Description of Amendment

ViaSat, Inc. ("ViaSat") hereby amends its pending application to launch and operate a Ka-band fixed satellite service satellite ("VIASAT-89W") at the nominal 89º W.L. orbital location. *See* FCC File Nos. SAT-LOA-20100217-00029, SAT-AMD-20100602-00120, Call Sign S2809 ("Satellite Application").[1] Specifically, ViaSat seeks to further amend the Satellite Application to permit VIASAT-89W to operate using the 18.8-19.3 GHz band on a non-conforming, non-interference basis and in the 28.6-29.1 GHz band on a secondary, non-interference basis, in addition to the 18.3-18.8 GHz, 19.7-20.2 GHz, 28.1-28.6 GHz, and 29.5-30.0 GHz bands currently specified in the Satellite Application.

The attached Supplemental Technical Annex and the associated Schedule S contain the relevant technical details. This amendment application contains only information associated with the requested addition of frequencies and does not affect any information already on file in the Satellite Application.

I. Spectrum Availability

The 18.8-19.3 GHz and 28.6-29.1 GHz bands are available for assignment at the requested orbital location; no entity is authorized by the Commission to use these frequencies at or within two degrees of 88.9º W.L. Moreover, these frequencies are not authorized for use by any NGSO system, and as demonstrated in the Supplemental Technical Annex, VIASAT-89W would be able to share this spectrum with any NGSO systems that may be authorized in the future, including the NGSO system proposed by O3b Limited. *See* FCC File No. SES-LIC-20100723-00952.

The 28.6-29.1 GHz and 18.8-19.3 GHz bands are allocated internationally for GSO and NGSO use on a co-primary basis, but in the U.S. Table of Allocations are allocated only to the NGSO FSS on a primary basis. ViaSat seeks to operate at 28.6-29.1 GHz pursuant to the secondary U.S. allocation of this band for GSO FSS use. Additionally, and consistent with Commission precedent, ViaSat requests a waiver of the U.S. Table of Frequency Allocations to use the 18.8-19.3 GHz band on a GSO FSS spacecraft on a non-conforming basis.

II. Waiver Request for 18.8-19.3 GHz Band

ViaSat seeks authority to use spectrum in the 18.8-19.3 GHz band for downlink operations. The 18.8-19.3 GHz band is allocated in the United States for NGSO FSS operations on a primary basis, with no secondary allocation for GSO FSS operations. Accordingly, ViaSat requests a waiver of Section 2.106 of the Commission's rules, and specifically footnote NG165

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[1] The Satellite Application has been placed on public notice. *See* Public Notice, Satellite Space Applications Accepted for Filing, Rep. No. SAT-00699 (rel. June 18, 2010).

thereto, to permit ViaSat to operate its GSO FSS system in this band on a non-conforming, non-interference basis in the United States.[2]

Grant of this waiver is appropriate because such a grant "would better serve the public interest than strict adherence to the general rule."[3] ViaSat's Ka-band service promises to bring a new and innovative alternative for broadband Internet access to residential consumers and businesses of all sizes, using technologies that make efficient use of currently unused spectrum. ViaSat's innovative satellite design enables the provision of affordable broadband satellite services to U.S. consumers at the level of quality demanded by the market. Through the use of efficient satellite design, spot beam capabilities and innovative ground terminal design, access to this additional Ka-band segment would allow ViaSat to both (i) expand significantly the capacity of the satellite and thus the number of supportable customers, and (ii) reduce the cost-per-bit of providing service, and thereby provide more cost-effective broadband services. Grant of this waiver thus would increase the availability of affordable high-data-rate communications services in the United States and therefore help satisfy the demand for satellite broadband access. Moreover, because there is no operating commercial NGSO system that uses these frequencies, grant of the waiver would allow ViaSat to make efficient use of an unused spectrum resource.

Significantly, the VIASAT-89 satellite is designed to be able to use this spectrum resource without causing harmful interference into any NGSO system that may be deployed in the future, as discussed further below. Grant of the requested waiver therefore is consistent with Commission precedent and with the Commission's orders allocating the 18.8-19.3 GHz band primarily for NGSO FSS use.

When the Commission established rules for licensing satellites in the 18 GHz band, it lacked record evidence that sharing between NGSO FSS and GSO FSS operations would be feasible in the 18.8-19.3 GHz band. Rather, the Commission left open the possibility that parties would submit information demonstrating that such sharing was possible[4] and found that, in principle, secondary use of the 18.8-19.3 GHz band would "be feasible if the stations of the secondary service could be designed to operate without impact on the primary service."[5] Since

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2 *See* 47 C.F.R. § 2.106 & n.NG165.

3 *See WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969). *See also Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1166 (D.C. Cir. 1990) (waiver appropriate where "the relief requested would not undermine the policy objective of the rule in question and would otherwise serve the public interest."); *Fugro-Chance, Inc.*, 10 FCC Rcd 2860, at ¶ 2 (IB 1995) (waiver of U.S. Table of Allocations appropriate "when there is little potential for interference into any service authorized under the Table of Frequency Allocations and when the non-conforming operator accepts any interference from authorized services.").

4 *Id.*

5 *Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the*

then, the Commission has entertained multiple requests for GSO use and have granted requests that contained an adequate showing that sharing was possible.[6] In granting each of Northrop Grumman Space & Mission Systems Corporation ("Northrop Grumman") and AtContact a waiver of Section 2.106 to permit the operation of GSO FSS satellites at 18.8-19.3 GHz on a non-conforming, non-interference basis, the Commission found that each applicant submitted a sufficient "quantitative demonstration" of how its GSO FSS satellites would operate in these bands while protecting the primary NGSO FSS systems.[7] The Commission has also granted (via stamp-grant) applications of ViaSat and Hughes that included waivers to operate in the 18.8-19.3 GHz band.[8] Consistent with this precedent, ViaSat below provides a similar quantitative showing of how it will protect primary NGSO users.

III. Non-Interference Showing for the 18.8-19.3 GHz and 28.6-29.1 GHz Bands

As demonstrated in the Supplemental Technical Annex, neither ViaSat's operations in the 28.6-29.1 GHz band pursuant to the secondary GSO FSS allocation, nor its operations in the 18.8-19.3 GHz band on a non-conforming, non-interference basis, will cause harmful interference to any NGSO FSS system (including that of O3b Limited for which a U.S. market access application is pending, and those that are similar to the design of the previously authorized Northrop Grumman and AtContact systems).[9] The VIASAT-89 satellite employs technology that will allow it to operate in a manner that protects NGSO FSS systems in the 18.8-19.3 GHz and 28.6-29.1 GHz bands from harmful interference, while still maintaining service in other frequency bands.

Specifically, the satellite has been designed with the capability to cease operations in the 18.8-19.3 GHz downlink band and in the associated 28.6-29.1 GHz uplink band in any spot beams where the predicted physical alignment of either (i) the VIASAT-89 satellite and an

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Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use, Report and Order, 15 FCC Rcd 13430, at ¶ 57 (2000).

6 *See Northrop Grumman Space & Mission Systems Corporation,* Order and Authorization, DA 09-428, at ¶¶ 86, 88 (rel. Feb. 23, 2009) ("*Northrop Grumman Order*")*; contactMEO Communications, LLC*, Order and Authorization, DA 06-864, at ¶¶ 33, 35 (rel. Apr. 14, 2006) ("*AtContact Order*").

7 *Northrop Grumman Order* at ¶¶ 86, 88; *AtContact Order* at ¶¶ 33, 35.

8 *See e.g.*, Public Notice, DA No. 10-686, ViaSat Modification Application, SAT-MOD-20091127-00129 (Apr. 23, 2010) (application granted Apr. 20, 2010); Public Notice, DA No. 10-785, Hughes Network Systems, Inc. Letter of Intent, SAT-LOI-20091110-00119 (May 7, 2010) (application granted May 5, 2010).

9 Northrop Grumman surrendered its system license on March 26, 2009, and AtContact surrendered its NGSO authorization on February 6, 2009. *See AtContact Letters*; Letter from Stephen D. Baruch, counsel to Northrop Grumman Space & Mission Systems Corporation, to Marlene H. Dortch, Secretary, FCC, Re: Surrender of Space Station and Satellite System Authorizations (File Nos. SAT-LOA-19970904-00080, *et seq*., Call Signs S2254, S2255, S2256, S2257, and S2258).

earth station communicating with an NGSO space station, or (ii) an NGSO space station and an earth station communicating with the VIASAT-89 satellite, is such that the angular separation between operational links of the two satellite networks would be equal to or less than a specified minimum line-of-sight separation angle. In that case, and for the short duration of the event, the affected VIASAT-89 satellite spot beam will be commanded to stop transmitting in the 28.6-29.1 GHz band, and the VIASAT-89W satellite receive system will be switched off such that any NGSO earth station's uplink transmissions cannot be retransmitted by the VIASAT-89W satellite.

In the Supplemental Technical Annex, ViaSat demonstrates that the VIASAT-89 satellite's operations in the 18.8-19.3 GHz and 28.6-29.1 GHz bands will not interfere with primary NGSO operations. As part of this quantitative demonstration, ViaSat analyzed the U.S. operations of the proposed NGSO system of O3b,[10] and determined that the calculated interference-to-noise ratio based on a worst case scenario is -25.9 dB, which corresponds to a ΔT/T of only 0.25%, assuring the technical compatibility of VIASAT-89W with the proposed operation of the O3b network. For operations outside of the U.S., ViaSat will abide by the coordination procedures set forth in the ITU Radio Regulations and will operate in accordance with any coordination agreements that it may enter into with O3b or other non-U.S.-licensed NGSO system operators.[11]

Additionally, ViaSat analyzed the NGSO systems of AtContact and Northrop Grumman and determined that the calculated interference-to-noise ratio based on worst case scenarios is -28.8 dB, which corresponds to a ΔT/T of only 0.13%. These ΔT/T levels are well below the level the Commission considered in finding that GSO use of these bands by Northrop Grumman and AtContact would not cause harmful interference to other NGSO systems.[12] Moreover, ViaSat's technical showing contains the same type of quantitative data provided by Northrop Grumman and AtContact and relied upon by the Commission when it granted those licensees authority to operate GSO satellites in the 18.8-19.3 GHz and 28.6-29.1 GHz bands on a non-interference basis.[13]

ViaSat commits to abide by the terms of any coordination agreements that it may enter into with NGSO system operators, and otherwise will cease operations in the 18.8-19.3 GHz and 28.6-29.1 GHz bands in the unlikely event that it does cause harmful interference into

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10 *See* Application of O3b Limited, FCC File No. SES-LIC-20100723-00952.

11 *See Rulemaking to Amend Parts 1, 2, 21 and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, Third Report and Order, 12 FCC Rcd 22310, 22339 ¶ 72 (1997) (international coordination governs operations outside the U.S. of U.S. satellite licensees and non-U.S.-licensed satellite systems).

12 *Northrop Grumman Order* at ¶ 86; *AtContact Order* at ¶ 33.

13 The non-interference analyses provided by Northrop Grumman and AtContact for each of their networks of four GSO satellites using the NGSO primary bands are equally applicable to a single GSO satellite.

NGSO FSS operations. ViaSat will also accept interference that it may receive from NGSO FSS operations in these bands.

Supplemental Technical Annex

A.1 SCOPE AND PURPOSE

ViaSat amends its pending application for the VIASAT-89W satellite by requesting authority to operate in the 18.8-19.3 GHz and 28.6-29.1 GHz bands, in addition to the 18.3-18.8 GHz, 19.7-20.2 GHz, 28.1-28.6 GHz, and 29.5-30.0 GHz bands currently specified in the Satellite Application .[1] The purpose of this Annex is to describe the technical and operational characteristics of the 28.6-29.1 GHz and 18.8-19.3 GHz bands of the VIASAT-89W satellite.

This Annex provides the technical information relating to the requested modification and is intended to supplement the information regarding the VIASAT-89W satellite previously submitted to the Commission in its license amendment application. Any Part 25 requirements not included in this Annex or the associated Schedule S form have been previously provided to the Commission and have not changed.

A.2 GENERAL DESCRIPTION

The VIASAT-89W satellite at 88.9° W.L. will provide Ka-band services to CONUS and parts of South America through two wide-area beams. The satellite will operate in the 28.1-29.1 GHz and 29.5-30.0 GHz bands (Earth-to-space) and the 18.3-19.3 GHz and 19.7-20.2 GHz bands (space-to-Earth). This amendment relates only to the 28.6-29.1 GHz and 18.8-19.3 GHz bands. These bands will be used to provide wideband communications between a limited number of larger gateway-type antennas.

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[1] *See* SAT-LOA-20100217-00029; SAT-AMD-20100602-00120.

A.3 SPACE STATION TRANSMIT AND RECEIVE CAPABILITY

ViaSat has previously provided the Commission with the characteristics of the transmit and receive CONUS and South American beams in terms of each beam's capabilities, their service areas and gain contours[2] for the 28.1-28.6 GHz, 29.5-30 GHz, 18.3-18.8 GHz and 19.7-20.2 GHz bands. These characteristics apply equally to the 28.6-29.1 GHz and 18.8-19.3 GHz bands, and thus, are not changed by this modification application. The proposed addition of the 28.6-29.1 GHz and 18.8-19.3 GHz frequency bands would add capacity to the beams, but does not affect the beams' technical characteristics already provided to the Commission.

A.4 FREQUENCY AND POLARIZATION PLAN

The VIASAT-89W satellite's frequency plan and beam-connectivity for the 28.6-29.1 GHz and 18.8-19.3 GHz bands is provided in the Schedule S form. There are a total of eight channels, four in each polarization and each with a bandwidth of 110 MHz.

For these frequency bands, four transponders are nominally assigned for inter-CONUS traffic and four transponders are nominally assigned for inter-South American traffic, although any of the four CONUS transponders can be switched to downlink to the South American beam and any of the four South American transponders can be switched to downlink to the CONUS beam.

For the 28.6-29.1 GHz and 18.8-19.3 GHz bands, the satellite will employ full frequency re-use through the use of two spatially separated beams: the CONUS and South American beams. Each beam operates in a single polarization and the two beams operate in opposite polarizations from each other. This satisfies the requirements of §25.210(d) of the Rules.

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[2] *See* SAT-AMD-20100602-00120.

A.5 TWO DEGREE COMPATIBILITY

This section demonstrates that uplink transmissions in the 28.6-29.1 GHz bands and downlink transmissions in the 18.8-19.3 GHz band are two-degree compatible.

Hughes Network Systems, LLC ("Hughes") has a pending application before the Commission for the Ka-band SPACEWAY 6 satellite at the 90.9º W.L. location.[3] Hughes seeks authority to use the 28.6-29.1 GHz and 18.8-19.3 GHz bands. Table A.5-1 provides a summary of the uplink and downlink transmission parameters of the SPACEWAY 6 satellite network, as taken from Hughes' LOI application.

Table A.5-2 provides a summary of the uplink and downlink transmission parameters of the VIASAT-89W satellite network. These parameters were derived from the VIASAT-89W link budgets that are embedded in the associated Schedule S form.

Interference calculations were performed using the transmission parameters in Tables A.5-1 and A.5-2. The interference calculations assumed a 1 dB advantage for topocentric-to-geocentric conversion, all wanted and interfering carriers are co-polarized and all earth station antennas conform to a sidelobe pattern of 29-25 log(θ). The C/I calculations were performed on a per Hz basis.

Table A.5-3 shows the results of the interference calculations in terms of the overall C/I margins. The table is provided in a format similar to that of the output of the Sharp Adjacent Satellite Interference Analysis program. It can be seen that the C/I margins are positive in all cases.

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3 *See* SAT-LOI-20091110-00121.

Note that the SPACEWAY 6 satellite network's return links (i.e., subscriber-to-gateway links) do not use the 28.6-29.1 GHz band. Accordingly, the C/I calculations for certain interferer/victim carrier combinations only calculate the downlink interference. The grayed cells in Table A.5-3 are overall C/I margins (i.e., combined uplink and downlink C/I margins), while the non-grayed cells are downlink C/I margins only.

Table A.5-1. SPACEWAY 6 transmission parameters.

Carrier ID	Emission Designator	Bandwidth (MHz)	Tx E/S Gain (dBi)	Uplink EIRP (dBW)	Downlink EIRP (dBW)	Rx E/S Gain (dBi)	C/I Criterion (dB)
1	250MG7W	250	58.9	72.0	64.0	42.1	21.5
2	250MG7W	250	58.9	72.0	64.0	42.1	20.4
3	250MG7W	250	58.9	72.0	64.0	42.1	18.8
4	3M67G7W	3.67	N/A	N/A	43.7	55.3	20.4
5	1M22G7W	1.22	N/A	N/A	38.8	55.3	19.3
6	612KG7W	0.612	N/A	N/A	35.8	55.3	18.7
7	612KG7W	0.612	N/A	N/A	35.8	55.3	11.0

Table A.5-2. VIASAT-89W transmission parameters.

Carrier ID	Emission Designator	Bandwidth (MHz)	Tx E/S Gain (dBi)	Uplink EIRP (dBW)	Downlink EIRP (dBW)	Rx E/S Gain (dBi)	C/I Criterion (dB)
8	110MG7D	110	65.0	70.0	44.0	61.4	17.3
9	110MG7D	110	65.0	75.0	44.0	61.4	20.6
10	25M0G7D	25	65.0	71.2	35.5	61.4	20.6
11	25M0G7D	25	65.0	62.7	35.5	61.4	14.8

Table A.5-3. Summary of the C/I margins (dB).

		Interfering Carriers										
	Carrier ID	1	2	3	4	5	6	7	8	9	10	11
Wanted Carriers	1	0.1	0.1	0.1	2.1	2.2	2.2	2.2	15.4	13.5	12.6	17.1
	2	1.2	1.2	1.2	3.2	3.3	3.3	3.3	16.5	14.6	13.7	18.2
	3	2.8	2.8	2.8	4.8	4.9	4.9	4.9	18.1	16.2	15.3	19.8
	4	12.5	12.5	12.5	14.5	14.6	14.6	14.6	28.9	28.9	31.0	31.0
	5	13.5	13.5	13.5	15.4	15.6	15.6	15.6	29.9	29.9	32.0	32.0
	6	14.1	14.1	14.1	16.0	16.2	16.2	16.2	30.5	30.5	32.6	32.6
	7	21.8	21.8	21.8	23.7	23.9	23.9	23.9	38.2	38.2	40.3	40.3
	8	7.1	7.1	7.1	9.2	9.3	9.3	9.3	22.1	19.9	18.7	23.8
	9	3.9	3.9	3.9	5.9	6.0	6.0	6.0	19.8	18.8	18.8	21.7
	10	1.8	1.8	1.8	3.8	3.9	3.9	3.9	18.1	17.7	18.8	20.1
	11	7.6	7.6	7.6	9.6	9.7	9.7	9.7	22.9	21.0	20.0	24.6

A.6 SHARING WITH NGSO FSS IN THE 28.6-29.1 GHZ AND 18.8-19.3 GHZ BANDS

While the 28.6-29.1 GHz and 18.8-19.3 GHz bands are allocated internationally for GSO and NGSO use on a co-primary basis, these bands are allocated to NGSO FSS on a primary basis in the U.S. Table of Allocations. The U.S. Table allocates the 28.6-29.1 GHz band to GSO FSS on a secondary basis, while the 18.8-19.3 GHz band has no current GSO FSS allocation. For service within the U.S., ViaSat will use the 28.6-29.1 GHz band on a secondary, non-interference basis, and the 18.8-19.3 GHz band on a non-conforming, non-interference basis, and thus, requests a waiver of Section 2.106 of the FCC's rules to permit the use of the 18.8-19.3 GHz band on the VIASAT-89W satellite. The FCC granted such a waiver to AtContact and to Northrop Gumman Space & Mission Systems Corporation ("NGST") for the GSO spacecraft in their respective systems.[4] The interference analysis for those networks of GSO satellites using the NGSO primary bands is equally applicable to ViaSat's single GSO satellite, as demonstrated

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[4] *See Northrop Grumman Space & Mission Systems Corporation*, Order and Authorization, DA 09-428, at ¶¶ 86, 88 (rel. Feb. 23, 2009); *contactMEO Communications, LLC*, Order and Authorization, DA 06-864, at ¶ 35 (2006).

herein. The analysis demonstrates that the operations of VIASAT-89W will protect from harmful interference the HEO satellite systems previously licensed to AtContact and NGST.[5]

O3b Limited ("O3b") has applied for U.S. market access for its constellation of NGSO satellites[6]. O3b proposes to communicate with a gateway earth station to be located in Hawaii using the 28.6-29.1 GHz and 18.8-19.3 GHz bands. Interference analyses provided herein demonstrate that no harmful interference between O3b's system, as proposed, and the VIASAT-89W network will occur.

The VIASAT-89W satellite network employs technology that will allow it to operate in a manner that will, where appropriate, protect any NGSO FSS systems from harmful interference in the 18.8-19.3 GHz and 28.6-29.1 GHz bands. Successfully sharing with NGSO FSS in the 28.6-29.1 GHz and 18.8-19.3 GHz bands can be ensured by having both the ground earth stations and the VIASAT-89W spacecraft temporarily cease operations in the 28.6-29.1 GHz uplink band (and thus the corresponding 18.8-19.3 GHz downlink band) when the minimum allowable topocentric line-of-sight ("TLOS") angular separation is not met. Both the North American and South American beams are individually controllable. The specific characteristics of each proposed NGSO system must be evaluated prior to becoming operational in order to determine the minimum allowable TLOS angular separation between the VIASAT-89W satellite and the proposed NGSO system.

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5 Although the NGSO networks of NGST and AtContact are no longer authorized to operate, ViaSat includes these systems in its analysis to demonstrate that systems like AtContact and NGST's previously licensed systems would be protected from harmful interference from ViaSat's GSO network.

6 *See* SES-LIC-20100723-00952.

A.6.1 Sharing with U.S. Licensed Systems

Both the AtContact and NGST NGSO systems were authorized to use identical HEO constellations of three satellites with the characteristics shown in Table A.6-1. The sharing analyses submitted by NGST and AtContact each state that the minimum operational altitude of the HEO spacecraft is 16,000 km. Additionally, the minimum operational elevation angle from the NGST or AtContact earth stations to the HEO satellites is stated as 10°.

Table A.6-1. Summary of VIASAT-89W and NGST / AtContact parameters.

Parameters	ViaSat System	NGST / AtContact Systems
Minimum Operational Altitude	N/A	16000 km
Minimum Operational E/S Elevation Angle	23.5°	10°
Earth Station Uplink Input Power Density	-64.8 dBW/Hz	-63.45 dBW/Hz
Satellite Rx Antenna Gain	35.5 dBi	46.5 dBi
Satellite Rx System Noise Temp	795 K	504 K
Satellite Tx EIRP Density	-33.4 dBW/Hz	-18 dBW/Hz
Earth Station Rx System Noise Temperature	210 K	315 K

After examining the range of potential earth station locations in the service area for the VIASAT-89W network, the minimum TLOS angular separation between either (i) the VIASAT-89W satellite and an earth station communicating with an NGSO space station, or (ii) an NGSO space station and an earth station communicating with the VIASAT-89W satellite, given the orbital characteristics of the two HEO systems, has been determined to be 31.1°. However, to be conservative, the interference calculations assumed a minimum angular separation of 30°. Table A.6-2 shows the predicted interference degradations to the NGST and AtContact systems due to operation of the VIASAT-89W network and vice versa.

Table A.6-2. Interference calculations between VIASAT-89W and NGST / AtContact.

Victim network Interfering network		GESN / ATCONTACT VIASAT-89W	VIASAT-89W GESN / ATCONTACT
E/S Latitude	degrees	50.4	50.4
E/S Longitude	degrees	-124.1	-124.1
Uplink:			
Frequency band	GHz	28.85	28.85
Interfering uplink input power density	dBW/Hz	-64.8	-63.45
Angular separation between interfering E/S and victim satellite	degrees	30	30
Slant range (Interfering path)	km	16455	39222
Free space path loss (Interfering path)	dB	206.0	213.5
Atmospheric losses	dB	1.2	1.2
Victim satellite receive antenna gain	dBi	46.5	35.5
Victim Satellite's Antenna Discrimination towards Interfering E/S	dB	0	0
Victim satellite Rx system noise temperature	K	504	795
No	dBW/Hz	-201.6	-199.6
Io	dBW/Hz	-230.4	-247.6
Io/No	dB	-28.8	-48.0
ΔT/T	%	0.1311	0.0016
Downlink:			
Frequency band	GHz	19.05	19.05
Interfering satellite downlink EIRP density	dBW/Hz	-33.4	-18.00
Slant range (Interfering path)	dB	39222	16455
Free space path loss (Interfering path)	dB	209.9	202.4
Atmospheric & scintillation losses	dB	1	1
Angular separation between interfering satellite and victim E/S	degrees	30	30
Interfering Satellite's Antenna Discrimination towards Victim E/S	dB	0	0
Victim Rx earth station system noise temperature	K	315	210
No	dBW/Hz	-203.6	-205.4
Io	dBW/Hz	-249.2	-226.3
Io/No	dB	-45.6	-20.9
ΔT/T	%	0.0027	0.8099

The results show that both the AtContact and NGST systems are adequately protected. The calculated ΔT/T values in all cases are very small, indicating the technical compatibility of the VIASAT-89W satellite network with the GESN and ATCONTACT networks.

A.6.2 Sharing with the U.K.-Authorized O3b System

O3b proposes to communicate with a gateway earth station to be located in Hawaii using the 28.6-29.1 GHz and 18.8-19.3 GHz bands. The O3b constellation will use eight satellites in a medium earth orbit with an altitude of 8062 km and an inclination of zero degrees (i.e., an equatorial orbit). The satellites have steerable spot beams which are maintained on the target geographic location as the satellites traverse their orbit. Table A.6-3 shows the pertinent parameters of the VIASAT-89W network and the O3b system.

Table A.6-3. Summary of VIASAT-89W and O3b parameters.

Parameters	ViaSat System	O3b System
Minimum Operational E/S Elevation Angle	23.5°	3°
Earth Station Uplink Input Power Density	-64.8 dBW/Hz	-53.4 dBW/Hz
Satellite Rx Antenna Gain	35.5 dBi	34.5 dBi
Satellite Rx System Noise Temp	795 K	1000 K
Satellite Tx EIRP Density	-33.4 dBW/Hz	-28.32 dBW/Hz
Earth Station Rx System Noise Temperature	210 K	225 K

The minimum elevation angle for service to the Hawaiian gateway is stated as being 3 degrees. From this we can determine the furthest eastern location of an O3b satellite, just before it can no longer communicate with the Hawaiian gateway, as being at 99.67°W.L. This location provides the smallest TLOS angular separation with respect to the VIASAT-89W network. Any location of an O3b satellite further west will necessarily create a larger TLOS angular separation with respect to the VIASAT-89W network.

Based on the range of potential earth station locations in the service area of the VIASAT-89W network, the minimum TLOS angular separation between the VIASAT-89W satellite and the Hawaiian gateway earth station communicating with an O3b space station was found to be 9.1 degrees, and the minimum TLOS angular separation between an O3b space station and an earth station communicating with the VIASAT-89W satellite was found to be 15.2 degrees.

In addition, the VIASAT-89W satellite provides at least 30 dB of satellite antenna discrimination towards Hawaii in both uplink and downlink directions and the O3b satellites communicating with the Hawaiian gateway provide at least 20 dB of satellite antenna discrimination towards the service area of the VIASAT-89W satellite in both uplink and downlink directions.

Table A.6-4 shows the predicted interference degradations to the O3b system due to operation of the VIASAT-89W network and vice versa. The results show that the O3b system is adequately protected. The calculated ΔT/T values in all cases are extremely small, indicating the technical compatibility of the VIASAT-89W satellite network with the proposed operation of the O3b network.

Table A.6-4. Interference calculations between VIASAT-89W and O3b (Hawaii).

Victim network		O3b (Hawaii)	VIASAT-89W
Interfering network		VIASAT-89W	O3b (Hawaii)
E/S Latitude	degrees	21.67	31
E/S Longitude	degrees	-158.03	-116
Uplink:			
Frequency band	GHz	28.85	28.85
Interfering uplink input power density	dBW/Hz	-64.8	-53.4
Angular separation between interfering E/S and victim satellite	degrees	15.2	9.1
Slant range (Interfering path)	km	9883	40502
Free space path loss (Interfering path)	dB	201.5	213.8
Atmospheric losses	dB	1.2	1.2
Victim satellite receive antenna gain	dBi	34.5	35.5
Victim Satellite's Antenna Discrimination towards Interfering E/S	dB	20	30
Victim satellite Rx system noise temperature	K	1000	795
No	dBW/Hz	-198.6	-199.6
Io	dBW/Hz	-250.6	-254.9
Io/No	dB	-52.0	-55.3
ΔT/T	%	0.0006	0.0003
Downlink:			
Frequency band	GHz	19.05	19.05
Interfering satellite downlink EIRP density	dBW/Hz	-33.4	-28.32
Slant range (Interfering path)	dB	40502	9883
Free space path loss (Interfering path)	dB	210.2	197.9
Atmospheric & scintillation losses	dB	1	1
Angular separation between interfering satellite and victim E/S	degrees	9.1	15.2
Interfering Satellite's Antenna Discrimination towards Victim E/S	dB	30	20
Victim Rx earth station system noise temperature	K	275	210
No	dBW/Hz	-204.2	-205.4
Io	dBW/Hz	-266.6	-244.8
Io/No	dB	-62.4	-39.4
ΔT/T	%	0.0001	0.0114

The preceding demonstrates that the ViaSat-89W satellite network is compatible with O3b's proposed operations with a gateway earth station located in Hawaii. O3b's application states that O3b intends to seek authority to operate a second gateway to be located on U.S. soil at a future time, but it does not state the intended location.

The following analysis demonstrates that the VIASAT-89W satellite network is compatible with the operation of any O3b ground antenna that complies with the antenna gain pattern of §25.209 and is located anywhere on U.S. soil within ITU Region 2.

The O3b system has an equatorial orbit. From the perspective of sharing with a GSO network, this means that the location of a GSO network's earth station that causes the most interference to the O3B system would be a location closest to the equator. The location closest to the equator that is within U.S. territory in Region 2 is St. Croix, U.S. Virgin Islands (17.75°N, 64.75°W). The following analysis assumes the VIASAT-89W and O3b networks each have an earth station collocated at these geographic coordinates. Although the design of VIASAT-89W satellite does not allow it to provide service to St. Croix, it has been assumed that the satellite does in fact have coverage over St. Croix in order to be conservative.

Given the preceding assumptions, a computer simulation was performed to determine the highest levels of interference that could be caused to the O3b system. Table A.6-5 shows the interference calculations for this worst case situation. The results show that the O3b system is adequately protected. The calculated $\Delta T/T$ values in all cases are small, indicating the technical compatibility of the VIASAT-89W satellite network with the O3b network and with an O3b earth station located anywhere within the U.S.

Table A.6-5. Interference calculations between VIASAT-89W and O3b (St. Croix).

Victim network		O3b (St. Croix)	GSO Network
Interfering network		GSO Network	O3b (St. Croix)
E/S Latitude	degrees	17.75	17.75
E/S Longitude	degrees	-64.75	-64.75
Uplink:			
Frequency band	GHz	28.85	28.85
Interfering uplink input power density	dBW/Hz	-64.8	-53.4
Angular separation between interfering E/S and victim satellite	degrees	9.4	9.4
Slant range (Interfering path)	km	9005	37011
Free space path loss (Interfering path)	dB	200.7	213.0
Atmospheric losses	dB	1.2	1.2
Victim satellite receive antenna gain	dBi	34.5	35.5
Victim Satellite's Antenna Discrimination towards Interfering E/S	dB	0	0
Victim satellite Rx system noise temperature	K	1000	795
No	dBW/Hz	-198.6	-199.6
Io	dBW/Hz	-224.5	-224.4
Io/No	dB	-25.9	-24.8
ΔT/T	%	0.2547	0.3280
Downlink:			
Frequency band	GHz	19.05	19.05
Interfering satellite downlink EIRP density	dBW/Hz	-33.4	-28.32
Slant range (Interfering path)	dB	36753	9005
Free space path loss (Interfering path)	dB	209.3	197.1
Atmospheric & scintillation losses	dB	1	1
Angular separation between interfering satellite and victim E/S	degrees	9.4	9.4
Interfering Satellite's Antenna Discrimination towards Victim E/S	dB	0	0
Victim Rx earth station system noise temperature	K	275	210
No	dBW/Hz	-204.2	-205.4
Io	dBW/Hz	-236.1	-218.8
Io/No	dB	-31.8	-13.4
ΔT/T	%	0.0654	4.5949

For service outside of the U.S., in the 28.6-29.1 GHz and 18.8-19.3 GHz bands, ViaSat will coordinate with O3b to define a mutually acceptable interference criterion, which in turn will define the minimum TLOS angular separation that protects the O3b network.[7]

In the uplink direction, the required angular separation varies depending on the proximity of the ViaSat earth station to the equator as well as any O3b satellite receive antenna discrimination towards the ViaSat earth station.

In the downlink direction, the required angular separation varies depending on the proximity of the O3b earth station to the equator, as well as any satellite transmit antenna discrimination the VIASAT-89W satellite provides to the O3b earth station.

All these considerations will be part of the coordination discussions between ViaSat and O3b. ViaSat will be able to cease transmissions in the 18.8-19.3 GHz and 28.6-29.1 GHz bands where appropriate.

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[7] Outside the U.S., ViaSat will coordinate with O3b following the procedures set forth in the ITU Radio Regulations.

A.6.3 Sharing with Other NGSO Systems

The VIASAT-89W satellite and ground segment will be designed to be capable, where appropriate, of protecting any future NGSO systems whose orbital characteristics differ from those NGSO systems used in the preceding analyses. Thus, if a future NGSO system is brought into operation with a system design different from those analyzed herein, ViaSat's system will still be able, where appropriate, to successfully protect such an NGSO system from harmful interference. ViaSat will coordinate with NGSO operators to determine the minimum required TLOS angular separation necessary to protect each system.

The VIASAT-89W spacecraft will be designed with the capability to temporarily cease operation in the 18.8-19.3 GHz and 28.6-29.1 GHz bands upon receipt of appropriate ground command signals. The fail-safe condition of the VIASAT-89W spacecraft is to temporarily cease operations in the 18.8-19.3 GHz and 28.6-29.1 GHz bands to protect NGSO networks when the minimum TLOS angular separation is not met.

A processor at the central control site for the satellite will determine the predicted orbits of the victim NGSO satellites through the use of well understood algorithms and regularly updated 2-line element set data obtained from reliable on-line sources and directly from the NGSO operator itself. The processor will then calculate the predicted TLOS angular separation for each gateway earth station.

When the angular separation is predicted to be equal to, or below the desired TLOS value, the earth stations located within either beam will be commanded to stop transmitting in the 28.6-29.1 GHz band and, similarly, the VIASAT-89W satellite receive system will be switched off such that any NGSO earth station's uplink transmissions cannot be re-transmitted by the VIASAT-89W satellite. When the angular separation increases to a value above the cut-off threshold, normal operation is restored to the earth stations and the satellite.

A.7 POWER FLUX DENSITY AT THE EARTH'S SURFACE

§25.208 does not contain any PFD limits that apply in the 18.8-19.3 GHz band for GSO satellite networks, however it is noted that Article 21 of the ITU Radio Regulations does include PFD limits applicable to GSO satellites using the 18.8-19.3 GHz band. The ITU limits are identical to those in §25.208(c). The PFD limits of §25.208(c) are as follows:

- -115 dB(W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;
- -115+(δ-5)/2 dB(W/m^2) in any 1 MHz band for angles of arrival δ (in degrees) between 5 and 25 degrees above the horizontal plane; and
- -105 dB(W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

The maximum downlink EIRP density and hence the maximum PFD levels that will be transmitted by the VIASAT-89W satellite occurs with the transponder-saturating single-carrier 110 MHz emission. Tables A.7-1 and A.7-2 show the maximum PFD levels that will be transmitted by the CONUS and South American beam, respectively, and compare those to the ITU PFD limits. It can be seen that the maximum PFD levels are below the ITU PFD limits for both beams.

Table A.7-1. Maximum PFD levels for the CONUS beam.

Maximum EIRP (dBW)	47.0						
Occupied Bandwidth (MHz)	93.62						
Elevation Angle (degrees)	0	5	10	15	20	25	Boresight
Beam Contour (dB)	-16.9	-16.9	-17.5	-13.8	-8.7	-5.1	0
Spreading Loss (dB/ m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.3
Maximum PFD (dBW/m^2/MHz)	-152.9	-152.8	-153.3	-149.5	-144.3	-140.6	-134.9
ITU PFD Limit (dBW/m^2/MHz)	-115	-115	-112.5	-110	-107.5	-105	-105
Margin (dB)	37.9	37.8	40.8	39.5	36.8	35.6	29.9

Table A.7-2. Maximum PFD levels for the South American beam.

Maximum EIRP (dBW)	47.0						
Occupied Bandwidth (MHz)	93.62						
Elevation Angle (degrees)	0	5	10	15	20	25	Boresight
Beam Contour (dB)	-12.4	-11.8	-10.4	-8.3	-6.0	-3.7	0
Spreading Loss (dB/ m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.6
Maximum PFD (dBW/m^2/MHz)	-148.4	-147.7	-146.2	-144.0	-141.6	-139.2	-135.2
ITU PFD Limit (dBW/m^2/MHz)	-115	-115	-112.5	-110	-107.5	-105	-105
Margin (dB)	33.4	32.7	33.7	34.0	34.1	34.2	30.2

A.8 PREDICTED RECEIVER AND TRANSMITTER CHANNEL FILTER RESPONSE CHARACTERISTICS

The predicted receiver and transmitter frequency responses of the 110 MHz channels, as measured between the receive antenna input and transmit antenna, are shown in Table A.8-1 below. In addition, the frequency tolerances of §25.202(e) and the out-of-band emission limits of §25.202(f) (1), (2) and (3) will be met.

Table A.8-1: Predicted Channel Receiver and Transmitter Frequency Responses

	Attenuation Relative to Peak Level (dB)		
Offset from Channel Center Frequency (MHz)	Receive Section	Transmit Section	Total
±18	0.10	0.12	0.22
±28	0.15	0.29	0.44
±38	0.20	0.59	0.79
±49	0.30	0.96	1.26
±55	0.80	2.54	3.34
±67	15.3	10.2	25.5
±78	30.3	25.2	55.5
±92	35.3	25.2	60.5

A.9 POST MISSION DISPOSAL

At the end of the operational life of the VIASAT-89W satellite, ViaSat will maneuver the satellite to a disposal orbit with a minimum perigee of 300 km above the normal GSO operational orbit. The post-mission disposal orbit altitude is based on the following calculation, according to §25.283:

Total Solar Pressure Area "A" = 96 m^2

"M" = Dry Mass of Satellite = 3370 kg

"C_R" = Solar Pressure Radiation Coefficient = 2 (worst case)

Therefore the Minimum Disposal Orbit Perigee Altitude is calculated as:

= 36,021 km + 1000 x C_R x A/m

= 36,021 km + 1000 x 2 x 96/3370

= 36,078.0 km

= 292.0 km above GSO (35,786 km)

To provide adequate margin, the disposal orbit will be increased to 300 km. This will require approximately 14.8 kg of propellant, taking account of all fuel measurement uncertainties, which will be allocated and reserved in order to perform the final orbit raising maneuver.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this pleading, that I am familiar with Part 25 of the Commission's rules that I have either prepared or reviewed the engineering information submitted in this pleading, and that it is complete and accurate to the best of my knowledge and belief.

/s/

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