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

In the Matter of	)	
	)	
	)	
The Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band	)	IB Docket No. 01-96
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REPORT AND ORDER

FURTHER NOTICE OF PROPOSED RULEMAKING

Adopted: April 18, 2002 **Released:** April 26, 2002

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By the Commission:

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I. INTRODUCTION

1. With this *Report and Order*, we decide the means for intra-service sharing among prospective licensees in a new non-geostationary satellite orbit, fixed satellite service ("NGSO FSS") in Ku-Band frequencies. The pending applications for this service propose to provide a variety of data, video and telephony services. Several applicants propose to provide services through broadband channels. Implementation of these new NGSO FSS systems will introduce an additional means for providing advanced broadband services to the public by satellite, thus increasing competition to existing satellite and terrestrial services.

2. The policies we adopt in this *Report and Order* determine the sharing parameters for all Ku-Band NGSO FSS operations. Licensees in this service will also be subject to the new service rules that we adopt in this *Report and Order*. All pending applications for NGSO FSS in the Ku-Band will need to be amended to conform to the rules and requirements we adopt today. Once applicants have filed conforming amendments and the public has had an opportunity to comment upon them, we intend to award licenses expeditiously so that applicants can commence launch and operation of satellites in this new service.

3. In the *Further Notice of Proposed Rulemaking* portion of this document, we propose to adopt a methodology by which the NGSO FSS applicants will demonstrate that they meet our previously-adopted limit on their interference into geostationary-satellite orbit ("GSO") systems operating in shared frequencies. We seek comment on the means and timing for implementing that methodology. The *Further Notice of Proposed Rulemaking* also requests comment on a refinement of the definition of in-line interference events, which is a critical component of the sharing option we adopt in today's *Report and Order*. Neither issue raised for consideration in the *Further Notice of Proposed Rulemaking* will delay implementation of this new NGSO FSS service in Ku-Band frequencies.

II. BACKGROUND

4. The Commission initiated a proceeding in 1998 that proposed, among other subjects, to permit NGSO FSS operations in certain segments of the Ku-Band.[1] At the same time, the Commission issued a Public Notice that established a cut-off date for filing NGSO FSS system applications in the proposed portions of the Ku-Band.[2] Seven satellite applications for the service are now pending, including the application of SkyBridge L.L.C. ("SkyBridge"), whose petition for rulemaking and application prompted the Public Notice, and six other applications filed by the cut-off date. These applications are based on very different constellation designs, including satellites in low-Earth orbits ("LEOs"), satellites in mid-Earth orbits ("MEOs"), and satellites in highly elliptical orbits ("HEOs").[3] After full comment by the NGSO FSS applicants and other parties, in November 2000 the Commission

[1] *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*, Notice of Proposed Rulemaking, 14 FCC Rcd. 1131 (1998) (*"Ku-Band Sharing NPRM"*).

[2] Report No. SPB-141, released November 2, 1998 (*"Ku Band Cut-Off Notice"*). The filing cut-off was for NGSO FSS applications in the 10.7-12.7, 12.75-13.25, 13.75-14.5, and 17.3-17.8 GHz frequency bands. The Commission subsequently decided not to allocate the 17.3-17.8 GHz band to NGSO FSS.

[3] *See* Appendix D to *Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band*, Notice of Proposed Rulemaking, 16 FCC Rcd. 9680, 9710-12 (2001) (describing system applications).

adopted an order permitting NGSO FSS operations in portions of the Ku-Band.[4] Since some of the individual pending applications requested authority to operate in the entire available spectrum, the Commission was then required to determine how the applicants could share that spectrum.

5. The Commission initiated this proceeding in May 2001, to determine the means by which multiple authorized NGSO satellite networks can share the Ku-Band spectrum designated for NGSO FSS operations.[5] We sought to choose a means to accommodate all of the proposed satellite network applications within the available spectrum. The *Notice* described the available Ku-Band spectrum in detail, noting that the various portions of spectrum are not interchangeable, in that each segment has significantly different allocation and inter-service sharing constraints. In the *Notice*, the Commission proposed four possible sharing options based upon proposals received from the pending NGSO FSS applicants, and upon sharing mechanisms previously employed for other satellite services. In addition to proposing sharing options, the *Notice* proposed a number of service rules for the NGSO FSS service in Ku-Band frequencies.

6. The *Notice* also discussed the need to limit cumulative interference from multiple NGSO FSS systems into GSO networks.[6] Co-frequency sharing between GSO FSS and NGSO FSS systems in the Ku-Band has been a matter of particular concern, given the extent of incumbent GSO operations and the fact that there has not yet been widespread experience with NGSO operations in these frequencies. Techniques for GSO/NGSO co-frequency sharing were developed during extensive investigation by International Telecommunication Union Radiocommunication ("ITU-R") study groups, whose work was adopted by the 2000 World Radiocommunication Conference ("WRC-2000"). In the *First Report and Order*, the Commission adopted technical sharing criteria for NGSO FSS and GSO FSS operations in all bands, consistent with decisions taken at WRC-2000. Those criteria focus on equivalent power flux density ("EPFD") limits on uplink (Earth-to-space station) and downlink (space-to-Earth) communications.

7. The Commission's *First Report and Order* in the *Ku-Band Sharing* proceeding adopted single-entry and aggregate EPFD limits, which define the level of acceptable interference from an NGSO FSS system into a GSO FSS system.[7] These technical sharing criteria are designed to allow co-frequency operation of NGSO networks without causing unacceptable interference to incumbent GSO networks, without undue constraints on future growth of incumbent services, and without limiting the flexibility of new NGSO FSS systems. Although the *First Report and Order* adopted the maximum aggregate interference level, the Commission deferred the decision on when and how NGSO FSS applicants would be required to demonstrate that they could meet the aggregate EPFD limits.[8] The Commission deferred the decision in part due to ongoing study within the ITU-R. Subsequent progress in those ITU-R studies

[4] *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*, First Report and Order and Further Notice of Proposed Rulemaking, 16 FCC Rcd. 4096 (2000) (*"First Report and Order"*).

[5] *Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band*, Notice of Proposed Rulemaking, 16 FCC Rcd. 9680 (2001) (*"Notice"*).

[6] *Notice*, 16 FCC Rcd. at 9698.

[7] *First Report and Order*, 16 FCC Rcd. at 4128.

[8] *First Report and Order*, 16 FCC Rcd. at 4140.

has provided methodologies for demonstrating that NGSO FSS systems meet the aggregate limits.[9] In the *Further Notice of Proposed Rulemaking* in this proceeding, we propose to adopt and apply these new methodologies to Commission licensees in the NGSO FSS in Ku-Band frequencies.

III. DISCUSSION

A. Spectrum Sharing Options Considered

8. In the *Notice,* we tentatively concluded that sufficient spectrum within the Ku-Band NGSO FSS allocation is available to accommodate all seven proposed NGSO networks. We then sought comment on four means to license specific Ku-Band spectrum for use by particular NGSO FSS licensees. We named these spectrum sharing options: (1) Flexible Band Segmentation; (2) Dynamic Band Segmentation; (3) Avoidance of In-line Interference Events; and (4) Homogeneous Constellations. In our choice among these options, we seek to establish a regulatory framework that does not favor any particular technology or operational method, as we continue to believe that the satellite services marketplace should decide which of these proposed NGSO FSS systems is successful. We describe each of these proposals below.

9. We have three principal objectives that guide us as we decide which spectrum sharing option will direct this service. First, we seek to ensure that all applicants have equal access to spectrum. Second, we seek to avoid any spectrum warehousing by non-implemented NGSO FSS systems at the expense of operational systems. Third, we want to incorporate sufficient flexibility to promote and accommodate spectrum coordination among operating systems.

10. The first two spectrum sharing options proposed in the *Notice* are based upon segmenting the available Ku-Band spectrum between licensees. As described in the *Notice*, the sharing constraints on various portions of the available spectrum are not equal.[10] In keeping with our objective of ensuring that all applicants have equal access to spectrum, the *Notice* presumed that all licensees in this service must have access to some spectrum in each of the different spectrum sub-bands.

11. We named the first proposed option Flexible Band Segmentation. Under this option we would segment the available spectrum at the time of licensing, so that each of the six sub-bands would be divided into distinct spectrum segments of equal bandwidth based on the number of authorized systems. The segments would consist of adjacent blocks stretching from one end of the sub-band to the other.[11] Each NGSO FSS licensee would identify one spectrum segment in each sub-band at the time that the first satellite in its system reaches its intended orbit and initiates transmission and reception. [12] Each licensee

[9] ITU-R Study Group 4, *Draft New Recommendation: Methodologies for calculating aggregate* $epfd_{down}$ *produced by multiple non-GSO FSS systems into a GSO FSS network*, Revision 1 to Document 4/62-E (19 November 2001).

[10] *Notice*, 16 FCC Rcd. at 9686.

[11] For instance, if there are seven applicants, we would identify seven equal spectrum segments within the 12.75-13.25 GHz, 13.75-14.0 GHz, 14.0-14.5 GHz, 10.7-11.7 GHz 11.7-12.2 GHz and 12.2-12.7 GHz sub-bands.

[12] A satellite's intended orbit is the orbit it will occupy to provide commercial service.

would be required to notify the Commission, in writing, of its identified segments. An assortment of six segments (one in each sub-band) would represent each operator's Selected Spectrum Assignment.

12. The second proposed method of band segmentation is Dynamic Band Segmentation. Under this option, we proposed to subdivide each NGSO FSS spectrum sub-band equally by the number of operational systems, as opposed to subdividing the spectrum by the number of systems authorized, as would be done under the Flexible Band Segmentation option. Each time a new system becomes operational, other operational systems would be required to surrender spectrum to accommodate the new entrant. The system would be considered "operational" at the time that the first satellite in its system reaches its intended orbit and initiates transmission and reception. As in Flexible Band Segmentation, we proposed that the first operational system would get priority in selecting spectrum segments, and we proposed that it could use the entire allocated spectrum when no other systems were operational.

13. Under either of these first two band segmentation proposals, in addition to operating in its own selected spectrum, each licensee could provide service anywhere else within NGSO FSS Ku-Band frequencies not occupied by an operating NGSO FSS system. Operations outside a licensee's selected spectrum would be subject to appropriate coordination with other operational NGSO FSS systems. In the *Notice*, we recognized that the amount of spectrum available to each system under either band segmentation proposal would decrease as more NGSO FSS operators implemented their systems.

14. The third spectrum sharing option proposed in the *Notice* is called Avoidance of In-Line Interference Events. This option is premised on the necessity for NGSO FSS antennas being capable of pointing in different directions. In proposing this option, we expected that separate NGSO satellite systems could share and operate throughout the same spectrum frequency as long as they avoid in-line interference events. In the *Notice*, we described an in-line interference event as an unintentional transmission in either direction between an Earth station of one system and a satellite of another caused by physical alignment. This is a physical phenomenon in which one NGSO FSS system's in-line transmission path between its satellite and one of its Earth stations is intersected by the in-line transmission path of another NGSO FSS system's satellite or its Earth station, all of them arranged in a straight line. During such an in-line event, an NGSO FSS Earth station would receive the highest interference level from the other NGSO FSS system's transmitting satellite when the satellite mainbeam transmission is aligned with the Earth station antenna. Conversely, the other NGSO FSS system's satellite would receive the highest interference level by the in-line transmission path of the Earth station's mainbeam transmission. The potential for in-line interference events increases with the number of operational NGSO FSS systems.

15. The fourth sharing option is called Homogeneous Constellations. Because the ITU has determined that several NGSO FSS systems can share the same frequency band without interference when they employ nearly identical orbital parameters, we asked commenters to address whether we should adopt one or more unifying constellation designs that could accommodate seven NGSO FSS systems. If the Commission adopted a homogeneous constellation design, we could assign an equivalent amount of the available spectrum to each applicant. Each NGSO FSS licensee would then be required to deploy its system within a defined envelope of orbital and transmission parameters comprising an identified constellation design, and to share its spectrum assignment with systems of like design.

16. We sought proposals for specific homogeneous constellation designs that we might adopt. Virtual Geosatellite, L.L.C. ("Virtual Geo") proposed a constellation design using highly elliptical NGSO

satellite orbits, which it calls virtual geostationary orbits ("VGSO").[13] Because this orbit is designed to emulate characteristics of conventional geostationary orbits during the specific operational phase of its orbit, the applicant describes it as a "virtual" geostationary system. Virtual Geo asserted that if the Commission were to adopt its proposed constellation design, a much larger number of satellite systems could be accommodated than if the Commission adopted another design. With respect to the NGSO FSS applications that are now pending, Virtual Geo also proposed a band-sharing plan.[14] Its proposed band plan would assign slightly less than half of all NGSO FSS spectrum in each sub-band to Virtual Geo's proposed homogeneous constellation design, leaving slightly less than half of the spectrum to be shared among NGSO FSS licensees that do not adopt that design. The small remainder would be a "growth" band. Virtual Geo subsequently modified its band-sharing plan to blend sharing Options 3 and 4. Under its modified proposal, all proposed NGSO FSS systems may use all spectrum, but during an in-line interference event, systems would move to permanently assigned primary spectrum in one half of all available Ku-Band NGSO FSS spectrum for the duration of the event.[15]

17. We also received an alternative proposal from Boeing.[16] Boeing's alternative was based on Primary and Secondary Spectrum Use, where each applicant would receive primary spectrum similar to the Dynamic Band Segmentation proposal, but in addition would be allowed to use the rest of the spectrum on a secondary basis. Under Boeing's proposal, all applicants in the secondary spectrum would share equally among themselves but would need to protect the primary applicant in its band. Other commenters did not support Boeing's alternative proposal.

18. Most of the applicants and commenters found Options 1 and 2 unacceptable. Several commenters were concerned that the amount of bandwidth available to individual licensees in sub-band segments would not meet the requirements of a viable service.[17] Hughes noted that dividing the sub-bands into equal portions would also create a need for guard bands, further reducing the actual spectrum available. Hughes stated that the reduced quantity of spectrum would be a constraint on carrier size and access method, which could affect payload and Earth station costs. SkyBridge noted that broadband transmission might require more spectrum than would be provided in the licensees' equally divided portions. Teledesic LLC ("Teledesic") commented that this option results in a decrease in available spectrum even when no interference exists. Virtual Geo and SkyBridge also raised concerns with the effect that these options would have on international coordination if other administrations segment the

[13] Virtual Geosatellite LLC Notifications of *Ex Parte* Presentations in ET Docket No. 98-206 (filed November 21, 2000, November 28, 2000, December 15, 2000, and February 16, 2001).

[14] Virtual Geosatellite LLC Notifications of *Ex Parte* Presentations in ET Docket No. 98-206 (filed January 22, 2001 and January 24, 2001).

[15] Virtual Geosatellite LLC Notification of *Ex Parte* Presentation in IB Docket No. 01-96 (filed February 12, 2002).

[16] Comments of The Boeing Company (filed July 6, 2001) ("Boeing Comments") at 3. Unless otherwise noted, hereafter "comments" and "reply comments" refer to pleadings filed in response to the *Notice* in International Bureau Docket No. 01-96.

[17] Comments of SkyBridge L.L.C. (filed July 6, 2001) ("SkyBridge Comments") at 7; Comments of Hughes Communications, Inc. (filed July 6, 2001) ("Hughes Comments") at 8; Comments of Virtual Geosatellite LLC (filed July 6, 2001) ("Virtual Geo Comments") at 29.

band differently.[18] Hughes, SkyBridge and Virtual Geo expressed concern about regulatory and spectrum risks as other systems become operational under band segmentation sharing options.[19] Their comments asserted that the available spectrum would be reduced to meet the needs of the new system, possibly at just the time previously operating systems needed more spectrum for growth in their business. Hughes noted that this consequence of Dynamic Band Segmentation runs counter to normal business expectations.[20] The only favorable comments on Options 1 and 2 came from a non-applicant, which indicated that this spectrum sharing regime would be more compatible for inter-system sharing with GSO FSS systems.[21] More specifically, PanAmSat stated that the two band segmentation options would limit the aggregate interference received by GSO FSS operators.[22]

19. Comments for Option 3, Avoidance of In-Line Interference Events, were generally more favorable, with a majority of the applicants supporting adoption of this method. Teledesic urged adoption of Option 3, as the option meets the Commission's objectives of equal access for all applicants, preventing warehousing of spectrum, and cooperative sharing among system proponents.[23] Denali commented that the same interference avoidance methods could work for HEO systems and MEO systems as with LEO systems under this option.[24] SkyBridge and The Boeing Company ("Boeing") supported this option because it offers the most flexible and efficient method of spectrum sharing among the proposed systems.[25] SkyBridge noted that the option encourages development of mitigation techniques and does not force design changes to systems. SkyBridge further commented that the option permits the technologies and services provided by the applicants to be dictated by the market. Teledesic noted that Option 3 does not limit operators due to spectrum constraints of other countries. [26]

20. PanAmSat commented that if the Commission adopts Option 3, then non-in-line events resulting in aggregation of EPFD must also be considered.[27] Hughes raised concerns as to how this option might affect system complexity, as Hughes believes that the option would require increased inter-system coordination.[28] As a result, Hughes argued that frequency coordination requirements of the system could exceed the system's capacity if multiple terminals required frequency isolation simultaneously. To effect this method, Hughes asserted that an operator would be required to use either

[18] Virtual Geo Comments at 30; SkyBridge Comments at 9.

[19] Hughes Comments at 9; SkyBridge Comments at 9; Virtual Geo Comments at 29.

[20] Hughes Comments at 10.

[21] Comments of PanAmSat Corporation (filed July 6, 2001) ("PanAmSat Comments") at 6.

[22] Reply Comments of PanAmSat Corporation (filed August 6, 2001) at 1.

[23] Comments of Teledesic LLC (filed July 5, 2001) ("Teledesic Comments") at 2.

[24] Comments of Denali Telecom LLC (filed June 18, 2001) ("Denali Comments") at 3.

[25] SkyBridge Comments at 17; Boeing Comments at 2.

[26] Teledesic Comments at 3.

[27] PanAmSat Comments at 6.

[28] Hughes Comments at 11.

satellite diversity or frequency isolation techniques. The operators would need to have ephemeris and satellite and antenna pattern data of the operator's network and those of the other system. Hughes noted that because terminals would not be evenly distributed, the effects of this option required more study. In addition, Hughes was concerned that what it calls "full mesh" systems would have an unequal burden in sharing versus those of a "gateway driven" system.[29] In its reply comments, Teledesic asserted that what Hughes called "full mesh" systems would have the mechanism in place to handle hand-over between satellites as that mechanism was already required to avoid geostationary satellites.[30]

21. Virtual Geo argued that the Avoidance of In-Line Interference Events option would double its costs and result in system inefficiencies.[31] Virtual Geo said that for its VGSO system, use of satellite diversity or frequency diversity is unsatisfactory. Because the derivation of revised satellite ephemeris data cannot be determined immediately after maneuvers, available ephemeris data may be inaccurate.[32] In any event, Virtual Geo argued that ephemeris data should be published. SkyBridge agreed with Virtual Geo that each licensed system should be required to publish up-to-date ephemeris information, but disagreed with Virtual Geo as to the reliability of that data.[33] SkyBridge noted that ephemeris data has been tested for assessing compliance with single-entry operational limits of NGSO FSS systems and has been demonstrated to be sufficiently accurate for both the ITU-R and the Commission.[34]

22. In its reply comments, SkyBridge asserted that since systems can still use half of spectrum during an in-line event utilizing frequency isolation, Option 3 does not require satellite diversity.[35] Teledesic also argued that Virtual Geo is mistaken that satellite diversity is the main avoidance method.[36] Teledesic said instead that the default method is frequency isolation. Boeing also observed that Virtual Geo gave no explanation as to why it thought frequency avoidance is unacceptable.[37] Boeing and SkyBridge noted that by Virtual's own analysis, it would have access to the entire spectrum 99 percent of the time and access to less than 50 percent of the spectrum just .01 percent of the time.[38] In addition,

[29] Hughes Comments at 11-12 ("full-mesh" systems are those that rely on communicating with numerous, small Earth stations, as opposed to systems using a design organized around communications with gateway Earth stations).

[30] Reply Comments of Teledesic LLC (filed August 6, 2001) ("Teledesic Reply") at 4.

[31] Virtual Geo Comments at 20.

[32] Virtual Geo Comments at 25.

[33] SkyBridge Reply at 15.

[34] ITU Document 4A/9, *report of epfd measurement exercise, 17-21 July 2000*, indicates that an NGSO constellation creating peaks of interference to an Earth station in a geostationary-satellite network can be readily identified by using publicly-available ephemeris data.

[35] Reply Comments of SkyBridge L.L.C. ("SkyBridge Reply") at 5.

[36] Teledesic Reply at 3.

[37] Reply Comments of The Boeing Company (Filed August 6, 2001) ("Boeing Reply") at 3.

[38] SkyBridge Reply at 7; Boeing Reply at 9.

SkyBridge noted that Virtual Geo would always have two satellites visible from an Earth station, although one may have an elevation angle less than 40°.

23. Virtual Geo favored the Homogeneous Constellations option. Virtual Geo initially advocated splitting all of the sub-bands into two equal assignments, one half (actually slightly less than half, because of a zone reserved for growth) for VGSO-type constellations, and the other half for all other constellations.[39] More recently, Virtual Geo proposed to operate under an avoidance of in-line interference events sharing method, but again proposed splitting all the sub-bands in half.[40] In its revised proposal, Virtual Geo and other VGSO-type constellations would be granted permanent, primary use in a fixed portion of the NGSO FSS Ku-Band spectrum. VGSO-type systems would always operate in this permanently assigned spectrum whenever they are involved in an in-line interference event.

24. Several non-applicant comments also supported the Homogeneous Constellations option. PanAmSat indicated that adoption of homogeneous constellations would result in a well-defined sharing environment.[41] Northpoint, a terrestrial wireless proponent in the 12.2-12.7 GHz band, stated that adoption of a VGSO homogeneous constellation in a shared frequency band would allow for simpler coordination between NGSO FSS systems and Northpoint's terrestrial use of shared Ku-Band frequencies.[42]

25. Other comments were not in favor of Option 4. Denali stated that choosing a particular constellation would eliminate the potential variety of system services and designs expected from applicants.[43] SkyBridge commented that different systems are more appropriate for different types of services and that establishing one constellation will require applicants to revise significantly, or even to sacrifice their business plans.[44] SkyBridge further asserted that if Virtual Geo's system design were selected, SkyBridge would be forced to abandon most of its business objectives.[45] Hughes questioned why the Virtual Geo system design should be given preference over any other high-Earth orbit system design, or over other types of constellations.[46] Hughes also suggested that if the Commission should choose the homogeneous design sharing option, it should let the applicants decide amongst themselves on the single constellation design, rather than impose Virtual Geo's design.[47]

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[39] Virtual Geosatellite, LLC *Ex Parte* Presentation in ET Docket No. 98-206 (Notification filed January 22, 2001).

[40] Virtual Geosatellite, LLC *Ex Parte* Presentation in IB Docket No. 01-96 (Notification filed February 12, 2001).

[41] PanAmSat Comments at 6.

[42] Reply Comments of Northpoint Technology, Ltd. (filed August 6, 2001) at 4.

[43] Denali Comments at 4.

[44] SkyBridge Comments at 11.

[45] SkyBridge Comments at 13.

[46] Hughes Comments at 15.

[47] Reply Comments of Hughes Communications, Inc. (filed August 6, 2001) ("Hughes Reply") at 12.

26. SkyBridge questioned the asserted superiority of the Virtual Geo constellation design, saying that the design would not allow non-time-sensitive traffic types, would not allow optimal coverage of the tropics, and was not demonstrably better able to accommodate a large number of homogeneous systems than any other system design.[48] Boeing noted that allocation based on homogeneity could result in half of all spectrum being given to one system without any regard as to whether that system would become operational or not.[49] Teledesic also argued that any band plan tailored to a particular system runs the risk of being made obsolete or inefficient as plans change and will result in wasted spectrum.

B. Spectrum Sharing Plan Chosen

27. Our principal objectives in choosing among the proposed sharing options are to allow equal access to the available spectrum, to avoid spectrum warehousing, and to encourage system flexibility to promote spectrum coordination. We find that Option 3 meets all our objectives, and we therefore adopt the Avoidance of In-Line Interference Events spectrum sharing method as the basis of our Ku-Band sharing rules.

28. In optimal circumstances, all NGSO FSS systems authorized will be allowed to operate in all the Ku-Band frequencies allocated to this service. All will have equal access to the available spectrum. We realize, of course, that operating conditions will be less than optimal in those instances when Earth stations and space stations of different systems are so aligned that they create an in-line interference event. At the present, speculative stage of system design and development, there is no certain measure of the percentage of time when systems will have access to all the spectrum, versus the percentage of time when they must undertake mitigation measures to avoid in-line interference events. Based upon the best available estimates by the applicants and other comments in the record, we anticipate that licensees in this service will have the freedom to operate in the entire allocated spectrum for a large majority of all possible operating time.

29. Freedom to operate in all allocated spectrum is the foundation of the sharing method we adopt today. A corollary of this operating freedom is that no licensee has any ability to impede the operations of any other licensee. In addition to allowing equal access to all spectrum, the sharing option we adopt today therefore accomplishes our second objective as well. There is neither any incentive nor any possibility for non-implemented systems to warehouse allocated spectrum at the expense of operational systems.

30. We believe that the technical criteria that we adopt today also incorporate sufficient flexibility to promote coordination among the operating systems in this new NGSO FSS service in the Ku-Band. The rules that we adopt today establish the limits of a minimum operational system in this new service. The record before us leads us to believe that operational systems may have access to the entire allocated spectrum for a majority of the time. The rules we adopt also provide incentive and opportunity for operational systems to coordinate among themselves to improve upon their operational capacity, so that they can achieve the freedom to operate in all available spectrum for an even larger percentage of the time. Proposals in our *Further Notice of Proposed Rulemaking* hold the possibility that coordinating systems can still further increase the amount of time in which they can operate in the entire allocated spectrum.

[48] SkyBridge Reply at 18.

[49] Boeing Reply at 8.

31. We also find that our choice of the Avoidance of In-Line Interference Events sharing option provides necessary regulation while allowing market forces to direct the course of this service. So long as NGSO FSS operators avoid causing in-line interference events among themselves, and so long as they remain within the parameters of the inter-service sharing environment defined for this service, they are free to design any constellation and any service offerings best suited for their business plans and the markets they seek to serve.

32. For these reasons, we find that the Avoidance of In-Line Interference Events method better meets our objectives than any homogeneous constellation design. If Virtual Geo's projections are correct, its constellation design holds the promise of re-creating the capacity of the geostationary-satellite orbit, in new locations in the northern and southern hemispheres, and in multiple frequency bands. We are dissuaded from imposing this design on other applicants, however, by the lack of any existing or impending demand for Virtual Geo's design. No other applicant has proposed to operate in the constellation design proposed by Virtual Geo, and some have opposed it.

33. The various band plans proposed by Virtual Geo do not ameliorate the lack of support for its proposal. Its first proposed band plan would evenly split all available Ku-Band spectrum, with Virtual Geo granted half of all available spectrum, while all other applicants would have to fit within the remaining half of the allocation. On its face, this proposal offers a single applicant an extremely favorable authorization. Virtual Geo's assertion that future operators can be accommodated in its patented constellation design by sharing its half of the spectrum, does little to mitigate the favoritism of its proposal.

34. Virtual Geo's revised band plan accepts the prospect that it will operate its system under the Avoidance of In-Line Interference Events method, but requests that it be granted primary status in one half of the available spectrum whenever an in-line interference event occurs.[50] Virtual Geo is indifferent as to which half of the spectrum would be its primary status spectrum. In order to implement the Avoidance of In-Line Interference Events method, we discuss and adopt, below, a default sharing mechanism for cases where the operators have not reached coordination agreements.[51] When two systems are involved in an in-line interference event, they will default to the respective halves of the service spectrum they will choose before launching their first satellites. Our default sharing mechanism thus grants the choice of home zone spectrum to the first launched among any two systems coordinating to avoid in-line interference events. We find that Virtual Geo can achieve the result it desires – fixed home zone spectrum -- under the default sharing mechanism we adopt, if it is the first or second launched system. Virtual Geo can also achieve its desired result through coordination with other systems, even if it is not first or second to launch.

35. We do not adopt Virtual Geo's revised band plan, proposing that the Commission grant specific home zone spectrum in advance of launch. Although Virtual Geo is indifferent with regard to which half of spectrum it will use during in-line interference events, other licensees may have strong preferences. Our first goal in deciding sharing for this service is that all applicants should have equal access to spectrum. Granting pre-coordinated spectrum to one applicant would abandon that goal. Adopting Virtual Geo's revised proposal would also remove the incentive for it to coordinate with other NGSO FSS systems. The default sharing mechanism we adopt today allows the first launched system to

[50] Virtual Geosatellite LLC, *Ex Parte* Presentation in IB Docket No. 01-96 (filed February 12, 2002).

[51] *See* ¶ 53, *infra*.

choose its preferred "home zone" spectrum, an incentive for early launch. By proposing that we set aside specific spectrum at the time of licensing, Virtual Geo's band plans would remove this incentive for rapid deployment of NGSO FSS systems.

36. At that same time, we believe that Virtual Geo is capable of competing equally with all the other applicants in this service under the sharing option we adopt. We note that Denali, another applicant proposing to operate in a highly elliptical orbit, asks us to adopt the avoidance of in-line interference events.[52] We also note that in its revised band-sharing proposal, Virtual Geo offers to operate its system by sharing in an Avoidance of In-Line Interference Events regime. Thus, we are not convinced that NGSO systems in highly elliptical orbits are generically unable to share in an avoidance of in-line interference environment. We are also persuaded by the analysis of Boeing and SkyBridge that Virtual Geo will be able to use half of the available spectrum under Option 3, even considering the asserted limited ability of its system to mitigate in-line interference events.[53] Since Virtual Geo originally proposed reserving just half of the available spectrum for its system design, this analysis leads to the conclusion that Virtual Geo will be granted access to more spectrum under Option 3 than under its proposal. This is because the vast majority of in-line interference events will involve only two systems, so that Virtual Geo will have access to half the available service spectrum for the duration of such an event, which is the amount of spectrum it requests. In addition, however, Virtual Geo will have access to the entire service spectrum for most of its operating time, when it is not involved in in-line interference events.

37. We appreciate that Virtual Geo attempted to quantify the minimum amount of spectrum that could support its system. In the *Notice*, we asked that any commenters asserting that any of our proposed options do not provide sufficient spectrum capacity substantiate that assertion with concrete technical and economic analysis.[54] Virtual Geo was the only commenter to respond to this request for comment. While the other applicants are either unable or unwilling to quantify the amount of spectrum necessary to operate their systems, they are unified in asserting that just one equally divided portion of the available spectrum is insufficient for any viable system.[55] While proposed Options 1 and 2 meet our objectives of equal access to spectrum and requiring coordination among licensees to achieve optimal conditions, we also acknowledge the commenters' united opposition to either Option 1 or Option 2 as the sharing method for this service. We find that the two band segmentation options are overly restrictive, and could result in insufficient spectrum for commercially viable operations. We do note, as several commenters realized, that the default sharing scheme whenever two systems involved in an in-line interference event cannot agree on other mitigation measures, is in fact a form of band segmentation for the duration of the event.

38. We find that Option 3 meets all of our stated objectives in deciding among proposed sharing methods, and we therefore adopt the Avoidance of In-Line Interference Events method as the basis of our Ku-Band NGSO FSS sharing rules.

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[52] Denali Comments at 2.

[53] Boeing Reply at 3; SkyBridge Reply at 7.

[54] *Notice*, 16 FCC Rcd. at 9687.

[55] Virtual Geo Comments at 29; Hughes Comments at 8; Denali Comments at 7; SkyBridge Comments at 7.

C. Implementing Avoidance Of In-Line Interference Events

39. In this section, we discuss how the Commission will implement Avoidance of In-Line Interference Events as the basis for intra-service sharing among Ku-Band NGSO FSS systems. The ideal state of operation under this sharing option is that all systems are free to operate in the entire available Ku-Band spectrum. In implementing this option, our primary goal is to allow licensees to achieve that ideal state of operation as much as possible. But as our name for this sharing option indicates, an unavoidable consequence of the fact that multiple NGSO FSS systems may be circling the Earth in non-homogeneous orbits is that in-line interference events may occur among their satellites. To implement regulation of this sharing option in the NGSO FSS in the Ku-Band spectrum, we must first adopt a means for understanding when in-line interference events occur, which we achieve by defining what they are. Then we must adopt regulations to ensure successful operation of co-frequency NGSO FSS systems even during in-line interference events. In keeping with our overall goals for this service, we hope that the rules we adopt provide both the means and the incentive for service operators to coordinate among themselves to maximize the amount of time in which all systems can operate in the entire available spectrum. But in the event that inter-system coordination fails at any point, we also find it necessary to adopt a "default" sharing mechanism that can be understood and applied by the NGSO FSS operators themselves without further intervention by the Commission except to enforce the default mechanism. We start by defining exactly what an "in-line interference event" is.

1. Defining In-Line Interference Events.

40. The *Notice* stated that the Commission would need to establish an unambiguous technical definition of in-line interference parameters should it choose Option 3 as the means for intra-service sharing among NGSO FSS licensees.[56] The need for that definition generated extensive comments. Three possible definitions have been discussed, including the two proposed in the *Notice* and a third proposed in the comments. The comments and reply comments on the *Notice* debate the merits of these three proposed definitions, which we refer to as change in total system noise power, angular separation, and bit error rate ("BER") time allowance, respectively.

a. Change in Total System Noise Power.

41. The first definition proposed in the *Notice* is based upon the trigger for coordination between GSO FSS systems. Coordination among GSO FSS networks is required when the inter-network interference caused by Earth and space station emissions of one network is greater than six percent of the total system noise power of another GSO FSS network operating in the same frequency band under clear-sky conditions. The *Notice* proposed applying the same criterion used for GSO FSS networks for the definition of an in-line interference event trigger between NGSO FSS systems.

42. Boeing supports the use of the change in total system noise power.[57] Boeing noted that since ITU-R working party studies are focusing on different percentages of change in noise power, the Commission should defer its decision as to the exact percentage of change used in this service.[58] Teledesic commented that the change in total system noise power definition is unsatisfactory for this

[56] *Notice*, 16 FCC Rcd. at 9691.

[57] Boeing Comments at 2.

[58] Boeing Reply at 6.

service, because its use for GSO satellites is for 100 percent of the time, while NGSO/NGSO interference naturally varies by time. SkyBridge criticized the change in total system noise power definition as an unnecessary and inefficient use of spectrum resources, because SkyBridge believes that NGSO systems can cope with higher interference levels for short periods of time.[59]

b. Angular Separation.

43. Alternatively, the *Notice* discussed SkyBridge's proposal to adopt an Earth-based, approximately 10-degree angle between the satellites of NGSO FSS constellations as a trigger for the in-line event. SkyBridge supported a 10-degree separation angle it calls a "home zone," but noted that accommodation for significantly different power levels may be needed as a result of selecting angles based on link budgets and performance objectives.[60] SkyBridge also commented that uniform power would only be used for a particular angle size and that larger angles could be used for higher power.[61] If the Commission chooses to adopt SkyBridge's proposed home zone approach and therefore selects a separation angle, SkyBridge requested that we err on the side of caution.

44. Teledesic argued against SkyBridge's angular separation proposal on the grounds that it might be under- or over-inclusive, depending on system parameters.[62] Virtual Geo commented that an angular separation definition would require uniform power levels and that the home zone can be smaller for gateway stations due to size of the antenna beam, therefor the home zone should be based on the terminal size. Hughes dislikes the angular separation definition because it believes that avoidance angles vary among the proposed systems.[63] Hughes claimed that with some systems, an angular separation of as much as 20 degrees might be necessary.[64] In addition, Hughes asserts that these angles could be exceeded as much as 58 percent of the time or as little as 12 percent of the time, depending on Earth station location.[65]

c. Bit Error Rate Time Allowance.

45. Teledesic proposed a third alternative to the two we proposed in the *Notice*.[66] Noting the ITU-R recommendations and draft recommendations that define allowable aggregate short-term interference into an NGSO FSS system, Teledesic proposes that an in-line interference event be defined by an aggregate interference time allowance of 10 percent of the time allowance for the bit error rate ("BER") specified in the short-term performance objectives of the system. Teledesic also noted

[59] SkyBridge Reply at 14.

[60] SkyBridge Comments at 19-21. If angular separation is not chosen as the definition, in the alternative, SkyBridge recommends an unavailability increase of 10 percent using sync loss.

[61] SkyBridge Reply at 9.

[62] Teledesic Comments at 7.

[63] Hughes Comments at 12.

[64] Hughes Reply at 7.

[65] *Id.* at 8.

[66] Teledesic Comments at 5.

recommendations developed in recent ITU-R working party studies on aggregate interference.[67] SkyBridge commented that short-term performance objectives could be based on a time allowance for BER, but stated that Teledesic's proposed method, while perhaps more accurate, is far too complex for a default coordination solution.[68]

d. Definition Adopted.

46. In adopting our definition of in-line interference events, we first reiterate the Commission's long-standing policy of encouraging private coordination among satellite operators. We emphasize that our definition of an in-line interference event in no way prevents satellite operators from using any other definition or any method of coordination by which operators may achieve better results between themselves. Sufficiently motivated coordination should be able to use any or all of the proposed definitions to more precisely define the occurrence of in-line interference events between two coordinating systems. By more precisely defining the events between them, two systems can increase the amount of time each system is able to operate in the entire available spectrum. We find, however, that we must adopt a baseline definition of an in-line interference event as a starting point for effective coordination.

47. Our goal is to adopt an indisputable standard easily understood by all parties. We therefore adopt an Earth-surface based (topocentric) angular separation standard to define an in-line interference event. In doing so, we note that choosing a specific degree of angular separation criterion requires a balancing of technical goals. Larger angles may be required to limit interference between systems which are either very susceptible to interference or are more likely to cause it. On the other hand, if the angle is too large the efficiency of the orbit is greatly reduced, as there will be an increase in the percentage of time that satellite operations are restricted. Several parties made estimates of the occurrence of in-line interference events among the proposed NGSO FSS systems. Based on the estimates, we note that a 10-degree angle of separation allows all systems to operate in the entire available Ku-Band spectrum for at least 82 percent of the time, whereas with a 20-degree angle of separation, all systems achieve full-spectrum operation approximately 41.6 percent of the time.[69] We also note that with a 10-degree angle of separation, most NGSO FSS systems will achieve full-spectrum operation for more than 90 percent of the time. By contrast, with a 20-degree angle of separation, most systems will achieve full-spectrum operation less than 80 percent of the time.

48. We also note that commenters indicated that a 10-degree angle of separation might be an overly pessimistic definition of in-line interference events in size, especially for feeder link bands where larger antenna sizes may be utilized.[70] These commenters proposed that a smaller angle of separation define an in-line interference event, in order to maximize the amount of time in which all systems are free to operate in the entire available Ku-Band spectrum. Considering smaller angles of separation, estimates of the occurrence of in-line interference events among the proposed systems indicate that a five-degree angle of separation could allow all systems to achieve full-spectrum operation for 95.5 percent of the

[67] Teledesic Reply at 9-11.

[68] SkyBridge Reply at 15.

[69] SkyBridge L.L.C. *Ex Parte* Presentation in ET Docket No. 98-206 (Notification filed March 27, 2001) at 9; SkyBridge L.L.C. *Ex Parte* Presentation in IB Docket No. 01-96 (Notification filed February 13, 2002) at 20.

[70] Virtual Geo Comments at 22

time.[71] At the same time, avoiding harmful interference with a smaller angle of separation requires additional constraints on antenna size and power levels. We believe that smaller angles of separation can be negotiated during coordination between the parties, and that the resultant increase in full-spectrum operation is an incentive toward reaching an agreement.

49. We adopt a 10-degree-avoidance angle between satellites of different networks. Setting the baseline definition at a 10-degree angle of separation should reduce the impact on systems that may be more susceptible to interference while not overly constraining others.[72] We expect system transmitter designers to take this angle into account as they balance the Earth station antenna diameters and input power levels in their systems.

50. We do not adopt the change in total system noise power definition as the method for defining an in-line interference event. The change in total system noise power measure, usually referred to as $\Delta T/T$,[73] is used as a coordination trigger mechanism among GSO FSS systems, requiring them to coordinate long term requirements of their systems. Several parties indicated that the six- percent $\Delta T/T$ GSO FSS coordination trigger is a long-term interference characteristic that is inappropriate to regulate short-term in-line interference events between non-geostationary systems.[74] We agree, and find that the standard we use to trigger a coordination requirement between geostationary orbit systems is not an appropriate criterion to define in-line interference events between non-geostationary orbit systems.

51. We also do not adopt the change in BER Time Allowance. The current draft revision from ITU-R Study Group 4 recommends that NGSO FSS systems be responsible for a maximum of 10 percent of the time allowance for BER specified in the short-term performance objectives of the desired network.[75] It is assumed that exceeding that time allowance, like exceeding a limit on total system noise power, is a coordination trigger between networks. The BER Time Allowance measure also has characteristics that are long term. This method is thus not as definitive as a specific angular separation. We also believe that this method may be overly complicated for use in defining a baseline sharing arrangement. Based on current ITU studies, we find that coordination will likely be required between

[71] *Id.*

[72] This balancing approach is analogous to the approach we took in creating the two-degree spacing rules applied to the GSO FSS. *See Licensing of Space Stations in the Domestic Fixed-Satellite Service*, 54 Rad. Reg. 2d (P&F) 577, 589 (1983) (*Reduced Orbital Spacing*). In that setting, we looked to balance the need for protecting against interference while still maximizing the orbital resource. The result was a series of rules that implement this balance. *See* 47 C.F.R. §§ 25.209, 25.210(e), 25.210(k), and § 2.106, Footnote NG 104. Although we expected that there would be interference between GSO satellites space two degrees apart, we anticipated that the interference could be managed by coordination between the affected operators. Similarly, therefore, although we expect that a ten-degree angle of separation in this NGSO FSS may allow some interference between operators, the potential interference can be managed by coordination among the affected operators.

[73] $\Delta T/T$ is the apparent increase in the satellite link noise temperature as a result of the additional interference from another system, usually given in percent increase, where ΔT represents the increase in temperature of the link caused by the interference, and T represents the system noise temperature without the additional interference.

[74] Virtual Geo Comments at 27

[75] ITU-R Study Group 4 studies sharing issues in the fixed-satellite service.

most NGSO FSS systems operating co-frequency because we have adopted the avoidance of in-line interference method for NGSO FSS system sharing. [76]

52. We expect that a baseline definition should result in more efficient sharing techniques and will likely encourage parties to reach agreements. This expectation is informed by our experience with coordination among geostationary orbit systems. The end result of our two-degree separation policy is that communications links of adjacent systems have been balanced, resulting in efficient and equitable use of the spectrum by competing networks. We expect the same result when NGSO FSS systems in the Ku-Band coordinate with each other, starting from a baseline definition of a 10-degree-avoidance angle between satellites of different networks.

2. Default Sharing Mechanism.

53. Finally, we find it necessary to adopt a "default" sharing mechanism that can be understood and applied by the NGSO FSS operators themselves without further intervention by the Commission. We require that if operators fail to reach a coordination agreement with a new entrant, they must establish an in-line event spectrum sharing procedure based on the frequency isolation technique. Prior to the launch of its first satellite, each NGSO FSS operator must complete coordination with all other operational NGSO FSS systems, and choose its home base spectrum vis a vis every other operational system.[77] This required coordination would segment the spectrum among the operating systems involved in the predicted specific in-line interference event for the duration of the event. During all other times, NGSO FSS systems can operate using the entire allocated and licensed NGSO FSS Ku-Band spectrum. More precisely, and taking into account the definition of an in-line interference event that we have adopted, when satellites of different networks reach positions at which the topocentric angle between them is less than 10 degrees, as measured from an Earth station, the parties shall split the frequency band equally according to their chosen home base spectrum.

54. Nothing in this default sharing mechanism prohibits parties from agreeing on a smaller angle of separation, or upon other methods of definition of in-line events in a mutually agreed coordination. As we discussed in the *Notice*, there are at least two possible techniques for coping with in-line interference events: the frequency isolation technique employed in our default sharing mechanism, and satellite diversity.[78] With satellite diversity, NGSO FSS systems can avoid an in-line interference event by selecting another visible satellite within their system constellation (performing a hand-over process) whenever the current satellite approaches the in-line event with a satellite operating in another NGSO FSS system constellation. Coordinating between themselves, NGSO FSS systems can employ satellite diversity in combination with other available interference mitigation techniques to avoid in-line interference events. Either method of coping with in-line interference events requires close cooperation of the involved NGSO FSS operators, including, at a minimum, periodic exchanges of ephemeris data.

55. We believe that coordination between systems will result in agreements to use smaller angles

[76] "Preliminary Draft Revision of Recommendation ITU-R S.1323-1" Revision 1 to Document 4A/TEMP/74 (May 1, 2001).

[77] A system is deemed operational when at least one of its satellites reaches its intended orbit and initiates transmission and reception of radio signals.

[78] *See* ITU-R S.1431. In addition to these two primary mitigation methods, NGSO FSS systems may also be able to employ alternate polarization to avoid in-line interference events.

of separation, and that systems can achieve some degree of link balancing as well. Our requirement that systems coordinate, when combined with a baseline 10-degree angular separation, should reduce the risk that any system will cause excessive interference, or be overly susceptible to interference. This belief is rooted in our experience with GSO FSS systems operating with two-degree spacing. We expect that some interference may arise between networks using different design parameters at angles greater than our baseline 10-degree angle of separation, just as some interference has arisen between GSO FSS systems operating with two-degree spacing.[79] We expect, however, that coordination between the parties can resolve these differences. We consider the 10-degree separation angle that we adopt a balance between full spectrum availability and the potential for interference between networks. While flexibility of network design is desired, we must also balance this with a degree of responsibility of the licensee to provide for efficient spectrum use.

D. Earth Station Licensing

56. In the *First Report and Order*, the Commission recognized that the network architecture of NGSO FSS systems contains two different types of Earth stations: gateway Earth stations and user terminal Earth stations.[80] By adopting a functional definition of gateway Earth station use in the *First Report and Order*, the Commission restricted NGSO FSS Earth station usage in frequency spectrum bands shared with terrestrial operations. Only gateway Earth station use is permitted in the 10.7-11.7 GHz, 12.75-13.15 GHz, 13.2125-13.25 GHz, and 13.75-14.0 GHz bands.[81] This restriction is intended to avoid ubiquitous deployment of NGSO FSS Earth stations in shared bands, thereby allowing the continued use and growth of terrestrial operations in those bands.[82]

57. ***Blanket Licensing.*** In the *Notice* in this proceeding, we proposed to implement blanket licensing procedures to regulate ubiquitously deployed NGSO Earth stations in the Ku-Band NGSO FSS, for operations in frequency bands not restricted to gateway Earth station use. In the United States, those bands are the 11.7-12.2 GHz and 12.2-12.7 GHz downlink bands, and the 14.0-14.5 GHz up-link band.[83]

58. All of the commenters that addressed this issue support our proposal to extend blanket licensing procedures to NGSO FSS user Earth stations in the 11.7-12.2 GHz and 12.2-12.7 GHz downlink bands, and the 14.0-14.5 GHz up-link bands. Based on the Commission's experience with blanket licensing procedures for NGSO Earth stations in other satellite services, we believe these procedures

[79] In its Comments, Hughes argues that separation angles as large as twenty degrees may be needed. Hughes Comments at 13.

[80] *See First Report and Order*, 16 FCC Rcd. at 4110.

[81] *See* 47 C.F.R. §§ 25.209(h), 25.208(k). *See also First Report and Order*, 16 FCC Rcd. at 4126.

[82] Further, in the *First Report and Order*, the Commission adopted some restrictions on NGSO FSS deployment in the 11 GHz and 13 GHz gateway bands in specified geographic areas in order to protect incumbent services' use of the bands, but concluded that these "growth zones" for incumbent services needed further analysis in order to address better the needs of all affected parties. The Commission therefore decided to evaluate, in a separately docketed proceeding, methods for defining growth zones that serve all interested parties in the NGSO FSS gateway bands (10.7-11.7 GHz, 12.75-13.25 GHz, and 13.8-14.0 GHz bands). *First Report and Order*, 16 FCC Rcd. at 4126.

[83] There may not be similar bands available in other countries.

ensure safe and secure communications for the public and other licensees while reducing the regulatory burden on our prospective NGSO FSS licensees. We therefore adopt blanket licensing procedures for NGSO FSS user Earth stations in these specific frequency bands.

59. ***Annual Reports.*** The *Notice* proposed to require that licensees submit an annual report of the number of user terminal Earth stations actually brought into service under this blanket licensing authority, a reporting requirement instituted with blanket licensing in other satellite services. Some commenters oppose this reporting requirement, arguing that there is no demonstrated need in this service, and that the information required is competition-sensitive.[84] Hughes asserts that if the purpose of the annual report of user terminal Earth stations brought into use is to ensure maximum deployment, that purpose is already served by the space station construction milestones.[85] Once licensees have made the investment necessary to construct and launch space stations, Hughes says, they have every incentive to maximize usage of Earth station resources. We are persuaded that this annual reporting requirement may impose a burden that outweighs its usefulness for regulating the licensees. We therefore do not adopt our proposal.

60. ***Antenna Reference Pattern.*** In the *Notice*, we recognized that specifying an antenna reference pattern for NGSO FSS user terminal Earth stations has the potential to facilitate sharing among NGSO FSS systems by suppressing antenna sidelobes.[86] We noted at that time that we had little evidence that imposing such an antenna reference pattern on NGSO FSS user Earth stations would significantly improve that sharing. The comments on the *Notice* did not provide any such evidence, and no commenter supported a specified antenna reference pattern for this reason. We therefore do not, at this time, adopt an additional antenna reference pattern for NGSO FSS user terminal Earth stations.[87] With the selection of Option 3 as the sharing method, and with our decision to use angular separation between satellites for the definition of an in-line interference event, antenna reference patterns may be needed in the future to further the licensees' sharing.[88]

61. ***EIRP Density Limits.*** Similarly, in the *Notice* we recognized that spectrum use efficiencies are associated with off-axis equivalent isotropically radiated power ("EIRP") density limits, but proposed not to mandate them for NGSO FSS at this time.[89] Most comments supported our restraint from specifying these limits. SkyBridge does support mandating off-axis EIRP limits, however, arguing that the Commission's failure to impose them on GSO FSS Earth stations conflicts with international agreements. We note that our rules currently require GSO FSS systems to meet antenna gain characteristics.[90] Routine licensing provisions of our rules also limit the antenna input power density of

[84] Boeing Comments at 17, Hughes Comments at 16.

[85] Hughes comments at 16.

[86] *Notice*, 16 FCC Rcd. at 9695.

[87] *See* 47 § 25.209(h) (antenna reference pattern for GSO Earth stations and NGSO gateway Earth stations); *see also Further Notice of Proposed Rulemaking, infra* at ¶ 90 (off-axis power flux density limits).

[88] Option 3 relies on antenna directivity to facilitate sharing. The ability of an antenna to reject or suppress off-axis signals has an impact on the angular dimensions of the potential interference zone. We address this issue in the *Further Notice of Proposed Rulemaking* that we are also adopting today.

[89] *Notice*, 16 FCC Rcd. at 9695.

[90] 47 C.F.R. § 25.209.

carriers.[91] These rules effectively result in off-axis EIRP limits for GSO networks that meet the standards specified in international agreements. When operators create any variance from these rules, they must either seek coordination with affected parties, or provide a demonstration that the variance will not cause any unacceptable interference to other parties, and they are required to accept interference from other lawfully operating radiocommunications facilities. We therefore do not accept SkyBridge's argument that our GSO FSS Earth station rules conflict with international agreements. As we proposed, we do not mandate EIRP density limits for NGSO FSS Earth stations at this time.

E. Service Rules

62. In the *Notice*, we requested comment on licensing and service rule issues for Ku-Band NGSO FSS in light of the decisions made in the *First Report and Order*, and in light of the NGSO FSS spectrum sharing proposals presented in the *Notice*.[92]

63. ***Coverage requirement.*** We proposed to adopt, for the Ku-Band NGSO FSS, coverage requirements similar to those we apply to other NGSO FSS systems. Specifically, we proposed to require that NGSO FSS systems be capable of providing service on a continuous basis throughout the fifty states, Puerto Rico, and the U.S. Virgin Islands. We also sought comment on whether we should require NGSO FSS systems to be capable of serving locations as far north as 70 degrees latitude and as far south as 55 degrees latitude for at least 75 percent of every 24-hour period.[93]

64. The comments generally support both proposed coverage requirements, although Virtual Geo proposes an exception to the coverage requirement for systems such as its own that have highly elliptical orbits. We conclude that these coverage requirements maximize use of a global spectrum resource allocated to this service. We therefore adopt our coverage proposals. We acknowledge that NGSO FSS systems' geographical coverage on the surface of the Earth may not always equate to their actual service area coverage, because the latter may be affected by NGSO/NGSO sharing and aggregate interference limits. Nevertheless, we find that coverage requirements expressed in geographic terms provide a rough definition of the areas in which we expect NGSO FSS systems to provide service. Although actual service may be limited by sharing requirements, our coverage requirements prohibit service coverage from being limited by system design. We therefore require that NGSO FSS systems in the Ku-Band must be capable of providing service on a continuous basis throughout the fifty states, Puerto Rico, and the U.S. Virgin Islands. These systems must also be capable of serving locations as far north as 70 degrees latitude and as far south as 55 degrees latitude for at least 75 percent of every 24-hour period.

65. ***Financial qualifications.*** Since the *Notice* proceeded from the assumption that a spectrum sharing plan can be devised to accommodate all the pending applicants' proposed systems as well as future entry, we did not propose a strict financial qualification standard for the Ku-Band NGSO FSS. We advised, however, that if the record developed in this proceeding indicated that the available spectrum

[91] 47 C.F.R. § 25.212.

[92] The Commission recently requested comment on changes to a number of satellite license rules. Any changes adopted in that pending proceeding will apply to all satellite licensees, including licensees in this NGSO FSS in the Ku-Band. *See Amendment of the Commission's Space Station Licensing Rules and Policies*, Notice of Proposed Rulemaking and First Report and Order, 17 FCC Rcd. 3847 (adopted February 14, 2002) ("*Space Station Reform NPRM*").

[93] We made this proposal in order to require that applicants cover the majority of the world's population.

could not accommodate all applicants, we might impose a strict financial qualifications standard. The *Notice* sought comment on what demonstration would be required, were we to find a need for strict financial qualifications.

66. Only Boeing advocated imposing financial qualifications.[94] Boeing did so because it disagrees with a basic premise of the *Notice*, which is that sufficient spectrum to accommodate all the applicants is allocated to the service. Boeing hopes that financial qualifications will clear away applicants or licensees who do not have the resources to initiate service. To assist applicants that may not presently have sufficient financing, Boeing proposed to defer the financial qualification finding until one year after licensing, effectively converting the financing of the system into an enforcement milestone.[95] Boeing advocates requiring that the funds should be earmarked specifically for this satellite system. Boeing asserts that applicants who fail to raise the capital necessary to implement their systems within a year of licensing would do so because of business or technical faults in their proposals. Although Hughes notes that it has long supported the application of financial qualifications, it believes the current standards are not suited to global, multi-spacecraft networks.[96] If financial qualifications were imposed in this service, Hughes proposes that NGSO FSS applicants be required to demonstrate current assets equal to just 25 percent of the estimated cost to construct, launch and operate their system for one year, rather than the entire cost of the system.[97] Hughes' suggestion that the Commission combine financial qualifications with current milestone requirements appears to concur somewhat with Boeing's views.[98]

67. We appreciate the proposals made by Boeing and Hughes. Our financial qualifications policy was designed to make efficient use of spectrum by preventing under-financed applicants from depriving another fully capitalized applicant of the opportunity to provide service to the public. In this service, that objective is addressed by our choice of spectrum sharing option. Our decision to use the avoidance of in-line interference events is premised upon equal access to all spectrum by all licensees in this service, thereby preventing any under-financed applicant from obstructing another applicant's service in any part of the spectrum. Accordingly, we do not see a need to impose additional regulatory oversight of the applicants' financial backing, with its attendant regulatory difficulties and expenditure of government resources. We do not adopt a strict financial qualification standard for the Ku-Band NGSO FSS.

68. ***System license and license terms.*** The *Notice* proposed to authorize Ku-Band NGSO FSS space stations under blanket licenses for constellations of technically identical satellites that may be launched and retired at different times, a licensing approach previously applied to a number of other NGSO services. The commenters uniformly support this proposal. We therefore adopt our proposals for system license and license terms. NGSO FSS authorizations will cover all construction and launches necessary to implement the complete constellation and to maintain it until the end of the license term, including any replacement satellites necessitated by launch or operational failure, or by retirement of satellites prior to the end of the license period. All replacement satellites must be technically identical to those in service, including the same frequency bands and orbital parameters, and may not cause a net increase in the number of operating satellites

[94] Boeing Comments at 14.

[95] Boeing Comments at 15.

[96] Hughes Comments at 26.

[97] Hughes Comments at 27.

[98] *Id.*

in the authorized orbital planes or an additional orbital plane. The license term will run from the date on which the first space station in the system begins transmitting and receiving radio signals, and be valid for fifteen years from that point in time.[99] The filing window for system replacement applications prior to the expiration of the license must be sufficient to allow adequate time for the Commission to act upon system replacement applications. System replacement applications must be filed no earlier than three months prior to the end of the thirteenth year of the existing system license, and no later than one month after the end of the thirteenth year.

69. ***Regulatory Classification***. In the *Notice*, we observed that all geostationary-orbit fixed-satellite operators in the C-Band and Ku-Band can elect to operate on a common carrier or non-common carrier basis. All of the Ku-Band NGSO FSS applicants propose to operate their services on a non-common carrier basis. All comments support our proposal to allow applicants to elect their regulatory classification. We conclude that it is in the public interest to also allow the NGSO FSS licensees the same election. We therefore adopt the proposal. NGSO FSS licensees in the Ku-Band can elect to operate on a common carrier or non-common carrier basis.

70. ***Implementation milestones.*** In the *Notice*, we proposed that all NGSO FSS Ku-Band licensees would be required to adhere to a strict timetable for system implementation. We proposed implementation milestones that track the schedules recently imposed on other NGSO systems, including a requirement that NGSO FSS licensees enter into a non-contingent satellite manufacturing contract for the system within one year of authorization. We further proposed to require that a licensee complete critical design review[100] within two years of authorization, begin physical construction of all satellites in the system within two and a half years of authorization, and complete construction and launch of the first two satellites within three and a half years of grant. Each licensed NGSO FSS system will have to be launched and operational within six years of authorization. We proposed to require operators to submit certifications of milestone compliance within 10 days following a milestone specified in their authorization.

71. Alternatively, we proposed tying NGSO FSS licensees to the ITU "Bringing Into Use" date.[101] If that were done, we could require licensees to demonstrate to the Commission that they are on a launch manifest at a designated time prior to the Bringing Into Use date for this service in the database of the ITU. Boeing supports the adoption of the implementation milestones proposed in the *Notice*, but

[99] S*ee Space Station Reform NPRM*, 17 FCC Rcd. at 3894. The Commission adopted rule revision that enable it to issue satellite licenses with 15 years terms, rather than the 10-year license terms previously authorized. The rule revision for 15-year terms will apply to all space station and earth station licenses granted after the effective date of the rule change, April 18, 2002. 67 Fed. Reg. 12485 (March 19, 2002).

[100] The critical design review is the stage in the space station implementation process at which the design and development phase ends, and the manufacturing phase begins.

[101] *See* ITU RR Art. S11.44. Generally, ITU Radio Regulations require that the satellite be "brought-into-use" (BIU) no later than five years from the date the ITU publishes the advance publication information. ITU Radio Regulations Article S11.44. The ITU may extend the BIU date by two years under the conditions specified in ITU Radio Regulations Articles S11.44B through S11.44I (launch failure; launch delays due to circumstances outside the control of the administration or operator; delays caused by modifications of satellite design necessary to reach coordination agreements; problems in meeting the satellite design specifications; delays in reaching coordination after a request for ITU Radiocommunication Bureau assistance; financial circumstances outside the control of the administration or operator; and force majeure).

opposes tying Commission milestones to ITU dates.[102] Boeing asserts that milestones are necessary to ensure the timely and efficient use of spectrum resources. Hughes and Virtual Geo oppose our proposal to require additional milestones, including the critical design review within two years of authorization.[103] Hughes and Virtual Geo argue that these additional milestones are overly burdensome and limit an operator's flexibility in building out its system. Virtual Geo proposes that the milestone for entering into a non-contingent construction contract be set at 18 months, rather than 12 months, because it asserts that NGSO service in the Ku-Band is less established than GSO service, and there are no product lines geared to the necessary technology.[104]

72. SkyBridge notes that it has long supported milestones as a means to ensure usage of spectrum.[105] SkyBridge was the only commenter supporting the proposal to tie Commission milestones to ITU bringing into use dates, asserting that such milestones could achieve regulatory simplification.[106] Viewing our milestones policy from a larger perspective, SkyBridge also argued that if the Commission adopted the Avoidance of In-Line Interference Events sharing option, the underlying policy rationale for milestones is met, because delays in building one system would not adversely affect other systems.

73. We believe that SkyBridge's last point is well taken. But we also believe that milestones do more than prevent one licensee from obstructing a co-licensee's expansion. Milestones also serve the purpose of testing and regulating the licensees' ability and intention to use valuable spectrum in the public interest, whether or not a licensee's inactivity is obstructing another licensee. This oversight function of milestones is an effective way to ensure that our licensees are serving the public interest in use of radio spectrum. We believe that licensees who are motivated to put their spectrum in service will not find these milestones burdensome. We therefore adopt the milestones we proposed in the *Notice*. We are not persuaded there is any need to extend the first milestone to 18 months, as Virtual Geo proposes. While Virtual Geo explains that another six months is needed because no product lines exist for this new service, we expect that the service parameters adopted in this *Report and Order* will dictate the specifications of the necessary products. Because applicants must file conforming amendments and be authorized before the milestones begin to run, a process that will likely take several months, we see no reason to extend, by six months, the milestone for entering into a non-contingent satellite manufacturing contract.

74. We do not adopt the alternative proposal to tie our milestones to ITU bringing into use dates, because we prefer to preserve the independence of Commission deadlines. ITU bringing into use dates occur five to seven years after it publishes advance notification of a new satellite service.[107] Although the initiation of a new service sometimes requires lengthy spectrum allocation proceedings and processing rounds at the Commission, with the result that Commission license milestones begin to approximate ITU dates, we prefer to retain our milestones separate, to retain flexibility. At the same time, we stress that the

[102] Boeing Comments at 18.

[103] Hughes Comments at 29; Hughes Reply at 15; Virtual Geo Comments at 46; Virtual Geo Reply at 25.

[104] Virtual Geo Reply Comments at 25.

[105] SkyBridge Comments at 24.

[106] SkyBridge Comments at 25.

[107] *See supra* at n. 98.

Commission will not advocate extension or re-filing for ITU bringing into use dates on behalf of applicants who fail to meet Commission milestones.[108]

75. We adopt the following implementation milestone schedule for NGSO FSS systems in the Ku-Band frequencies. These milestones will be incorporated as conditions in all NGSO FSS licenses.[109] Non-compliance with implementation milestones will result in cancellation of the authorization. Licensees must submit certifications of milestone compliance within 10 days following each milestone specified in their authorization. Failure to file a timely certification of milestone compliance, or filing disclosure of non-compliance, will result in automatic cancellation of an operator's system authorization with no further action required on the Commission's part.

- NGSO FSS systems must enter into a non-contingent satellite manufacturing contract for the system within 12 months of authorization, complete critical design review within two years of authorization, begin physical construction of all satellites in the system within two and a half years of authorization, and complete construction and launch of the first two satellites within three and a half years of grant.
- The entire system must be launched and operational within six years of authorization.

76. ***Reporting requirements.*** The *Notice* proposed to apply to the NGSO FSS a slight variation of the Part 25 rules governing reporting requirements for FSS systems.[110] FSS licensees are required to file, on June 30 of each year, an annual report with the Commission describing: the status of satellite construction and anticipated launch dates, including any major delays or problems encountered, and a detailed description of the use made of each satellite in orbit.[111] Any anticipated delay in these schedules requires a request for an extension of time. The commenters generally support our proposed reporting requirements. We find that the information is required for streamlining our regulation of this satellite service. Without these reports, Commission resources would be required to investigate licensees' progress in building systems in their assigned spectrum. Our milestone requirements monitor licensees' progress in constructing and launching their systems. This annual reporting requirement provides system-monitoring information for launched systems. We therefore adopt the proposed reporting requirements, but provide that annual reports must first be filed when an NGSO FSS system has launched its first two satellites. Until that time, reports should be provided within 10 days of the milestone dates.

77. ***International Coordination.*** The *Notice* observed that we have permitted licensing, launch and operation of a U.S.-licensed satellite system before international coordination is completed, so long as it avoids causing harmful interference to systems of other administrations and it accepts interference from

[108] These milestones will be incorporated as conditions to individual licensing decisions on each application. The milestone time periods run from the effective date of the licenses.

[109] S*ee Space Station Reform NPRM*, 17 FCC Rcd. at 3882. In that notice of proposed rulemaking, the Commission proposes other options for satellite space station milestones.

[110] *See generally Streamlining the Commission's Rules and Regulations for Satellite Applications and Licensing Procedures,* Report and Orde*r*, 11 FCC Rcd 21581 (1996) ("*Part 25 Streamlining Order"*).

[111] *See* 47 C.F.R. § 25.210(l) (1) and (3).

other countries' systems.[112] Our policy has thus permitted systems to launch and begin providing service under U.S. licenses while at the same time observing international obligations. As there was no dissenting comment, we adopt our proposal to follow the coordination procedure prescribed by the ITU to effect coordination with other administrations for the U.S.-licensed Ku-Band NGSO FSS systems.

78. In the *Notice*, we also expressed concern as to how the NGSO FSS spectrum sharing arrangement we adopt will affect international coordination. We noted in the *Notice* that we have adopted, as a general approach, a policy of pursuing international coordination for U.S.-licensed satellite systems consistent with our domestic frequency band plans.[113] We asked for comment on whether that policy is appropriate for this service.

79. Both SkyBridge and Hughes oppose international coordination linked to our domestic band plan.[114] Both parties express alarm that such a policy will unduly restrict the flexibility of Commission licensees. We are persuaded by their comments that our decision to adopt avoidance of in-line interference events as the sharing mechanism among the NGSO FSS licensees generally eliminates the need for global operation according to a band plan. Since all licensees are allowed to operate in the entire available spectrum so long as they avoid causing an in-line interference event, the licensees have the option to use other spectrum bands when they provide service to other countries. In the case of an in-line interference event involving only Commission licensees, the policies we adopt today direct their mitigation efforts. If their coordination fails, the default technique is a form of band segmentation. Although our rules will impose that default solution in all unresolved in-line interference events involving only U.S.-licensed systems, ITU procedures will direct coordination of in-line interference events involving Commission licensees and systems licensed by other administrations. We cannot promise that international coordination under ITU procedures will result in band segmentation being chosen for mitigation of these in-line interference events, as we require for coordination between U.S.-licensed systems.

80. ***Exclusive Arrangements.*** We do not adopt a proposed rule restricting exclusive arrangements because the rule has been superseded. Congress has statutorily prohibited satellite operators from entering into or enjoying exclusive arrangements with other countries.[115]

81. ***Orbital Debris Mitigation.*** In the *Notice*, we proposed to adopt a requirement that NGSO FSS applicants disclose their orbital debris mitigation plans. The few comments addressing this issue support orbital debris requirements that are generally applicable to all satellite services.[116] Consistent with our recent practice in other satellite services, we find in this case that it is in the public interest to

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[112] *See In The Matter Of Amendment Of The Commission's Rules To Establish Rules And Policies Pertaining To A Mobile Satellite Service In The 1610-1626.5/2483.5-2500 Mhz Frequency Bands*, Report and Order, ET Docket No. 92-28, 9 FCC Rcd 5936, 6018 (1994) (*"Big LEO Report and Order*").

[113] *See Notice*, 16 FCC Rcd. at 9700.

[114] SkyBridge Comments at 28; Hughes Comments at 33.

[115] *See* 47 U.S.C. § 765g (section 648 of the "Open-Market Reorganization for the Betterment of International Telecommunications Act").

[116] SkyBridge Comments at 30; Boeing Comments at 19.

require NGSO FSS applicants to disclose their orbital debris mitigation plans before licensing.[117] In their conforming amendments, applicants must submit a narrative statement describing the debris mitigation design and operational strategies, if any, that they will use. Applicants are specifically required to submit a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the spacecraft. In preparing such exhibits, applicants may find guidance in the U.S. Government Orbital Debris Mitigation Standard Practices.[118] The Commission recently initiated a rulemaking proceeding that addresses orbital debris issues concerning Commission space station licenses. Among other things, this rulemaking proposes to require disclosure of debris mitigation plans by all satellite systems providing service to the United States.[119]

82. ***Sale of license.*** We proposed a rule prohibiting any Ku-Band NGSO FSS licensee from selling a bare license, without any associated facilities, for a profit.[120] The few comments addressing this rule note that there is no reason to diverge in these service rules from the general rule applied to all other satellite services. We adopt the rule as proposed. We note that while we believe that the policies of deterring speculation and unjust enrichment have been well served by the anti-trafficking rule that we have applied in other satellite services, we have requested comment from the public in a separate proceeding on certain Commission space station licensing rules and policies, including our anti-trafficking rule.[121] Any rule or policy changes adopted in that proceeding will be applied to all satellite services.

83. ***Conforming Amendments***. The Commission has frequently allowed satellite system proponents an opportunity to amend their applications to bring them into conformity with the requirements and policies adopted for satellite systems during processing rounds.[122] Based on our decisions today, applicants will need to amend their applications in order to receive continued consideration. Therefore, we will provide 30 days after a summary of this *Report and Order* is published in the Federal Register for system proponents to amend their filings.

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[117] *The Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band*, Report and Order, 15 FCC Rcd. 16127, 16188.

[118] http://orbitaldebris.jsc.nasa.gov/mitigate/mitigation.html. *See also* National Aeronautics and Space Administration Safety Standard 1740.14. http://orbitaldebris.jsc.nasa.gov/mitigate/nss1740/nss1740.html. *See also*, *In The Matter Of Application Of Constellation Communications Holdings, Inc.*, Order and Authorization, 16 FCC Rcd. 13724, 13731 (Int'l Bur. and Office of Eng. and Tech. 2001); *In The Matter Of Application Of The Boeing Company*, Order and Authorization, 16 FCC Rcd. 13691, 13702 (Int'l Bur. 2001).

[119] *In the Matter of Mitigation of Orbital Debris*, Notice of Proposed Rulemaking, FCC No. 02-80, IB Docket No. 02-54 (adopted March 14, 2002).

[120] *Notice*, 16 FCC Rcd. at 9701.

[121] 47 C.F.R. § 25.143(g) (2GHz MSS and Big LEO services trafficking rule); 47 C.F.R. § 25.145 (d) (Ka-Band FSS trafficking rule). S*ee Amendment of the Commission's Space Station Licensing Rules and Policies*, Notice of Proposed Rulemaking and First Report and Order, IB Docket No. 02-34, FCC No. 02-45 (adopted February 14, 2002). In that notice of proposed rulemaking the Commission proposes lifting the anti-trafficking rule.

[122] *See*, *e.g.*, *The Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band*, Report and Order, 15 FCC Rcd. 16127, 16149 (2000).

IV. CONCLUSION

84. This *Report and Order* allows expeditious deployment of Ku-Band NGSO FSS in the United States, by establishing a spectrum sharing plan and service rules for implementation of these systems. The services proposed in the pending applications can soon be provided to consumers by allowing market forces to play a role in the implementation of these systems. We believe it is in the public interest to provide opportunities for multiple systems to compete, providing more service choices and competitive prices in the marketplace. We believe that the sharing plan we adopt today is sufficiently flexible to accommodate all of the NGSO FSS systems put forth by the pending applicants. We also hold open the possibility that additional systems may be accommodated. With the implementation of the proposed systems, the greater public interest will be served, as consumers will have access to competitive voice and data services, in some cases with broadband capacity and a worldwide reach.

V. FURTHER NOTICE OF PROPOSED RULEMAKING

85. In today's *Report and Order*, we have adopted the means by which NGSO FSS licensees will share the Ku-Band spectrum designated for their service. The rules adopted in the *Report and Order*, together with previously adopted rules applicable to this service, provide the parameters within which NGSO FSS licenses may operate in this service. Together, the rules we have adopted for NGSO FSS in the Ku-Band provide sufficient regulatory certainty for system design that we will require applicants to file amendments to make their applications conform to these rules within 30 days of publication of the *Report and Order* in the Federal Register. The rules proposed in this *Further Notice of Proposed Rulemaking* will not slow system development or deployment. Our consideration of these additional issues will not excuse licensees' noncompliance with Commission milestones or otherwise justify any extension of time to meet those milestones.

86. Our review of the record filed in response to the *Notice* suggests that we could optimize spectrum efficiency in this service by refining the angular separation definition of an in-line interference event. The record developed in response to the *Notice* also informs us of a significant amount of progress in ITU-R studies on the power flux density criteria that sets the bounds of NGSO/GSO sharing in these Ku-Band frequencies. In both the *First Report and Order* and the *Notice* in this proceeding, the Commission has consistently stated that all NGSO FSS licensees will be required to demonstrate that they collectively meet a limit on aggregate power flux density, although the means for making that demonstration had not yet been developed.[123] We propose to adopt the newly developed ITU-R methodology for NGSO FSS licensees, and seek comment on issues related to this new methodology. Accordingly, we initiate a *Further Notice of Proposed Rulemaking* in this proceeding, to address these two refinements to the NGSO FSS rules.

VI. DISCUSSION

A. Angular Separation to Avoid In-Line Interference Events

87. With our adoption of a 10-degree Earth based topocentric angular separation definition of an in-line event in today's *Report and Order*, we adhere to existing Commission policy encouraging satellite operators to work together through coordination to prevent harmful interference between their systems. The embodiment of that policy in the definition of in-line interference events effectively requires that

[123] *See Notice*, 16 FCC Rcd. at 9698; *First Report and Order*, 16 FCC Rcd. at 4140.

applicants coordinate the operations to avoid harmful interference outside the defined 10-degree angular separation.

88. While our rules allow and encourage working arrangements to be made within the 10-degree separation angle, we also note that the potential exists for harmful interference outside the separation angle. In other services, antenna input power density limitations have been used to prevent harmful interference into adjacent satellite systems. One example of this is found in our rules for very small aperture terminal stations ("VSAT") in the GSO FSS service.[124] In the VSAT service, operations in excess of the limit are permitted, but subject to a certification or showing that potentially affected parties acknowledge and do not object to the applicant's proposed higher power density. We note, then, that the use of small-diameter Earth station antennas with very high power density levels at the input of the antenna can result in harmful interference to other satellite systems. The harmful interference arises from a combination of the off axis characteristics of the Earth station antenna and the higher input power. Two alternative solutions to the problem can avoid harmful interference. One is to use larger antennas, thus reducing the transmitter power level input to the antenna or improving off-axis performance of the Earth station antenna or both. Another solution is to require wider angles of separation between satellite systems.

89. We note that comments on the *Notice* expressed the view that a wider angle trigger may be required for some systems.[125] We are concerned, however, that imposing a wider angle for some systems may discourage coordination between parties, because a system that can operate under the "benefit" of a wide-angle trigger has no incentive to coordinate with other systems, thus restricting those systems' ability to use the entire Ku-Band spectrum. We are also concerned that employing two different angular separation measures may encourage the use of system parameters that are inefficient and result in limiting spectrum available to other systems. We adopt a 10-degree angle of separation based upon a balancing of the interference requirements of systems on the one side, and spectrum and orbital efficiency on the other. Recognizing the potential for high-powered systems to tip the balance by creating spectrum inefficiencies, we seek comment on whether a second angular separation for higher power systems is needed, and if so, what angle should be used. If comments indicate that we should indeed require another angle of separation for high-powered systems, we request that the comments also provide and justify the power flux density ("PFD") level limitation that would be needed as a trigger level. A system that achieves the trigger level would be defined as a "high-powered system" for this purpose. In an *ex parte* presentation, SkyBridge proposed defining as a "high-powered uplink" an on-axis PFD in excess of 18 $dBW/m^2/40$ kHz and an off-axis PFD at 10-degrees or greater in excess of -10 $dBW/m^2/40$ kHz.[126] We request comment on this proposed definition of a high-powered uplink.

90. We note that if we were to adopt input power flux density limitations, the impact of that rule would be felt most by systems with highly elliptical orbits, because the distance from the Earth to their space stations creates a greater path loss, and requires higher transmitter power than satellites with lower operating altitudes. At the same time, we note that the highly elliptical orbit systems proposed in this processing round anticipate sharing with other systems utilizing orbit planes with satellites aligned in

[124] 47 C.F.R. § 25.134(b).

[125] SkyBridge Reply at 9; Hughes Reply at 6.

[126] SkyBridge L.P., *Ex Parte* Filing in File Nos. 48-SAT-P/LA-97, 89-SAT-AMEND-97, 130-SAT-AMEND-98, and ET Docket No. 98-206 (adopted February 1, 2002).

adjacent positions, and kept in the adjacent position as the satellites move through the orbit plane. If implemented, that type of sharing would require a greater degree of antenna discrimination in order to prevent interference between those adjacent systems. We note that in the case of GSO VSAT services if the level of –14 dBW/4kHz is exceeded at the antenna input, agreement from affected parties is required. We note that some NGSO systems have orbital parameters with service arc operations at altitudes of similar magnitude to those utilized by GSO spacecraft. This input power level results in an off axis power flux density at 10 degrees utilizing an antenna that meets section 25.209 of our rules, which requires -7dBW/4kHz.

91. We request comments on whether an off axis PFD limit may be utilized with or without an additional off-axis angle to limit harmful interference to satellites of different networks that are 10 degrees or farther apart. We request comment on whether a value of –7 dBW/4kHz may be appropriate for interference mitigation. We also request comment on whether any other value would be more appropriate.

B. NGSO/GSO Sharing: Aggregate Equivalent Power Flux Density

92. In the *First Report and Order*, the Commission adopted an international compromise solution to NGSO FSS/GSO FSS and NGSO FSS/Broadcast Satellite Service sharing issues.[127] The Commission concluded that it is possible for the NGSO FSS to share spectrum with incumbent services, including GSO FSS, without causing unacceptable interference to them or unduly constraining their future growth. Technical criteria for NGSO FSS operations are critical to the compromise and the Commission's adoption of it. Specifically, the Commission adopted equivalent power flux density limits for NGSO FSS uplink and downlink operations.[128] The Commission found that the single-entry and aggregate EPFD limits it adopted define the level of acceptable interference from an NGSO FSS system into a GSO FSS system.

93. At the same time, the Commission noted practical difficulties in verifying compliance with aggregate limits of any kind.[129] This issue has been considered within the ITU, with the active participation of the United States.[130] We placed NGSO FSS applicants on notice in the *First Report and Order* that we will require them to demonstrate their ability to meet aggregate $EPFD_{down}$ limits that may be set in the future, as set out in Section 25.208(h).

94. At the time the Commission adopted the *Notice* in this proceeding, a suitable methodology had not yet been developed that would allow the calculation of the aggregate $EPFD_{down}$ produced by all NGSO FSS systems, including systems not serving the United States. Without such methodology we could not establish procedures for NGSO FSS applicants to follow for demonstration of compliance with the aggregate $EPFD_{down}$ limits. That methodology has now been developed.

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[127] *First Report and Order*, 16 FCC Rcd. at 4109.

[128] *First Report and Order*, 16 FCC Rcd. at 4128.

[129] *First Report and Order*, 16 FCC Rcd. at 4140.

[130] *See* Submission of the United States of America to ITU-R Working Party 4A (Doc. 4A/112). This document is a preliminary draft of a new recommendation entitled "Methodologies for Calculating Aggregate $EPFD_{down}$ Produced by Multiple Non-GSO FSS Systems into a GSO Network."

95. ITU-R Working Party 4A has developed and sent to ITU-R Study Group 4 a draft new recommendation providing three methodologies for calculating aggregate $EPFD_{down}$ limits into GSO networks.[131] As the Commission noted in the *First Report and Order*, the ITU-BR will determine whether an NGSO FSS system meets validation limits by using software developed in accordance with these methodologies.[132] The first two methodologies are conservative calculations, but require less information to perform than the third methodology. The third methodology is more detailed, and produces results closer to expectation, but it requires information that is not likely to be available early in the aggregate $EPFD_{down}$ calculation process. In addition, the third methodology is likely to be used only when the first and second methodologies indicate a potential for exceeding the aggregate $EPFD_{down}$ limits. All three methodologies are described in more detail in Appendix C.

96. We note that the first and second methodologies can be performed with publicly available information, while the third methodology requires the use of non-public information for its calculations. We assume that the third methodology calculations would therefore have to be performed late in the satellite network design and coordination process. In addition, one of the required information inputs for the third methodology is the result of coordination agreements between NGSO systems.

97. We seek comment on whether the ITU-R Working Party 4A recommendation should be adopted as the method for determining aggregate $EPFD_{down}$ for NGSO FSS systems in the Ku-Band. We also seek comment on the timing of when a showing would be required from applicants. We seek comment on the availability of ITU-BR validation software based on Recombination ITU-R S.1503 for use by NGSO FSS applicants to demonstrate compliance with the aggregate $EPFD_{down}$ limits.

98. We note that the coordination process may affect final system designs. We also note that with the choice of Avoidance of In-Line Interference Events as the method for intra-service sharing, that coordination agreements between networks should take place prior to implementation of their systems. We expect that final system characteristics will be known prior to launch. We therefore seek comment on whether the showing that an applicant's system does not exceed the aggregate $EPFD_{down}$ limit should be made six months prior to launch of the system's first spacecraft, or, alternatively, at the time of critical design review. We ask commenters to focus on whether our assessment of the timing of this issue is accurate.

[131] Draft New Recommendation ITU-R S.[DOC. 4/62] "Methodologies for calculating aggregate $EPFD_{down}$ produced by multiple non-GSO FSS systems into a GSO FSS network." Recommendation attached.

[132] *First Report and Order*, 16 FCC Rcd. at XXX paragraph 78. ITU-R Recommendation BO.1503 contains the specification for the software, which the ITU-BR will use to determine whether a NGSO system meets the single-entry $EPFD_{down}$ validation limits. *See* ITU-R Recommendation BO.1503 entitled, "Functional Description to be Used in Developing Software Tools for Determining Conformity of non-GSO FSS Networks With Limits Contained in Article S22 of the Radio Regulations." The output of the software is represented by continuous curves of cumulative density function (CDF) as a function of percentage of time which will be compared to the single-entry validation limits contained in Article S22, Table S22-1A.

VII. PROCEDURAL INFORMATION

A. Final Regulatory Analysis

99. *Final Regulatory Flexibility Analysis.* The analysis regarding the *Report and Order*, pursuant to the Regulatory Flexibility Act of 1980*, see* 5 U.S.C. Section 604, is contained in Appendix D.

B. Initial Regulatory Flexibility Analysis

100. As required by the Regulatory Flexibility Act, *see* 5 U.S.C. § 603, the Commission has prepared an Initial Regulatory Flexibility Analysis ("IRFA") of the possible significant economic impact on small entities of the proposals suggested in this *Further Notice of Proposed Rule Making*. The IRFA is set forth in Appendix E. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments filed in this *Further Notice of Proposed Rule Making ("Further NPRM")*, and must have a separate and distinct heading designating them as responses to the IRFA.

C. Paperwork Reduction Analysis

101. The Report and Order and Further Notice of Proposed Rulemaking contain proposed and modified information collections. 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 Order, as required by the Paperwork Reduction Act of 1995, Public Law 104-13. 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.

102. Written comments on the proposed and modified information collections must be submitted on or before 60 days after date of publication in the Federal Register. A copy of any comments on the information collections contained herein should be submitted to Judy Boley Herman, Federal Communications Commission, Room 1-C804, 445 12th Street, SW, Washington, DC 20554, or via the Internet to jboley@fcc.gov.

D. Ex Parte Presentations

103. This is a permit-but-disclose notice and comment rule making proceeding. Members of the public are advised that ex parte presentations are permitted, except during the Sunshine Agenda period, provided they are disclosed under the Commission's Rules.[133]

E. Comment Dates

104. Pursuant to Sections 1.415 and 1.419 of the Commission's Rules, 47 C.F.R. §§ 1.415 and 1.419, interested parties may file comments on or before **45 days from date of publication in the Federal Register** and reply comments on or before **60 days from date of publication in the Federal**

[133] *See generally* 47 C.F.R. §§ 1.1202, 1.1203, 1.1206(a).

Register. Comments may be filed using the Commission's Electronic Comment Filing System (ECFS) or by filing paper copies. 63 Fed. Reg. 24121 (1998).

105. Comments filed through the ECFS can be sent as an electronic file via the Internet to http://www.fcc.gov/e-file/ecfs.html. Generally, only one copy of an electronic submission must be filed. If multiple docket or rule making numbers appear in the caption of this proceeding, however, commenters must transmit one electronic copy of the comments to each docket or rule making number referenced in the caption. In completing the transmittal screen, commenters 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 for e-mail comments, commenters should send an E-mail to ecfs@fcc.gov, and should including the following words in the body of the message, "get form <your e-mail address>." A sample form and directions will be sent in reply.

106. Parties who choose to file by paper must file an original and four copies of each filing. If more than one docket or rule making number appear in the caption of this proceeding, commenters must submit two additional copies for each additional docket or rule making 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). The Commission's contractor, Vistronix, Inc., will receive hand-delivered or messenger-delivered paper filings for the Commission's Secretary at 236 Massachusetts Avenue, N.E., 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. U.S. Postal Service first-class mail, Express Mail, and Priority Mail should be addressed to 445 12th Street, SW, Washington, DC 20554. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission. Comments and reply comments will be available for public inspection during regular business hours in the FCC Reference Center of the Federal Communications Commission, Room TW-A306, 445 12th Street, S.W., Washington, D.C. 20554.

107. Parties who choose to file by paper should also submit their comments on diskette. These diskettes should be submitted to the Commission's Secretary, Marlene H. Dortch, Office of the Secretary, Federal Communications Commission. The Commission's contractor, Vistronix, Inc., will receive hand-delivered or messenger-delivered diskette filings for the Commission's Secretary at 236 Massachusetts Avenue, N.E., 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. U.S. Postal Service first-class mail, Express Mail, and Priority Mail should be addressed to: 445 12th Street, SW, Washington, DC 20554. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission. Such a submission should be on a 3.5-inch diskette formatted in an IBM compatible format using Word for Windows or compatible software. The diskette should be accompanied by a cover letter and should be submitted in "read only" mode. The diskette should be clearly labeled with the commenter's name, the docket number of this proceeding, type of pleading (comment or reply comment), date of submission, and the name of the electronic file on the diskette. The label should also include the following phrase "Disk Copy - Not an Original." Each diskette should contain only one party's pleading, preferably in a single electronic file. In addition, commenters must send diskette copies to the Commission's copy contractor, Qualex International, Portals II, 445 12th Street, S.W., Room CY-B402, Washington, D.C. 20554.

108. Alternative formats (computer diskette, large print, audio cassette and Braille) are available to persons with disabilities by contacting Brian Millin at (202) 418-7426, TTY (202) 418-7365, or at bmillin@fcc.gov. This *Report and Order* and *Further Notice of Proposed Rulemaking* can also be downloaded at http://www.fcc.gov.

F. Further Information

109. For further information concerning this *Further Notice of Proposed Rulemaking*, contact: Robert Nelson at (202) 418-2341, Internet address: rnelson@fcc.gov, or J. Mark Young at (202) 418-0762, Internet address: myoung@fcc.gov, International Bureau, Federal Communications Commission, Washington, DC 20554.

VIII. ORDERING CLAUSES

110. IT IS ORDERED, that pursuant to Sections 4(i), 7(a), 303(c), 303(f), 303(g), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 157(a), 303(c), 303(f), 303(g), and 303(r), this *Report and Order* and *Further Notice of Proposed Rulemaking* is hereby ADOPTED.

111. IT IS FURTHER ORDERED that in order to continue their consideration in this processing round, the applicants must file conforming amendments and all necessary fees no later than 30 days after a summary of this *Report and Order* is published in the Federal Register.

112. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this Report and Order and Further Notice of Proposed Rulemaking, including the Final Regulatory Flexibility Certification and Initial Regulatory Flexibility Certification, in a report to Congress pursuant to the Congressional Review Act, *see* 5 U.S.C. § 801(a)(1)(A); and shall also send a copy of this Report and Order and Further Notice of Proposed Rulemaking, including the Final Regulatory Flexibility Certification and Initial Regulatory Flexibility Certification, to the Chief Counsel for Advocacy of the Small Business Administration. *See* 5 U.S.C. § 605(b). A copy of this Report and Order and Further Notice of Proposed Rulemaking, including the Final Regulatory Flexibility Certification and Initial Regulatory Flexibility Certification, will be published in the Federal Register. *See* 5 U.S.C. § 605(b).

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

LIST OF PARTIES

Comments

Denali Telecom LLC
Teledesic LLC
PanAmSat Corporation
DirecTV, Inc.
Lockheed Martin Corporation
The Boeing Company
Virtual Geosatellite LLC
Hughes Communications, Inc.
SkyBridge L.L.C.

Reply Comments

Northpoint Technology, Ltd. and Broadwave USA, Inc.
Lockheed Martin Corporation
Teledesic LLC
PanAmSat Corporation
Hughes Communications, Inc.
Virtual Geosatellite LLC
The Boeing Company
SkyBridge L.L.C.

APPENDIX B: FINAL RULES

For the reasons set forth in the preamble, part 25 of title 47 of the Code of Federal Regulations is proposed to be amended as follows:

PART 25-SATELLITE COMMUNICATIONS

The authority citation for Part 25 continues to read as follows:

AUTHORITY: 47 U.S.C. 701-744. Interprets or applies Sections 4, 301, 302, 303; 307, 309 and 332 of the Communications Act, as amended, 47 U.S.C. Sections 154, 301, 302, 303, 307, 309 and 332, unless otherwise noted.

1. Section 25.114 is amended by adding a new paragraph (22) to read as follows:

(22) Applications for authorizations in the non-geostationary satellite orbit fixed-satellite service (NGSO FSS) in the bands 10.7 GHz to 14.5 GHz. shall also provide all information specified in § 25.146.

2. Section 25.115 is amended by adding a new paragraph (f) to read as follows:

§ 25.115 Application for earth station authorizations.

* * * * *

(f) User transceivers in the non-geostationary satellite orbit fixed-satellite service in the 11.7-12.2 GHz, 12.2-12.7 GHz and 14.0-14.5 GHz bands need not be individually licensed. Service vendors may file blanket applications for transceiver units using FCC Form 312, Main Form and Schedule B, and shall specify the number of terminals to be covered by the blanket license. Each application for a blanket license under this section shall include the information described in §25.146.

Any earth stations that are not user transceivers, and which transmit in the non-geostationary satellite orbit fixed-satellite service in the 10.7-11.7 GHz, 12.75-13.15 GHz, 13.2125-13.25 GHz, and 13.75-14.0 GHz bands must be individually licensed, pursuant to paragraph (a) of this § 25.115.

2. Section 25.146 is amended by adding the following:

§ 25.146 Licensing and operating authorization provisions for the non-geostationary satellite orbit fixed-satellite service (NGSO FSS) in the bands 10.7 GHz to 14.5 GHz.

(g) System License: Applicants authorized to construct and launch a system of technically identical non-geostationary satellite orbit fixed satellite service satellites will be awarded a single "blanket" license covering a specified number of space stations to operate in a specified number of orbital planes.

(h) In addition to providing the information specified in §25.114 above, each NGSO FSS applicant shall provide the following:

(1) A demonstration that the proposed system is capable of providing fixed-satellite services on a continuous basis throughout the fifty states, Puerto Rico and the U.S. Virgin Islands, U.S.; and

(2) A demonstration that the proposed system be capable of providing fixed-satellite services to all locations as far north as 70 deg. latitude and as far south as 55 deg. latitude for at least 75 percent of every 24-hour period; and

(3) Sufficient information on the NGSO FSS system characteristics to properly model the system in computer sharing simulations, including, at a minimum, NGSO hand-over and satellite switching strategies, NGSO satellite beam patterns, NGSO satellite antenna patterns and NGSO earth station antenna patterns. In particular, each NGSO FSS applicant must explain the switching protocols it uses to avoid transmitting while passing through the geostationary satellite orbit arc, or provide an explanation as to how the power-flux density limits in Section 25.208 are met without using geostationary satellite orbit arc avoidance. In addition, each NGSO FSS applicant must provide the orbital parameters contained in Section A.3 of Annex 1 to Resolution 46. Further, each NGSO FSS applicant must provide a sufficient technical showing to demonstrate that the proposed non-geostationary satellite orbit system meets the power-flux density limits contained in Section 25.208, as applicable. And

(4) A description of the design and operational strategies that it will use, if any, to mitigate orbital debris. Each applicant must submit a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the spacecraft.

(i) Considerations involving transfer or assignment applications.

(1) "Trafficking"" in bare licenses issued pursuant to paragraph (g) of this section is prohibited.

(2) The Commission will review a proposed transaction to determine if the circumstances indicate trafficking in licenses whenever applications (except those involving *pro forma* assignment or transfer of control) for consent to assignment of a license, or for transfer of control of a licensee, involve facilities licensed pursuant to paragraph (g) of this section. At its discretion, the Commission may require the submission of an affirmative, factual showing (supported by affidavits of a person or persons with personal knowledge thereof) to demonstrate that no trafficking has occurred.

(j) Implementation Milestone Schedule. Each NGSO FSS licensee in the 10.7-12.7 GHz, 12.75-13.25 GHz and 13.75-14.5 GHz frequency bands will be required to enter into a non-contingent satellite manufacturing contract for the system within one year of authorization, to complete critical design review within two years of authorization, to begin physical construction of all satellites in the system within two and a half years of authorization, to complete construction and launch of the first two satellites within three and a half years of grant, and to launch and operate its entire authorized system within six years of authorization. Each NGSO FSS licensee in the 10.7-12.7 GHz, 12.75-13.25 GHz and 13.75-14.5 GHz frequency bands must submit certifications of milestone compliance within 10 days following a milestone specified in its authorization.

(k) Reporting Requirements. All NGSO FSS licensees in the 10.7-12.7 GHz, 12.75-13.25 GHz and 13.75-14.5 GHz frequency bands shall, on June 30 of the first year following launch of the first two space stations in their system, and annually thereafter, file a report with the International Bureau and the Commission's Laurel, Maryland field office containing the following information**:**

(1) Status of space station construction and anticipated launch date, including any major problems or delay encountered;

(2) Identification of any space station(s) not available for service or otherwise not performing to specifications, the cause(s) of these difficulties, and the date any space station was taken out of service or the malfunction identified.

(l) Replacement of Space Stations within the System License Term. Licensees of NGSO FSS systems in the 10.7-12.7 GHz, 12.75-13.25 GHz and 13.75-14.5 GHz frequency bands authorized through a blanket license pursuant to paragraph (g) of this section need not file separate applications to launch and operate technically identical replacement satellites within the term of the system authorization. However, the licensee shall certify to the Commission, at least thirty days prior to launch of such replacement(s) that:

(1) The licensee intends to launch a space station into the previously-authorized orbit that is technically identical to those authorized in its system authorization and

(2) Launch of this space station will not cause the licensee to exceed the total number of operating space stations authorized by the Commission.

(m) In-Orbit Spares. Licensees need not file separate applications to operate technically identical in-orbit spares authorized as part of the blanket license pursuant to paragraph (g) of this section. However, the licensee shall certify to the Commission, within 10 days of bringing the in-orbit spare into operation, that operation of this space station did not cause the licensee to exceed the total number of operating space stations authorized by the Commission.

APPENDIX C: METHODOLOGIES FOR CALCULATING AGGREGATE EQUIVALENT POWER FLUX DENSITY

Describing ITU Draft New Recommendation ITU-R S.[DOC.4/62]

1. The first methodology – entitled "Convolution of the envelope of single entry $EPFD_{down}$ curves at several test points" – uses single entry $EPFD_{down}$ curves generated using Recommendation ITU-R S.1503.[134] The curves are readily available from the ITU BR validation assessment required for every NGSO FSS system. The methodology relies on convolution of each of the single entry $EPFD_{down}$ curves into an aggregate mask. The aggregate mask is then compared to the aggregate limit to determine if the limit is exceeded. This method requires the single entry $EPFD_{down}$ curve from each test location of each NGSO system to be convolved with the single entry $EPFD_{down}$ curve from each test location of all other NGSO systems. Thus, if there are "M" test locations for each of the "N" NGSO systems, then M^N convolutions are required. A second way to implement the first methodology is to produce a cumulative density function ("CDF") envelope curve that bounds all of the single entry $EPFD_{down}$ curves (that is, curves representing all the test locations) for each of the NGSO systems. The aggregate mask is then calculated based upon the convolution of the CDF envelopes.

2. The second methodology – entitled "Convolution or simulation to calculate the aggregate $EPFD_{down}$ at the same earth station test points – is also implemented using Recommendation ITU-R 1503, and like the first methodology, it has two options. In the first, an NGSO $EPFD_{down}$ curve for a test point would be convolved with the $EPFD_{down}$ curves of all other NGSO systems at the same test point. Appropriate test point locations would be selected according to the constellation characteristics. The second option would be to input data for all of the NGSO systems into the ITU BR software and generate an aggregate EPFD mask. It should be noted that locations exhibiting the highest $EPFD_{down}$ limits in the short term might not be the same locations that exhibit the highest aggregate levels in the long term.

3. The third methodology – entitled "Operational Simulation" – departs from the use of satellite pfd masks, and relies instead on detailed simulations (using, for example, the guidelines of Recommendation ITU-R S.1325).[135] This methodology uses the operational characteristics of and constraints on the NGSO systems.[136] As in the other two methodologies, two measuring options exist. In the first, a single entry $EPFD_{down}$ curve for each NGSO system is generated using ITU-R S.1325. This method would not use interference mitigation techniques between NGSO systems in the calculations, but

[134] This Appendix C generally describes the three methodologies recently upgraded to draft new recommendation status by the ITU-R. ITU Draft New Recommendation ITU-R S.[Revision 1 to Doc. 4/62-E], *Methodologies for calculating aggregate epfd$_{down}$ produced by multiple non-GSO FSS systems into a GSO FSS network* (19 November 2001). *See also* Preliminary Draft Revision of Recommendation ITU-R S.1503, *Functional Description to be Used in Developing Software Tools for Determining Conformity of Non-Geostationary-Satellite Orbit Fixed-Satellite System Networks With Limits Contained in Tables S22-1, S22-2, and S22-3 of Article S22 of the Radio Regulations* (2000) (describing methodology for generating curves).

[135] Recommendation ITU-R S.1325-1, *Simulation Methodologies for Determining Statistics of Short-Term Interference Between Co-Frequency, Codirectional Non-Geostationary-Satellite Orbit (Non-GSO) Fixed-Satellite Service (FSS) Networks and Other Non-GSO or GSO FSS Networks*.

[136] Operational characteristics may include interference avoidance switching and coordination agreements among systems.

could use a reference switching strategy.[137] In the second option, a different set of input parameters is considered, including NGSO/NGSO coordination agreements and expected maximum traffic characteristics.

[137] Examples of such strategies would include longest satellite visibility and best elevation angle.

APPENDIX D: FINAL REGULATORY FLEXIBILITY CERTIFICATION FOR REPORT AND ORDER

The Regulatory Flexibility Act of 1980, as amended (RFA),[138] requires that a regulatory flexibility analysis be prepared for notice and comment rulemaking proceedings, unless the agency certifies that "the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."[139] The RFA generally defines "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[140] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[141] A small business concern is one which: (a) is independently owned and operated; (b) is not dominant in its field of operation; and (c) satisfies any additional criteria established by the Small Business Administration (SBA).[142]

The objective of the *Report and Order* and of this proceeding is to assign the NGSO FSS spectrum to satellite systems operators who can implement their proposals in a manner that serves the public interest. The final rules in the *Report and Order* will reduce regulatory burdens and, with minimal disruption to existing FCC permittees and licensees, result in the continued development of NGSO FSS and other satellite services to the public.

Neither the Commission nor the U.S. Small Business Administration has developed a small business size standard specifically for NGSO FSS licensees. The appropriate size standard is therefore the SBA standard for Satellite Telecommunications, which provides that such entities are small if they have $12.5 million or less in annual revenues.[143]

The rules adopted in this *Report and Order* apply only to entities providing NGSO FSS. Small businesses will not have the financial ability to become NGSO FSS system operators because of the high implementation costs, including construction of satellite space stations and rocket launch, associated with satellite systems and services.[144] Since the spectrum and orbital resources available for assignment are not

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[138] *See* 5 U.S.C. § 603. The RFA, 5 U.S.C. § 601- 612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA. Pub. L. No. 104-121, 110 Stat. 857 (1996).

[139] 5 U.S.C § 605(b).

[140] *Id.*at § 601(6).

[141] *Id.* at § 601(3) (incorporating by reference the definition of "small business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), 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."

[142] Small Business Act, 15 U.S.C. § 632.

[143] 13 C.F.R. § 121.201, North American Industry Classification System ("NAICS") code 513340.

[144] *See, e.g.*, *Final Analysis Communication Services, Inc.*, 13 FCC Rcd. 6618, 6644 (1998) (non-geostationary satellite applicant estimated that "cost of construction, launch and first-year operating costs for two satellites was approximately $6.22 million").

open to new entrants, we estimate that only the seven applicants whose applications are pending will be authorized by the Commission to provide these services. None of the seven applicants is a small business because each has revenues in excess of $11 million annually or has parent companies or investors that have revenues in excess of $11 million annually.[145]

Therefore, we certify that the rules adopted in this *Report and Order* will not have a significant economic impact on a substantial number of small entities. The Commission will send a copy of this *Report and Order*, including this Final Regulatory Flexibility Certification, in a report to Congress pursuant to the Congressional Review Act.[146] In addition, the *Report and Order* and this final certification will be sent to the Chief Counsel for Advocacy of the Small Business Administration, and will be published in the Federal Register.[147]

[145] 13 C.F.R. § 121.201, North American Industry Classification System ("NAICS") code 513340.

[146] *See* 5 U.S.C. § 801(a)(1)(A).

[147] *See* 5 U.S.C. § 605(b).

APPENDIX E: INITIAL REGULATORY FLEXIBILITY CERTIFICATION FOR FURTHER NOTICE OF PROPOSED RULEMAKING

The Regulatory Flexibility Act of 1980, as amended (RFA),[148] requires that an initial regulatory flexibility analysis be prepared for notice and comment rulemaking proceedings, unless the agency certifies that "the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."[149] The RFA generally defines "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[150] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[151] A small business concern is one which: (a) is independently owned and operated; (b) is not dominant in its field of operation; and (c) satisfies any additional criteria established by the Small Business Administration (SBA).[152]

This *Further Notice of Proposed Rulemaking* ("*Further NPRM"*) seeks comment on two proposals. One proposal is to adopt a methodology by which non-geostationary satellite orbit, fixed satellite service ("NGSO FSS") applicants will demonstrate that they meet a limit on their interference into geostationary-satellite orbit systems operating in shared frequencies. The second proposal is to refine the definition of an in-line interference event to accommodate high-powered NGSO FSS systems. If commenters believe that the proposed rules discussed in the *Further NPRM* require additional RFA analysis, they should include a discussion of this in their comments.

Neither the Commission nor the U.S. Small Business Administration has developed a small business size standard specifically for NGSO FSS licensees. The appropriate size standard is therefore the SBA standard for Satellite Telecommunications, which provides that such entities are small if they have $12.5 million or less in annual revenues.[153]

The rules adopted in this *Report and Order* apply only to entities providing NGSO FSS. Small businesses will not have the financial ability to become NGSO FSS system operators because of the high implementation costs, including construction of satellite space stations and rocket launch, associated with

[148] *See* 5 U.S.C. § 603. The RFA, 5 U.S.C. § 601- 612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA. Pub. L. No. 104-121, 110 Stat. 857 (1996).

[149] 5 U.S.C § 605(b).

[150] *Id.*at § 601(6).

[151] *Id.* at § 601(3) (incorporating by reference the definition of "small business concern" in Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), 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."

[152] Small Business Act, 15 U.S.C. § 632.

[153] 13 C.F.R. § 121.201, North American Industry Classification System ("NAICS") code 513340.

satellite systems and services.[154] Since the spectrum and orbital resources available for assignment are not open to new entrants, we estimate that only the seven applicants whose applications are pending will be authorized by the Commission to provide these services. None of the seven applicants is a small business because each has revenues in excess of $11 million annually or has parent companies or investors that have revenues in excess of $11 million annually.

Therefore, we certify that the proposals in this *Further NPRM*, if adopted, will not have a significant economic impact on a substantial number of small entities.

The Commission will send a copy of the *Further NPRM*, including a copy of this Initial Regulatory Flexibility Certification, to the Chief Counsel for Advocacy of the Small Business Administration.[155] This initial certification will also be published in the Federal Register.[156]

[154] *See, e.g.*, *Final Analysis Communication Services, Inc.*, 13 FCC Rcd. 6618, 6644 (1998) (non-geostationary satellite applicant estimated that "cost of construction, launch and first-year operating costs for two satellites was approximately $6.22 million").

[155] 5 U.S.C. § 605(b).

[156] 5 U.S.C. § 605(b).