposal to extend ESV service and licensing rules to VMES); MTN at 2 (ESV rules "excellent starting point"); SIA at 3-4, 5 (ESV rules "useful starting point" as they include requirements for off-axis E.I.R.P. spectral density and antenna pointing accuracy designed to protect rest of FSS; rules are "appropriate starting point"). *But see* SES Americom at 5 (cautioning that it may be difficult for VMES to meet the ESV antenna pointing and cessation requirements due to terrain variations encountered by vehicles, particularly during off-road operations); Qualcomm at 2 (supporting ESV rules as basis for technology-neutral VMES service rules, but stating that Commission should be vigilant in developing rules that control off-axis emissions because uplink interference from small antennas is a significant source of degraded quality of service).

[101] *See generally* 47 C.F.R. § 25.209. In the *Sixth Report and Order and Third Further Notice*, the Commission invited comment on replacing the current Part 25 earth station licensing regime for "routinely" licensed Ku-band earth stations with an off-axis E.I.R.P.-density approach. *Sixth Report and Order and Third Further Notice*, 20 FCC Rcd at 5597, ¶ 8. If adopted, this change could result in the routine licensing of antennas smaller than 1.2 meters. Routinely licensed earth stations are those that can be licensed without a case-by-case review. *Id.* at 5597, ¶ 6 n.18.

[102] Petition at 5 (stating that, after extensive testing, Ku-band antennas with apertures of as small as 0.45 meters have demonstrated no greater deviation from the Part 25 ESV radiation pattern requirements than have the 0.6 meter terminals that have met and exceeded the Part 25 requirements).

use even smaller antennas.[103] The use of ultra-small antennas implies the use of FSS earth stations with wide beam widths and reduced side-lobe isolation that, in turn, raises the potential for increased interference power being received by other FSS satellites.[104] Preventing the possibility of interference to adjacent FSS satellites is of major concern to the Commission. We seek comment on whether VMES systems are sufficiently similar in operation to ESV systems to support adoption of the ESV rules, without modification, to VMES, without weakening the Commission's two-degree spacing environment.

50. In this regard, we note that General Dynamics states that the VMES antenna pointing system that it has developed has been tested to meet Commission service rules while the vehicle travels over a selected road-course, specifically, the Churchville B course at the U.S. Army Aberdeen Proving Grounds.[105] General Dynamics states that the antenna transmit-control system mutes the transmitter when the antenna mispoints by more than 0.5 degrees in the GSO orbital plane, thereby preventing interference to neighboring FSS satellites.[106] Whatever the design specifications of a VMES antenna tracking mechanism, the possibility exists that prevailing off-road conditions will cause design specifications to be exceeded. This situation does not exist for Ku-band ESV systems except under unusual circumstances. We ask if it is reasonable to structure service rules for VMES that use an E.I.R.P.-density envelope that is lower than that used for VSATs and ESVs.[107] In this regard, we note that the authorizations for certain Ku-band AMSS systems limit the aggregate E.I.R.P.-density to one-dB less than the E.I.R.P.-density envelope that is defined for routinely-authorized VSATs.[108] Would a similar rule requiring a one-dB reduction in the E.I.R.P.-density envelope, or a certification from adjacent satellite operators,[109] be reasonable for VMES applications? Is there a reason to use a larger or smaller reduction than one-dB in E.I.R.P.-density to protect FSS neighboring satellites, or is the ESV E.I.R.P.-density envelope sufficient?

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[103] *See, e.g.*, ViaSat at 3 (urging rules that would allow the operation of small, low-profile antennas that consumers could afford to install on standard vehicles). *See also* November 21 Response to Information Request Attachment at 7 (typical parabolic antenna on order of 0.40 meter might be employed in VMES). *But see* November 21 Response to Information Request Attachment at 11 (proposed VMES antenna pointing requirements will require additional level of design and production complexity that likely will keep VMES terminals above the range of consumer products).

[104] *See, e.g.*, December 18 Response to Information Request Attachment at 1 (stating that beam width of smaller-than-one-meter antennas is broad enough to disperse significant amount of energy onto an adjacent satellite).

[105] December 18 Response to Information Request Attachment at 6-7. General Dynamics describes driving conditions that are worse than those at the Aberdeen test course to provide an example of the interaction of the antenna pointing and transmit-control function in this situation. *Id.* at 7.

[106] December 18 Response to Information Request Attachment at 6.

[107] The E.I.R.P.-density envelope for ESV transmitters is consistent with the off-axis E.I.R.P.-density limits for routinely-licensed VSAT transmitters for co-polarized signals transmitted toward the GSO. *See ESV Report and Order*, 20 FCC Rcd at 716, ¶ 99. The off-axis E.I.R.P.-density limits for ESV transmitters are set out in 47 C.F.R. § 25.222(a)(1)-(5).

[108] *See* The Boeing Company, Radio Station Authorization, E000723, File No. SES-MFS-20050701-00853, Special Provision 5411 (granted Dec. 20, 2005); *ARINC Incorporated, Application for Blanket Authority for Operation of Up to One Thousand Technically Identical Ku-band Transmit/Receive Airborne Mobile Stations Aboard Aircraft Operating in the United States and Adjacent Waters*, Order and Authorization, DA 05-1016, 20 FCC Rcd 7553, 7573, ¶ 58(k) (Int'l Bur. and OET 2005).

[109] This rule would be similar to the requirement set forth in section 25.220(e)(2) for VSAT transmitters. 47 C.F.R. § 25.220(e)(2).

2. Proposed Modifications to ESV Model

51. Certain commenters suggest that the VMES service rules should deviate from the ESV model contained principally in section 25.222 of the Commission's rules. In particular, they propose changes to the interference protection rules set out in paragraphs (a)(1)-(7) of section 25.222.

a. Pointing Accuracy Requirements

52. SES Americom states that, because of terrain variations, VMES operators may find it difficult to comply with section 25.222(a)(6)-(7) of the Commission's rules, which requires antenna pointing accuracy and cessation of transmissions that exceed spectral limits.[110] SES Americom states that an applicant may be able to demonstrate that momentary deviations from the nominal antenna pointing by a VMES terminal with a very low transmit power-density would not cause harmful interference to adjacent satellites.[111] Accordingly, SES Americom proposes adopting, for VMES, an exception to section 25.222(a)(6)-(7) that would be based on two conditions. The first condition would require the VMES applicant to demonstrate that its proposed system complied with the off-axis E.I.R.P.-density limits set out in section 25.222(a), notwithstanding its failure to comply with specified antenna pointing accuracy requirements. The second proposed condition would require the applicant to obtain and submit affidavits from potentially affected satellite operators agreeing to the applicant's proposed operations.[112] We seek comment on whether adoption of this proposal would provide sufficient protection to adjacent FSS systems.

53. ViaSat states that systems using spread spectrum modulation techniques in which individual antennas operate at extremely low E.I.R.P.-densities, and in which there is central control of aggregate power density, generally do not require pointing accuracy rules.[113] In the event that certain antennas cannot control interference through spread spectrum and/or power control technology, ViaSat supports pointing accuracy limits that are a function of antenna beam width rather than a specific fixed angular limit applied equally to all sizes of antennas.[114] Similarly, Qualcomm proposes that the Commission look at alternative ways to specify the pointing accuracy, such as a "fraction of the antenna beam width" instead of a fixed value.[115] General Dynamics, on the other hand, would prefer that the Commission not reduce existing antenna pointing accuracy requirements.[116]

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[110] SES Americom at 5. *See also* 47 C.F.R. § 25.222(a)(6)-(7).

[111] SES Americom at 5.

[112] SES Americom at 5-6.

[113] ViaSat at 5-6. *See also* SES Americom at 5 (departure from ESV pointing accuracy requirement may be warranted where low power-density Code Division Multiple Access, or "CDMA," or similar technology is used for network transmission).

[114] ViaSat at 6.

[115] Qualcomm at 4.

[116] November 21 Response to Information Request Attachment at 13-14 (stating that General Dynamics would prefer that the Commission not reduce the antenna pointing accuracy requirements and then have to compensate by reducing the permitted E.I.R.P.-density levels below those in the ESV regulations, and stating that such changes would tend to require VMES terminals to use additional spectral spreading to compensate for the reduced E.I.R.P.-density required by a lower pointing accuracy and therefore would make the terminals less spectrum efficient and less likely to be interoperable with other FSS Ku-band earth stations).