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

In the Matter of	)	
	)	
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations.	)	IB Docket No. 97-95

THIRD NOTICE OF PROPOSED RULEMAKING

Adopted: October 29, 2010 **Released: November 1, 2010**

By the Commission:

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I. INTRODUCTION

1. In this Notice of Proposed Rulemaking (*Notice*), we propose several measures to increase the potential for sharing between terrestrial and satellite services in the 37.5-42.5 GHz band, otherwise known as the V-band. Such sharing permits more efficient use of the band, and could allow both

terrestrial and satellite operators to realize economies of scale in equipment manufacture, ultimately promoting investment in the band and enabling additional services and lower costs for consumers and businesses. We propose to delete the Broadcasting Satellite Service (BSS) allocation in the 42.0-42.5 GHz band and seek comment on adding a primary allocation for the Fixed Satellite Service (FSS) (space-to-Earth) in the 42.0-42.5 GHz band. We also seek comment on what limitations we should impose on FSS in the 42.0-42.5 GHz band to protect Radioastronomy (RAS) operations in the adjacent 42.5-43.5 GHz band, should we decide to add the primary allocation for FSS in the 42.0-42.5 GHz band. We further seek comment on the approach we should take in establishing criteria for coordination between FSS earth stations and Fixed Service (FS) stations in the 37.5-40.0 GHz band. Finally, we propose to allow FSS operators to take certain measures, including increasing power, to compensate for signal attenuation due to certain weather conditions.

2. In accordance with the provisions of the Office of Management and the Budget's *Final Information Quality Bulletin for Peer Review (Peer Review Bulletin),*[1] the scientific study upon which this *Notice* is based[2] has been subject to peer review by engineers in the Commission's Media Bureau. The peer review report found the assumptions, calculations, and methodologies used to conduct this study to be proper and consistent with sound engineering practices.[3]

II. BACKGROUND

3. The Commission first considered the 37.5-43.5 MHz band in the *Millimeter Wave Proceeding* in 1994, when it proposed to allocate the 40.5-42.5 GHz and the 47.2-48.2 GHz bands for communications using new technologies.[4] In order to further promote the use of new technologies, in 1995, the Commission proposed rules for FS point-to-point microwave operations in the 37.0-38.6 GHz band and proposed to assign licenses for FS point-to-point microwave operations by competitive bidding in areas not yet licensed.[5] Before the Commission acted on these proposals, however, rapid changes in technology, spectrum allocations, and market conditions caused the Commission to propose a band plan for the entire 36.0-51.4 GHz band in the *First V-band Notice*.[6] The *First V-band Notice* proposed to accommodate the spectrum needs of satellite operators, FS operators, and the Federal government. In 1998, in the *36-51 GHz Order*, the Commission adopted a band plan based on the proposals in the *First V-band Notice*.[7] The *36-51 GHz Order*: (1) designated four gigahertz of spectrum for FSS use on a

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[1] *OMB Final Information Quality Bulletin for Peer Review (Peer Review Bulletin)*, 70 Fed. Reg. 2664-02 (2005).

[2] *See* Appendix A.

[3] A copy of the peer review request, the peer review report, the response to the peer review report, and this document can be found at http://www.fcc.gov/ib/peer_review/.

[4] *See Amendment of Parts 2, 15, and 21 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications*, Notice of Proposed Rulemaking and Order, ET Docket No. 94-124, FCC 94-273, 9 FCC Rcd 7078, 7083, ¶ 11 (1994) (*Millimeter Wave Notice*).

[5] *See Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40 GHz Band – Implementation of Section 309(j) of the Communications Act,* Notice of Proposed Rulemaking and Order, ET Docket No. 95-183, FCC 95-500, 11 FCC Rcd 4930 (1995) (*39 GHz Notice*).

[6] *See Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band, Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, Notice of Proposed Rulemaking, IB Docket No. 97-95, FCC 97-85, 12 FCC Rcd 10130 (1997) (*First V-band Notice*).

[7] *See Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless*

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primary basis in the 37.6-38.6 GHz, 40.0-41.0 GHz, and 48.2-50.2 GHz bands; (2) retained designations of 2.4 gigahertz of spectrum for FS use on a primary basis in the 38.6-40.0 GHz and 47.2-48.2 GHz bands; (3) added 3.2 gigahertz of new FS designations on a primary basis in the 37.0-37.6 GHz, 41.0-42.5 GHz, 46.9-47.0 GHz, and 50.4-51.4 GHz bands, for a total of 5.6 gigahertz designated for FS use on a primary basis; and (4) retained existing designations for unlicensed commercial vehicular radar in the 46.7-46.9 GHz band and for amateur services in the 47.0-47.2 GHz band. The *36-51 GHz Order* did not designate uses for the 36.0-37.0 GHz, 42.5-46.7 GHz, and 50.2-50.4 GHz bands.[8]

4. Consistent with these allocations and designations,[9] the U.S. delegation to the International Telecommunication Union (ITU) World Radiocommunication Conference of 2000 (WRC-2000) developed a band-sharing arrangement for the 37.5-42.5 GHz band that proposed a system of "soft segmentation" whereby both FS and FSS would enjoy co-primary status throughout the 37.5-42.5 GHz band. The soft segmentation system uses service rules to encourage FS deployment below 40 GHz by imposing more restrictive power flux density (PFD)[10] limits on satellite operators below 40 GHz and more liberal PFD limits above 40 GHz. The soft segmentation system encourages ubiquitous FS in the 37.5-40.0 GHz and 42.0-42.5 GHz bands, and ubiquitous FSS in the 40.0-42.0 GHz band.[11] WRC-2000 reached several conclusions relating to V-band spectrum including: (1) a comprehensive sharing arrangement for FS and FSS in the 37.5-42.5 GHz band based largely on the U.S.-proposed approach; (2) Resolution 84 (WRC-2000),[12] which identified the 37.0-40.0 GHz and the 40.5-43.5 GHz bands for high-density fixed service (HDFS) operations; (3) an FSS allocation in the 40.5-42.5 GHz band for ITU Region 1 (generally Europe, Russia and Africa); (4) PFD limits in the 40.0-40.5 GHz band for FSS and provisional PFD limits in the 37.5-40.0 GHz and 40.5-42.5 GHz bands for FSS, MSS, and BSS; and (5) a secondary MSS allocation in ITU Region 2 (the Americas and the Caribbean) in the 40.5-41.0 GHz band.[13]

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Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations, Report and Order, IB Docket No. 97-95, FCC 98-336, 13 FCC Rcd 24649 (1998) (*36-51 GHz Order*).

[8] *See 36-51 GHz Order*, 13 FCC Rcd at 24651, ¶ 2.

[9] We distinguish between spectrum "allocations" and "designations." A spectrum allocation assigns radio frequency spectrum to one of the various pre-defined radio services listed in the Commission's rules. 47 C.F.R. § 2.105(b) and n.7. "A designation provides an allocated service or services use of a specific frequency band for which other services may also be allocated . . . . Designations are generally only needed where bands are allocated to more than one service and sharing between these services may be difficult." *36-51 GHz Order,* 13 FCC Rcd at 24650 n.3. Spectrum designations for a particular service do not preclude other allocated services from operating in a given band, provided that the allocated service can meet the technical constraints that the spectrum designation imposes. Unlike allocations, no "primary" or "secondary" designations exist. *V-band Further Notice,* 16 FCC Rcd at 12247 n.17; *see also V-band Second Report and Order*, 18 FCC Rcd at 25429 n.3 (*citing 36-51 GHz Order,* 13 FCC Rcd at 24650 n.3).

[10] Power flux density (PFD) is the power per unit area normal to the direction of radio wave propagation, usually expressed in terms of watts per square meter (W/m²) in a reference bandwidth. In spectrum management, this term is generally used to specify the signal strength at the Earth's surface produced by emissions from a space station, usually expressed in terms of decibels referenced to one watt per square meter (dB (W/m²)) in a reference bandwidth; in this context, the abbreviation used is "PFD."

[11] Ubiquitous deployment generally means high-density employment in an area without coordination with other services.

[12] Invites 7 of ITU-R Res. 84 (WRC-2000).

[13] *See Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services;*
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5. The World Radiocommunication Conference of 2003 (WRC-03) revised some of the footnotes to the International Table of Allocations pertaining to the 37.5-42.5 GHz frequency band. Some of these changes emphasized the use of high-density applications of the FSS in the 40.0-42.0 GHz and 48.2-50.2 GHz bands in ITU Region 2.[14] Other footnote changes established PFD limits on both FSS and BSS operations in the 41.0-42.5 GHz band to protect RAS operations at 42.5-43.2 GHz.[15]

6. As a result of the actions taken at WRC-2000 and WRC-03, the sub-bands 37.5-40.0 GHz and 40.0-42.5 GHz are internationally designated for high-density FS applications. The designations include a notation that the sub-bands 39.5-40.0 GHz and 40.5-42.0 GHz are also internationally designated for high-density FSS applications, which could constrain potential high-density FS applications in these sub-bands.[16] The specific designations for high-density FSS applications, however, vary by region, and are 39.5-40.0 GHz in Region 1, 40.0-40.5 GHz in all Regions, and 40.5-42.0 GHz in Region 2.[17]

7. In November 2003, the Commission adopted the *V-Band Second Report and Order*,[18] which modified the band plan for the 36.0-51.4 GHz band. The Commission adopted various designation and allocation changes that reflected decisions reached at WRC-2000 and WRC-03 and created contiguous spectrum for FSS, FS, and Mobile Service (MS) in the V-band. The *V-Band Second Report and Order* finalized the satellite and terrestrial designations reflecting the "soft segmentation" approach. Specifically, the Commission redesignated the spectrum available for FS from 41.0-42.0 GHz to 37.6-38.6 GHz, and redesignated the spectrum available for satellite uses from 37.6-38.6 GHz to 41.0-42.0 GHz. In so doing, the Commission provided three gigahertz of contiguous spectrum (37.0-40.0 GHz) designated for FS and two gigahertz of contiguous spectrum (40.0-42.0 GHz) designated for FSS.[19] The Commission also adopted service rules for satellite services, including PFD limits for FSS. In the 37.5-40.0 GHz band, where FS has been designated a ubiquitous service, the Commission adopted an envelope of PFD limits for FSS, defining both the lower PFD limits that satellite systems can use for "clear-air" operations, and generally permitting higher PFD limits for use during periods of rain fade, a condition which exists when raindrops scatter the FSS satellite's signal, reducing its ability to be received by the earth station. In making its decision, the Commission sought to bring technical and regulatory certainty to systems currently operating in the 37.0-40.0 GHz portion of the spectrum and to codify the concept of soft segmentation, thus allowing ubiquitous deployment of FS and FSS operations in the V-band.[20]

8. In the *V-band Second Report and Order*, the Commission said that it would defer the following issues to a future Notice of Proposed Rulemaking: (1) protection limits for RAS in the 42.5-

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and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations, Further Notice of Proposed Rulemaking, IB Docket No. 97-95, 16 FCC Rcd 12244, 12249 at ¶ 11 (2001) (*V-band Further Notice*).

[14] *See* WRC-03 Final Acts, 5.516B.

[15] *See id*., 5.551H and 5.551I and Res. 743.

[16] *See id.*, 5.547.

[17] *See id.*, 5.516B.

[18] *See Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, Report and Order, IB Docket No. 97-95, FCC 03-296, 18 FCC Rcd 25428 (2003) (*V-band Second Report and Order*).

[19] *See V-band Second Report and Order*, 18 FCC Rcd at 25434, ¶ 14.

[20] *See id.* at 25439, ¶ 24.

43.5 GHz band; (2) whether to delete the BSS allocation or add an FSS allocation in the 42.0-42.5 GHz band, or both; (3) conditions under which FSS in the 37.5-40.0 GHz band can exceed the clear-air PFD limits to compensate for rain fade; and (4) specific criteria for coordination among gateway earth stations and terrestrial FS stations in the 37.5-40.0 GHz band.[21]

9. As a result of the *V-band Second Report and Order*, the 37.5-43.5 GHz band is currently allocated and designated in the United States as follows:[22]

Frequency	Federal Allocation	Non-Federal Allocation	Designation (*V-band Second R&O*)
37.5-38	FIXED MOBILE SPACE RESEARCH (space-to-Earth)	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE	FS
38-38.6	FIXED MOBILE		FS
38.6-39.5		FIXED FIXED-SATELLITE (space-to-Earth) MOBILE	FS
39.5-40	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE	FS
40-40.5	EARTH-EXPLORATION SATELLITE (Earth-to-space) FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) SPACE RESEARCH (Earth-to-space) Earth-exploration satellite (space-to-Earth)	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)	FSS
40.5-41	FIXED-SATELLITE (space-to-Earth) Mobile-Satellite (space-to-Earth)	FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE Fixed Mobile Mobile-satellite (space-to-Earth)	FSS
41-42.0		FIXED FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE MOBILE	FSS
42-42.5		FIXED MOBILE BROADCASTING BROADCASTING-SATELLITE	

[21] *See id.* at 25430, ¶ 2.

[22] Primary allocations are listed in all upper-case letters. Secondary allocations are listed in lower-case letters. Bands where no Federal allocations appear are allocated exclusively to non-Federal services. This table is similar to the Table of Frequency Allocations found at 47 C.F.R. § 2.106, but does not contain the footnotes found in that table. The purpose of this table is to provide an overview of the allocations in the 37.5-43.5 GHz band. *See 36-51 GHz Order*, 13 FCC Rcd at 24651 n.4.

42.5-43.5	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE except aeronautical mobile RADIO ASTRONOMY	RADIO ASTRONOMY	

Non-Federal services in the 37.5-42.5 GHz band are governed by Parts 25 (Satellite Communications) and 101 (Fixed Microwave) of the Commission's Rules.

10. In March 2004, the Commission adopted the *37-40 GHz Third Notice*, which proposed service rules for fixed, point-to-point microwave service in the 37.0-38.6 GHz and 42.0-42.5 GHz bands that would substantially conform to the rules already adopted by the Commission for the 38.6-40.0 GHz band.[23] Among other things, the Commission sought comment on coordination among FS stations in the 37.0-40.0 and 42.0-42.5 GHz bands, coordination among FS and FSS stations in the 37.5-40.0 and 42.0-42.5 GHz bands, and coordination between non-Federal government and Federal government services at 37.0-38.6 and 39.5-40.0 GHz.[24] The Commission is considering those issues in this separate docket.

III. DISCUSSION

11. In this *Notice*, we continue the process of establishing rules to govern the 37.5-43.5 GHz band, and particularly to allow sharing of the band between FS and FSS. In this *Notice*, we make proposals with respect to some of the issues raised in the *V-band Second Report and Order* and request comment from interested parties regarding all of these issues.

A. Allocations

1. Broadcasting Satellite Service and Broadcasting Service in the 42.0-42.5 GHz Band

12. We propose to delete the BSS allocation in the 42.0-42.5 GHz band. The National Telecommunications and Information Administration (NTIA) has requested that we delete this allocation because NTIA believes it would be difficult or impossible to reduce out-of-band emissions into the 42.5-43.5 GHz band, where sensitive RAS operations are located, if BSS operations were to be implemented in the 42.0-42.5 GHz band.[25] ITU-R Resolution 128 (WRC-2000) addressed the provisional status of the PFD limits that WRC-2000 adopted,[26] stating that "unwanted emissions from GSO BSS and FSS (space-to-Earth) space stations in the band 42-42.5 GHz may result in harmful interference to radio astronomy service in the band 42.5-43.5 GHz."[27] WRC-03 produced two sets of out-of-band limits for BSS and FSS in the band. First, footnote 5.551H to the International Table of Frequency Allocations limits NGSO FSS and BSS space stations in the 42.0-42.5 GHz band to specific equivalent power flux density limits (ePFD)[28] into the radio astronomy band 42.5-43.5 GHz that may only be exceeded for a specific

[23] *Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands; Implementation of Section 309(j) of the Communications Act – Competitive Bidding, 37.0-38.6 GHz and 38.6-40.0 GHz Bands*, Third Notice of Proposed Rulemaking, ET Docket No. 95-183, PP Docket No. 93-253, FCC 04-78, 19 FCC Rcd 8232 (2004) (*37-40 GHz Third Notice*).

[24] *37-40 GHz Third Notice*, 19 FCC Rcd at ¶¶ 69-95.

[25] *See* letter from William T. Hatch, Associate Administrator, Office of Spectrum Management, NTIA, to Bruce Franca, Acting Chief, Office of Engineering and Technology, FCC (dated Aug. 31, 2001) at 2-3.

[26] *See* Final Acts of WRC-2000, Art. 5, footnote 5.551G.

[27] ITU-R Resolution 128, *Considering b*) (WRC-2000).

[28] Equivalent power flux density limits define a maximum aggregate PFD, as a percent of time, at the surface of the earth from a constellation of non-geostationary satellites.

percentage of time. Second, footnote 5.551I contains out-of-band PFD limits for FSS and BSS geostationary orbit (GSO) space stations into the RAS band.[29] These footnotes place severe limitations on the power and out-of-band emissions permitted for BSS and FSS in the 42.0-42.5 GHz band, which diminish the value of the band to BSS and FSS. We note that deletion of the BSS allocation in the band would leave 1.5 gigahertz available to BSS in the 40.5-42.0 GHz band.

13. In the *V-Band Further Notice*, Astrolink International LLC (Astrolink) argued against deleting the BSS allocation in the 42.0-42.5 GHz band, noting that the BSS allocation in the band predated the 1992 World Administrative Radio Conference, and should therefore not be deleted.[30] Astrolink states that there is no evidence to suggest that the PFD limits adopted by WRC would not fully protect RAS in the 42.5-43.5 GHz band. Rather, Astrolink believes we should develop a solution to meet the needs of both BSS and RAS.[31]

14. We note that the 42.0-42.5 GHz band has been internationally and domestically designated for HDFS usage but not HDFSS usage and is potentially available for the ubiquitous deployment of FS systems.[32] We also note that we have designated this band for HDFS. FSS may be able to share spectrum with ubiquitously-deployed HDFS by using narrow spot-beams to gateway earth stations. BSS, however, usually involves ubiquitous deployment of consumer receivers and very broad coverage by the satellite signal. We do not believe these two ubiquitously-deployed services would be able to share spectrum without substantial difficulties.

15. We are unsure at this point that we should maintain the allocation for BSS in the 42.0-42.5 GHz band simply because it has been in place for many years. Given the difficulty of designing a viable BSS system while simultaneously assuring protection to RAS in the 42.5-43.5 GHz band and sharing with ubiquitous, high-density deployment of fixed systems, we propose to delete the BSS allocation at 42.0-42.5 GHz.[33] We seek comment on this proposal, and on whether it would be preferable, if it is technically feasible, to develop service rules to ensure that BSS in this band would not cause harmful interference to RAS in the adjacent 42.5-43.5 GHz band and simultaneously share spectrum with HDFS. We encourage commenters to submit suggested coordination criteria or other service rules, including specific suggestions for changes to our rules. Commenters should provide technical descriptions of expected BSS

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[29] Footnotes 5.551H and 5.551I note that ITU-R Resolution 743 applies in Region 2, which corresponds approximately to the Americas, including the United States. *See* 47 C.F.R. § 2.104. Resolution 743 resolves that an administration planning to operate BSS or FSS in the 42.0-42.5 GHz band that cannot meet the values or percentage of time criteria in the 42.5-42.77 GHz band shall enter into discussions with the administration operating the affected single dish radio telescopes to arrive at a mutually satisfactory arrangement with respect to the unwanted emissions. *See* ITU-R Resolution 743 (WRC-03) "Protection of single-dish radio astronomy stations in Region 2 in the 42.5-43.5 GHz band."

[30] *See* Astrolink Comments in response to *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band, Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, Further Notice of Proposed Rulemaking, IB Docket No. 97-95, 16 FCC Rcd 12244 (2001) (*V-band Further Notice*) at 6 (dated Sep. 4, 2001).

[31] *See* Astrolink Comments at 7.

[32] The 40.5-43.5 GHz band is available for high density development for fixed service systems, and international footnote 5.516B identifies the 40.0-42.0 GHz band for HDFSS. *See* 47 C.F.R. § 2.106, int'l nn. 5.516B, 5.547.

[33] We note that the Broadcasting Service also has a co-primary allocation in the 42.0-42.5 GHz band. We do not make any proposals with regard to this allocation because terrestrial broadcasting involves transmission in local areas on the surface of the earth, where BSS involves transmitting signals down from space. Thus, terrestrially-based broadcasting does not present the same potential for interference to RAS that BSS presents.

services in this band and explain from a technical perspective how to meet the needs of BSS and HDFS for technical rules that allow them to offer efficient service, as well as the need of RAS for protection from interference.

16. We further seek comment on whether we should delete the allocation for the Broadcasting Service in the 42.0-42.5 GHz band. We believe it would be difficult for HDFS to share the band with broadcasting for the same reason that we doubt the feasibility of HDFS sharing with BSS, *i.e.*, the ubiquitous nature of broadcasting. We also question whether broadcasting in the 42.0-42.5 GHz band could adequately protect RAS in the 42.5-43.5 GHz band from harmful interference. We seek comment on all of these allocation issues. We encourage commenters to provide technical descriptions of expected broadcasting or BSS in this band and explain from a technical perspective how broadcasting or BSS could share the 42.0-42.5 GHz band with HDFS, as well as protecting RAS from interference.

2. Addition of an Allocation for FSS in the 42.0-42.5 GHz Band

17. We seek comment on whether we should add a primary allocation for FSS (space-to-Earth) in the 42.0-42.5 GHz band. Such an allocation would provide additional spectrum for FSS. WRC-03 adopted PFD limits to protect RAS in the 42.5-43.5 GHz band from FSS operations in 42.0-42.5 GHz,[34] and FSS is allocated on a primary basis internationally. These actions permit FSS in the 42.0-42.5 GHz band. We now seek further information on how the addition of an FSS allocation in this band would affect RAS services. At the same time, we note that, under the band plan the Commission established in the *Second V-band Report and Order*, the 42.0-42.5 GHz band is not paired with any other band, and therefore may not be useful to FSS.

18. With respect to the differences between FSS and BSS operations in the 42.0-42.5 GHz band, we note that V-band FSS systems could use spot beams to communicate with relatively few gateway earth stations in the band. BSS, by contrast, typically uses wide-area coverage systems operating to ubiquitously deployed receivers. The use of a limited number of spot beams may enhance the possibility of sharing between RAS and FSS operations in the V-band. The operation of BSS satellite downlinks to ubiquitously deployed receivers, however, would make sharing with adjacent band RAS operations very difficult. FSS should be able to operate with greater constraints on PFD than BSS, and therefore be better positioned to protect RAS from out-of-band emissions than the higher PFD satellites serving ubiquitous BSS receivers.

19. Specifically, we seek comment on whether the addition of an allocation for FSS in the 42.0-42.5 GHz band is necessary to promote the band sharing arrangement the Commission adopted in the *V-band Second Report and Order*. If we decide to add an FSS allocation to the 42.0-42.5 GHz band, should we require FSS operators to operate according to the same rules as the 37.5-40 GHz band? Furthermore, we seek comment on whether the addition of an FSS allocation in this band would cause harmful interference to RAS operations. We also seek comment on how gateway earth stations could take advantage of additional spectrum in the 42.0-42.5 GHz band.

B. Protection for Radioastronomy Operations in the 42.5-43.5 GHz Band

20. We seek comment on what limitations we should impose on FSS systems in the 42.0-42.5

[34] ITU-R Resolution 743 resolves that an administration that plans to operate a GSO FSS or BSS satellite or a non-GSO FSS or BSS system in the 42-42.5 GHz band shall take all practicable steps to avoid exceeding the PFD value of -153 dB(W/m2) in any 500 kHz for a GSO satellite, and the EPFD value of -246 dB(W/m2) in any 500 kHz for any non-GSO system in the 42.5-42.77 GHz band, for more than 2% of the time, at the site of a radio astronomy station registered as a single-dish radio telescope in Region 2. Resolution 743 also resolves that a GSO FSS or BSS satellite in the band 42-42.5 GHz shall not exceed the values given in No. 5.551I for more than 2% of the time at any radio astronomy station in Region 2 registered as a single-dish radio telescope in the 42.5-43.5 GHz band.

GHz band, should we decide to allocate that band for FSS. We seek comment on measures that would protect RAS in the 42.5-43.5 GHz band, while allowing FSS to operate in the 42.0-42.5 GHz band. We proposed above to delete the BSS allocation in the 42.0-42.5 GHz band partly to protect RAS in the 42.5-43.5 GHz band. We now seek comment as to what, if any, additional measures we should adopt.

21. Currently, ITU rules limit the PFD that FSS and BSS may produce in the 42.5-43.5 GHz RAS band. The ePFD in the 42.5-43.5 GHz band produced by all space stations in any NGSO FSS or BSS system operating in the 42.0-42.5 GHz band may not exceed, for more than two percent of the time, -230 dB(W/m^2) in 1 GHz and -246 dB(W/m^2) in any 500 kHz of the 42.5-43.5 GHz band at the site of an RAS station registered as a single dish telescope. ITU rules also prohibit NGSO FSS and BSS systems from exceeding, for more than two percent of the time, an ePFD of -209 dB(W/m^2) in any 500 kHz of the 42.5-43.5 GHz band at the site where a RAS station is registered as a very long baseline interferometry (VLBI) station.[35]

22. In addition, neither GSO FSS nor BSS operations in the 42.5-43.5 GHz band may produce PFD in the 42.0-42.5 GHz band exceeding, at any time, -137 dB(W/m^2) in 1 GHz and -153 dB(W/m^2) in any 500 kHz of the 42.5-43.5 GHz band at the site of any radio astronomy station registered as a single dish telescope. FSS and BSS systems are also prohibited from exceeding, at any time, -116 dB(W/m^2) in any 500 kHz of the 42.5-43.5 GHz band at the site where a RAS station is registered as a VLBI station.[36]

23. We request comment on whether these limits are sufficient to protect RAS in the 42.5-43.5 GHz band. Specifically, we seek information on the effect that adopting PFD limits would have on services in this band. Would RAS operations be sufficiently protected? Would we need tighter limits to provide sufficient protection? Would tighter limits prevent FSS operators from offering certain types of services? We encourage commenters to suggest PFD limits and provide detailed explanations of the protection these limits would provide for RAS operations, and the consequences of these limits for FSS services.

24. We also request comment on whether a viable GSO FSS or BSS system could be operated in a way that meets the less stringent PFD limits for NGSO FSS and BSS in footnote 5.551H. PFD limits for NGSO FSS or BSS systems in the 42.0-42.5 GHz band are based on levels that the systems may not exceed for more than 2 percent of the time.[37] By contrast, GSO FSS or BSS systems in the band may not exceed the PFD limits at any time.[38] We note that any FSS or BSS systems authorized in the 42.0-42.5 GHz band, due to technology constraints, might be forced to use narrow beams that would illuminate only a very small portion of the surface of the Earth at any point. Thus it may be possible to operate a GSO FSS/BSS system that could use narrow beams to avoid RAS sites, while providing service elsewhere. We invite comment on whether this technological limitation of narrow beams could be used to promote sharing between FSS or BSS and RAS and how limiting the beam size of BSS systems could affect the operations of BSS, which is usually a ubiquitous service. If so, would allowing GSO FSS or BSS systems to meet the less stringent PFD limits established for NGSO FSS/BSS provide sufficient protection from interference to RAS? If so, how could the limits in 5.551H be enforced for GSO FSS or BSS?

25. We further seek comment on what other measures, if any, we should take to protect RAS in the 42.5-43.5 GHz band. Specifically, we seek comment on whether we should change the allocation

[35] *See* 47 C.F.R. § 2.106, n.5.551H. In Region 2, these limits can be modified by negotiated agreement.

[36] *See id*. § 2.106, n.5.551I. In Region 2, these limits can be modified by negotiated agreement.

[37] *See id*. § 2.106, n.5.551H.

[38] *See id*. § 2.106, n.5.551I.

for the Mobile Service in the 40.5-42.5 GHz band to exclude the Aeronautical Mobile Service (AMS).[39] AMS use of the 40.5-42.5 GHz band could cause in-band interference to FSS gateway earth stations and HDFS receivers as well as increasing the chance for harmful out-of-band interference to RAS. The combination of the mobility of airborne transmitters and the large area over which an airborne transmitter is visible make AMS sharing with FSS downlinks and HDFS reception very difficult. With respect to RAS, footnote US212 states that, in the 40.5-42.5 GHz band, applicants for airborne or space station assignments are urged to take all practicable steps to protect RAS observations in the adjacent bands from harmful interference.[40] The elimination of AMS service in the 40.5-42.5 GHz band would ease both of these potentially difficult sharing problems.

C. Coordination Between FSS Gateway Earth Stations and FS stations in the 37.5-40.0 and 42.0-42.5 GHz Bands

26. We request comment on the criteria for coordination between FSS gateway earth stations and FS stations in the 37.5-40.0 and 42.0-42.5 GHz bands. As a part of its "soft segmentation" approach for the 37.0-42.0 GHz band, the Commission concluded that some restrictions should be placed on FSS gateway earth station operations in the 37.5-40.0 GHz band to help preserve the FS designation in that band.[41] The Commission concluded that the text of the footnote to Part 25.202(a)(1) of our rules, adopted in the *V-band Second Report and Order*, strikes the proper balance between this wireless designation and the limited FSS use of the 37.5-40.0 band.[42] As such, FSS use of this band is limited by rule to gateway earth stations that obtain a Part 101 license under our rules or reach a sharing agreement with a Part 101 licensee for the area in which a gateway earth station is to be located.[43] FSS operators in this band are prohibited from ubiquitously deploying earth stations and a single gateway earth station may not be used to serve an individual consumer.[44] Because the allocation for FSS is space-to-Earth,[45] gateway earth stations do not transmit in these bands and FSS operators obtain Part 101, wireless terrestrial site licenses, to protect reception at the earth station from terrestrial operations. FSS operators not site-licensed under Part 101 for a given gateway earth station may deploy earth stations on a non-protected basis at their sole risk—in areas that do not require coordination with Part 101 licensees, *i.e.*, unlicensed areas—so as not hinder the deployment of ubiquitous fixed service operations in these bands.[46]

27. The Commission has proposed two different methods of ensuring coordination between

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[39] AMS is a mobile service between aeronautical stations and aircraft stations, or between aircraft stations. 47 C.F.R. § 87.5.

[40] We also note that footnote US74 applies to the RAS operations in the 42.5-43.5 GHz band. US74 states that RAS operations shall be protected from unwanted emissions only to the extent that such radiation exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates. *See* 47 C.F.R. § 2.106, nn. US74, US212.

[41] *See V-band Second Report and Order*, 18 FCC Rcd at 25442, ¶ 33.

[42] *See V-band Second Report and Order*, 18 FCC Rcd at 25442, ¶ 33. *See also* 47 C.F.R. § 25.202(a)(1), n.15.

[43] Earth stations operating in the 37.5-40.0 GHz bands must be gateway earth stations, as defined in 47 C.F.R. § 25.202(a)(1), n.15. *See V-band Second Report and Order*, 18 FCC Rcd at 25442, ¶ 33. Under the current rules, an FSS earth station applicant may obtain authority to operate within the 39 GHz band by securing a Part 101 license through competitive bidding or through partitioning in an area in which it wants to operate its earth station. An FSS earth station operator also can apply for a Part 25 license, provided that the earth station applicant has secured an agreement with all affected Part 101 licensees prior to filing an application. *37-40 GHz Third Notice*, 19 FCC Rcd at 8262, ¶ 75.

[44] *See 37-40 GHz Third Notice*, 19 FCC Rcd at 8262, ¶ 75.

[45] *See* 47 C.F. R. § 2.106.

[46] *See V-band Second Report and Order*, 18 FCC Rcd at 25441, ¶ 32.

FSS gateway earth stations and FS stations to prevent interference. First, in the *V-band Further Notice*, the Commission proposed that FSS earth stations be treated as the same as terrestrial stations operating under Part 101 of its rules for the purposes of coordination between FS terrestrial and FSS earth stations in the 37.5-40.0 GHz band.[47] In order to address interference concerns, the Commission proposed to require an FSS licensee to coordinate any FSS earth stations it planned to locate within 16 km of the boundary of its licensed service area with FS and FSS licensees in adjacent service areas. Under this approach, the pre-existing FS or FSS station would be entitled to protection from the proposed FSS earth station. The FSS licensee could locate earth stations in an area more than 16 km from the nearest border of its service area without coordinating.[48] Most commenters that addressed this issue approved of the proposal.[49] Only one commenter objected, stating that requiring FS licensees to coordinate with FSS gateway earth stations imposes an inequitable technical and economic burden on licensees that paid for their spectrum at auction.[50]

28. The Commission proposed the second approach to coordination between FSS and FS on March 31, 2004, in the *37-40 GHz Third Notice*. In that Notice, the Commission sought comment on a proposal to apply the coordination requirement based upon PFD limits rather than distance between stations, using the same coordination criterion for Part 101 earth station licensees in the 37.5-40.0 GHz and 42.0-42.5 GHz bands as the criterion proposed for FS terrestrial stations in the same bands. The Commission noted that it had proposed to require 37.0-38.6 GHz and 38.6-40 GHz licensees to follow the frequency coordination process set out in Section 101.103(d) of the rules[51] and proposed to establish a maximum PFD or field strength limit at licensees' geographic boundaries.[52] The Commission further noted that it had eliminated specific distance coordination requirements for the 24 GHz band and required instead that operators whose stations have optical line of sight into adjacent areas contact the relevant licensees regarding mutually agreeable coordination of facilities.[53] The Commission also noted that it had completed two bilateral agreements with Canada (the Canadian Agreements), that require coordination based on PFD parameters for systems operating in the 24, 28, and 39 GHz bands near the border of the United States and Canada.[54] In the *37-40 GHz Third Notice*, the Commission tentatively concluded that these coordination agreements among U.S. licensees in the 37-42 GHz band should be based on the PFD levels referenced in the Canadian Agreements.[55] The Commission proposed to require any 37-42 GHz FS

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[47] This issue was not decided in the *V-band Second Report and Order*. The *V-band Second Report and Order* specified that this issue would be resolved in a subsequent document in the proceeding. *See V-band Second Report and Order*, 18 FCC Rcd at 25430, ¶ 2.

[48] *See V-band Further Notice,* 16 FCC Rcd at 12262, ¶¶ 49-51.

[49] *See, e.g., V-band Further Notice*, TRW Inc. Comments at 27 (filed Sep. 4, 2001); Boeing Company Reply Comments at 5-6 (filed Oct. 3, 2001); Bala Equity IV, Inc. Reply Comments at 6 (filed Oct 3, 2001).

[50] *See V-band Further Notice*, 16 FCC Rcd 12244, Wireless Communications Ass'n Int'l, Inc. Comments at 6 (filed Sep. 4, 2001).

[51] *See 37-40 GHz Third Notice,* 19 FCC Rcd at 8259-60, ¶ 69 (*citing* 47 C.F.R. § 101.103(d)).

[52] *See 37-40 GHz Third Notice,* 19 FCC Rcd at 8259-60, ¶ 69 (*citing Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands*, Notice of Proposed Rulemaking and Order, 11 FCC Rcd at 4986-87, ¶ 117 (1996)).

[53] *See 37-40 GHz Third Notice,* 19 FCC Rcd at 8260, ¶ 70 (*citing* 47 C.F.R. § 101.509).

[54] These agreements can be found at http://www.fcc.gov/ib/sand/agree/can_nonbroad_agree.html. Licensees in the 24 GHz and 39 GHz bands are required to comply with the agreements. The acceptable PFD limits under these agreements are -114 dB(W/m2) in any 1 megahertz band for both 24 GHz and 28 GHz, and -125 dB(W/m2) in any 1 megahertz band for 39 GHz.

[55] *See 37-40 GHz Third Notice*, 19 FCC Rcd at 8260, ¶ 71. In the Commission's proposal, coordination would not be necessary if the PFD generated at the boundary of another licensee's service area was below -125 dBW/m^2 in any one megahertz band.

licensee to coordinate with other licensees when its antennas had lines of sight into the other licensees' service areas.[56] Further, the Commission proposed to require such coordination for co-channel 37-42 GHz licensees in adjacent geographic areas and the same geographic areas whenever there was a case of aggregation, disaggregation, or partitioning of service areas.[57] The Commission proposed the same coordination requirements for FSS earth stations in the 37.5-42.5 GHz band.[58] All commenters that addressed this issue supported this proposal.[59] This proposal has several advantages. It permits, and even encourages, taking advantage of terrain features to shield potentially mutually interfering stations from each other. It offers greater flexibility than the distance-based rule, and is less arbitrary, because it relies on actual PFD, rather than imposing a distance criterion that is a surrogate for PFD. Finally, as noted above, it is the method currently favored in bilateral coordinations with Canada, and would therefore make our domestic requirements consistent with our international requirements.

29. In order to seek more extensive public comment on this issue, we seek comment on which of these approaches we should adopt for FSS gateway earth stations in the 37.5-40.0 GHz band, or if some other coordination requirements would better ensure effective coordination between FSS gateway earth stations and FS stations. We note that the IEEE Standard 802.16.2 calls for coordination between fixed wireless systems with separation distances of less than 80 km.[60] Given this new information, we think it appropriate to seek further comment on coordination between FS stations and FSS gateway earth stations. Commenters should provide explanations of how the approaches they support would ensure effective coordination between FSS gateway earth stations and FS stations. We will consider all comments received on this issue in both this proceeding and in our pending *37-40 GHz* proceeding.[61] We will also consider whether any proposals, the Commission's or those submitted by commenters, are consistent with the ITU Radio Regulations.[62]

D. Compensating for Rain Fade of FSS Signals in the 37.5-40.0 GHz Band

30. We propose to require FSS operators in the 37.5-40.0 GHz band to take ameliorative measures other than raising the PFD of the satellite signal to compensate for signal attenuation due to rain before they may increase PFD. We believe that requiring FSS operators to use such non-power

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[56] Optical line of sight is a visual path (an unobstructed straight line) from the transmitting antenna to another site or antenna. Buildings, curvature of the earth, or mountains would block the path of an optical line of sight transmission. Signals in these frequency ranges are subject to relatively high path and attenuation losses such that they are generally capable of causing interference over relatively short distances. We have therefore chosen to use optical line of sight, which differs slightly from radio line of sight in that optical line of sight does not take into consideration the refraction of radio waves in the atmosphere, which would have an effect if these signals traveled longer distances. Optical line of sight can be calculated using the formula $d=3.57\sqrt{h}$, where d is the distance between the antenna and the horizon in kilometers and h is the antenna height in meters. The formula for radio or effective line of sight is $d=3.57\sqrt{(Kh)}$, where K=4/3 and is the adjustment for refraction. The maximum optical distance between two antennas where htx is the transmit antenna height and hrx is the receive antenna height is $d=3.09(\sqrt{htx} +\sqrt{hrx})$.

[57] *See 37-40 GHz Third Notice,* 19 FCC Rcd at 8259-8260, ¶ 71.

[58] *See id.* at 8263, ¶ 77.

[59] *See, e.g., 37-40 GHz Third Notice*, 19 FCC Rcd 8232, Fixed Wireless Communications Coalition Comments at 1 (filed Dec. 3, 2004) and Reply Comments at 5 (filed Jan. 3, 2005); Winstar Communications, LLC Comments at 6 (filed Dec. 3, 2004) and Reply Comments at 4 (filed Jan 3, 2005); Northrop Grumman Space & Mission Systems Corp. *ex parte* submission (filed Jan. 21, 2005).

[60] *See* IEEE Standard 802.16.2, Section 6.11 "Recommendation 2-1."

[61] *See 37-40 GHz Third Notice,* 19 FCC Rcd at 8260, ¶ 71.

[62] *See* ITU RR, Appendix 7, Annex 7.

ameliorative measures before raising the PFD of the satellite signal will reduce the potential for interference to HDFS receivers in the 37.5-40.0 GHz band.

31. In implementing the soft segmentation approach in the *V-band Second Report and Order*, the Commission acknowledged that FS use of the 37.5-40.0 GHz band is primarily for HDFS applications,[63] while FSS use of this band is for gateway earth stations.[64] Accordingly, the soft segmentation approach accommodates FS in the 37.5-40.0 GHz band and FSS in the 40.0-42.0 GHz band by implementing clear-air PFD limits on FSS at a level 12 dB lower in the 37.5-40.0 GHz band than in the 40.0-42.0 GHz band.[65] As the Commission has previously stated, the availability of higher power in the 40.0-42.0 GHz band is intended to motivate HDFSS to use that band rather than the 37.5-40.0 GHz band.[66] At the same time, lower clear-air PFD limits in the 37.5-40.0 GHz band provide significant protection to ubiquitously deployed HDFS stations from interference from FSS signals. The Commission strengthened the soft segmentation concept by limiting FSS use of the 37.5-40.0 GHz band to gateway earth stations, specifically prohibiting satellite earth stations in the band from being ubiquitously deployed or used to serve individual consumers.[67]

32. Radio signals in the 37.5-42.5 GHz band are highly susceptible to "rain fade," which occurs when water droplets in the air scatter or absorb a significant portion of the radio energy. Rain fade causes substantial loss of signal, which can be compensated by increasing the power of the transmitter signal or by applying signal-processing techniques that do not involve increasing power. Rain fade affects both FS and FSS in the band.

33. The Commission acknowledged in the *V-band Second Report and Order* that rain fade would require FSS to increase PFD above the normal clear-air limits in order to meet system availability requirements.[68] The Commission did not, however, specify the precise conditions under which it would permit such power increases; nor did it define what constitutes a rain fade condition. The Commission stated in the *V-band Second Report and Order* that the record was insufficiently developed to adopt rules regarding rain fade,[69] and stated in the rules that it would continue to study rain fade and conduct a further rulemaking to decide the issue.[70]

34. The HDFS applications that have developed in the V-band have generally differed from FS operations in other bands in that a larger percentage of HDFS terminals point at increased elevation angles. An increase in the elevation angle of a fixed terminal increases the likelihood it will receive interference from FSS systems. According to both Commission and ITU studies, FS operators that implement HDFS terminals without consideration of FSS operations in the band will, in some cases, experience interference from FSS stations operating at clear-air PFD levels.[71] As FSS PFD levels increase above the normal, clear-air PFD limit to compensate for rain fade, a greater number of FS

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[63] *See V-band Second Report and Order*, 18 FCC Rcd at 25438, ¶ 23.

[64] *See id.* at 25442, ¶ 33.

[65] *See id.* at 25438, ¶ 23. The PFD limits for FSS in the band are contained in 47 C.F.R. § 25.208(q)-(t).

[66] *See id.* at 25438, ¶ 23.

[67] *See V-band Second Report and Order*, 18 FCC Rcd at 25442, ¶ 33; 47 C.F.R. § 25.202 (a)(1), n.15.

[68] *See V-band Second Report and Order*, 18 FCC Rcd at 25440, ¶ 29.

[69] *See id.* at 25440, ¶ 29.

[70] *See* 47 C.F.R. § 25.208 (p) note, (q) note.

[71] *See id*.

stations will be affected.[72]

35. Commission staff analysis of rain fade indicates that, under rain fade conditions, in order to provide service at least 99.9 percent of the time, FSS satellites will occasionally need to increase their PFD above the lower clear-air PFD limit.[73] At the same time, this analysis concludes that, at the clear-air PFD limits, approximately one percent of the FS links could receive harmful interference from FSS.[74] At PFD limits 12 dB higher than the clear-air PFD limits (*i.e.*, the maximum PFD limits for FSS in the 40.0-42.0 GHz band), between four and five percent of FS links could experience interference from FSS.[75] We seek ways to reduce the potential for the occurrence of possible interference from FSS to FS, while still allowing FSS to maintain some level of service.

36. There are at least three measures that FSS operators can take to increase the robustness of their signals without increasing power: 1) changing to more robust modulation schemes, 2) increasing channel coding, and 3) reducing data throughput.[76] The difficulty with these measures is that they generally reduce the FSS link capacity approximately in inverse proportion to the increase in the ability of the FSS user equipment to receive a usable signal, known as "signal reliability."[77] In other words, at a fixed PFD level, FSS operators must trade off between the amount of data they can transmit and the robustness of the satellite signal. Because we are pursuing the twin goals of allowing FSS to maintain signal availability, while at the same time minimizing the possibility of interference to FS, we believe that these non-power ameliorative measures should be used in combination with PFD increases to compensate for rain fade. In this way, FSS operators can minimize the amount of time that an FS link receives a PFD above clear-air levels from FSS.

37. We therefore seek a balance between minimizing the amount of time FS links could experience any increase in PFD from FSS above clear-air levels on one hand, and allowing FSS to use a combination of PFD increases and non-power ameliorative measures to maintain the desired signal availability on the other. We believe that the best compromise is to ensure that FS links experience PFD increases from FSS above clear-air levels no more than 1.5 percent of the time.[78] This will allow FSS to maintain signal availability in all areas of the country by applying non-power ameliorative measures that

[72] *See* Appx. A, § 3.3.

[73] *See* Appx. A, § 3.2.

[74] In this analysis "interference" means that the FS link is receiving a level of unwanted power that is greater than one-tenth of the existing FS noise level from GSO FSS satellites assuming the GSO is fully loaded with satellites.

[75] *See* Appx. A, § 3.2.

[76] As noted in Appendix A the bandwidth of FSS uplink and downlink bands associated with the FSS gateway operations in HDFS bands are unbalanced. That is, one gigahertz from 47.2-48.2 GHz is paired with the 2.5 gigahertz from 37.5-40.0 GHz. We seek comment on whether the additional 500 MHz from 42.0-42.5 GHz could be used to decrease the loss of channel-capacity in FSS systems during times of high rain fade. In particular, we ask if FSS systems operating in this 500 MHz can meet RAS sharing criteria if we assign this band to FSS systems operating in the areas of the United States with the highest rain rates, in order to increase FSS system availability.

[77] For example, an increase of 3 dB in the FSS link margin provided by the non-power ameliorative measures mentioned above (thereby doubling the robustness of the signal) would be accompanied by a 3 dB decrease in system capacity (halving the amount of information the system could carry).

[78] While this *Notice* is intended to make proposals to ensure that FS experiences PFDs greater than clear-air PFDs no more than 1.5 percent of the time, we realize, as described below and in Appendix A, that there is a tradeoff between the impact of our proposed rules on FS and FSS. As described in Section 4.4 of Appendix A, reducing the percent of time FS experiences increased PFDs increases the negative impact on FSS, and vice versa. We request input from both the FS and FSS stakeholders on the proper values to use in making this tradeoff in support of soft segmentation.

reduce FSS system capacity by up to 73% in the areas with the most severe rain fades (*i.e.*, where average yearly rainfall is heaviest, as explained below) while maintaining signal availability in all areas of the country.

38. In order to achieve our goal of ensuring that FS links experience increased PFD from FSS no more than 1.5 percent of the time, we propose to require FSS operators experiencing rain fade to first use non-power ameliorative measures to a level calculated to ensure that FS operators experience increases in PFD at most one and one-half percent of the time.[79] Specifically, we propose to require FSS operators in the 37.5-40.0 GHz band whose systems suffer from rain fade to apply non-power ameliorative measures to a level of "X" dB, where X depends upon the rain rate[80] at the location of the earth station, after which we would allow them to increase PFD up to 12 dB to compensate for additional rain fade. A detailed discussion of this approach is contained in Appendix A.

39. For example, in order for an FSS Earth station located near New York City to maintain signal reliability 99.9 percent of the time, rain fade conditions would require the FSS operator to increase its signal robustness by up to 25 dB.[81] Our staff analysis indicates, however, that if the FSS operator used a 12 dB increase in PFD to overcome rain fade, some FS links would experience an increased probability of interference.[82] If, in this example, the FSS operator raised PFD levels to compensate for the first 12 dB of rain fade, some FS links would experience an increase in PFD – and therefore an increased likelihood of interference – from FSS as much as ten percent of the time.[83] If, on the other hand, the FSS operator employed 4.2 dB of non-power ameliorative measures to overcome rain fade prior to increasing PFD, our analysis indicates that this would reduce the exposure of the FS link to an increase in PFD above the clear-air values from ten percent down to a maximum of one and one-half percent of the time. These non-power ameliorative measures would also reduce the exposure of the FS link to the full 12 dB increase in PFD to less than one-quarter of one percent of the time.

40. To continue the example, our proposal would require the FSS operator near New York City to use 4.2 dB of non-power ameliorative measures before increasing PFD levels. If rain conditions were severe enough to require an increase in signal reliability of more than 4.2 dB, our proposal would allow the FSS operator to apply PFD increases of up to 12 dB as needed to maintain signal reliability. The 4.2 dB of non-power ameliorative measures plus an increase of 12 dB in PFD equals an effective increase in signal robustness of 16.2 dB, which would maintain signal reliability 99.8 percent of the time. If a rain fade were so severe as to require an even greater increase in signal robustness (approximately two-tenths of one percent of the time), the FSS operator could then apply more non-power ameliorative

[79] This means that our calculation determines a location, some distance away from the FSS target Earth station, which has the highest probability of experiencing PFD levels higher than clear-air values. We expect that FS links would experience PFD levels above "clear-air" level no more than 1.5% of the time. All other locations would experience increased PFD levels for less than 1.5% of the time.

[80] Rain rate is a commonly used measure of the rain statistics of a geographic area. An area's rain rate is amount of rain, in millimeters per hour (mm/hr), that the area exceeds for 0.01% of the average year.

[81] Some of the "robustness" and "link margin" values used here and in Appendix A may not be operationally practical, and we use them as examples. The values we use in this *Notice* are the result of the availability values for FSS signals, *i.e.*, 99.9%. The result of the tradeoff analysis in Appendix A, which involves the percent of time an FS in a worst-case location may experience an increase in PFD versus the capacity loss of an FSS, are not dependent on the value of availability used in the FSS link.

[82] An increase in PFD would not necessarily result in an increase in interference to any particular FS link, because interference is caused by a number of factors, including orientation of the FS receive antenna. An increase in PFD would, however, increase the probability that an FS link would receive interference from the FSS operator.

[83] Using ITU-R 618-7, an FSS operating to the area of New York City, with an elevation angle of 30 degrees, will experience a full 12 dB rain fade only 0.42% of the time.

measures, up to the level needed to overcome the rain fade.

41. In other words, during the first stage of a rainstorm in New York City, the FSS earth station would receive a weaker signal from the FSS space station, and the FSS operator would respond by applying non-power ameliorative measures. As the rain fade worsened and the FSS operator reached the point where it was applying the full 4.2 dB of non-power ameliorative measures, it could then begin to increase its PFD to maintain signal availability, using the minimum power necessary to overcome the marginal signal loss caused by the rain fade after the full 4.2 dB of non-power ameliorative measures have been applied.[84] Using the non-power ameliorative measures and full increase of 12 dB in PFD, the FSS operator would have a total of 16.2 dB increase in robustness. If, however, the rainstorm continued to worsen, the FSS operator could then apply further non-power ameliorative measures to maintain signal reliability. A further 8.8 dB of non-power ameliorative measures, added to the previous 16.2 dB of combined non-power ameliorative measures and PFD increases, would equal a total increase of 25 dB in signal robustness. The 25 dB level would allow an FSS earth station to maintain 99.9 percent signal availability in the New York City area even during the worst rainstorms. By requiring the initial use of 4.2 dB of non-power ameliorative measures, this proposal would ensure that an FS link in the New York City area would experience any increase in PFD above the clear-air level no more than of 1.5 percent of the time, because FS links are shielded from FSS PFD both by the same rain fade that affects FSS earth stations and by the FSS antenna roll-off.[85] Such an FS link would experience PFD a full 12 dB above clear-air levels less than one-quarter of one percent of the time. This must be compared with the FS experiencing increased PFDs for about 10 percent of the time if the FSS uses PFD to overcome rain fade in an uncontrolled fashion.

42. Our proposal also applies to cities with lower and higher rain rates than New York City. Our proposed mixture of non-power ameliorative measures and PFD increases maintain two goals in almost every case: reception of increased PFD by FS links no more than 1.5 percent of the time and reduction of signal capacity for FSS of no more than 75 percent. Of the 32 cities in our technical analysis, the city with the lowest rain rate, San Diego, associates a rain fade loss for FSS of approximately 10.5 dB for an availability of 99.9 percent for FSS. After applying one dB of non-power ameliorative measures, an FSS operator would need to increase PFD by only 9.5 dB in order to maintain the 99.9 percent signal availability, and would never need to increase PFD by the full 12 dB. In the worst case location near San Diego, an FS link would experience some increase in PFD from FSS no more than 1.5 percent of the time, and would never experience the maximum 12 dB increase in PFD. If increased PFDs were used exclusively to overcome rain fade, unaccompanied by non-power ameliorative measures, FS stations near San Diego would experience increased PFDs about 4 percent of the time.[86]

43. Atlanta, on the other hand, has one of the higher rain rates in the United States. In order to maintain a signal availability of 99.9 percent in Atlanta, FSS would have to be capable of overcoming a maximum rain fade of approximately 36 dB. In this case, assuming the FSS was not using a diversity

[84] By applying 4.2 dB of non-power ameliorative measures, the FSS operator in New York would sacrifice a substantial percentage of system capacity. By allowing the FSS operator to increase PFD only on a dB-by-dB basis, we would allow the FSS operator to increase PFD only to the extent needed to overcome rain fade in excess of the 4.2 dB of rain fade that the FSS operator overcame by applying non-power ameliorative measures. We do not propose to allow the FSS operator to increase PFD to regain the system capacity lost through applying non-power ameliorative measures.

[85] Stations sufficiently far away from the FSS Earth station experience lower level of PFD because of the roll-off of the FSS spot beam antenna; *see* Appx. A, § 3.3.

[86] In the rain fade analysis presented in Appendix A below, Los Angeles is listed as the city with the lowest level of rain fade loss. Here we analyze the case of San Diego because San Diego has the lowest rain rate of the 32 cities in the study. Los Angeles has the second lowest rain rate of the cities in the study and due to secondary factors in the analysis has the lowest rain fade.

Earth station, our proposal would require FSS to apply 6.1 dB of non-power ameliorative measures before increasing PFD. If the FSS increased PFD the maximum of 12 dB, the total increase in robustness would be 17.9 dB. This increase in signal robustness would be capable of overcoming rain fade 99.6 percent of the time. The decrease in FSS channel capacity with this level of non-power ameliorative measures would be approximately 75 percent. The remaining signal robustness required to reach an availability of 99.9 percent of the time would have to be obtained without further increase in PFD. FS links in the worst case location near Atlanta would experience some increase in PFD from FSS no more than 1.5 percent of the time, compared with the 10 to 15 percent of the time with no constraints on FSS, and would experience the maximum 12 dB increase in PFD from FSS approximately 0.4 percent of the time.[87]

44. Our reasoning addresses the needs of FS and FSS in the 37.5-40.0 GHz band while maintaining our soft segmentation approach. FS operators want to reduce the increase in PFD from FSS as much as possible. FSS operators are interested in maintaining a level of signal reliability at or above a commercial level, and in keeping system capacity as high and uniformly stable as possible. The decision to designate the 37.5-40.0 GHz band primarily for HDFS by soft segmentation obligates us to establish rules that favor FS, but also to allow FSS to continue operating. Under our proposal, FSS in areas with the heaviest rainfall must apply 5.7 dB of non-power ameliorative measures before they are permitted to increase PFD and to use diversity earth stations. This means that, in rain fade conditions, FSS will sacrifice approximately 73 percent of its system capacity in applying non-power ameliorative measures prior to being permitted to increase PFD levels and to assume the added expense of a diversity Earth station.[88] We believe that requiring a higher level of non-power ameliorative measures than that already proposed would effectively deny the 37.5-40.0 GHz band to FSS by requiring too great a reduction in system capacity. The requirements we have proposed for non-power ameliorative measures would ensure that FS links experience some PFD levels from FSS above the clear-air PFD level no more than 1.5 percent of the time compared with the significantly higher percentages of time that would occur without such rules.

45. We believe this approach will not burden FS. First, 1.5 percent of the time is the maximum that FS would experience any increase in PFD from a single FSS satellite.[89] In most cases the

[87] Miami has the highest rain rate of any of the 32 cities studied, and is one of the four cities that cannot meet our goals of both increased PFD to FS no more than 1.5% of the time and reduction of FSS signal capacity of no more than 75% without the use of diversity earth stations. The rain fade in Miami is 51 dB. In order to meet the goal of ensuring that FS links receive the full 12 dB of increased PFD no more than 1.5% of the time, FSS satellites transmitting to Miami must apply 5.7 dB of non-power ameliorative measures before increasing PFD by up to 12 dB. Even at the full 17.7 dB of combined non-power ameliorative measures and PFD increase, FSS gateway earth stations in Miami will need to use diversity earth stations to compensate for rain fade. These measures in combination will produce an FSS signal availability of 99.6%, lower than our goal of 99.9%. Orlando, Tampa and Houston would also not be able to meet 99.9% signal availability without the use of diversity earth stations. We acknowledge that our proposal does not meet our stated goals for these cities, but we believe our proposal is a reasonable trade-off between FSS signal availability versus minimizing the potential for interference to FS.

[88] If a diversity earth station is not employed by an FSS system serving Miami, the system would have to employ 7.8 dB of non-power ameliorative measures, which would cost approximately 84% of the FSS link capacity.

[89] The percentage to time analysis in Appendix A addresses an FSS satellite bore-sighted on a single earth station. If multiple earth stations exist within the footprint of the FSS downlink beam, several possibilities exist. If the earth stations are treated as being independent, the percent of time that the FSS satellite would use higher PFD would increase to compensate for rain-fades at multiple locations. If the earth stations were linked together to form a diversity network, the percent of time that the FSS satellite would have to use higher PFD would decrease because of the effects of the diversity-gain. We seek comment on whether it is likely that FSS operators will use multiple gateway earth stations within the footprint of a single FSS beam, given that this band is reserved for gateway earth stations. If so, we seek comment on which effect is the most likely - an increase or a decrease in the percent of time PFDs are raised.

PFD increases from FSS would not approach the maximum allowable level of 12 dB above clear-air PFD limits. Second, PFD increases do not necessarily constitute harmful interference. Our staff analysis includes a substantial safety margin for FS links.[90] Third, FS links can use both power control and non-power ameliorative measures to mitigate the possibility of interference, just as FSS can use these techniques.

46. The balance in our proposal would allow FSS to cause increased PFD to FS links not more than 1.5 percent of the time. Meeting this requirement would require FSS serving areas with the highest rain rates to cut system capacity by up to 73 percent during the worst rain fades before it could raise PFD. Under our proposal, a 73 percent reduction in channel capacity would occur only in the areas of the United States with the highest rain rates, such as the Miami area. In regions of the United States with moderate rain rates, the maximum loss of channel capacity would be approximately 65 percent and in regions with low rain rates, such as San Diego, the maximum loss of channel-capacity would be approximately 25 percent. Further, these maximum losses of channel capacity would only occur during the most severe rain events.[91] Other values for the amount of time FS links experience increased PFD produce other values for the percentage of FSS system capacity reduction. Section 4.4 of Appendix A addresses the tradeoff between the costs to the FS systems and the costs to the FSS system of implementing this form of soft-segmentation. We tentatively conclude that the balance of increased PFD to FS links no more than 1.5 percent of the time, which would require FSS to cut system capacity by 73 percent during the worst rain storms, is appropriate. We ask if this is the proper trade-off point between the FS and FSS operations.

47. We do not need to define precisely rain fade or account for different average rain rates in the United States, because an FSS operator will have a strong incentive to avoid reducing its system capacity by employing non-power ameliorative measures, unless absolutely necessary to maintain signal availability. Therefore, we do not expect FSS operators to use their rain fade PFD increases except to respond to demands placed on their systems by rain fade. Further, because non-power ameliorative measures are accompanied by reduction of FSS system capacity, FSS operators will avoid using non-power ameliorative measures whenever they are not needed. Therefore, because our proposal only allows FSS operators to increase PFD after they have applied non-power ameliorative measures, FSS operators will have an incentive to avoid increasing PFD unless genuinely needed.[92]

48. We request comment on this proposal. Specifically, we request comment on whether the levels of non-power ameliorative measures we require of FSS and our determination that an increase in PFD from FSS experienced by FS links a maximum of 1.5 percent of the time, balanced with requiring FSS to reduce its system capacity no more than 73 percent to overcome rain fade, is the most appropriate implementation of our soft segmentation approach. Commenters should fully explain the implications of their suggestions for both services of any other level of interference to FS or signal availability for FSS and explain how these implications fit within the context of soft-segmentation. If FS links require protection from PFD increases from FSS so that the FS links experience increased PFD levels less than 1.5 percent of the time, we request that the commenter supply a detailed technical analysis as to the appropriate value. Further, we ask that commenters identify any other non-power ameliorative measures

[90] The ITU analysis upon which our staff analysis is based contains a number of conservative assumptions. Using these assumptions in our staff analysis provides a safety margin for FS links. *See* Appx. A, § 3.3.

[91] *See* Appx. A, § 4.4.

[92] Because increases in PFD and rain fades are measurable, FS operators that believe they are experiencing increased PFD from satellites when rain fades do not justify PFD increases can complain to the Commission. Should such a complaint come to us, we would be able to verify from the records of FSS operators whether non-power ameliorative measures or FSS PFD was increased at a specific time, and to determine whether non-power ameliorative measures were applied prior to the increase in PFD, as required by our proposal.

that may exist. We also inquire whether we should apply specific numerical criteria to each of the non-power ameliorative measures, or whether we should simply require an overall increase in signal reliability by one or more ameliorative measures. We request detailed technical analyses of any alternatives suggested by commenters.

49. Commenters should also address whether the approach described in Appendix A can be implemented using technology currently available to FSS operators. Does limiting FSS operators to increasing PFD only after non-power ameliorative measures are used during rain fade conditions overly constrain FSS operations or overly protect HDFS operations? On the other hand, does this approach adequately protect HDFS operations from harmful interference? Are our assumptions in Appendix A, including an assumption that FSS operators desire 99.9 percent signal reliability, valid? If not, what other assumptions should we consider as we develop our rules? If we adopt our approach in a future proceeding, will there be disincentives for future FSS or HDFS implementation? If so, are there alternative approaches to compensating for rain fade that would provide an incentive to both FSS and HDFS operations and that would encourage greater use of the V-band?

50. Alternatively, we could require all FSS operators to apply a uniform minimum of non-power ameliorative measures before increasing power. This would be less complicated for FSS operators and the Commission than using a variable approach because it would avoid disagreements over the application of statistical weather data for a given area. We note, however, that this uniform approach would increase protection for FS in areas with lower rain rates by requiring FSS operators to cut their system capacity when it may not be necessary to ensure that FS links experience PFD increases from FSS above clear-air levels no more than 1.5 percent of the time. A uniform requirement of six dB of non-power ameliorative measures, for example, would require operators in the Los Angeles area to cut system capacity by up to 75 percent before increasing power. A uniform reduction of six dB would tend to decrease protection for areas with high rain rates, such as Miami, which could receive increased PFD from satellites more than 1.5 percent of the time if we set the uniform minimum too low. For example, with a uniform requirement of six dB of non-power ameliorative measures before FSS operators could increase power, Los Angeles FS would experience a rise in PFD only about 0.2 % of the time while FS in the Miami area would experience a rise about 2.2 % of the time. We seek comment on this alternative. Specifically, we inquire whether six dB is the appropriate figure, if a uniform standard is desirable.

51. A second alternative the Commission could adopt is to require that the pointing centers of FSS satellites' spot beams cannot fall over any of the top 200 cities in the continental United States where FS is presumed to operate. For instance, one satellite beam could be pointed halfway between Chicago and St. Louis. Satellites could then raise their PFD much higher and more often if all FS stations were in the higher roll-off zones. Typically, the satellite coverage contour in this frequency band from an antenna with a beamwidth of 0.5 degree will have its maximum gain over an ellipsoid on the surface of the earth with a long axis of the ellipse of about 200 miles (320 kilometers). Inside this ellipse will be the optimum area for earth stations to be located and operate. Outside of this "maximum gain" contour, the antenna gain decreases (rolls off) and makes it more difficult for the earth stations to operate, while at the same time improving the environment for FS stations due to the lesser potential for harmful interference from the satellite. The satellite power drops below 12 dB at about 750 miles from the pointing center of the ellipse. This means that FS stations outside of 750 miles from the center of the ellipse will probably never experience clear air PFD values from one satellite even if it increases its power to the full rain fade value of 12 dB. The potential downside of this proposal is that FSS gateway earth stations would operate most effectively only in more rural areas and would likely have to backhaul their signals to cities.[93] We

[93] *See Amendment of the Commission's Rules Regarding the 37-38.6 GHz and 38.6-40.0 GHz Bands; Implementation of Section 309(j) of the Communications Act – Competitive Bidding, 37.0-38.6 GHz and 38.6-40.0 GHz Bands*, Memorandum Opinion and Order, ET Docket No. 95-183, RM-8553, PP Docket No. 93-253, FCC 99-

(continued....)

seek comment on this alternative.

52. A third alternative could be to require the satellite operators to determine where each FS station is located and further determine whether the FS station is experiencing the same rain fade as the earth station making the power request. The most significant problem for FS operations is that a rain cell may only be a few kilometers wide. A rain cell may therefore be over an earth station, which then requires a PFD increase from the satellite due to rain fade, but the same rain cell may not be between the FSS satellite and the FS stations. Under these circumstances, the FS stations could receive the full power from the satellites and suffer an increased chance of harmful interference. Several ways exist to implement this alternative; however, each would require that FS and FSS stations inform each other of the locations of their sites, operating frequency bands, and pointing angles, which could be accomplished by maintaining a registration database in addition to implementing a real-time monitoring system to determine where rain cells are located. We seek comment on this alternative. Particularly, we inquire what the costs of such coordination and operation would be, and who should bear those costs.

53. We could also require that maximum rain fade PFD limits account for the additive effect of signals from multiple satellites reaching the same area on the ground. This would eliminate the need to calculate how many orbital locations are filled. We would also need to consider foreign satellite compliance with PFD limits over the United States, and we seek comment on this issue. Where the clear air PFD limit would be exceeded during rain fade, we could require that all satellite operators transmitting to the same location on the surface of the earth with overlapping beams in the same frequency band coordinate their power increases so that the total cumulative increase does not exceed the allowed value of 12 dB. We note that this alternative would require real-time coordination among satellite operators, which we have never required in the past, and would involve the unusual interpretation that the PFD limits placed on GSO satellite are actually aggregate limits from all GSO FSS and not individual limitations on each satellite. We seek comment on this alternative, including the costs of such coordination and who should bear those costs.

54. We request that commenters address the possible impact of existing international agreements or letters of understanding on this proposal and alternatives. The United States currently has an arrangement with Canada that specifies that FSS operators will not raise PFD above our clear-air limits without coordination with Canada.[94] What technical or regulatory problems could arise from allowing FSS operators to increase PFD to compensate for rain fade in the United States, while at the same time meeting the requirement for the lower, clear-air PFD levels in Canada?

55. We also note that the designation of 2.5 gigahertz of downlink (space-to-Earth) spectrum for FSS in the 37.5-40 GHz band is paired with one gigahertz of uplink (Earth-to-space) spectrum, resulting in an asymmetrical designation. The non-power ameliorative measures we have addressed above do not make use of the unbalanced uplink and downlink bandwidths associated with FSS gateway frequency bands. There are at least two sharing techniques that could make use of these unbalanced bandwidths to reduce the effect of FSS operations on the HDFS. Both the ITU and the Commission staff model referred to in Appendix A, section 3.4, assume that each FS antenna is receiving unwanted power from all visible FSS satellites. One way to reduce the unwanted power at the FS site would be to limit the FSS to a maximum of 1 GHz of downlink within the 2.5 GHz wide 37.5-40.0 GHz band. A limitation of this type would reduce unwanted power from the transmitting FSS seen by the average FS site by about

(...continued from previous page)
179, 14 FCC Rcd 12428, 12455 n.193 (noting that terrestrial facilities may be deployed in urban areas while satellite facilities, particularly gateway earth stations, may be deployed in rural areas).

[94] *See, e.g.*, Arrangement Between Canada and the United States on Principles to Govern Use of the 37.4-42.5 GHz Band (attachment to letter from Michael Binder, Assistant Deputy Director, Spectrum Information Technologies and Telecommunications, Industry Canada, to Don Abelson, Chief, International Bureau (dated Apr. 10, 2002)).

60 percent, thereby reducing the probability that any given FS site would receive interference. A rule of this type might improve soft segmentation sharing between the FSS and FS while permitting the FS to operate to gateway Earth stations. Another approach could be to require that the FSS use spectrum spreading to take advantage of the larger downlink bandwidth prior to increasing PFD. We note that, typically, satellites are power limited and increasing the downlink bandwidth at a fixed power density level would require that the satellite increase the power in the downlink, which may not be possible, depending upon the satellite communication load at the time. We request comment on requiring the use of spectrum spreading on the satellite downlink prior to permitting any increase in PFD.

IV. PROCEDURAL MATTERS

A. Regulatory Flexibility Act

56. As required by the Regulatory Flexibility Act, the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) regarding the possible significant economic impact on a substantial number of small entities of the proposals addressed in this *Third Notice of Proposed Rulemaking* (*Third Notice)*. The IRFA is set forth in Appendix B. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines for comments on the *Further Notice*, and they should have a separate and distinct heading designating them as responses to the IRFA.

B. Paperwork Reduction Act of 1995

57. This *Third Notice* contains either a proposed or modified information collection. As part of its continuing effort to reduce paperwork burdens, we invite the general public and the Office of Management and Budget (OMB) to take this opportunity to comment on the information collections contained in this *Third Notice*, as required by the Paperwork Reduction Act of 1995, Public Law 104-13. Public and agency comments are due at the same time as other comments on this *Third Notice*; OMB comments are due 60 days from date of publication of this *Third Notice* in the Federal Register. Comments should address: (a) whether the proposed collection of information is necessary for the proper performance of the functions of the Commission, including whether the information shall have practical utility; (b) the accuracy of the Commission's burden estimates; (c) ways to enhance the quality, utility, and clarity of the information collected; and (d) ways to minimize the burden of the collection of information on the respondents, including the use of automated collection techniques or other forms of information technology.

58. The Commission will send a copy of this *Notice of Proposed Rulemaking* in a report to Congress and the Government Accountability Office pursuant to the Congressional Review Act.[95]

C. Ex Parte Rules

59. *Permit-But-Disclose.* This proceeding will be treated as a "permit-but-disclose" proceeding subject to the "permit-but-disclose" requirements under Section 1.1206(b) of the Commission's rules.[96] *Ex parte* presentations are permissible if disclosed in accordance with Commission rules, except during the Sunshine Agenda period when presentations, *ex parte* or otherwise, are generally prohibited. Persons making oral *ex parte* presentations are reminded that a memorandum summarizing a presentation must contain a summary of the substance of the presentation and not merely a listing of the subjects discussed. More than a one- or two-sentence description of the views and

[95] *See* 5 U.S.C. § 801(a)(1)(A).

[96] *See* 47 C.F.R. § 1.1206(b); *see also* 47 C.F.R. §§ 1.1202, 1.1203.

arguments presented is generally required.[97] Additional rules pertaining to oral and written presentations are set forth in Section 1.1206(b).

D. Filing Requirements

60. *Comments and Replies*. Pursuant to Sections 1.415 and 1.419 of the Commission's rules,[98] interested parties may file comments and reply comments **on or before** 45 days after publication in the Federal Register and reply comments **on or before** 75 days after publication in the Federal Register. Comments may be filed using: (1) the Commission's Electronic Comment Filing System ("ECFS"), (2) the Federal Government's eRulemaking Portal, or (3) by filing paper copies.[99]

61. *Electronic Filers:* Comments may be filed electronically using the Internet by accessing the ECFS: http://www.fcc.gov/cgb/ecfs/ or the Federal eRulemaking Portal: http://www.regulations.gov. Filers should follow the instructions provided on the website for submitting comments. For ECFS filers, if multiple docket or rulemaking numbers appear in the caption of this proceeding, filers must transmit one electronic copy of the comments for each docket or rulemaking number referenced in the caption. In completing the transmittal screen, filers should include their full name, U.S. Postal Service mailing address, and the applicable docket or rulemaking number. Parties may also submit an electronic comment by Internet e-mail. To get filing instructions, filers should send an e-mail to ecfs@fcc.gov, and include the following words in the body of the message: "get form." A sample form and directions will be sent in response.

62. Written comments by the public on the proposed and/or modified information collections are due **on or before** 45 days after publication in the Federal Register. Written comments must be submitted by the Office of Management and Budget (OMB) on the proposed and/or modified information collections on or before 60 days after date of publication in the Federal Register. In addition to filing comments with the Secretary, a copy of any comments on the information collection(s) contained herein should be submitted to the Secretary, Federal Communications Commission, Room TW-A325, 445 12th Street, SW, Washington, DC 20554, or via the Internet to jboley@fcc.gov and to Virginia Huth, OMB Desk Officer, 10236 NEOB, 725 – 17th Street, N.W., Washington, DC 20503 or via the Internet to vhuth@omb.eop.gov.

63. *Paper Filers:* Parties who choose to file by paper must file an original and four copies of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number. Filings can be sent by hand or messenger delivery, by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail (although we continue to experience delays in receiving U.S. Postal Service mail). All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.

- The Commission's contractor will receive hand-delivered or messenger-delivered paper filings for the Commission's Secretary at 236 Massachusetts Avenue, NE., Suite 110, Washington, DC 20002. The filing hours at this location are 8:00 a.m. to 7:00 p.m. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes must be disposed of before entering the building.
- Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9300 East Hampton Drive, Capitol Heights, MD 20743.

[97] *See id*. § 1.1206(b)(2).

[98] *See id*. §§ 1.415, 1.419.

[99] *See Electronic Filing of Documents in Rulemaking Proceedings*, Report and Order, GC Docket No. 97-113, FCC 98-56, 13 FCC Rcd 11322 (1998).

- U.S. Postal Service first-class, Express, and Priority mail should be addressed to 445 12th Street, SW, Washington DC 20554.

64. *Availability of Documents*. Comments, reply comments, and *ex parte* submissions will be available for public inspection during regular business hours in the FCC Reference Center, Federal Communications Commission, 445 12th Street, S.W., CY-A257, Washington, D.C., 20554. These documents will also be available via ECFS. Documents will be available electronically in ASCII, Word 97, and/or Adobe Acrobat.

65. *Accessibility Information*. To request information in accessible formats (computer diskettes, large print, audio recording, and Braille), send an e-mail to fcc504@fcc.gov or call the FCC's Consumer and Governmental Affairs Bureau at (202) 418-0530 (voice), (202) 418-0432 (TTY). This document can also be downloaded in Word and Portable Document Format (PDF) at: http://www.fcc.gov.

V. ORDERING CLAUSES

66. Accordingly, **IT IS ORDERED** that, pursuant to the authority contained in Sections 4(i), 303(r), 403, and 405 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 303(r), 403, and 405, this *Third Notice of Proposed Rulemaking* **IS ADOPTED**.

67. **IT IS FURTHER ORDERED** that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, **SHALL SEND** a copy of this *Third Notice of Proposed Rulemaking*, including Initial Regulatory Flexibility Certification, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

Development of Possible HDFS/FSS Gateway Earth Station Sharing Criteria

1.0 Summary

This Appendix describes a possible approach to developing V-band Fixed Satellite Service (FSS) service rules that would significantly limit potential interference to the high density Fixed Service (HDFS) in the 37.5-40.0 GHz band, while permitting FSS to operate gateway earth stations in the band.

The 37.5-40.0 GHz band is shared between Fixed Service (FS) systems and downlinks of the FSS. FS uses this band for HDFS[100] while FSS uses it for gateway operations.[101] Normally, co-primary FS and FSS systems must go through a coordination process to ensure that newly introduced stations of either service will not cause or receive interference. Implementation of HDFS, on the other hand, on a co-primary basis with FSS implies deployment without coordinating with FSS and without receiving harmful interference.

The Commission has designated the 40.0-42.0 GHz frequency band for high density FSS (HDFSS) operations to customer premises. In the 37.5-40.0 GHz band, current Commission regulations permit FSS to operate continuously with 'clear-air' power flux density (PFD)[102] levels and allow increases in PFD levels up to 12 dB above the clear-air level to compensate for rain fades. In the 40.0-42.0 GHz band FSS may operate continuously at the higher PFD level.

Severe rain fades that occur in the V-band affect the way both FS and FSS systems are designed and operated.[103] The intense rainstorms responsible for creating the most severe rain-fades are generally only a few kilometers wide. The use of diversity earth stations within the FSS system can alleviate, but will not eliminate, the need for PFD levels above the clear-air level. Some operations above clear-air PFD levels will be necessary for FSS to meet system availability requirements.

If HDFS terminals are implemented without consideration of FSS systems, FSS clear-air PFD levels will cause some interference to some FS sites. Both International Telecommunication Union (ITU) and Commission staff studies agree that higher FSS PFD levels affect more FS links. The HDFS applications used in the V-band differ from fixed operations in many other bands because a relatively high number of FS station antennas are pointed at higher elevation angles, and are therefore more likely to be sensitive to receiving interference from FSS systems.

[100] The designation of a frequency band as a "high density" band means that the designated service should be able to deploy a large number of terminals (i.e., ubiquitous deployment), within a given area, without undergoing the expense and delay of having to coordinate with other co-primary services.

[101] Gateway operations do not originate or terminate traffic, but interconnect user terminals with the satellite. Gateway operations are not for the exclusive use of a single customer. As a result, we expect FSS gateway operations to employ relatively few receiving sites, and those sites will not be ubiquitously deployed on customer premises.

[102] Power flux density is a measure of the satellite transmitted power, in a reference bandwidth, incident on the surface of the Earth. "Clear-air" PFD is the level of PFD that is 12 dB below the internationally authorized PFD levels for the V-band contained in ITU-R International Radio Rules, Art. 21, Table 4.

[103] Rain fade is the phenomenon by which radio signals are scattered and absorbed by water droplets in the air, thus reducing signal reliability. Rain fade varies with frequency, and is quite severe in the 37.0-43.0 GHz band.

FS operators seek to limit FSS use of PFD above the clear-air level in order to minimize the number of HDFS sites that may receive interference when FSS operates at higher PFD. FSS operators, on the other hand, seek to provide service at a specified availability level to gateway earth stations that require operating some period of time above the clear-air PFD levels. The Commission seeks to find a way to meet the operational needs of FSS without causing unreasonable interference to HDFS.

Because of high rain fade losses over much of the country, FSS systems must use several different techniques, in addition to raising PFD levels, to meet system availability requirements. Rain fade in the United States ranges from a high of 51 dB in Miami, FL, to a low of 9 dB in Los Angeles, CA.[104] The rain fade for New York City (NYC), for the conditions under discussion, is approximately 25 dB.[105] Rain fades in most parts of the United States are considerably greater than the maximum allowable increase in PFD of 12 dB. In many cases, alternate rain fade compensation techniques, referred to here as "non-power ameliorative measures," will be required in addition to increased PFD levels. Use of these non-power ameliorative measures should have no negative effect on the HDFS. If FSS uses non-power ameliorative measures prior to increasing PFD levels, the percentage of time that PFD is raised above 'clear-air' levels can be limited. At the same time, the percentage of time that FS stations are exposed to the highest levels of PFD can be significantly reduced.

Implementing non-power ameliorative measures, however, affects FSS by reducing the amount of user traffic that can be transmitted over a given bandwidth. This means a loss of channel capacity for the FSS systems while non-power ameliorative measures are in use. Conversely, increasing PFD to overcome rain fade does not directly result in reduced channel capacity. A schedule that defines how much non-power ameliorative compensation to employ, prior to increasing PFD levels, can be developed based on the average rain rate at the earth station location. Such a rain fade compensation schedule could form the basis for rules regarding FSS rain fade compensation. FSS systems could be required to apply non-power ameliorative measures to compensate for certain amounts of rain fade prior to increasing PFD levels. The deployment of such a schedule can account for the use of diversity earth stations. This approach involves a trade-off that limits the percentage of time FS sites are exposed to PFD levels above those of clear-air operations, at the cost of reduced channel capacity for FSS operations during rain fades. Developing service rules based on such a rain fade compensation schedule would permit HDFS to operate in a known, relatively benign interference environment while permitting FSS to operate with the desired reliability.

2.0 Introduction

The World Radiocommunication Conference of 2000 (WRC-2000) considered allocations in the 37.5-43.0 GHz range to both FS and FSS.[106] The decision of WRC-2000, supported by the United States, was

[104] These figures assume 99.9% satellite signal availability, a satellite link elevation angle of 30º and a mid-band frequency of 38.75 GHz. The assumed availability figure comes from the ITU JWP4-6S Chairman's Report 3 July 2002, Attachment 4, Annex 2, page 2. Additionally, because rain-fade losses increase significantly as the elevation angle of the Earth station decreases, we expect that most GSO FSS systems will operate with elevation angles of 30 degrees or higher.

[105] This means that rain fade conditions near NYC cause the signal reliability of FSS systems to degrade from clear-air levels by 25 dB or more, for 0.1 percent of the time. In order to maintain acceptable system reliability for a gateway earth station near NYC, the FSS operator must increase its system reliability by 25 dB during severe rain fade events.

[106] WRC-2000 produced a compromise on the allocations in the V-band, designating spectrum below 40 GHz for primary use by high density FS, and spectrum above 40 GHz for primary use by high density FSS. The decision called for ensuring spectrum sharing between FS and FSS via service rules, rather than assigning discrete spectrum blocks to each service. The intent of this compromise is to favor FS to operate in 37.5-40 GHz, while permitting GSO FSS to operate downlink to gateway stations at PFDs 12 dB below Table 4 of ITU Appendix 21 (Table 21-4). GSO FSS may also have limited use of PFDs higher than 12 dB below Table 21-4 to Earth station gateways;

(continued....)

to allocate the entire 37.5-42.0 MHz band to both FSS and FS on a co-primary basis, but to permit HDFS operations in 37.5-40.0 GHz band and HDFSS downlinks in the 40.0-42.0 GHz band. This approach, know as "soft segmentation," was accomplished by "designating" FS operations below 40 GHz for HDFS operations and FSS operations above 40 GHz for HDFSS operations.[107] The Commission stated that it would implement this designation by structuring the service rules to provide for the high-density, non-coordinated operations of the designated service in each sub-band, while permitting limited operations of the non-designated service.[108] The *V-Band Second Report and Order*, released on Dec. 5, 2003, modified the U.S. Table of Frequency Allocations to reflect the International Table of Allocations in the 35.7-42.0 GHz band with respect to FS and FSS services and designations. This Appendix addresses the development of proposed service rules for FSS in the 37.5-40.0 GHz band that would allow FSS to operate to gateway earth stations while sharing on a co-frequency basis with HDFS operations.

FS, FSS, and the Mobile Service share co-primary allocations in the 37.5-42.0 GHz band.[109] In the HDFS band at 37.5-40.0 GHz, the Commission established a PFD limit envelope for FSS. This PFD envelope defined the PFD limit for FSS systems for clear-air operations, and a higher PFD limit FSS systems may use to compensate for rain fade conditions. The *V-Band Second Report and Order* did not address the conditions under which the FSS system could use the higher PFD limits, nor how long the FSS system could remain above the lower clear-air limits. The higher PFD limits are based on the ITU Radio Regulations, Article 21, Table 4. The lower, clear-air PFD limits are 12 dB below these limits.

Additionally, the *V-Band Second Report and Order* limited the type of FSS earth stations that will be permitted in the HDFS portion of the band to gateway Earth stations,[110] in order to reduce the coordination impact of FSS earth stations on the deployment of HDFS stations without specifying a numerical limit on the number of FSS Earth stations in the HDFS band.

This Appendix presents a technical discussion of possible rules that could permit the deployment of HDFS systems with a minimum of system constraints, while permitting FSS systems to operate to gateway earth stations.

3.0 Background

3.1 FS Characteristics

FS operations in the United States in the 37.5-40.0 GHz band are described in ITU-R documents dealing with Joint Working Party 4-9S and in the *V-band Second Report and Order*.[111] In general, this band is used to supply "last mile" connections to fiber backbone systems in, among other places, large cities. The fixed links that make up these systems go from building to building and, because of the high cost of roof-top antenna sites, some of the links may go from the side of one building to the top, or side, of another building.

(...continued from previous page)
however, the maximum FSS PFDs may not be raised over the limit set by Table 21-4. In the V-band Report and Order, the Commission adopted the lower PFD limit by Table 21-4 minus 12 dB for "clear-air" operation and the upper PFD limit by Table 21-4. PFDs above Table 21-4 minus 12 dB may only be justified on case-by-case basis.

[107] *See V-band Second Report and Order,* 18 FCC Rcd at 25434, ¶ 14.

[108] *See id.* at 25438, ¶ 23.

[109] *See* 47 C.F.R. § 2.106.

[110] *See id*. § 25.202(a)(1) n.16.

[111] *See, e.g.*, Appendix 3 to Attachment 4 of the 2003 ITU Chairman's Report for JWP4-9S; *ex parte* comments from Winstar in IB Docket No. 95-95 (filed Mar. 4, 2004).

Most FS applications are designed to transport information from one point on the Earth's surface to another across substantial distances. Because the installation of the transmit/receive equipment, including supporting towers, is expensive, FS operators typically locate their antennas as far apart as is technically feasible. This means that most FS antennas point toward the horizon and, therefore, have low elevation angles. By contrast, interconnecting facilities in large cities mean that a substantial portion of the V-band fixed FS links go from one building to another where the receiving antenna on one building may be many floors above or below the transmitting antenna on another building. Having short FS links separated by large vertical distances means that many of the V-band FS antennas do not point at the horizon but, rather, point at higher elevation angles. As of 2000, approximately 48 percent of FS links in the V-band had receive antenna elevation angles above 10 degrees, and 7 percent of FS links in the V-band had elevation angles above 45 degrees.[112] The use of high elevation angles for FS link receive antennas renders V-band FS systems more susceptible to interference from FSS transmissions than other types of FS systems.

3.2 Fixed Satellite Service Operations

FSS systems operating in the 37-50 GHz band will have available a number of frequency bands for different uses. For communications to and from the high density FSS user community, the 40.0-42.0 GHz downlink is paired with the 48.2-50.2 GHz uplink band. For operations to gateway Earth stations, the 37.5-40.0 GHz downlink band is paired with the 47.2-48.2 GHz uplink band. This latter band pairing includes a larger bandwidth in the downlink direction than in the uplink direction. The Commission authorized the greater downlink bandwidth for FSS in the V-band because it recognized that FSS gateway operation in this high-density FS band would necessitate the use of lower FSS downlink PFDs than in other FSS bands. Therefore, FSS operators would have to use robust, relatively low-data rates; simpler modulations; and channel codings to maintain signal availability with lower PFD.[113] Because these robust modulations and channel codings lower the data rate per hertz of bandwidth, the Commission authorized greater bandwidth in the 37.5-40.0 GHz band so FSS operators could improve their data throughput by using wider bandwidths in the FSS downlink spectrum at 37.5–40.0 GHz than in the 47.2-48.2 GHz uplink band.[114]

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[112] JWP 4-9S Chairman's report Attachment 4, annex 3 at 1.

[113] The use of lower-data rates (which reduces the E_b/N_o for the same BER), lower order modulations (for example QPSK, in lieu of 8PSK), and channel coding could be used to maintain signal availability with a lower PFDs, at the cost of a lower information data rate transmitted in a given bandwidth. We note that part of the extra downlink bandwidth could be used to add Forward Error Correction (FEC) coding, which could be used to reduce the E_b/N_o requirements for the same BER. The use of FEC coding would also increase the link margin by up to 5 dB, which would be a significant benefit. The remainder of the any extra bandwidth could be used to increase data throughput. We observe, however, that if the FSS operator were to use Trellis Coded Modulation (TCM), then all of the extra downlink bandwidth would be available for increased data throughput since TCM does not require the extra bandwidth.

[114] *See V-band Second Report and Order,* 18 FCC Rcd at 25458, ¶ 67.

Rain fade of FSS operations results from water droplets in the air reflecting or scattering radio waves.[115] This is analogous to driving in a fog, where the scattering effects of the very small water droplets that make up the fog scatter the light from the automobile headlights, thereby making it difficult to see objects ahead of the car.[116] Similarly, the intensity of the rain and the size of the rain drops may significantly attenuate the amount of a V-band radio signal that reaches the receiver. For example, when communicating with an Earth station near New York City, a geostationary orbit (GSO) FSS satellite located at 110 degrees west longitude can experience over 25 dB of attenuation for relatively small periods of time during intense rain storms.[117] One method to compensate for this attenuation is to increase the transmit power level at the satellite. This method would increase the PFD on the surface of the Earth and increase the possibility of interference into some HDFS receivers in the same band.[118] Additionally, as mentioned above, the Commission has limited the maximum allowable PFD in the V-band to only 12 dB higher than the clear-air PFD. Therefore, the FSS system would have to use additional techniques to compensate for the remaining 13 dB of the 25 dB attenuation caused by rain fade in this example.

Because the rain statistics vary across the United States, the amount of rain attenuation experienced by the FSS system will vary with location of the gateway earth station served by the satellite. As an example, an earth station in the Miami-Ft. Lauderdale area would experience a maximum rain fade attenuation of almost 51 dB, while an earth station in Los Angeles would experience less than 9 dB of attenuation.[119] The large rain fade in Miami would make it difficult for an FSS system to communicate with the Miami earth station, having to make up 39 dB (51 dB total compensation minus 12 dB PFD increase) of attenuation via non-power ameliorative measures. As a result, an FSS operator serving Miami-area gateway earth stations may have to reduce the percentage of time it provides service to those Earth stations. On the other hand, in Los Angeles, an FSS operator would have to overcome a total of 9 dB of attenuation, and could therefore increase power to compensate for rain fade in Los Angeles and still remain within the PFD envelope described in the *V-Band Second Report and Order*.

[115] This physical scattering effect is strongest when the wavelength of the radio wave is comparable to the size of the rain drops. The wavelength of a 40 GHz radio wave is 0.75 cm, or approximately 1/3rd of an inch. Because the wavelength is close to the rain drop size, the scattering is very pronounced in this frequency range. Therefore, when a rain storm passes between a transmitter and a receiver, the radio signal at the receive site is reduced by the scattering effect of the rain drops. Additionally, water vapor, which tends to be in higher concentration when it is raining, absorbs radio waves. However, the peak water peak absorption frequency is at 22.235 GHz, so the principal transmission impairment at 40 GHz is caused by hydrometeor, or rain drop, scattering. *See* ITU-R Rec. P676-6, Table 2; ITU-R Rec. P.840.3; ITU-R Rec. P.618-8.

[116] There are two effects caused by fog – first, a high percentage of the scattered light is scattered back towards the viewer masking any objects behind the fog, and second, the scattering significantly reduces the light that actually illuminates the subject. The second of these effects is analogous to the reduction in RF receiver power.

[117] The attenuation value was obtained from ITU-R Rec. 618-7 based on a location of 40.753°N/73.994°W. The percentage of time of 0.1% was used because FSS operating in this band generally are interested in link availabilities on the order of 99.9% (=100%-0.1%). *See* ITU JWP4-6S Chairman's Report 3 July 2002, Attachment 4, Annex 2, page 2.

[118] An increase in PFD at a particular geographic location does not automatically result in interference to an FS receiver. Whether or not actual interference will occur, *i.e.*, a loss of data within the FS system, depends on a number of additional factors such as the presence of an FS receiver at that location, the specific geometry of the FS receiver antenna and the FSS satellite, the actual signal level within the FS system and the rain fade within the FS system and between the FS and FSS systems that exists when the PFD is raised.

[119] These values are for the satellite-to-Earth station slant path attenuation for 0.1% of the time for the locations sighted. This analysis assumes a 30 degree elevation angle. We used ITU-R Rec. P.618-7 to calculate the attenuation versus percent of time relationship.

Attachment 4 to the 2003 Chairman's report for ITU Joint Working Party (JWP) 4-9S describes the possible differences in the faded and non-faded operations of a FSS system: "in the normal [clear-air] operation, the [FSS] system operates with higher order modulations (8PSK), light coding and high transmit data rate to achieve the desired capacity. During fading conditions, the system will operate with conventional QPSK modulation, heavy coding and reduced transmit data rate to achieve the desired link availability."[120] For most of the United States, some of these techniques will be required in addition to the use of higher PFD levels to meet the availability requirements of FSS systems.

One alternative open to FSS system operators to increase system availability in the face of high rain fades is to deploy "diversity" earth stations. A diversity earth station is a second earth station, interconnected with the first, located some distance from the first earth station. This configuration of multiple earth stations increases FSS signal availability because rain storms with the heaviest rain, causing the highest rain fades, tend to be relatively small in size. The diameter of these "rain cells" is typically significantly less than 100 km. Therefore, the use of a second earth station located more than a "rain-cell distance" from the first earth station means that a single rain cell is unlikely to affect both earth stations at the same time, and increases the probability that FSS operators will be able to maintain the FSS link. Having a diversity earth station effectively reduces rain-fade attenuation by a factor known as the "diversity gain."[121] The diversity gain depends on the distance between the diversity earth stations, the relative location of the two stations with respect to the satellite, and the rain rate in the area of the earth stations. For the Miami area, the diversity gain could be as high as 20 dB and for the New York City area 9 dB.[122] Near Los Angeles, the diversity gain would be approximately 3 dB. The drawback of this approach for FSS operators is the added cost of the second earth station.

In New York City, for example, rain fade producing a 25 dB or more of attenuation is expected to occur 0.1 percent of the time.[123] FSS operators that wish to operate in the V-band require a system availability of 99.9 percent and, therefore, must design their systems to overcome any losses expected to occur for all but 0.1 percent of the time. Rainfall, however, in the New York City area occurs for more than 0.1 percent of the time. Table 3.1 shows the percents of time that FSS links serving New York City will experience certain levels of rain fade. For example, an FSS link serving New York may experience a rain fade loss of more than 6 dB for 1.32 percent of an average year. This percentage represents four days, 20 hours spread out throughout the year.[124] The last column of Table 3.1 shows the loss (1/4th in this example) expressed as a fractional value. This is the portion of clear-air FSS signal level that is received at the Earth station during a 6 dB rain-fade. A 30 dB rain fade means that only 0.001 (1/1000th) of the clear-air signal is being received. This condition, or worse, can be expected to occur 0.07 percent of the time, or approximately six hours a year for the New York City example.

Table 3.1 Rain-Fade Statistics for New York City at V-Band[125]

[120] ITU JWP4-6S Chairman's Report 3 July 2002, Attachment 4, Annex 2, page 2.

[121] *See* ITU-R P.618-7 Section 2.2.4 for a discussion of diversity gain.

[122] These diversity gain values were calculated to a 10 km Earth station separation, a path elevation of 30 degrees and an angle between the propagation path and Earth station base line of 90 degrees.

[123] To provide an idea of just what 0.1% for the time actually means, 0.1% of a year represents a total of 8 hours and 45 minutes spread throughout the year. The slant-path rain fade attenuation calculations are based on ITU-R Recommendation P.618-7.

[124] Actually most locations have "rainy seasons" in which it is more likely to rain than other times of the year so these high rain-fades would occur more often in these wet seasons.

[125] The equations used to calculate the percentage of time that a given rain-fade affects an area were developed to measure small amounts of time and are therefore not valid for time values greater than 5%. Also, note that durations have been simplified for the purpose of this example.

Slant-Path Rain Fade Exceeded (dB)	Percent of Average Year Fade Exceeded	Days	Hours	Proportion of Signal Received
3	3.72%	13	14	½
6	1.32%	4	20	1/4th
9	0.69%	2	12	1/8th
12	0.42%	1	12	1/16th
15	0.28%	1	0	1/31nd
18	0.20%	0	17	1/63th
21	0.15%	0	12	1/126th
24	0.11%	0	9	1/251th
27	0.09%	0	7	1/501th
30	0.07%	0	6	1/1000th

As the intensity of rainfall increases, rain fade loss increases in magnitude, and the percentage of time that that specific value of loss is exceeded decreases. For example, an FSS link serving an earth station near New York will experience a rain fade 12 dB higher than the initial example of 6 dB (*i.e.*, 6+12 = 18 dB) for 0.20 percent of the time, approximately 1/6 the time of the 6 dB fade. Similarly, a rain-fade of 24 dB or greater will occur for 0.11 percent of the time or about 1/4 the duration of a 12 dB, or greater, fade. Because the Commission limits FSS systems to a maximum change in PFD level of 12 dB, the FSS operator must resort to a combination of increased PFDs and non-power ameliorative measures to meet the stated availability requirements. The Commission could require FSS operators to use non-power ameliorative measures to overcome several dB of rain fade prior to increasing the satellite PFD. For example, if the FSS system were to compensate for the first 12 dB of rain fade by raising PFD, it would operate 3 dB above the clear-air PFD level 3.72 percent of the time, and 9 dB above the clear-air level 0.69 percent of the time. If non-power ameliorative measures were used to compensate for the first 6 dB of rain fade and PFD increases were used to compensate for the rain fades from 6 to 18 dB, the FSS system would operate at 3 dB above the clear-air level 0.69 percent of the time instead of the 3.72 percent. This would reduce the time FS stations were exposed to an increased PFD 3 dB above the clear-air level from 3.72 percent to 0.69 percent of the time, and would reduce the sharing burden on the HDFS systems.

There is a cost to the FSS operator of using these non-power ameliorative measures to compensate for rain fade. All of the non-power ameliorative measures listed require either that additional information be transmitted along with the users' data, or that less data be transmitted at the same power levels. In either case, non-power ameliorative measures make the data stream more robust and reduce the effect of rain fade. These measures, however, reduce the total amount of user data being transmitted in a given bandwidth. Thus, all of the non-power ameliorative measures result in a reduced channel capacity for the FSS. This reduced channel capacity results in a reduced ability to serve the same number of customers, compared to clear-air operations, during the time of the rain fade.

Current Commission regulations permit FSS to operate continuously with clear-air PFD levels, and allow increases in PFD levels up to 12 dB above the clear-air level, on a case-by-case basis, to compensate for rain fade. FSS operators will occasionally need to operate at levels above clear-air PFD levels in order to meet system availability requirements even if diversity Earth stations are deployed. By requiring FSS operators to use non-power ameliorative measures prior to increasing PFD, the Commission could structure FSS service rules to reduce significantly the interference potential to HDFS, at a cost of reducing the channel capacity of FSS during rain fade conditions.

3.3 Worst-Case Distance from an FSS Earth Station

For faded operations, where the satellites are transmitting at the maximum permitted PFD, the percentage of FS receivers experiencing interference depends on the distance between FS receivers and the target earth station that is receiving the satellite transmission. Two factors, however, minimize the interference to FS receivers: 1) the FSS satellites will be using large antennas to concentrate the satellite power into very small beams, keeping the PFD constrained to areas near the target earth station; and 2) the same rain storm that blocks the signal between the satellite and the earth station also blocks, or partially blocks, the satellite signal received as interference at the FS receiver. On the surface of the earth, these satellite beams would typically constrain the power from a single FSS to areas approximately a few hundreds of kilometers in diameter. That is, FS receivers more than a few hundreds of kilometers away from the FSS earth station would receive significantly reduced levels of PFD because of the satellite antenna pattern. FS receivers far enough away from the earth station would never receive PFD levels above the clear-air PFD levels even if the satellite transmitted at the maximum permitted PFD level because the FSS antenna would provide more than 12 dB of discrimination toward the FS receiver. With regard to the second point, because FSS operators would only increase the satellite PFD in order to compensate for rain in the vicinity of the earth station, for FS receivers close to the earth station the same rain event would block some of the satellite PFD. This blockage means that the rain itself provides some level of interference protection to FS receivers sufficiently close to the earth station. In this case, the size and severity of the rain storm determines how much interference protection is provided. Therefore, the mixture of rain blockage and satellite antenna patterns limits the areas in which FS receivers can be affected by satellite transmissions, and the potentially negative impact on the FS receivers will vary as the distance between the FS receiver location and the earth station changes.

This combination of rain fade and FSS satellite antenna roll-off creates a "worst-case" distance for the probability of interference to an FS receiver. Rain fade reduces the probability of interference near the satellite earth station, while the FSS satellite antenna roll-off reduces the probability of interference some distance away from the satellite Earth station. Rules limiting the probability of interference at this worst case distance will ensure that the probability of interference will be lower at all other distances from the Earth station.

3.4 Sharing Issues

Interference studies:

ITU ANALYSIS:

The ITU has addressed the problems of co-frequency sharing in the V-band between FS and FSS. The ITU analysis included in the JWP4-9S Chairman's report[126] indicates that under clear-air conditions, with a fully occupied FSS orbit where every satellite is transmitting at the clear-air PFD limits directly illuminating an FS system, approximately 1.25 percent of the FS receivers would be operating with an interference level that was one-tenth or more of the FS system internal noise level.

The ITU study makes a number of conservative assumptions in addressing possible interference to FS in the V-band. First, it assumes that the GSO is packed full of FSS satellites spaced every four degrees along the entire GSO orbit, and makes assumptions about the total radio energy emitted by satellites on that basis. We do not anticipate that the GSO will become fully packed with satellites.[127] Second, the ITU study makes assumptions of satellite power based on the total power from the entire GSO arc. We

[126] JPW 49-S Chairman's Report, Attachment 4, Annex 3, Section 3.1.1 ITU Doc 4-9S/301, 3 July 2002.

[127] The entire visible GSO orbit as seen from the United States covers the GSO longitudes from approximately 20°W to approximately 175°W. As of June 2004, the Commission has only four applications for V-band FSS satellite networks.

do not expect that satellites serving the United States will use the portions of the GSO arc that require operations at low elevation angles because the rain fade losses increase significantly as the elevation to the satellite decreases.[128] Third, the ITU study assumes that all FSS satellites that are visible to the FS receiver are illuminating every FS site with interference power, where in fact most FS sites will not be illuminated simultaneously by all of the visible FSS satellites.[129] Fourth, the ITU study ignores the shielding effect of structures, which we believe to be significant.[130] Finally, the ITU study fails to account for a number of technical factors, such as polarization isolation and power control within the FS system. Collectively, these assumptions produce results that overstate the risk of interference to FS links from FSS. However, we consider this overstatement to provide a desirable safety margin for FS.

COMMISSION STAFF ANALYSIS:

In order to evaluate the ITU study, Commission staff performed a different type of analysis. In performing its study, Commission staff used all of the assumptions discussed above except the assumption of an entirely full GSO orbit. The result of the Commission's analysis indicates that the percentage of FS receivers that could receive inference, with the FSS operating with the clear-air PFD level, is approximately 0.7 percent, as opposed to the roughly 1.25 percent obtained by using a full GSO orbit. With FSS operating at the maximum level of 12 dB above the clear-air PFD level, the number of fixed receivers receiving interference is approximately 4 percent, as opposed to the ITU-R value of greater than 10 percent.

Commission staff used a Monte Carlo approach to analyze this data. A Monte Carlo approach is a computational technique that uses random samples drawn from representative statistical distributions and other statistical methods to find solutions to mathematical or physical problems. The Commission staff's analysis was based upon the following assumptions provided in Table 3.2, below. These assumptions represent values the staff considers most likely to prevail in actual FS and FSS operations.[131]

The results of the Commission study generally agreed with the ITU's results, but also indicated that most interference occurred with FS receivers pointing upwards at elevation angles between approximately 35º and 50º. For clear-air operations, FS receivers with elevation angles below 10º were unlikely to receive interference, while approximately 20 percent of receivers with elevation angles between 35º and 50º could expect to receive interference, using the relatively conservative assumptions and definition of interference. According to the ITU reports, approximately 3.5 percent of all FS receivers have elevation angles between 35º and 50º. This use of high elevation angles, and their resulting sensitivity to the FSS transmissions, distinguishes V-band HDFS applications from many other FS applications.

[128] Rain fade attenuation and the need for higher PFD increases as the elevation angle to the satellite decreases. For this reason, it would be more reasonable to assume that FSS will only use orbit positions in the major orbital arc that serves the United States, *i.e.*, from 80°W to 120°W, and not the entire arc visible from the Unites States (20ºW to 175ºW), because this range of GSO longitudes provides the highest, and therefore the best, elevation angles to the continental United States.

[129] Technical limitations on available satellite power combined with high path losses associated with V-band operations make it necessary for FSS satellites to use antennas with narrow beam widths. The narrow beam widths of FSS antennas will limit the geographic areas that any FSS satellite can serve at any one time. Path loss is a loss in signal strength associated with the distance between the transmitter and the receiver. Path loss is a function of the separation distance and the frequency of the satellite signal.

[130] If an FS receiver is mounted on the side of a building, in many cases, the building itself will shield the receiver from the satellite PFD.

[131] For example, the assumption of FS antenna elevation is based on data provided by Winstar of actual FS antennas. Further, the analysis assumes FSS satellites only in those parts of the GSO arc likely to be used by FSS, and excludes portions of the arc that present very low elevation angles and are unlikely to be used.

Table 3.2 - Monte Carlo Study Assumptions

- One million iterations with PFD range from clear-air level to ITU Table 21-4 level
- Fixed Service parameters randomly selected from populations:
  - FS Antenna Azimuth (0 to 360 degrees)
  - FS Antenna Elevation (Winstar supplied distribution – from Record)
  - FS Site Latitude & Longitude selected by population from the 32 cities used in the MVDDS Item
- Fixed Service parameters
  - Gain = 44.2 dBi
  - FS System Noise 740 K
  - Antenna pattern ITU-R Rec. F.1245-1
  - Interference Criteria I/N => -10 dB
- Fixed Satellite Service parameters
  - 4 degree spacing in GSO arc from 80° to 120° W longitude
  - All FSS have maximum allowable PFD aimed at all FS sites
  - PFD Rule shape as a function of elevation angle – see ITU Table 21-4

4.0 FS/FSS Interactions in the V-band

4.1 Combined Rain-fade Protection and FSS Antenna Roll-off

To further examine the interactions between FS and FSS, the combined effects of both rain-fade and the FSS antenna roll-off have to be examined in detail.

The first factor in the Commission staff's analysis is the spatial relationship between the FSS satellite earth station and FS receivers. As discussed above, rain fade requires the FSS satellite to raise its PFD toward the target earth station in order to maintain system availability. The FSS satellite raises its PFD within the entire footprint of the antenna beam that is focused on the target earth station. Because the satellite antenna footprint will be several hundred kilometers across, all FS receivers within a large area will be exposed to increased PFD. As the PFD level increases, a higher percentage of FS receivers will experience interference. However, the rain fade that causes the need for higher PFD will also attenuate the interfering signal to FS receivers near the earth station, and will therefore provide some protection to FS receivers near the FSS earth station.[132]

The ITU provided a method of calculating the effect of rain on unwanted FSS signals received by an FS receiver located at a given distance from the FSS earth station, when the satellite increases the PFD at the earth station compensate for the rain fade.[133] Commission staff has calculated the upper bound on the probability of an FS receiver experiencing increased PFDs at a specific distance "d" from the FSS earth station by combining slant path rain statistic equations and diversity Earth station equations.[134] The inputs to the resulting equation are two values of PFD increase (p1 and p2) and a distance (d). The

[132] The ITU has addressed the role of rain fade in providing protection to the HDFS from increased FSS PFDs. *See* Liaison Statement to Working Party 4-9S concerning the percentage of time during which fixed-satellite service nominal clear-sky power flux-density levels may be exceeded to overcome fading conditions, while protecting the fixed service, and permitting operation of FSS earth stations in the bands 37.5-40 GHz and 42-42.5 GHz, ITU-R Document 4-9S/299, dated Jun. 4, 2002.

[133] *Id.*

[134] *See* ITU-R P.618-7 for technical discussions of both of these topics.

resulting equation permits the calculation of the upper bound probability of having a PFD increase in the range p1 to p2 at a distance "d" from the earth station. In this case, the phrase "upper bound" means that the equation does not predict the exact percentage of time that a specific value of increased PFD will occur, and instead predicts the maximum possible percentage of time that any increase within the range of increased PFDs are likely occur at a given distance from the earth station. For example, the Commission staff's approach calculates the upper bound on the percent of time that an increase in PFD from 2 to 5 dB will occur 100 km from an earth station. Evaluation of this effect indicates that rain fade in the region around the earth station will provide some limited protection to FS receivers. These FS receivers near the target earth station will experience the higher PFD values approximately 20 to 30 percent less of time than FS receivers a few hundred kilometers from the earth station. FS receivers more than a few hundred kilometers from the earth station will, however, receive an insignificant amount of rain fade protection from rainstorms at the earth station because the chance of both the earth station and the FS receiver experiencing rain fade simultaneously is very low. This approach does not take into account the natural roll-off of PFD caused by the FSS antenna.

The second factor of the Commission staff's analysis is the antenna pattern used on the FSS satellite. Because of technical power generation limitations and the fact that space-to-earth transmission losses are frequency-dependent, V-band FSS systems will be forced to use narrow spot beam antennas. The ITU lists typical characteristics of some V-Band GSO satellites.[135] The largest V-band antenna beam has a beam width of only approximately 0.5 degrees. This beam width represents the greatest likelihood for interference to FS links, because it will spread the satellite transmit power over a larger area of the Earth's surface compared to other V-band satellite antennas with narrower beams. If the FSS signal is incident at the target earth station with an elevation of 30º,[136] the PFD will decrease, as shown in Table 4.2, at greater distances from the earth station.[137] There are two causes for this decrease. First, because the FSS satellite antenna is pointed at the earth station, the gain of the FSS antenna decreases in all directions away from the earth station. Second, as the distance from the earth station increases, in a direction also away from the satellite, the range between the satellite and the ground point increases. This increased range accounts for a small decrease in PFD levels compared with the antenna roll-off.

Table 4.1 Calculated Decrease In PFD With Distance From The Earth Station[138]

Distance from Earth Station (km)	Reduction in PFD (dB)
0	0.0
100	0.3
200	1.0
300	2.2
400	3.8

[135] *See, e.g.*, Frequency Sharing Between The Fixed-Satellite Service And The Fixed Service In The Band 37.5-42.5 GHz, ITU-R Doc- 4-9s/179, dated Mar. 23, 2000.

[136] Because rain fade losses increase as the elevation angle of the Earth station decreases, we expect that most GSO FSS systems will operate above 30 degrees. Therefore, using a 30 degree elevation angle enlarges the area affected by the PFD leading to a conservative analysis.

[137] Table 4.1 assumes that the movement is away from the Earth station on the complement of the azimuth that connects Earth station with the satellite.

[138] Antenna beamwidth 0.5 degrees, elevation angle 30 degrees, moving from Earth station away from satellite on azimuth connecting satellite and Earth station.

500	5.7
600	7.9
700	10.4
800	13.0

By combining localized rain fade protection near the earth station and FSS antenna roll-off, it is possible to determine the maximum percent of time that an increase in PFD would be experienced by an FS receiver for a given range in FSS PFD levels. Additionally, if FSS operators use non-power ameliorative measures to compensate for rain fade prior to increasing PFD levels, the combination of these two factors[139] can determine the amount of FSS rain fade compensation required to limit the maximum percentage of time that an FS system is exposed to any PFD increase. We can calculate the percent of time that an FS receiver at the "worst-case" distance from an FSS earth station will receive an increase in PFD by adjusting the input parameters to the ITU WP-3M equation modified to take into account the change in PFD with distance from the earth station.[140]

Evaluating the non-power ameliorative measures required to limit the percentage of time that PFD increases occur for multiple locations within the United States yields a curve of the non-power ameliorative measures required versus the average rain rate at the target earth station. Furthermore, by incorporating diversity gain into the rain-statistics and repeating the analyses, it is possible to develop two curves of non-power ameliorative measures versus the rain rate at the target earth station: one curve for FSS systems that use diversity earth stations and one for systems that do not.

4.2 Development of Possible FSS V-Band Service Rules

Figure 4.1 shows the result of performing the calculations described above for 32 cities[141] with and without diversity earth stations. The upper set of points shows the values of non-power ameliorative measures required to limit the total increase in PFD to 1.5 percent of the time at the worst case distance

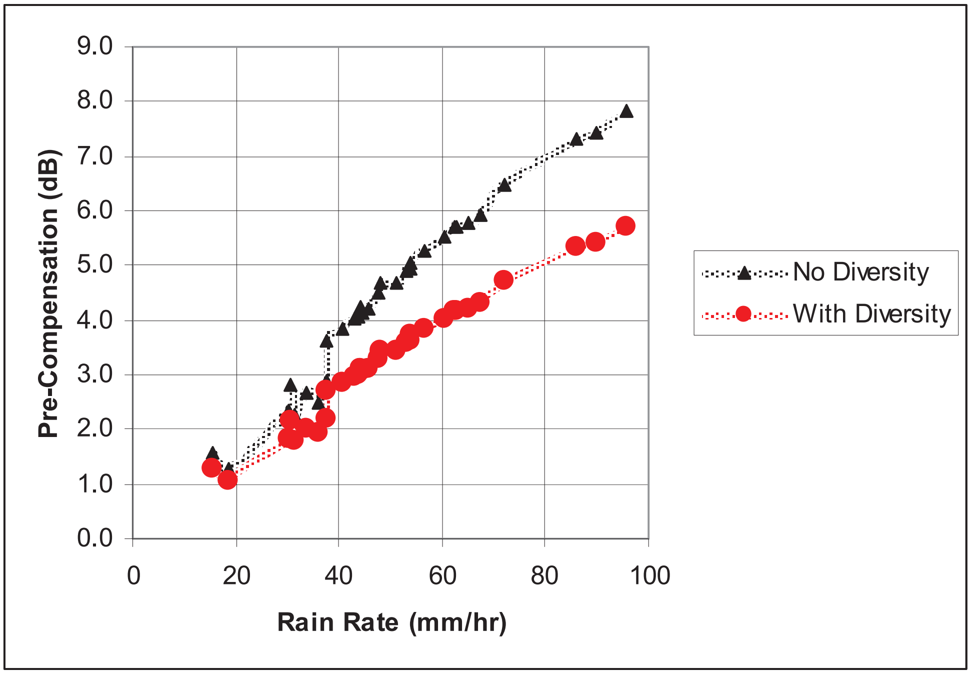
[139] *I.e.*, the partial correlation of rain-fade with distance from the earth station and the FSS antenna roll-off with distance from the earth station.

[140] As stated previously, the equation has three input parameters: two values defining the range of PFDs of interest (say, p1 and p2) and a distance (d) from the Earth station. The value of p2, the top of the PFD range is always 12 dB higher than the value of p1 – thus the probability will be the upper bound percentage of time that the FS receivers will experience any PFD increase within the permitted range. At the Earth station (*i.e.*, distance=0) the lower PFD of the range (p1) starts at the value of the alternate rain-fade technique used by the FSS system. The value of p1 is increased by the FSS antenna roll-off value at the distance from the Earth station where the calculation is made. This increase compensates for the reduced PFD as the distance from the Earth station increases, because the probability of interest is the probability that the clear-air PFD is exceeded. The calculation is performed iteratively, varying the distance and the value of the alternate rain-fade technique until the wanted upper bound percentage occurs at the distance that yields the highest percentage.

[141] The 32 cities selected here are the same as those used in *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; Amendment of the Commission's Rules to Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band by Direct Broadcast Satellite Licensees and Their Affiliates; and Applications of Broadwave USA, PDC Broadband Corporation, and Satellite Receivers, Ltd. to Provide A Fixed Service in the 12.2-12.7 GHz Band*, Memorandum Opinion and Order and Second Report and Order, ET Docket No. 98-206, FCC 02-116, 17 FCC Rcd 9614 (2002). In that item, the Commission used cities representing the top 32 television markets to analyze the potential interference from terrestrial transmitters to GSO satellite receivers. Approximately 55% of the nation's population lives in these 32 cities. In performing this study, the Commission assumed that the Earth station is located at the latitude and longitude of the nominal center of each city, despite the fact that the rain statistics change gradually with distance. In reality, one would be expected that the Earth station to be located several miles from the city center.

from the earth station. The "x-axis" is the average rain rate[142] at the location of the city. The "y-axis" parameter is the level of pre-compensation – in other words, the value, in dB, of non-power ameliorative measures that the FSS system would be required to implement prior to any increase in PFD above the clear-air value.

Figure 4.1 Results of Alternate Rain-Fade Techniques for 32 Cities



The lower series of points represents the value of non-power ameliorative measures if the FSS system also used a diversity earth station in addition to the primary earth station.[143]

Connecting the points of Figure 4.1, smoothing the lines and converting them to a schedule results in Table 4.2. This figure could form the basis of service rules that require FSS operators to implement the scheduled amount of non-power ameliorative measures prior to increasing PFD, where the value of non-power ameliorative measures, in dB, is dependent on the average rain rate at the target earth station.[144] Note that there is an apparent discontinuity in the curves in Figure 4.1 at a rain-rate value of 38 mm/hr. In producing Table 4.2, we divided the line into two separate linear portions: the first going from a rain rate of 0 to 38 mm/hr and the second from a rain rate of greater than 38 mm/hr to 100 mm/hr.

Table 4.2 - Possible Pre-PFD Rain-Fade Compensation Schedule[145]

Average Rain Rate at Earth Station	FSS Non-Power Ameliorative

[142] Rain rate is a commonly used measure of the rain statistics of a geographic area. An area's rain rate is amount of rain, in millimeters per hour (mm/hr), that the area exceeds for 0.01% of the average year.

[143] The diversity Earth station is assumed to be located 10 kilometers from the primary station with the azimuth towards the satellite forming a 90-degree angle with the chord that connects the two Earth stations.

[144] Average rain rate as calculated by techniques provided in ITU-R P.618-7, § 2.2.1.

[145] For values of rain rate between the rows of the table, use linear interpolation to obtain rain-fade compensation.

	Measures (dB)	
Rain Rate mm/hr @ 0.1%	Without Diversity	With Diversity
0	0.0	0.0
10	0.5	0.6
20	1.4	1.1
30	2.3	1.8
38	3.1	2.2
38.1	3.6	2.5
40	3.8	2.9
50	4.7	3.4
60	5.5	4.0
70	6.3	4.5
80	7.1	5.0
90	7.4	5.4
100	8.2	5.9

It should be noted that for locations approximately 750 km (470 mi) from the earth station, the reduction in FSS PFD due to the satellite antenna roll-off will be greater than 12 dB. Therefore, even if FSS raised the PFD to the maximum value specified in the *V-band R&O* (i.e., clear-air PFD plus 12 dB), FS receivers at or beyond this distance will never experience PFDs higher than the clear-air value. As noted above, there is a certain distance from an earth station, which varies from case to case, where there is a maximum probability of an FS receiver being exposed to increased PFD from an FSS satellite. If the FS receiver is closer to the FSS earth station than this "worst-case" distance, the rain fade at the FS receiver provides some, albeit limited, protection from increased PFD. If the FS receiver is farther away from the earth station than this "worst-case" distance, the FSS antenna roll-off results in lower PFDs and, therefore, fewer FS receivers experience interference.

4.3 Cost to FSS Operations

Implementing non-power ameliorative measures will cause the FSS system to lose channel capacity during a rain fade. The loss of channel capacity available for sale to customers decreases the potential revenues of the FSS system. Therefore, we refer to losses in channel capacity as "costs" to the FSS system. The amount of channel capacity lost depends on the amount of non-power ameliorative measures required. During peak rain fades, the FSS system will inevitably lose some amount of channel capacity or suffer reduced signal availability because, assuming the FSS systems desire 99.9 percent availability, rain fades in much of the United States are greater than the 12 dB. Implementing part of the total non-power ameliorative measures required prior to increasing the PFD means that the FSS system will lose channel capacity more often than it would if it could raise PFD whenever any rain fade occurred. In addition, over much of the country, the loss of channel capacity will be significant when it does occur. For example, the average rain rate in Miami is approximately 96 mm/hr., which occurs for 0.1 percent of the time in an average year. According to Table 4.1, an FSS system transmitting to an earth station near Miami would have to compensate for the first 7.9 dB of rain fade using non-power ameliorative measures prior to raising PFD assuming a diversity earth station is not used, and 5.7 dB assuming the existence of a diversity earth station. If these techniques are implemented, the loss of channel capacity would be approximately 84 percent without the diversity Earth station and approximately 73 percent with diversity. Assuming diversity, this loss would occur for approximately 2.3 percent of the time or approximately 7 days 20 hours per year. If FSS operators raise PFD levels prior to using non-power ameliorative measures, the same channel capacity loss would occur for only 0.3 percent of the time, or one day and three hours per year. Providing this level of protection to HDFS will negatively affect the operation of FSS.

The schedule presented in Table 4.2 is a balance between protecting the HDFS deployment in V-band and permitting the FSS to operate to gateway earth stations. The schedule also depends upon certain operating assumptions, and the values in the schedule will change if the underlying assumptions change. For example, Table 4.2 is based upon limiting the time the worse case FS station is exposed to PFDs higher than clear-air PFDs to 1.5 percent of the time. If the upper bound on the percentage of time that FS receivers are exposed to PFD levels in excess of the clear-air values is reduced from 1.5 percent to 0.1 percent, an FSS system serving New York would have to use 19.6 dB of rain-fade compensation prior to raising PFD levels, instead of the 5.4 dB required by Table 4.2.[146] This compensation requirement would decrease FSS channel capacity by over 99 percent during moderate rain fades, effectively forcing the FSS to cease operation. Even in Los Angeles, a city with a very low average rain rate, an FSS would have to compensate for 7.9 dB of rain fade prior to raising PFDs, compared with the 1.3 dB[147] of non-power ameliorative measures in Table 4.2. This means that, even in cities with low rain rates, FSS operators would be giving up nearly 84 percent of system capacity for a relatively large percent of the time, if PFD in excess of the clear-air values are permitted for only 0.1 percent of the time.

4.4 Trade-off Between the Costs to FS Operations and the Costs to FSS operations

The previous discussions have shown that it is possible to use mathematical models based upon work developed in the ITU to calculate the worst-case percentage of time that a FS receiver would experience any increase in PFDs as a function of the non-power ameliorative measures used by the FSS operators to compensate for rain fade prior to increasing PFD levels. Additionally, it has been pointed out that for each dB of non-power ameliorative measures used by the FSS operator the channel capacity of the FSS link will be reduced by about 1 dB. The relationship between the worst-case percentage of time that a FS receiver would experience any increase in PFDs and the reduction in FSS channel capacity will vary with the rain rate at the location of the FSS earth station.[148] For example, Figure 4.2 examines the tradeoff between these two factors for three cities: Los Angeles, CA; Philadelphia, PA; and Miami, FL. These three cities were chosen because they represent the range of rain rates experienced by urban areas of the US. The rain rate for Los Angeles is approximately 18 mm/hour, which occurs 0.1 percent of the time in an average year. For the Miami/Ft. Lauderdale area the rain rate is approximately 96 mm/hour and for Philadelphia the rain rate is approximately 48 mm/hour, or approximately half-way between that of Miami and Los Angeles.

Figure 4.2 - Worst-case Exposure of FS to Increased PFD Versus Worst-case Reduction in FSS Channel Capacity for Some Example City Locations

[146] The average rain rate for New York City (latitude = 40.8°N, longitude =74.0°W) is 44.0 mm/hour 0.1% of an average year.

[147] The average rain rate for Los Angeles (latitude = 34.1°N, longitude =118.2°W) is 18.5 mm/hour 0.1% of an average year.

[148] While not the only variable, the average rain rate is the major parameter in determining the worst-case percent of time that a FS receiver would experience any increase in PFD when non-power ameliorative measures are used by FSS operators to compensate for rain fade prior to increasing PFD levels.

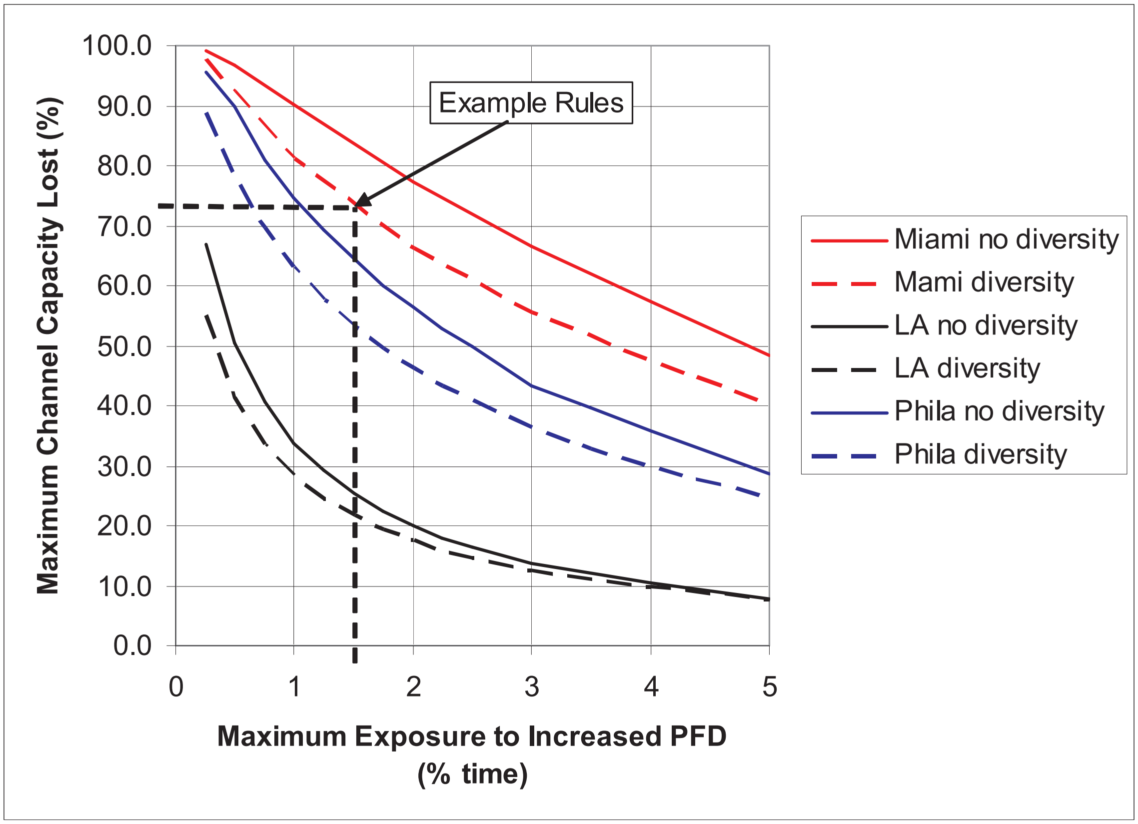


Figure 4.2 contains two curves for each of these three cities. The upper, solid curve shows the relation between the worst-case loss of FSS channel capacity and the exposure to increased PFD for the worst-case location of a FS receiver if the FSS system does not employ a diversity earth station. The lower, dashed curve assumes that the FSS system includes a diversity earth station. As can be seen in the Figure, reducing the percent of time FS are exposed to any increase in PFDs (i.e., looking at the left-hand side of Figure 4.2) increases the loss of channel-capacity for the FSS operator. In general, the channel-capacity loss also increases with rain rate at the earth station location, so, the channel-capacity loss in the Miami area would be significantly worse than in the Los Angeles area.

Soft-segmentation allows the FSS systems to operate to gateway earth station while favoring the deployment of ubiquitous HDFS systems. This implies crafting service rules for the FSS that result in exposing FS receivers to increased PFD for relatively low percentages of time while still permitting the FSS to operate.

APPENDIX B

Initial Regulatory Flexibility Analysis

As required by the Regulatory Flexibility Act (RFA),[149] the Commission has prepared this present Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on small entities by the policies and rules proposed in this *Third Notice of Proposed Rulemaking* (*Third Notice*). Written public comments are requested on this IRFC. Comments must be identified as responses to the IRFA and must be filed by the deadlines for comments provided in paragraph 59 of this *Third Notice*. The Commission will send a copy of this *Third Notice*, including this IRFC, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).[150] In addition, the *Third Notice* and IRFC (or summaries thereof) will be published in the Federal Register.[151]

A. Need for, and Objectives of, the Proposed Rules

The rules proposed in this *Third Notice* will allocate the 42.0-42.5 GHz sub-band to the Fixed Satellite Service (FSS), and remove the allocation of the same sub-band to the Broadcasting Satellite Service (BSS), in order to harmonize allocations in the 37.5-42.5 GHz band with the allocations agreed by the United States at the 2000 and 2003 World Radiocommunication Conferences. The rules proposed in this *Third Notice* will also ensure the protection of radioastronomy operations in the 42.5-43.5 GHz band from interference from satellite operations in the adjacent 37.5-42.5 GHz band. The rules proposed in this *Third Notice* will also provide standards for coordination of FSS gateway earth stations and Fixed Service (FS) stations, in order to prevent interference between these stations. Finally, the rules proposed in this *Notice* will establish a methodology for increasing power flux-density (PFD) from satellites operating in the 37.5-40.0 GHz band under rain fade conditions, in order to minimize the likelihood of interference to Fixed Service (FS) microwave links operating in the same band while at the same time ensuring the continuity of satellite service.

B. Legal Basis

The proposed action is authorized under Sections 4(i), 303(r), 403, and 405 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 303(r), 403, and 405.

C. Description and Estimate of the Number of Small Entities To Which the Proposed Rules Will Apply

The RFA directs agencies to provide a description of and, where feasible, an estimate of the number of small entities that may be affected by the proposed rules, if adopted.[152] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[153] In addition, the term "small business" has the

[149] *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. § 601 *et. seq.*, has been amended by the Contract With America Advancement Act of 1996, Pub. L. No. 104-121, 110 Stat. 847 (1996) (CWAAA). Title II of the CWAAA is the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA).

[150] *See* 5 U.S.C. § 603(a).

[151] *See id.*

[152] 5 U.S.C. § 603(b)(3).

[153] 5 U.S.C. § 601(6).

same meaning as the term "small business concern" under the Small Business Act.[154] A small business concern is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.[155]

Fixed Microwave Services. Fixed microwave services include common carrier,[156] private operational-fixed,[157] and broadcast auxiliary radio services.[158] At present, there are approximately 22,015 common carrier fixed licensees and 61,670 private operational-fixed licensees and broadcast auxiliary radio licensees in the microwave services. The Commission has not created a size standard for a small business specifically with respect to fixed microwave services. For purposes of this analysis, the Commission uses the SBA small business size standard for the category Wireless Telecommunications Carriers (except Satellite), which is 1,500 or fewer employees.[159] The Commission does not have data specifying the number of these licensees that have no more than 1,500 employees, and thus are unable at this time to estimate with greater precision the number of fixed microwave service licensees that would qualify as small business concerns under the SBA's small business size standard. Consequently, the Commission estimates that there are 22,015 or fewer common carrier fixed licensees and 61,670 or fewer private operational-fixed licensees and broadcast auxiliary radio licensees in the microwave services that may be small and may be affected by the rules and policies proposed herein. We note, however, that the common carrier microwave fixed licensee category includes some large entities.

Satellite Telecommunications and All Other Telecommunications. These two economic census categories address the satellite industry. The first category has a small business size standard of $15 million or less in average annual receipts, under SBA rules.[160] The second has a size standard of $25 million or less in annual receipts.[161] The most current Census Bureau data in this context, however, are from the (last) economic census of 2002, and we will use those figures to gauge the prevalence of small businesses in these categories.[162]

[154] 5 U.S.C. § 601(3) (incorporating by reference the definition of "small business concern" in 15 U.S.C. § 632). Pursuant to the RFA, the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register." 5 U.S.C. § 601(3).

[155] Small Business Act, 15 U.S.C. § 632 (1996).

[156] *See* 47 C.F.R. §§ 101 *et seq*. for common carrier fixed microwave services (except Multipoint Distribution Service).

[157] Persons eligible under parts 80 and 90 of the Commission's Rules can use Private Operational-Fixed Microwave services. *See* 47 C.F.R. Parts 80 and 90. Stations in this service are called operational-fixed to distinguish them from common carrier and public fixed stations. Only the licensee may use the operational-fixed station, and only for communications related to the licensee's commercial, industrial, or safety operations.

[158] Auxiliary Microwave Service is governed by Part 74 of Title 47 of the Commission's Rules. *See* 47 C.F.R. Part 74. This service is available to licensees of broadcast stations and to broadcast and cable network entities. Broadcast auxiliary microwave stations are used for relaying broadcast television signals from the studio to the transmitter, or between two points such as a main studio and an auxiliary studio. The service also includes mobile television pickups, which relay signals from a remote location back to the studio.

[159] 13 C.F.R. § 121.201, NAICS code 517210.

[160] 13 C.F.R. § 121.201, NAICS code 517410.

[161] 13 C.F.R. § 121.201, NAICS code 517919.

[162] 13 C.F.R. § 121.201, NAICS codes 517410 and 517910 (2002).

The category of Satellite Telecommunications "comprises establishments primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications."[163] For this category, Census Bureau data for 2002 show that there were a total of 371 firms that operated for the entire year.[164] Of this total, 307 firms had annual receipts of under $10 million, and 26 firms had receipts of $10 million to $24,999,999.[165] Consequently, we estimate that the majority of Satellite Telecommunications firms are small entities that might be affected by our action.

The second category of All Other Telecommunications comprises, *inter alia*, "establishments primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation. This industry also includes establishments primarily engaged in providing satellite terminal stations and associated facilities connected with one or more terrestrial systems and capable of transmitting telecommunications to, and receiving telecommunications from, satellite systems."[166] For this category, Census Bureau data for 2002 show that there were a total of 332 firms that operated for the entire year.[167] Of this total, 303 firms had annual receipts of under $10 million and 15 firms had annual receipts of $10 million to $24,999,999.[168] Consequently, we estimate that the majority of All Other Telecommunications firms are small entities that might be affected by our action.

D. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements

The NPRM proposes a rule change that will affect reporting, recordkeeping and other compliance requirements. Each of these changes is described below.

The NPRM proposes to require satellite operators and FS operators in the 37.5-40.0 GHz band to coordinate the siting of gateway earth stations and FS stations in the same band when station antennas have lines of sight into the other licensees' service areas, in accordance with the frequency coordination process set forth in Section 101.103(d) of the rules. In order to accomplish such coordination, operators wishing to establish new stations would be required to accomplish coordination with all licensees whose station antennas lie within line of sight of the proposed new station, and certify to the Commission that such coordination has been accomplished along with the application for authorization for the new station.

E. Steps Taken to Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

The RFA requires an agency to describe any significant alternatives that it has considered in reaching its proposed approach, which may include the following four alternatives (among others): (1) the

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[163] U.S. Census Bureau, 2007 NAICS Definitions, "517410 Satellite Telecommunications"; http://www.census.gov/naics/2007/def/ND517410.HTM.

[164] U.S. Census Bureau, 2002 Economic Census, Subject Series: Information, "Establishment and Firm Size (Including Legal Form of Organization)," Table 4, NAICS code 517410 (issued Nov. 2005).

[165] *Id*. An additional 38 firms had annual receipts of $25 million or more.

[166] U.S. Census Bureau, 2007 NAICS Definitions, "517919 All Other Telecommunications"; http://www.census.gov/naics/2007/def/ND517919.HTM#N517919.

[167] U.S. Census Bureau, 2002 Economic Census, Subject Series: Information, "Establishment and Firm Size (Including Legal Form of Organization)," Table 4, NAICS code 517910 (issued Nov. 2005).

[168] *Id*. An additional 14 firms had annual receipts of $25 million or more.

establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.[169]

A significant alternate coordination procedure considered in this *Notice* was to establish a specific distance between existing stations and proposed new stations within which the licensee proposing the new station must coordinate. The Commission decided, however, that the proposed coordination requirement, which is based on power-flux densities and actual lines of sight rather than a simple distance measure, provides more flexibility to licensees in siting new stations, while at the same time risking no greater likelihood of interference between stations.

F. Federal Rules that May Duplicate, Overlap, or Conflict With the Proposed Rule

None.

[169] *See* 5 U.S.C. § 603(c).