BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In re the Application of	)	
	)	File Nos. SAT-LOA-19970904-00080
Northrop Grumman Space & Mission	)	SAT-AMD-19971222-00219
Systems Corporation	)	SAT-AMD-20031104-00324
	)	
For Authority to Operate a Global Satellite	)	
System Employing Geostationary and	)	
Nongeostationary Satellites in the	)	
Fixed-Satellite Service	)	

AMENDMENT

Northrop Grumman Space & Mission Systems Corporation, by counsel and through its Northrop Grumman Space Technology sector ("NGST"), hereby amends, pursuant to Section 25.116 of the Commission's Rules (47 C.F.R. § 25.116), its above-captioned application for authority to launch and operate the non-geostationary satellite ("non-GSO") portion of its proposed Ka-band/V-band[1] hybrid fixed-satellite service ("FSS") network, provisionally called the Global EHF Satellite Network ("GESN"). In this Amendment, which is one of five associated amendments NGST is filing with regard to its GESN system on this date, NGST changes the orbital configuration of the non-GSO component of the GESN system from medium-Earth orbits to a combination of highly-elliptical orbits ("HEO") and geosynchronous circular orbits; reduces the number of non-GSO satellites from the currently-proposed 15 to 7 Ka-band/V-band satellites; clarifies the spectrum requirements for the system in both Ka-band and V-band based on allocation decisions made since the original filing, and provides additional or revised technical information concerning the system. NGST also updates certain corporate

[1] As used herein, "Ka-band" refers to the FSS Earth-to-space band at 27.5-30 GHz (including the primary non-GSO segment at 28.6-29.1 GHz) and the FSS space-to-Earth band at 17.7-20.2 GHz (including the primary non-GSO band at 18.8-19.3 GHz). "V-band" refers to the FSS Earth-to-space band at 47.2-50.2 GHz and the FSS space-to-Earth band at 37.5-42 GHz.

information to reflect recent minor changes in the officers and directors, and in the stock ownership, of its parent company.

This Amendment for the non-GSO component of the hybrid Ka-band/V-band, GSO/non-GSO GESN system is associated with – indeed, it is interconnected with – four additional amendments that NGST is filing on this date with respect to the GSO V-band component of GESN. As reflected collectively in NGST's five concurrently-filed Amendments, the GESN system will now have a total of seven spacecraft (down from 19 as originally filed). Three satellites will operate in HEO orbits, and four satellites will operate in geostationary orbits at 119º W.L., 89º W.L., 15º E.L., and 116.5º E.L.[2]

The three GESN non-GSO satellites in HEO will operate on a primary basis in the non-GSO primary segments of Ka-band (18.8-19.3 GHz and 28.6-29.1 GHz), on a secondary/non-unacceptable interference basis in the GSO primary segments of Ka-band at 19.7-20.2 GHz and 29.5-30 GHz, and on a shared basis with the GSO and other non-GSO systems in the V-band. The non-GSO component of GESN at Ka-band will also include 2 x 500 MHz of primary non-GSO spectrum on each of the four GSO satellites, and 2 x 3000 MHz of spectrum on a primary or equally-shared basis with GSOs in V-band subject to the sharing conditions to be clarified in a future Commission rulemaking proceeding. In both cases, the payloads containing this spectrum will be operated as a plane in the non-GSO constellation. NGST will subject the satellites to strict compliance with the Ka-band non-GSO sharing rules the Commission adopted just last year and any to-be-established V-band sharing rules.

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[2] Three of these four slots (the exception being 89º W.L.) were the slots licensed to NGST's Ka-band GSO component in August 2001. *See TRW Inc.*, 16 FCC Rcd 14407 (Int'l. Bur. 2001). At the time, had the V-band component of GESN been under processing, NGST would have amended its V-band GSO applications to move to the new locations (all three of which had parallel ITU filings in process for both Ka-band and V-band to accommodate GESN). The fourth slot licensed to NGST in *TRW Inc.* – the 79º W.L. orbital location -- was licensed at Ka-band to another U.S. operator on January 30, 2004, leading NGST to select 89º W.L. as an alternative that it will pursue even though the license for the 79º W.L. slot was very recently relinquished to the Commission. Thus, NGST is resurrecting, to the extent it is now able, its hybrid Ka-band/V-band GSO proposal, as that proposal effectively stood as of August 2001.

In Ka-band, the four geosynchronous satellites in the non-GSO component will supplement the HEO satellites in terms of coverage. The GESN non-GSO satellite system provides dual coverage of most of the populated areas of the world as shown in Figures 1, 2, and 3 in the Technical Appendix. In addition, these four geosynchronous satellites will enhance frequency sharing among non-GSO satellite systems in the 18.8-19.3 GHz and 28.6-29.1 GHz bands. Under the Ka-band non GSO FSS sharing rules the Commission adopted just last year, non-GSO Ka-band FSS satellite systems will not be able to operate in the full amount of non-GSO FSS spectrum when one of their satellites has a line-of-sight angular separation within 10 degrees of a satellite of another non-GSO FSS system. With the dual coverage capability of the GESN non-GSO satellite system, when this situation occurs between a GESN HEO satellite and another system's non-GSO satellite, the GESN system will use a geosynchronous satellite to provide the coverage (rather than have both systems reduce the amount of spectrum within which they operate). Thus, the plane of geosynchronous satellites allows both GESN and the other non-GSO FSS systems to use the full amount of spectrum system in the 18.8-19.3 GHz and 28.6-29.1 GHz bands even when in-line interference events occur among their non-GSO satellites. When non-GSO satellites of other systems are in-line with a GESN geosynchronous non-GSO satellite, the GESN system will use a HEO satellite to provide the coverage, meaning that there is no need for either GESN or another non-GSO system to reduce spectrum usage during in-line interference events, and that no burden is imposed on other non-GSO systems by GESN's use of geosynchronous satellites in the non-GSO bands.

NGST will have the capability to employ the same technique with the geosynchronous non-GSO satellites in V-band, should a Ka-band-like GSO/non-GSO segmentation-based sharing scheme be adopted for V-band in the future. In the interim, NGST

requests authority to include V-band spectrum on the geosynchronous satellites as part of the non-GSO constellation for dual coverage and efficiency reasons.

The GESN true GSO satellites at 119º W.L. and 116.5º E.L. will operate in the 3000 MHz (Earth-to-space) and 4500 MHz (space-to-Earth) of FSS spectrum at V-band and in the 2 x 1000 MHz of GSO primary spectrum at Ka-band. The GSO satellite at 89º W.L. will operate in the 3000 MHz (Earth-to-space) and 4500 MHz (space-to-Earth) of FSS spectrum at V-band and in the lower 2 x 500 MHz of GSO primary spectrum at Ka-band.[3] The 15º E.L. satellite will not include the Ka-band GSO primary spectrum, and will use only 2 x 3000 MHz of V-band spectrum (as requested in the initial GESN application).[4]

Table 1 below shows the overall orbital and frequency configuration of GESN, as proposed through today's interdependent and comprehensive series of amendments:

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[3] The 2 x 500 MHz of GSO primary spectrum in the 19.7-20.2 GHz and 29.5-30 GHz bands is currently under license to another U.S. licensee.

[4] Of the four GESN GSO V-band applications being amended, only the amendment to the 15º E.L. satellite is a true conforming amendment and nothing more. The other three satellites are undergoing changes in proposed orbital locations and the addition of frequency bands. Without regard to whether the changes in location for the 119º W.L. and 116.5º E.L. could arguably be considered as eligible for a waiver of Section 25.116, NGST accepts that changes of the type proposed for the three GSO satellites other than the 15º E.L. satellite are typically considered "major amendments" under the relevant provision of Section 25.116 of the Commission's Rules, 47 C.F.R. § 25.116.

Table 1: GESN Orbital and Frequency Configuration

GESN ORBITAL AND FREQUENCY PLAN		UPLINK	DOWNLINK
Non-GSO Component	3 HEO Satellites	• 28.6-29.1 GHz (Primary) • 29.5-30 GHz (Secondary/Non-Unacceptable Interference Basis) • 47.2-50.2 GHz (Gateway and user, per new FCC Rule)	• 18.8-19.3 GHz (Primary) • 19.7-20.2 GHz (Secondary/Non-Unacceptable Interference Basis) • 37.5-42 GHz (3000 MHz, flexibly assigned to accommodate future GSO/non-GSO sharing rules, and operating as non-GSOs; gateway and user, per new FCC Rule)
	4 Geosynchronous Circular-Orbit Satellites at 119ºW, 89ºW, 15ºE, and 116.5ºE	• 28.6-29.1 GHz (Secondary, and used to resolve MX situations during non-GSO in-line events) • 47.2-50.2 GHz (Gateway and user, per new FCC Rule)	• 18.8-19.3 GHz (Secondary, and used to resolve MX situations during non-GSO in-line events) • 37.5-42 GHz (3000 MHz, flexibly assigned to accommodate future GSO/non-GSO sharing rules, and operating as non-GSOs; gateway and user, per new FCC Rule)
GSO Component	GSO 1: 119º W	• 28.35-28.6 GHz (Primary) • 29.25-30 GHz (Primary) • 47.2-50.2 GHz (Gateway and user, per new FCC Rule)	• 18.3-18.8 GHz (Primary) • 19.7-20.2 GHz (Primary) • 37.5-42 GHz (Gateway and user, per new FCC Rule)
	GSO 2: 89º W	• 28.35-28.6 GHz (Primary) • 29.25-29.5 GHz (Primary) • 47.2-50.2 GHz (Gateway and user, per new FCC Rule)	• 18.3-18.8 GHz (Primary) • 37.5-42 GHz (Gateway and user, per new FCC rule)
	GSO 3: 15º E	• 47.2-50.2 GHz (Gateway and user, per new FCC Rule)	• 37.5-42 GHz (3000 MHz, flexibly assigned to accommodate future GSO/non-GSO sharing rules, and operating as a GSO; gateway and user, per new FCC Rule)
	GSO 4: 116.5º E	• 28.35-28.6 GHz (Primary) • 29.25-30 GHz (Primary) • 47.2-50.2 GHz (Gateway and user, per new FCC Rule)	• 18.3-18.8 GHz (Primary) • 19.7-20.2 GHz (Primary) • 37.5-42 GHz (Gateway and User, per new FCC rule)

The purpose of the instant amendment to the non-GSO component of GESN is two-fold. First, NGST conforms its V-band non-GSO application to the V-band spectrum allocation determinations the Commission made in its December 5, 2003 Second Report and Order in IB Docket No. 97-95.[5] There, the Commission made 3 GHz of uplink spectrum and 4.5 GHz of downlink spectrum available for immediate use by a mix of FSS gateway and user-terminal applications. Second, and to accommodate the realities of international coordination that were brought into play by the demise last year of the unrealized Teledesic venture, NGST has adjusted the orbital architecture of the Ka-band non-GSO component of GESN – and thus of the hybrid/co-platform V-band non-GSO component – to specify a mix of HEO satellites and payloads on the geosynchronous satellites that are readily capable of coordinating with the earlier-filed international GSO satellites under the provisions of Section II of Article 9 of the International Telecommunication Union ("ITU") Radio Regulations.

Rather than make line-by-line changes to the material included in the existing application, NGST provides a summary of the differences between the authority it now seeks and the requests it set out in the original application (as amended in December 1997). NGST also provides a Technical Appendix that includes a complete description of the Ka-band (20/30 GHz) and V-band (40/50 GHz) payloads for the non-GSO component of its GESN system.

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[5] *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 and 40.0-40.5 GHz Band for Government Spectrums, Second Report and Order*, IB Docket No. 97-95, FCC 03-296 (released Dec. 5, 2003) ("*V-Band Second Report and Order*").

1. Overview of the Amendment

a. Background – Original Applications

In September 1997, in response to a Commission cut off notice, NGST filed an application for authority to establish a global V-band FSS system. NGST proposed that GESN utilize fifteen (15) non-GSO satellites in medium Earth orbit ("MEO") operating in concert, via optical inter-satellite links, with four (4) GSO satellites strategically placed around the globe.[6] It was NGST's objective, from the outset, to have fully interconnected and interdependent GSO and non-GSO satellites operating in concert within GESN. For both the GSO and non-GSO components of GESN, NGST sought to employ three (3) gigahertz of V-band spectrum in each direction – initially proposed to be the then-internationally-allocated FSS bands at 47.2-50.2 GHz (Earth-to-space) and 37.5-40.5 GHz (space-to-Earth).[7] Services NGST proposed to provide via GESN include two-way point-to-point wideband data transport services, multimedia services, and private network services. GESN was to support a full range of data service rates, from T1 (1.5 Mbps) to OC-30 (1.552 Gbps), and was to have a total system capacity in excess of 1300 Gbps – the equivalent of more than 850,000 T1 circuits.

In December 1997, NGST amended its application by adding Ka-band capacity to each of the GESN system satellites – GSO and non-GSO.[8] In other words, the fully integrated

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[6] See Application of TRW Inc., File No. SAT-LOA-19970904-00080 (filed Sept. 4, 1997) ("NGST Application" or "NGST V-Band Application"). At that time, NGST was part of TRW Inc. ("TRW") and TRW was the applicant. TRW merged with Northrop Grumman Corporation in December 2002. In the course of the merger proceedings, the Commission established NGST's basic qualifications to be a Commission satellite licensee. *Application of TRW Inc., Transferor and Northrop Grumman Corporation, Transferee*, 17 FCC Rcd 24625 (Sat. Div. 2002).

[7] NGST also proposed to use two megahertz of spectrum in each direction in the extended C-band, 3650-3700 MHz (downlink) and 6425-6525 MHz (uplink), for transfer orbit and on-orbit emergency telemetry and command links. For on-orbit operations, the TT&C subsystem would use two megahertz of spectrum at around 40 GHz for telemetry links and two megahertz of spectrum at around 50 GHz for its command links. NGST also proposed to locate GESN's beacon links in three megahertz each of 40 GHz and 50 GHz FSS spectrum.

[8] In the same amendment, NGST sought to add 1000 MHz of Ka-band capacity to each of its four geostationary V-band satellites. With NGST's agreement, the Commission treated the Ka-band portions of the GESN GSO satellites as separate and independent applications, and in August 2001, granted NGST licenses for four

and interdependent GSO/non-GSO V-band system was expanded to be a fully-integrated and interdependent GSO/non-GSO V-band and Ka-band system. For the non-GSO component, NGST requested authority to provide service in 500 megahertz of spectrum in each the primary non-GSO FSS Earth-to-space (uplink) and space-to-Earth (downlink) bands – i.e., in the 28.6-29.1 GHz and 18.8-19.3 GHz bands, respectively -- as well as in an additional 500 MHz of spectrum in the 29.5-30 GHz (uplink) and 17.7-18.8/19.7-20.2 GHz (downlink) bands. At that time, NGST pledged to meet the WRC-97 provisional power limits imposed on Ka-band non-GSO FSS systems operating outside the 28.6-29.5 GHz and 18.8-19.7 GHz bands as a means of protecting GSO systems from unacceptable interference (as per No. 22.2 of the ITU Radio Regulations). In its December 1997 Amendment, NGST also proposed Ka-band spectrum for on-orbit TT&C and beacon links.[9]

b. Description of Amended Application

Since submission of the original filings comprising NGST's Ka-/V-band non-GSO proposal in the middle part of the last decade of the last century, there have been significant changes in the Commission's spectrum allocation scheme for these bands, in NGST's thinking concerning the optimal means of implementing its hybrid non-GSO FSS service, and in the state of the satellite technological art. Because the Ka-band portion of NGST's application could soon be ripe for grant, NGST is taking this opportunity to make changes in its system proposal to reestablish the critical interdependence of operations in these two bands within the GESN system

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Ka-band GSO satellites – three of which specified locations different from the locations proposed in the Dec. 1997 Amendment. For a variety of business reasons, including the fact that there was no immediate prospect of restoring the Ka-band and V-band components of the unified GESN system to a common implementation track, NGST surrendered its Ka-band GSO license to the Commission in March 2003. *See* Letter dated March 5, 2003, from Counsel to NGST to Secretary, FCC (File No. SAT-AMD-19971222-00229) ("March 2003 Letter").

[9] See Amendment, File No. SAT-AMD-19971222-00219 (filed Dec. 22, 1997) ("December 1997 Amendment" or "NGST Ka-band Amendment"). NGST sought to use two megahertz of spectrum centered on 29.997 GHz for command links, and its telemetry links would use two megahertz of spectrum centered on 20.197 GHz. NGST Dec. 1997 Amendment at 7. GESN's Ka-band beacon links would use 3 MHz of Ka-band spectrum in each direction).

(as well as with the GSO component of GESN), and to allow the Commission to consider these modifications in advance of final action on the application.

Amendment of the Ka-band non-GSO component of GESN has become acutely necessary because of the impending cancellation (if cancellation has not indeed happened already) of the ITU filing for Teledesic's non-GSO FSS system in the 18.8-19.3 GHz and 28.6-29.1 GHz bands. With the removal of the U.S. filing relating to the 2 x 500 MHz band associated with Teledesic, NGST (and the U.S.) would have to coordinate the GESN non-GSO system with any GSO networks that made filings under No. 9.7 and the other relevant provisions of Section II of Article 9 of the ITU Radio Regulations between the date of the ITU filing associated with Teledesic and the date of the ITU filing associated or to be associated with the same component of GESN. Experience has shown that it may be difficult for a circular orbit non-GSO system – even one using MEO orbits – to successfully coordinate a system that includes a large number of ubiquitously-deployed terminals with the previously-filed GSO networks (just as it would have been difficult for the GSOs to coordinate their networks with the then-previously-filed Teledesic system). By changing to a GSO-friendly and compatible HEO architecture that includes a plane of four equally GSO-friendly geosynchronous satellites in equatorial orbit, NGST accommodates the change in coordination status at 18.8-19.3 GHz and 28.6-29.1 GHz, and significantly enhances GESN's prospects for successful international implementation.

Because the final ITU and domestic spectrum allocation issues have been resolved with respect to V-band FSS in the past six months, the Commission is now in a position to process this long-pending aspect of the application simultaneously with the Ka-band portion.

The Commission's January 29, 2004 Public Notice[10] affording the remaining V-band applicants until March 15, 2004 to amend their applications to conform to the final allocation rules presents a concurrent opportunity for NGST to once again bring its Ka-band and V-band plans into alignment, as it originally envisioned. Accordingly, NGST also takes this opportunity to provide conforming changes to the V-band aspect of its proposal.

In this Amendment (and in its concurrently-filed GSO counterparts), NGST is requesting Commission authority to have the GSO and non-GSO components of GESN (as well as the Ka-band and V-band components) considered and processed as a unified system filing. This was the original concept behind GESN, and NGST's failure to remain fully faithful to its concept contributed to its 2003 decision to return the Ka-band GSO licenses it had received in 2001 – a decision that it specifically emphasized was being taken without prejudice to reapplying in the manner it is doing today.[11]

i. System Architecture

By this Amendment, NGST reduces the total number of spacecraft to be deployed in the non-GSO component of the GESN system from fifteen to seven – three of which will operate in HEO in Ka-band and V-band, and four of which will be included as a plane of satellites in geosynchronous orbit to supplement non-GSO operations and facilitate non-GSO/non-GSO sharing in Ka-band (and potentially at V-band). NGST is no longer proposing to operate any satellites in a MEO constellation. The three HEO spacecraft will be deployed in three orbital planes – one satellite per plane. The plane of four geosynchronous satellites will be located at 119º W.L., 89º W.L., 15º E.L. and 116.5º E.L. See Figure 1, below, System Configuration. To the extent that the Commission may ultimately decide to impose a coverage

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[10] *See* Public Notice, Report No. SPB-199, *International Bureau Invites Applicants to Amend Pending V-band Applications* (released January 29, 2004).

[11] *See* March 2003 Letter, at 2.

requirement for non-GSO satellites that is similar to the one contained in Section 25.217(b)(1) of the Commission's rules, 47 C.F.R. § 25.217(b)(1),[12] NGST's proposed seven-satellite non-GSO constellation would satisfy that requirement.

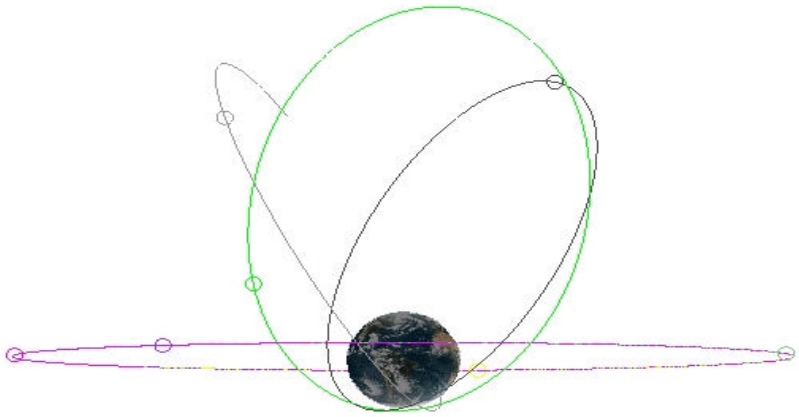

Figure 1: GESN System Configuration

ii. Ka-Band Spectrum Use

At Ka-band, the three HEO satellites will operate in the primary non-GSO FSS frequencies at 18.8-19.3 GHz and 28.6-29.1 GHz in accordance with the Commission's 28 GHz Band Plan. The HEO satellites will also operate on a secondary/non-unacceptable-interference basis in the 19.7-20.2 GHz and 29.5-30 GHz bands, subject to the applicable equivalent power flux-density limits ("EPFD") in Article 22 of the ITU Radio Regulations. This total amount of Ka-band spectrum, 1000 megahertz in each direction, is the same as was requested in NGST's December 1997 Ka-band Amendment.

In the primary non-GSO bands at 18.8-19.3 GHz and 28.6-29.1 GHz, the HEO spacecraft would operate with maximum power flux-density levels ("PFD") not in excess of

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[12] Section 25.217(b) imposes the coverage requirements of Section 25.143(b)(2)(ii) on "non-GSO-like" satellite licenses in bands where no band-specific service rules have yet been adopted. As NGST's application was filed before August 27, 2003, Section 25.217 literally does not apply. In the *V-Band Second Report and Order*, the Commission stated that any additional service rules that may be needed for V-band systems would be developed in a future rulemaking proceeding. *V-Band Second Report and Order*, FCC 03-296, slip op. at ¶ 1.

those specified in Article 21 (Table 21-4) of the ITU Radio Regulations, as applicable to non-GSO satellites in the 17.7-19.3 GHz band. Operation at or below these levels produces interference at levels that are presumptively permissible and that will protect the terrestrial service(s). By definition, there is no increase in the potential for interference in this respect.[13]

In 1997, when there was a secondary designation for non-GSO FSS satellites in the 29.5-30 GHz and 19.7-20.2 GHz bands, NGST proposed to operate the GESN non-GSO satellites in these bands on a secondary/non-unacceptable interference basis to GSOs. Now, with the adoption by the ITU of limits on the equivalent power flux-density ("EPFD") produced by non-GSO systems in the 19.7-20.2 GHz and 29.5-30 GHz bands, NGST can confirm unequivocally that its operation of HEO non-GSO FSS satellites will not cause harmful interference to co-frequency GSO FSS networks. The EPFD limits are a quantification of the obligation on non-GSO FSS systems not to cause unacceptable interference to GSO FSS networks that is imposed in No. 22.2 of the ITU Radio Regulations. Because the EPFD produced by NGST's HEO satellites will meet the EPFD limits for these bands established in Article 22 of the ITU Radio Regulations,[14] and because NGST will not claim protection from GSO networks in these bands, the HEO satellites clearly can operate on a secondary basis. If the interference produced by the HEO satellites does not rise to the levels objectively established in the Radio Regulations as unacceptable, such interference must be found not to be harmful. It would be irrational for a service to "accept" interference at a level that is harmful. NGST's

[13] The Commission has recognized, in an analogous context, that proposed increases in PFD, to levels that are higher than those sought in the initial applications but still compliant with PFD limits in Section 25.208 of the Commission's Rules, 47 C.F.R. § 25.208, do not pose significant interference problems and thus would not be major amendments. *Teledesic LLC*, 14 FCC Rcd 2261, 2270-71 (¶ 21) (Int'l. Bur. 1999).

[14] A demonstration of NGST's compliance with the applicable ITU EPFD limits is included in the Technical Appendix to this Amendment at Attachment D.

secondary operations also would not increase the potential for interference to the fixed service, as there is no cognizable fixed service in the upper 2 x 500 MHz of primary GSO spectrum.[15]

The four geosynchronous satellites that would operate on a secondary basis in the non-GSO primary bands would, along with the HEO satellites, operate under the conditions of sharing imposed on non-GSOs in the FCC's July 2003 Ka-band service rules order.[16] At all times other than in-line events, the geosynchronous satellites would operate across the non-GSO primary bands consistent with the rules applicable to the non-GSO network as a whole. During in-line events between non-GSO satellites of other systems and NGST's HEO satellites, however, and as described above, the geosynchronous satellites would reduce or eliminate the need for non-GESN non-GSO systems to reduce spectrum use in the manner they would otherwise be required to under the new Ka-band non-GSO FSS sharing rules. NGST's geosynchronous satellites will allow the HEO satellite users seamlessly and transparently to switch to the geosynchronous satellites for the duration of the in-line event. No burden will be added to other non-GSO systems by virtue of the fact that the other non-GSO systems' satellites will not have to reduce spectrum use when in-line with a GESN geosynchronous non-GSO satellites (in such instances, the HEO satellites will fill the void). This is the only way that GSO satellites can make effective and beneficial use of the 18.8-19.3 GHz and 28.6-29.1 GHz bands that is compliant in all respects with the letter and spirit of the Commission's 28 GHz Band Plan, and NGST, as the system operator, is uniquely able to ensure that this type of operation will be maintained.

The four-satellite plane of geosynchronous spacecraft would not utilize the primary GSO FSS bands at Ka-band as part of the non-GSO component of GESN. In its

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15 See additional discussion of this topic in Section 5, *infra.*

16 *See The Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ka-Band,* 18 FCC Rcd 14708, 14717-22 (¶¶ 29-45)(2003); 47 C.F.R. § 25.261.

concurrently-filed GSO amendments, however, NGST seeks to add some or all of the GSO primary bands to three of its four proposed GSO V-band satellites.

iii. V-Band Spectrum Use

At V-band, the non-GSO component of GESN system would operate in the 47.2-50.2 GHz in the Earth-to-space direction, and with space-to-Earth links in no more than 3000 MHz of spectrum within the 37.5-42 GHz band. NGST requests flexible authority with regard to the precise frequencies to be used in the 37.5-42 GHz band, in order to maximize its potential to successfully implement spectrum in this band in a way that accommodates both the variances in use of the spectrum by the fixed service (which has a primary designation in the entire 2.5 GHz segment of the downlink band) and the as-yet unclarified sharing conditions with GSO satellites in this band.[17] NGST's non-GSO component of GESN includes the payloads on the four satellites in geosynchronous, zero-degree inclination circular orbits that are used in the Ka-band non-GSO constellation. While these four satellites are also proposed – in today's other amendments from NGST – to operate portions of their capacity as conventional GSO satellites under separate authority, NGST's inclusion of the satellites as part of the non-GSO component of GESN will be fully compliant with the non-GSO element of any non-GSO/GSO sharing rules the Commission may ultimately adopt in this frequency range, and NGST welcomes a condition in its authorization to this effect. Specifically, if a Ka-band-like non-GSO/GSO sharing regime is ultimately adopted at V-band, NGST would be able to employ the Ka-band approach described above.

NGST's non-GSO satellites will comply with the gateway limitation in Section 25.202 of the Commission's Rules, as adopted for the 47.2-48.2 GHz and 37.5-40 GHz bands in

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[17] Specifically, GESN would divide the 4.5 GHz of downlink spectrum into nine 500 MHz channels. Its license would permit it to operate, on a flexible basis, on no more than six of the 500 MHz channels in this downlink spectrum. *See* Technical Appendix at Section 2.

the *V-Band Second Report and Orde*r. The non-GSO satellites (both HEO and geosynchronous) will also comply with the new PFD limits that have been established in new Sections 25.208(p)-(t) of the Commission's rules in the same Order, and which are expected to become effective later this year.[18] NGST specifically requests authority to increase its PFD levels in the 37.5-40 GHz band by up to 12 dB – i.e., from the levels in new Sections 25.208(p)(1) and (q)(1) to those in Sections 25.208(p)(2) and (q)(2) – as needed to overcome propagation impairments. NGST recognizes that this ability is subject to the interim inter-Bureau coordination procedure established in the *V-Band Second Report and Order,* and to the outcome of the Commission's forthcoming rulemaking proceeding on this subject, and will cooperate in both exercises.[19]

NGST emphasizes that its satellites will operate with maximum PFD levels not in excess of those specified in Article 21 (Table 21-4) of the ITU Radio Regulations, as applicable in the various segments of the 37.5-42 GHz band. Although the PFD levels in some instances is slightly higher than the levels proposed for parts of these bands in the initial NGST Application, the fact that all levels at or below the limits in Radio Regulations adopted since 1997 both ensures that the interference produced will protect the terrestrial service(s), and confirms that this amendment is one that is conforming to the actions just taken by the Commission in the *Second V-Band Report and Order*. By definition, there is no increase in the potential for interference in this respect.

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[18] *See Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, et al.*, FCC 03-296, slip op. at 14 (¶ 29) (released December 5, 2003); 47 C.F.R. §§ 25.208(p)-(t). For purposes of this rule, as protection of the fixed service is directly dependent on the type of FSS spacecraft producing the emissions of concern, the non-GSO payloads on the GSO satellites would be evaluated under the PFD limits applicable to GSO satellites.

[19] *See V-Band Second Report and Order*, FCC 03-296, slip. op. at ¶ 29.

iv. This Amendment is Not A "Major" Amendment Under The Commission's Rules.

The changes NGST makes here to its GESN system non-GSO architecture do not include any requests for additional frequency bands or orbital resources. Instead its instant Amendment reduces the overall spectrum request slightly, and significantly reduces the total number of non-GSO spacecraft to be deployed within the network to achieve enhanced efficiencies. Specifically, NGST has reduced the number of non-GSO spacecraft in GESN from 15 to 7 in V-band and in the non-GSO primary spectrum at Ka-band, and from 15 to 3 in 500 MHz of GSO primary spectrum at Ka-band. NGST also no longer requests the 2 x 2 MHz of TT&C spectrum at V-band for on-orbit operations (having consolidated these operations in Ka-band), and it no longer requests the 3 x 3 MHz of V-band beacon spectrum for the same reason. The C-band frequencies for transfer-orbit and emergency on-orbit command and telemetry links proposed herein remain unchanged from the initial NGST Application.[20]

Commission precedent supports a finding that NGST's adjustment of the orbital architecture of its non-GSO component from a MEO solution to a HEO/geosynchronous solution does not rise to the level of a major amendment. [21] Although the number of planes of NGST's non-GSO component increases from 3 to 4, despite the >50 percent reduction in satellites, the new plane of geosynchronous satellites will be operated in a way that facilitates rather than hinders the operation of the other non-GSO systems in the 18.8-19.3 GHz and 28.6-29.1 GHz

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[20] Because the transfer-orbit and emergency on-orbit use of C-band command and telemetry links is not in compliance with the mandate of Section 25.202(g) that TT&C functions be conducted at either or both edges of the allocated bands for the service (*see* 47 C.F.R. § 25.202(g)), NGST requests a waiver of this requirement in Section 5 below.

[21] *See, e.g., Orbital Communications Corporation*, 9 FCC Rcd 6476, 6481 (¶ 26) (1994) (finding that a change in the orbital architecture of an non-GSO satellite system, which "will not increase the potential for harmful interference to existing or planned systems," is not a "major" amendment under Section 25.116 of the Commission's rules).

bands; [22] it does so without imposing any burden whatsoever on other non-GSO systems to protect the geosynchronous satellites; and it affirmatively reduces, rather than increases, the potential for interference to other non-GSO systems.[23]

From an uplink and downlink interference standpoint, the characteristics of the system will create no greater potential for harmful interference than the system originally proposed, and will remain fully compliant with the PFD limitations applicable in the bands requested. Even though the PFD may have been slightly increased in some bands, the increases correspond to post-filing Commission Rules and ITU Radio Regulations; they meet the protection requirements of the potentially affected terrestrial services and thus do not increase the potential for interference in any practical way. Similarly, where uplink limits are imposed by rule or Radio Regulation, all have been adopted since 1997, and NGST's proposal conforms with each and every one (as demonstrated in the Technical Appendix). Moreover, NGST has substantially reduced per-satellite and overall system capacity for GESN from the levels initially proposed. Each GESN satellite will have a capacity of approximately 24 Gbps (compared with the 75 Gbps capacity proposed for the MEO satellites and the 50 Gbps proposed for the GSO satellites back in 1997). System-wide capacity is reduced from 1,300 Gbps to a still impressive figure of approximately 165 Gbps. It will operate with a lower overall per-satellite power (approximately 10.7 kW today, versus 12.7 kW proposed in 1997; and the number of beams

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[22] In the upper 500 MHz of Ka-band, only the 3 HEO satellites will operate. Thus, in these bands, the number of satellites is reduced by 80 percent from the original filings, and there is no increase in the number of orbital planes of non-GSO satellites.

[23] In these ways, the constellation adjustment proposed by NGST is completely distinguishable from the constellation change proposal the Commission found to be a major amendment in *Final Analysis Communications Services, Inc.*, 25 CR 311 (¶¶ 21, et seq.) (2001) (*"FACS"*). In *FACS*, the applicant proposed to increase its number of non-GSO satellites from 26 to 32, to increase its number of orbital planes by 50 percent, and to increase the coverage of its satellites (thereby increasing the potential for interference to other same-service systems). Here, NGST has reduced by 50 percent or more the number of satellites, added an orbital plane of geosynchronous satellites that serves to reduce the potential for interference (even permissible interference under the Ka-band sharing plan) to other non-GSO systems, and reduced the geographic coverage of the non-GSO component of GESN from full global to something less that still satisfies the coverage obligation.

(with spectrum reuse) per satellite is approximately the same as the number of beams initially proposed for Ka-band and is lower at V-band.[24]

For all of these reasons, and for the additional reason of the extreme passage of time and advancement in the state of the technological art in the ¾ of a decade since the initial applications were filed, the Commission should conclude that this amendment is a not a major amendment under Section 25.116 of the Commission's rules and applicable precedent. The Commission should thus determine that the non-GSO component of NGST's GESN Application remains subject to consideration within the existing V-band and Ka-band non-GSO processing rounds.

c. Service Objectives

Not surprisingly, given the passage of time since its original proposal was filed, NGST has somewhat revised its service objectives for GESN. NGST envisions that the V-band frequencies would be used primarily for feeder links/Hubs and trunked relay applications, while the spectrum at Ka-band (specifically the non-GSO primary spectrum) would be used for user links. NGST also believes that the combined HEO/GSO GESN system can be used as a big-pipe relay system to provide bandwidth for communications services to and from the moon. For a very high percentage of the time, one of the four GSO satellites and two of the HEO satellites have line-of-sight visibility to the moon, enabling a permanent direct connection.

d. Performance Objectives and Coverage Characteristics

GESN Earth terminal users will be able to communicate with any satellite in view, either a HEO satellite or the secondary GSO satellites. The user terminals will be equipped with tracking antennas, which will enable them to maintain continuous transmission with the satellites in view. The GESN system will provide good link availability for most locations

[24] In these respects again, the current situation is distinguishable from the various elements in *FACS* that the Commission concluded arose to major amendment levels.

around the world. The link availability will depend on the user types. GESN will employ four common types of user terminals: 0.7 m and 1.2 m diameter terminals for Ka-band, and 1.5 m and 2.7 m diameter terminals for V-band. Users operating in Ka-band with 0.7m and 1.2 m earth terminal antennas can achieve up to 10 dB of rain fade margin in the downlink and 12 dB of fade margin in the uplink. In V-band, users operating with 1.5 m earth terminal antennas could achieve up to 18 dB of rain fade margin. In order to achieve higher link availability, and to meet the system capacity objectives, adjustable coding, modulation and data rate will be utilized. In general, the users will reduce their transmit data rates, use heavy coding and/or operate with lower order modulation during the rain fade conditions. The links will operate at 2E-10 BER or lower.

Global coverage provided by the GESN constellation is detailed in the Technical Appendix. The coverage provided by the three HEO satellites is shown in Figure 1 thereof. The coverage provided by the four GSO satellites is shown on Figure 2. Aggregate coverage provided by the entire non-GSO constellation of HEO and geosynchronous zero-degree inclination satellites is depicted in Figure 3. This graphic demonstrates that the FCC's Ka-band non-GSO coverage requirement under Section 25.145(c) is readily satisfied, as would be the default coverage requirement in Section 25.217(b)(1) if it were applied to GESN in V-band.

2. Complete Technical Description

Full technical characteristics of the proposed system, as amended, are contained in the attached Technical Appendix. Pursuant to new Commission requirements, NGST provides material in the form of FCC Form 312, Schedule S. NGST also provides, with some slight redundancy, technical material in the conventional narrative format.[25] Collectively, this material

[25] NGST is taking this approach because it experienced some difficulties in completing the new, pre-official electronic version of FCC Form 312, Schedule S that the Commission first made available for public use on February 27, 2004. Despite repeated technical consultations with the Staff, some of the data entries NGST wished to make on Schedule S could not be accomplished successfully. All of the information requested on the form is

replaces the corresponding sections and appendices of the original application and Attachment 1 to the December 1997 amendment with respect to the non-GSO aspects of the system covered by this amendment. At the very least, NGST's technical submissions should be found sufficient to satisfy the obligation to propose a substantially complete technical approach for GESN.[26]

3. Implementation Schedule

The proposed construction milestones contained in the original GESN Application are not consistent with the Commission's more recently adopted standard milestone schedules for satellite systems. Accordingly, NGST takes this opportunity to delete the benchmarks from Section 7 of its application, and states that it will instead abide by the milestone schedule established by Commission rule that will be made part of its authorization when granted. *See* 47 C.F.R. § 25.164(b). *See also* Technical Appendix at Attachment A (FCC Form 312, Schedule S). To the extent that some of the spacecraft in the GESN non-GSO constellation are also spacecraft in the GESN GSO constellation, and thus are subject to some differing milestones under Section 24.164(a) of the Commission's Rules, 47 C.F.R. § 25.164(a), NGST proposes that the earlier of the dually-applicable milestones apply.[27]

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provided as a back-up in the narrative text of the Technical Appendix and its attachments. At this earliest of stages in the transition to Schedule S, NGST requests that the Commission rely upon both documents, as appropriate, in assessing NGST's technical proposal.

[26] NGST specifically notes that its compliance with the requirement of Sections 25.114(d)(7) and 25.140(b)(2) (47 C.F.R. §§ 25.114(d)(7) and 25.140(b)(2)) to provide interference analyses to demonstrate compatibility of GESN GSO satellites with satellites two degrees removed is achieved at Ka-band by virtue of its demonstration of compliance with the specifically applicable off-axis EIRP and pfd limitations. There are no satellites to be considered at this point in V-band.

[27] Specifically, even though they are also part of the non-GSO constellation, the GSO satellites would have to be brought into use by 60 months after licensing, as per Section 25.164(a), rather than at the 72 month mark permitted in Section 25.164(b). Similarly, construction of at least one of the non-GSO satellites (whether a HEO or a GSO satellite) would have to have commenced within 30 months after the day on which both the GSO and non-GSO components of GESN are licensed by the Commission (even though GSO construction does not have to begin until 36 months after the license is issued).

4. Public Interest Considerations

As noted in Section 2 of the original GESN application filed in September 1997, the explosion in demand for capacity for high-speed transmission for video, fax, data and Internet use has posed increasing challenges for terrestrial networks. GESN's innovative non-GSO/GSO network architecture will allow low-cost broadband services to be provided in a variety of areas within the United States and throughout the world without the costly capital investment that would be required to construct or upgrade terrestrial networks. The design concepts incorporated into GESN will significantly increase the capacity, flexibility, and availability of communications worldwide.

For rural areas of the U.S., and in developing countries, GESN will provide thin-route capacity that dynamically matches local needs, providing the same level of service that urban users expect. GESN will extend broadband data and video services to areas that are viewed as technically or economically impractical (or even impossible) to serve by any other means. The low cost first- and last-mile nature of the GESN system will help address national and international goals of providing connectivity to rural areas for telemedicine, education, and economic development.

GESN combines advanced technology with a design that minimizes cost. With wide bandwidths on relatively few satellites, GESN efficiently uses spectrum and orbital resources to deliver global connectivity. The technological advantages incorporated into the GESN system will provide other substantial public benefits as well. For example, much of the advanced processing technology employed by NGST in this system will find its way into next generation spacecraft operating in other commercial frequency bands, providing the basis for new products and services that more efficiently reuse that spectrum. Building on NGST's strong military technology heritage, the GESN system will also be a major source of new EHF

technology for other commercial space and terrestrial wireless applications. In turn, the cost advantages gained by widespread commercial use of EHF satellite terminals will help to increase availability and reduce the cost of such services to government users.

As noted above, among other benefits, GESN can provide a wideband pipeline for communications between the Earth and the moon. As the U.S. Government looks toward the possibility of establishing an extended manned presence on the moon,[28] the availability of such two-way communications capability could provide a critical contribution to this endeavor.

GESN will also make significant contributions to the nation's economy. Aside from the economic benefits of the new services and applications that it will support, the development of the GESN system itself will employ highly skilled workers at NGST's facilities in the U.S. Other elements of the system hardware, software and user terminals will be developed and manufactured by U.S. and international subcontractors.

Finally, the inclusion of non-GSO payloads on spacecraft that are operating in geostationary orbits has some significant public interest benefits. Such an approach, whereby the geosynchronous-orbit satellites reduce the need for non-GESN non-GSO systems to reduce spectrum use that during in-line events while imposing no burdens whatsoever on those systems' satellites to reduce spectrum when in line with a GESN geosynchronous satellite, greatly enhances the prospects for successful use of the non-GSO primary bands on a shared basis between multiple non-GSO FSS systems. At the same time, the use of the non-GSO bands by a satellite in geostationary orbit will not undercut in any way the current preclusion on GSO use of these bands. Given the benefits to non-GSO/non-GSO sharing that NGST's approach brings, and the absence of negatives, the inclusion of the non-GSO payloads on four geostationary satellites is an advance of the public interest, convenience, and necessity.

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[28] *See* Mike Allen & Eric Pianin, "Bush Outlines Space Agenda: President Calls for Moon Trip By 2020," *Washington Post*, at A1, January 15, 2004.

5. Requested Waivers of Commission Rules

As new spectrum allocations have been adopted for both Ka-band and V-band satellite service, and service rules are expected to be adopted as well, many of the waivers sought in Section 6 of the original GESN application have been or may be mooted by the time the application is granted. To the extent any waivers of the Commission's allocation or processing rules remain necessary, however, NGST's requests for waiver contained in its original application remain in effect.

At the same time, new Section 25.156(d)(3) of the Commission's rules raises a different issue, which may necessitate a modest waiver of the processing approach established under that rule. This rule specifies that applications for "systems employing two or more service bands will be treated like separate applications for each service band" (47 C.F.R. § 25.156(d)(3)), permitting the application to be granted in parts by the Commission on separate processing tracks. This could pose a special problem for NGST in that, as noted above, its Ka-band and V-band proposals are mutually interdependent – and indeed, have become more interrelated as the system design has evolved.

Accordingly, to the extent necessary, NGST requests that the Commission waive Section 25.156(d)(3) of its rules in order to allow both the Ka-band and V-band portions of its non-GSO system proposal to be considered and acted upon contemporaneously. Further, NGST requests that the Commission consider both the GSO and the non-GSO components of the amended GESN proposal as integrally related, and act upon all of today's Amendments contemporaneously.[29] The system concept is fundamentally dependent on use of the two bands and the package of orbital architectures together, and NGST would not be able to proceed with

[29] In this same regard, NGST specifically emphasizes that the four GSO satellites are an integral sub-package of the GESN system, and that staggered action on these applications would be inconsistent with NGST's vision and approach for a unified GESN system.

construction in one band without assurance that spectrum in the other band will also be assigned. This treatment appears consistent with the approach the Commission has stated it would follow in connection with hybrid satellite proposals, acting simultaneously on the requests for each band.[30]

Correspondingly, NGST also requests a contingent partial waiver of the Commission's performance bond requirement – if this requirement is applied at all to this application[31] – to permit the posting of a single non-GSO bond to cover the hybrid Ka-band/V-band non-GSO system. Due to the fact that NGST is seeking only a single system license covering both bands, and intends to build only hybrid satellites containing payloads for each of the requested bands, only one bond should be necessary. As only one Ka-/V-band non-GSO system of seven satellites will be constructed, only a single $7.5 million bond should be required as the Commission's rules are currently written. Nonetheless, to the extent that the Commission could deem the bond requirement applicable on a per frequency band basis, NGST hereby provisionally requests a waiver of the rule, if so applied.

Next, NGST requests a waiver of Section 25.202(g) of the Commission's Rules to permit it: (i) to place its transfer-orbit and emergency-mode on-orbit TT&C links in 4/6 GHz ("extended C-band") FSS frequencies, rather than at the band edge in the Ka-band and/or V-band frequencies; and (ii) to place its regular on-orbit TT&C links only at Ka-band rather than at both Ka-band and V-band, as seems to be required by Section 25.156(d)(3) of the Commission's Rules. As noted above, NGST only requests 2 MHz of spectrum in the extended C-band for transfer orbits and on-orbit emergency modes. NGST submits that good cause exists for the

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30 *See Space Station Licensing Reform Order*, 18 FCC Rcd 10760, 10817 (¶ 147)(2003).

31 NGST has filed a Petition for Reconsideration of the Commission's determination to apply the bond requirement to the current Ka-band non-GSO processing round, which has been pending for more than six years. *See* NGST Petition for Partial Reconsideration, IB Docket No. 02-19 (filed November 13, 2003).

grant of both waivers, and that grant of the requested waivers will not undermine the purpose of either rule.

The required link availability for the TT&C links is ~99.99% or higher. In order to achieve 99.99% link availability, the required fade margin in the C-band for low elevation angles and high rain-rate regions is ~10 dB. Typical C-band TT&C earth stations are in a range of from 12m to 20m in diameter. If either HEO or GSO satellites use Ka-band or V-band for transfer orbit and on-orbit emergency TT&C modes, the Ka/V-band TT&C earth terminals would have to be in a range of from 40m to 60m in diameter in order to achieve the same link availability as systems using C-band for TT&C. It is almost impossible to use this type of antenna sizes with the narrow beamwidths that are required for transfer orbits and on-orbit emergency modes.

The limited waiver requested by NGST is also appropriate because the required fade margin in the 4/6 GHz band is significantly lower than the required fade margin in the 20-50 GHz frequency range. The operations using 2 MHz of extended C-band spectrum for transfer orbits and on-orbit emergency modes will be extremely limited in duration (relative to the overall design life of the spacecraft), and they will be fully coordinated with other C-band users in the case of transfer-orbit operations (and coordinated to the greatest extent practicable in the case of on-orbit recovery operations). Routine on-orbit TT&C operations, which will occur in the Ka-band as per Section 25.202(g), will be restored as quickly as possible.

With respect to Section 25.156(d)(3), a contingent waiver is requested. This rule provides that applications for non-GSO or GSO systems employing two or more service bands will be treated like separate applications for each service band. If Section 25.156(d)(3) is read literally, then an additional waiver of Section 25.202(g) would be needed to enable NGST to include its TT&C on-orbit links at the band-edge of the Ka-band service bands, rather than in

both the Ka-band and V-band service bands.[32] The efficiencies of including only one set of TT&C links in the service bands to be included on a hybrid, multi-band satellite are self-evident, and reflect only part of the efficiencies and economies of scale that hybrid payloads permit. Good cause exists for the grant of this request – which is contingent on a finding that Section 25.156(d)(3) contemplates that Section 25.202(g) would apply to each of the multiple bands.[33]

Finally, and to the extent it may be needed, NGST requests a waiver of the Commission's 28 GHz Band Plan[34] in two respects. First, it requests a waiver of the plan in order that its HEO satellites may operate in the 19.7-20.2 GHz and 29.5-30 GHz bands on a secondary/non-unacceptable interference basis. As explained above, and as demonstrated in Attachment D of the Technical Appendix, NGST's HEO satellites meet the EPFD limits in Article 22 of the ITU Radio Regulations. In addition, with respect to short-term interference, the downlink EPFD levels of the GESN HEO satellites are at least 15 dB lower than the values in the relevant tables in Article 22, as shown in Figure 1 of Attachment D to the Technical Appendix. This means that no unacceptable interference would be caused to the GSO networks with primary designations in those bands – a not insignificant fact, as NGST will itself be a GSO licensee once again in those bands, upon grant of the GESN application package. If the HEO satellites can and will operate at levels that are acceptable to the GSO networks by operation of

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[32] In this regard, NGST adds that its on-orbit TT&C operations for the GSO satellite at 15ºE.L. will be performed in the Ka-band frequencies used by the non-GSO component of GESN (i.e., at around 18.8 GHz and 29.1 GHz). As the two bands are included on the same physical spacecraft, NGST does not expect that a waiver is required. If NGST's expectation is not met in this regard, however, it requests a waiver of Section 25.202(g) to the extent necessary to enable it to have on-orbit TT&C functions for the hybrid 15ºE.L. GSO and geosynchronous non-GSO spacecraft performed at the edges of the above-mentioned non-GSO FSS service link bands.

[33] NGST reminds the Commission that it has requested common and simultaneous consideration of its Ka-band and V-band "applications," in order to be assured of the opportunity to see its omnibus vision for the unified GESN system through to implementation. Only by rule are NGST's Ka-band and V-band proposals, and for that matter NGST's GSO and non-GSO proposals, "separate applications."

[34] *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 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed-Satellite Services*, 11 FCC Rcd 19005, 19030 (1996)

the Radio Regulations, they clearly are able to operate without causing harmful interference – i.e., on a secondary basis. To complete the loop, NGST will not claim protection from GSOs for its HEOs in the 19.7-20.2 GHz and 29.5-30 GHz band. Under these circumstances, where efficient use of the spectrum is significantly advanced, and no harm will come to the primary users, grant of the waiver requested by NGST is appropriate.

Second, and contingently, NGST requests a waiver of the 28 GHz Band Plan to permit it to use the four geosynchronous satellites to supplement the HEO satellites in the 18.8-19.3 GHz and 28.6-29.1 GHz bands. These satellites will comply with applicable pfd limits; they will (as noted in Section 5 above) facilitate rather than hinder implementation of the non-GSO/non-GSO sharing rules by reducing the need for non-GESN non-GSO system satellites to reduce spectrum use when in line with a GESN HEO satellite; they will not demand any protection or reduction in spectrum from other non-GSO operators when those operators' satellites are in line with a GESN geosynchronous satellite; and the use of the payloads allows NGST to reduce by more than 50 percent the number of spacecraft in both the non-GSO component of GESN and in GESN overall (with a concomitant reduction in future space debris). NGST supports secondary use by GSO satellites of the non-GSO primary bands,[35] and grant of a waiver under the unique and controlled circumstances presented here – if the Commission does not find that the payloads in question are indeed non-GSO as NGST maintains – will advance the public interest, convenience, and necessity without undermining the intent of the Commission's decision to limit the use of the 18.8-19.3 GHz and 28.6-29.1 GHz bands to non-GSO systems.

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[35] *See* Comments of NGST on Request of EchoStar Satellite Corp. for Amendment of the Commission's Rules to Redesignate the 28.6-29.1 GHz (Earth-to-space) and 18.8-19.3 GHz (space-to-Earth) Bands to Allow Geostationary Fixed-Satellite Service Operations on a Co-Primary Basis, RM 10767, at 18-19 (filed October 27, 2003).

6. Basic Qualifications – Updated Officers, Directors and Stockholders

Included as Exhibit H to this Amendment is updated information concerning the stockholders, officers, and directors of Northrop Grumman Corporation.

7. Orbital Debris Mitigation

In November 2003, NGST filed an orbital debris mitigation plan with the Commission, pursuant to Section 25.145(c)(3) of the Commission's Rules, with respect to its Ka-band non-GSO component.[36] With the modification of the orbital parameters of the non-GSO component of GESN that is proposed in this Amendment, it is necessary for NGST to make adjustments to its orbital debris mitigation plan. A revised Exhibit G to the NGST Application, as amended, is included with this Amendment. The revised orbital debris mitigation plan includes NGST's plan for both the HEO and the GSO satellites that will together comprise GESN.

8. ITU Filings and Cost Recovery

Shortly after NGST filed its initial V-band Application, and then again shortly after it filed its Ka-band Amendment, the Commission forwarded new advance publication materials for the non-GSO and GSO components of GESN to the ITU pursuant to the relevant provisions in Article 9 of the ITU Radio Regulations. At the time of the V-band ITU filings in November 1997, filers had as long as nine years (or until November 2006) to bring their published frequency assignments into use. At the time of the Ka-band ITU non-GSO filings in 1998, the bringing-into-use period had been shortened to seven years, leading to the imposition of a bringing-into-use deadline that expires for those assignments in 2005.

Clearly, NGST, even if it were to be fully licensed for GESN (pursuant to the Amendments filed today) in the next few months, and putting aside for the moment other

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[36] *See* Amendment of NGST, File No. SAT-AMD-20031104-00324 (filed Nov. 4, 2003), at Exhibit G.

relevant considerations, NGST would not be able to bring the proposed non-GSO and GSO frequency assignments into use prior to the expiration of the deadlines associated with the initial ITU filings for GESN. As a result, NGST is in the process of preparing the information necessary to allow U.S. Government Advance Publication and Coordination of the frequency assignments it proposes for the GSO and the non-GSO components of GESN in today's Amendments. As these filings are to be made with the ITU in an electronic format that is not conducive to inclusion with the instant Amendment filings, NGST will be providing these materials to the Commission's International Bureau shortly, under separate cover, for forwarding to the ITU.

NGST is aware that the ITU Council, in Decision 482 (Modified), has implemented a program of cost recovery for satellite network filings. As a result of this program, Commission applicants for satellite facilities are responsible for the payment of all cost-recovery charges that are associated with ITU advance publication or coordination filings, as appropriate, that the United States makes on behalf of their proposed systems and networks. NGST confirms that it is aware of the ITU cost recovery obligations that will be associated with its forthcoming ITU filings for the GESN system, and hereby accepts its obligations under Decision 482 (Modifed) and acknowledges its responsibility to pay any ITU cost recovery invoices for filings associated with this Amendment. Invoices received from the ITU for cost recovery associated with NGST's forthcoming filings should be forwarded, upon receipt from the Commission, to the contact person listed in the FCC Form 312 Application included with this Amendment.

9. Request for "Permit-But-Disclose" Treatment Under *Ex Parte* Rules

For administrative convenience, NGST also requests that the Commission exercise its authority pursuant to Section 1.1200(a) of its Rules (47 C.F.R. § 1.1200(a) (2003)) to

make this application subject to "permit-but-disclose" *ex parte* treatment under Section 1.1206 of the rules. 47 C.F.R. § 1.1206 (2003). Such treatment will bring the status of this application into alignment with the Ka-band non-GSO portion of the GESN network, which the Commission has previously designated for treatment under the "permit-but-disclose" provisions. *See* Public Notice, Report No. SAT-00012, at 11 (released March 16, 1999).

CONCLUSION

For the reasons set forth in the GESN application, as now amended, NGST is fully qualified in all respects to launch and operate the Ka-band/V-band non-GSO satellite network for which authority is requested. NGST has further shown that its proposed system will materially advance the public and national interests. NGST therefore requests that the Commission grant this application, so that the public interest benefits that its system promises may begin to be realized.

Respectfully submitted,

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TECHNICAL APPENDIX

TECHNICAL CHARACTERISTICS OF THE GLOBAL EHF SATELLITE NETWORK

The following information replaces, in its entirety, the technical information in Northrop Grumman Space Technology's (NGST) September 1997 Application for the Global EHF Satellite Network (GESN), as amended in December 1997. This Technical Appendix, including the information presented in the FCC Form 312, Schedule S (see Attachment A to this Technical Appendix), applies to the non-geostationary satellite-orbit (non-GSO) component of NGST's hybrid Ka-band and V-band GESN proposal. By separate concurrent filings, NGST is amending its four pending applications for the geostationary satellite orbit (GSO) spacecraft that comprise the geostationary component of GESN.

1. General Description of Overall System Facilities, Operations and Services (Section 25.114(d)(1))

The Global EHF Satellite Network (GESN) will use a constellation of seven spacecraft to provide a broad range of wideband telecommunications services, including two-way, wide-band data transport, multimedia services and private network services. The data rates are in a range from 75 Mbps to 750 Mbps for the downlink (space-to Earth) direction and 0.5 Mbps to 700 Mbps for the uplink (Earth-to-space) direction. The actual data rate will depend on the desired link availability, earth terminal antenna size, type of service, etc. A summary of the system features is included in Attachment E to this Technical Appendix.

The GESN system earth terminal users will be able to communicate with any of the GESN satellites in view, whether GSO or non-GSO. The GESN user terminals will be equipped with tracking antennas so that they can maintain continuous transmission with the satellites in view – a feature that is particularly useful for the three non-GSO satellites that will operate in highly-elliptical orbits (HEO). User earth terminal antenna sizes will range from 0.7 m to 2.7 m in diameter, depending on the applications and the desired link availability.

The GESN system will use fixed-satellite service (FSS) spectrum in both the Ka-band and V-band frequency ranges for its communications links. In the Ka-band, between the non-GSO and the GSO satellites, the bands 18.3-19.3 GHz, 19.7-20.2 GHz, 28.35-29.1 GHz and 29.5-30 GHz will be utilized (although not all bands will be used on all satellites, see Amendment at Table 1). In the V-band, the GESN satellites use the bands 37.5-42 GHz and 47.2-50.2 GHz for the downlink and the uplink, respectively (although, again, not all of the band 37.5-42 GHz will be used on all satellites, see Amendment at Table 1). All satellites in the system will use both left-hand circular polarization (LHCP) and right-hand circular polarization (RHCP).

Each GESN satellite will use two megahertz of spectrum in each direction of the extended C-band frequencies, 3650-3700 MHz for downlink and 6425-6525 MHz for uplink, for transfer orbit and on-orbit emergency telemetry and command (TT&C) operations. For regular on-orbit

operations, the GESN satellites' TT&C subsystem will use two megahertz of spectrum in each the 19 and 29 GHz bands for telemetry and for telecommands.

The GESN HEO satellites will, as NGST proposed for its non-GSO satellites in the December 1997 Amendment, operate in the 19.7-20.2 GHz and 29.5-30 GHz on a secondary, non-unacceptable interference basis. The ability of the HEO satellites to operate on such a basis is confirmed by the fact that the satellites meet the equivalent power flux-density (epfd) limits established in Article 22 of the International Telecommunication Union (ITU) Radio Regulations for the protection of GSO FSS satellite networks from unacceptable interference caused by non-GSO FSS systems (see Attachment D for a detailed showing of compliance with the epfd limits). The geosynchronous, circular-orbit satellites in the GESN non-GSO component will not operate in the 19.7-20.2 GHz and 29.5-30 GHz bands. All GESN satellites, non-GSO and GSO, meet the applicable power flux-density (pfd) limits in Section 25.208 of the Commission's Rules.

In the Ka-band, the GESN system plans to use small earth terminal antennas, in a range of from 0.7 m to 1.2 m in diameter. In the V-band, larger earth terminal antennas, in a range of from 1.5-2.7 m in diameter, will be used.

The inclination angle and perigee altitude of the GESN's HEO satellites are 63.4 deg and 1111 km, respectively, which corresponds to a 12-hour orbit period. The apogee altitude of the HEO satellites is 39,352 km. The HEO satellites are distributed over three orbit planes, one satellite per plane. The minimum operational elevation angles for the HEO satellites at Ka-band and V-band are 10 degrees and 15 degrees, respectively. The coverage of the HEO satellites is shown in Figure 1.

Four GSO satellites will be located at 119ºW, 89ºW, 15ºE and 116.5ºE. These satellites will also host the payloads of the four non-GSO satellites that comprise the GESN geosynchronous circular-orbit plane of satellites. The coverage of these four satellites is shown in Figure 2. The coverage of the entire GESN constellation, including 3 HEO satellites and the 4 GSO/geosynchronous satellites, is shown in Figure 3. In the calculation, the minimum operational elevation angle (10 degrees) was used. Figure 3 confirms that the GESN system will be capable of serving all populated areas of the world.

Each GESN satellite will have 60 (30 Ka + 30 V-band) active receive beams and 48 (24 Ka + 24 V-band) active transmit beams. Each beam will be able to operate on RHCP and/or LHCP. Each transmit and receive beam will be able to be assigned to any point in the satellite field of view. Each non-GSO satellite has an Earth coverage antenna beam for order wire. The purpose of the order wire is to support the communications between the ground terminals and the GESN satellites or/and GESN Network Control Center.

In addition, each GESN satellite will be equipped with three laser heads. These three laser heads will allow the GESN satellites to communicate via optical cross-links with each other and other satellite networks or space vehicles.

The capacity of each GESN satellite is ~24 Gbps. The overall system capacity of GESN is ~165 Gbps.

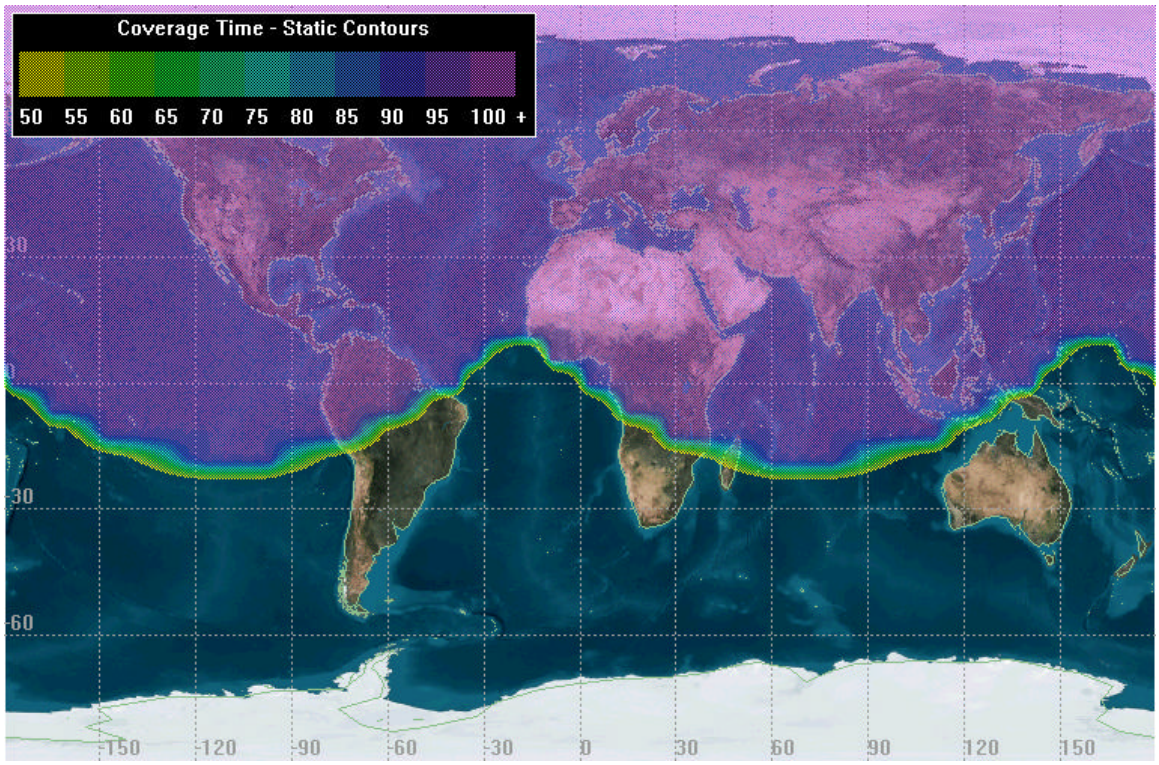

Figure 1: Coverage of Three HEO Satellites (Minimum Elevation Angle = 10 degrees)

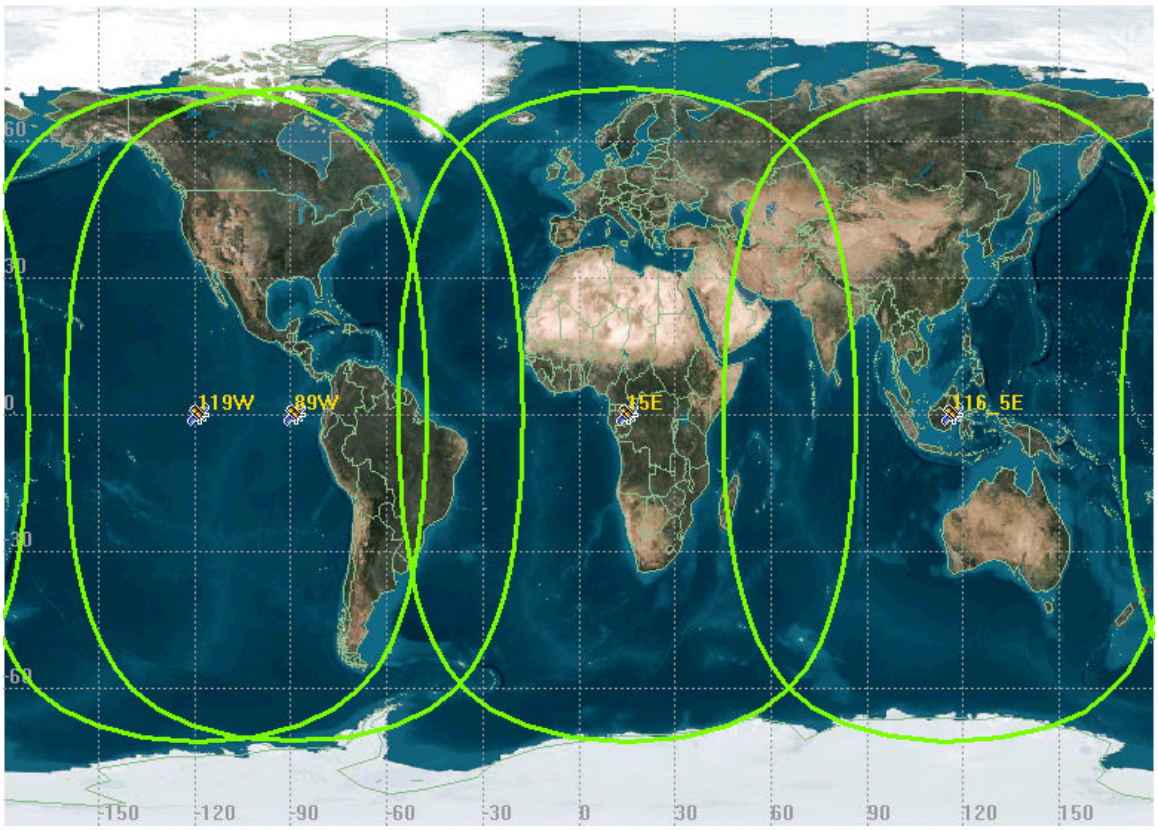

Figure 2: Coverage of Four GSO Satellites (Minimum Elevation Angle = 10 deg.)

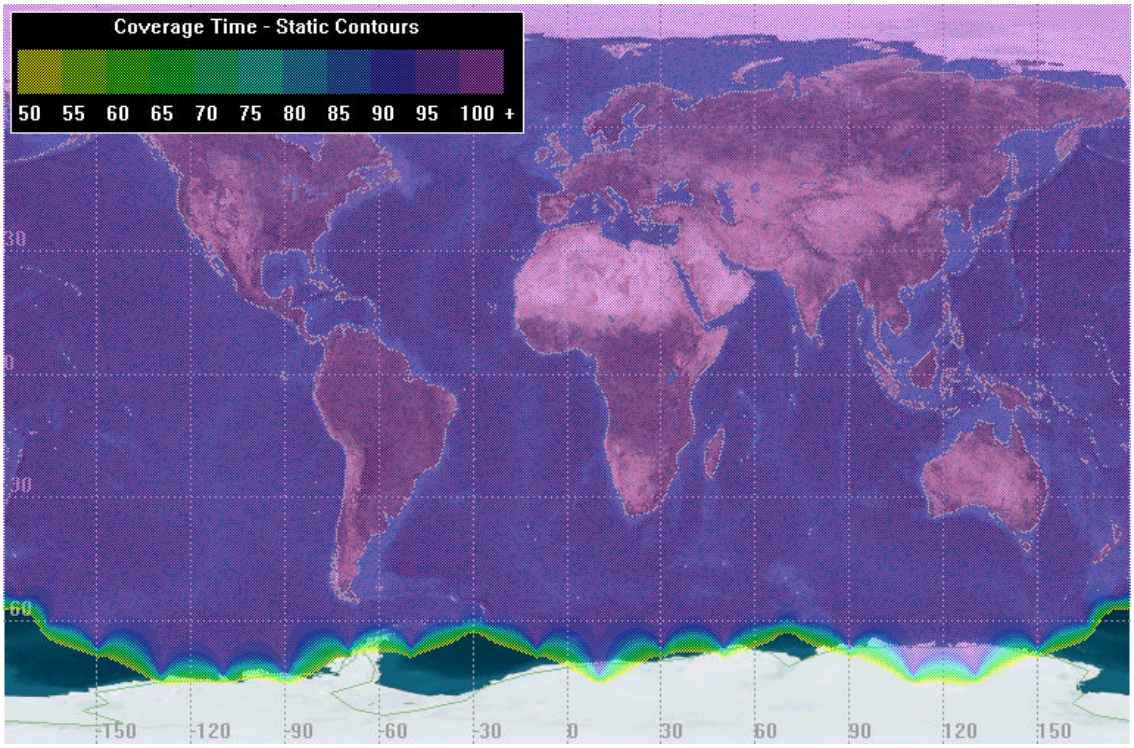

Figure 3: Coverage of GESN Constellation (7 Satellites)

2. Radio Frequency and Polarization Plan, Center Frequency and Polarization of transponders, emission designators and allocated bandwidth of emission, transmit power, EIRP (Section 25.114(c)(4))

- **GESN Frequency Plan (Non-GSO Component): (Section 25.114(c)(4)(i))**

  - **HEO Non-GSO Satellites:** Each satellite will utilize 1000 MHz of Ka-band spectrum and 3000 MHz of V-band spectrum in each direction, as shown in Figure 4A. In the uplink direction, the Ka-band spectrum will be divided into eight 125 MHz channels and the V-band spectrum will be divided into seven channels: two 300 MHz channels, one 400 MHz channel, and four 500 MHz channels. In the downlink direction, there will be four Ka-band 250 MHz channels and nine V-band 500 MHz channels (of which only six will be utilized). Each beam would be able to operate on LHCP and/or RHCP, depending on the traffic demand and sharing conditions.

    Note: In the 37.5-42 GHz band, each GESN non-GSO satellite only uses 3000 MHz of the 4500 MHz of downlink spectrum (i.e., six of the nine available channels). The actual configuration used is dependent on the outcome of future GSO/non-GSO sharing deliberations. NGST has requested a flexible authorization that will enable it to adjust without further application proceedings to the results of future proceedings.

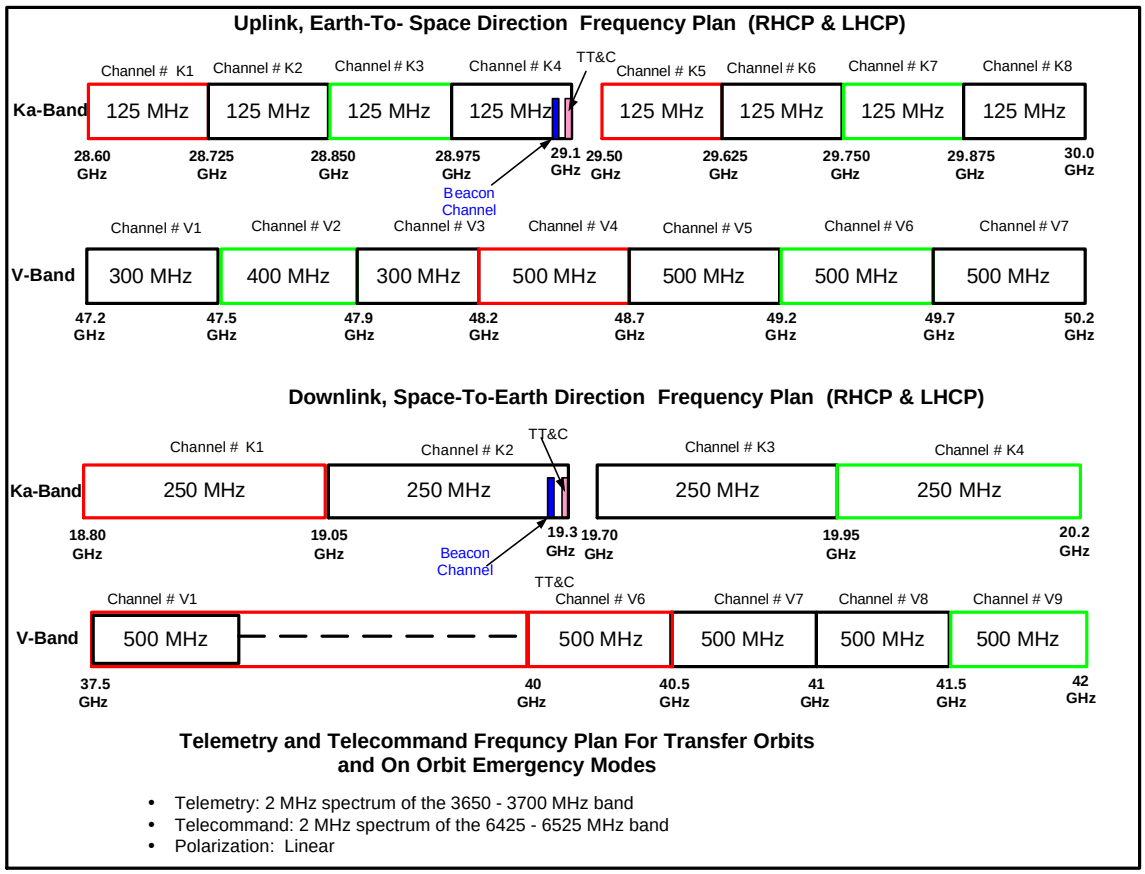

Figure 4A: Non-GSO Satellite (HEO) – Frequency and Polarization Plan

- **Geosynchronous Circular-Orbit Non-GSO Satellites:** Each satellite will utilize 500 MHz of Ka-band spectrum and 3000 MHz of V-band spectrum in each direction, as shown in Figure 4B. In the uplink direction, the Ka-band spectrum will be divided into four 125 MHz channels and the V-band spectrum will be divided into seven channels: two 300 MHz channels, one 400 MHz channel, and four 500 MHz channels. In the downlink direction, there will be two Ka-band 250 MHz channels and nine V-band 500 MHz channels (of which only six will be utilized). Each beam would be able to operate on LHCP and/or RHCP, depending on the traffic demand and sharing conditions.

  Note: In the 37.5-42 GHz band, each GESN non-GSO satellite only uses 3000 MHz of the 4500 MHz of downlink spectrum (i.e., six of the nine available channels). The actual configuration used is dependent on the outcome of future GSO/non-GSO sharing deliberations. NGST has requested a flexible authorization that will enable it to adjust without further application proceedings to the results of future proceedings.

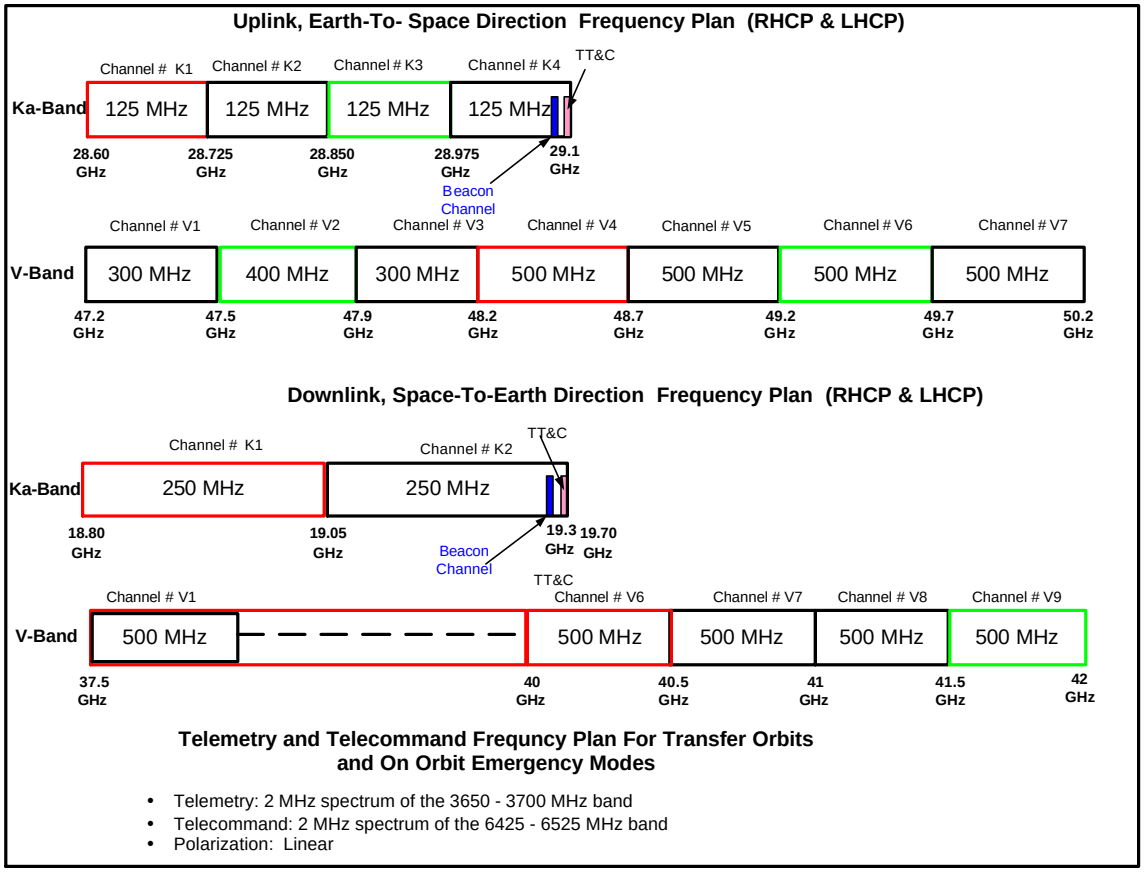

Figure 4B: Non-GSO Satellite (Geosynchronous Circular-Orbit) – Frequency and Polarization Plan

- **GESN Frequency Plan (GSO Component): (Section 25.114(c)(4)(i))**

    - **GSO satellites at 119°W and 116.5°E**: The GESN GSO satellites at 119°W and 116.5°E will utilize 2 x 1000 MHz of GSO FSS primary spectrum in the Ka-band, and the full 3000 MHz of V-band uplink and 4500 MHz of V-band downlink FSS spectrum as shown in Figure 5A. In the uplink direction, the 1000 MHz of Ka-band spectrum is divided into eight 125 MHz channels and the V-band spectrum is divided into seven channels: two 300 MHz channels, one 400 MHz channel, and four 500 MHz channels. In the downlink direction, there will be four Ka-band 250 MHz channels and nine V-band 500 MHz channels. Each beam would be able to operate on LHCP and/or RHCP, depending on the traffic demand and sharing conditions.

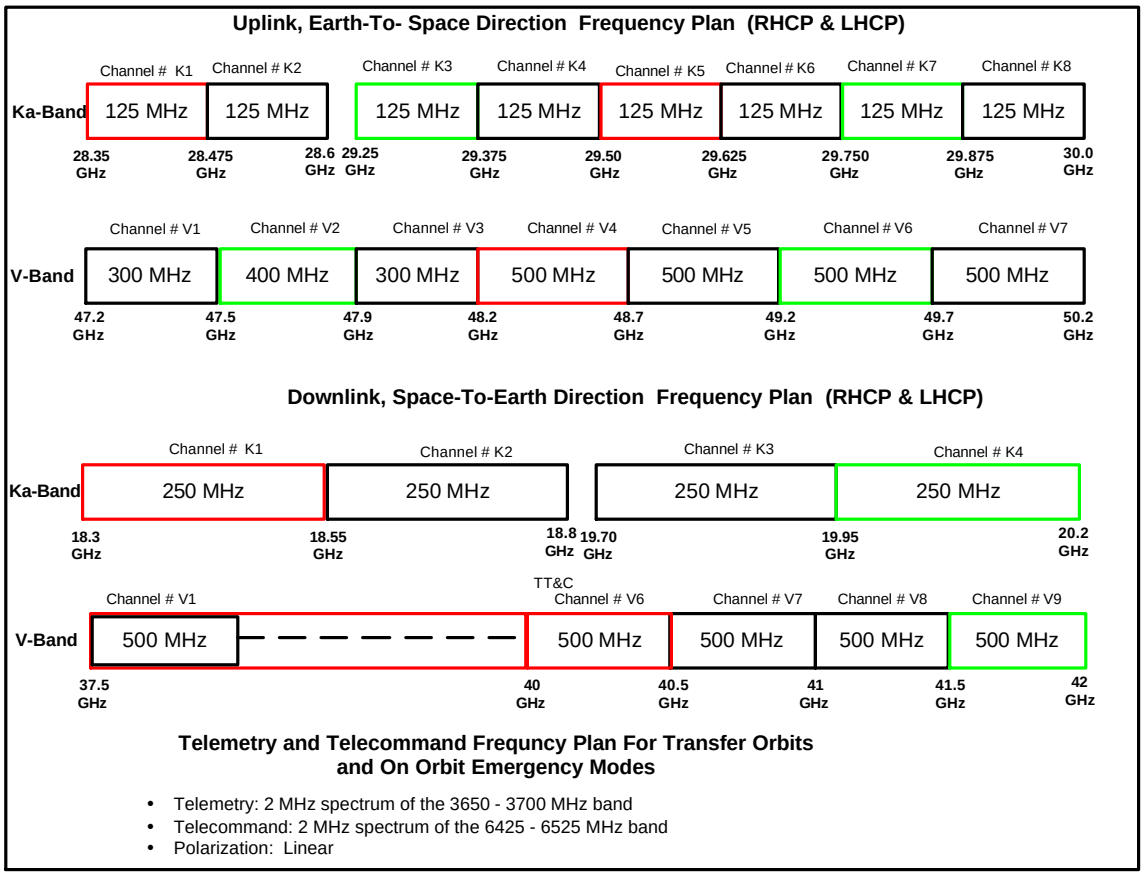

Figure 5A: GSO Satellites at 119°W and 116.5°E – Frequency and Polarization Plan

- **GSO satellite at 89°W**: The GESN GSO satellite at 89°W will utilize 2 x 500 MHz of GSO FSS primary spectrum in the Ka-band, and the full 3000 MHz of V-band uplink and 4500 MHz of V-band downlink FSS spectrum as shown in Figure 5B. In the uplink direction, the 500 MHz of Ka-band spectrum is divided into four 125 MHz channels and the V-band spectrum is divided into seven channels: two 300 MHz channels, one 400 MHz channel, and four 500 MHz channels. In the downlink direction, there will be two Ka-band 250 MHz channels and nine V-band 500 MHz channels. Each beam would be able to operate on LHCP and/or RHCP, depending on the traffic demand and sharing conditions.

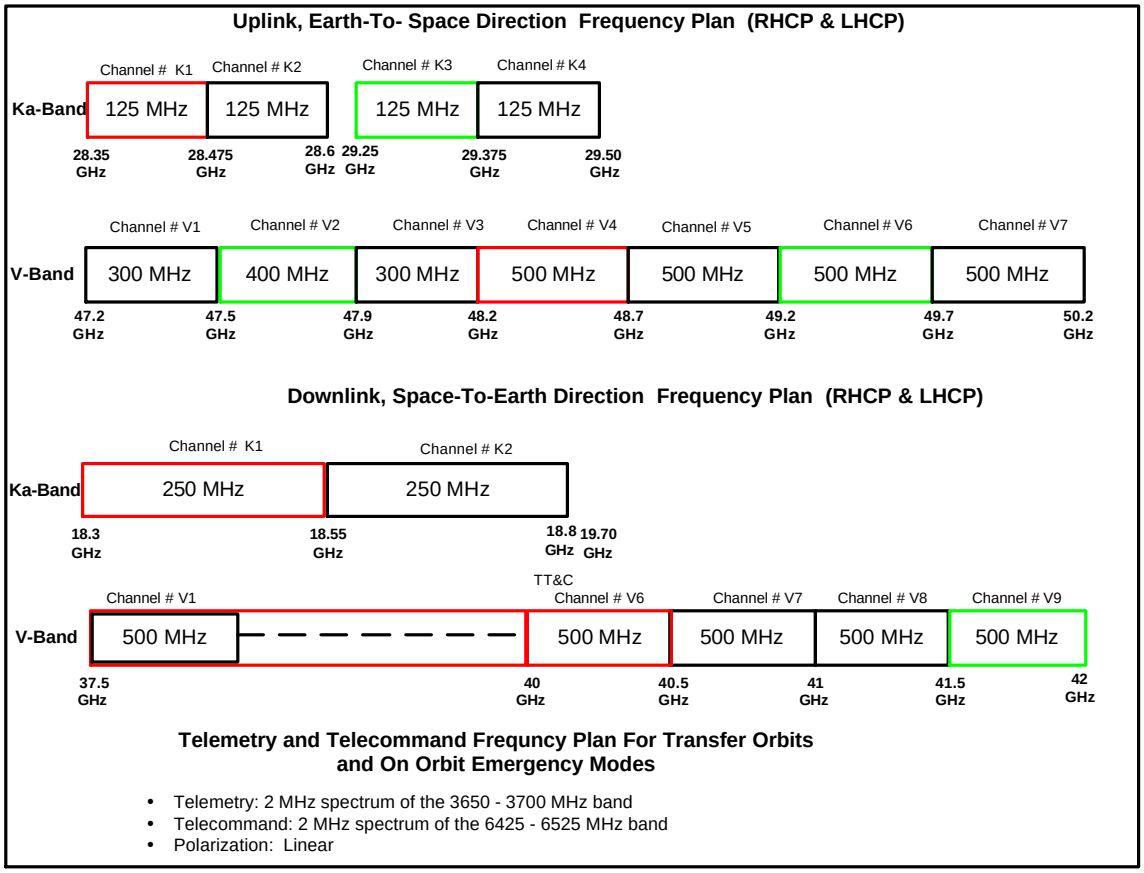

Figure 5B: GSO Satellite Located at 89°W – Frequency and Polarization Plan

- **GSO satellite at 15ºE**: The GESN GSO satellite at 15ºE will utilize the full 3000 MHz of V-band uplink and 3000 MHz of V-band downlink FSS spectrum as shown in Figure 5C. In the uplink direction, the spectrum is divided into seven channels: two 300 MHz channels, one 400 MHz channel, and four 500 MHz channels. In the downlink direction, six V-band 500 MHz channels will be utilized. Each beam would be able to operate on LHCP and/or RHCP, depending on the traffic demand and sharing conditions.

  Note: In the 37.5-42 GHz band, the GESN satellite at 15ºE only uses 3000 MHz of the 4500 MHz of downlink spectrum (i.e., six of the nine available channels). The actual configuration used is dependent on the outcome of future GSO/non-GSO sharing deliberations. The downlink frequency plan shown in Figure 5C is one possible configuration, and is dependent on the outcome of future GSO/non-GSO sharing deliberations. NGST has requested a flexible authorization that will enable it to adjust without further application proceedings to the results of future proceedings.

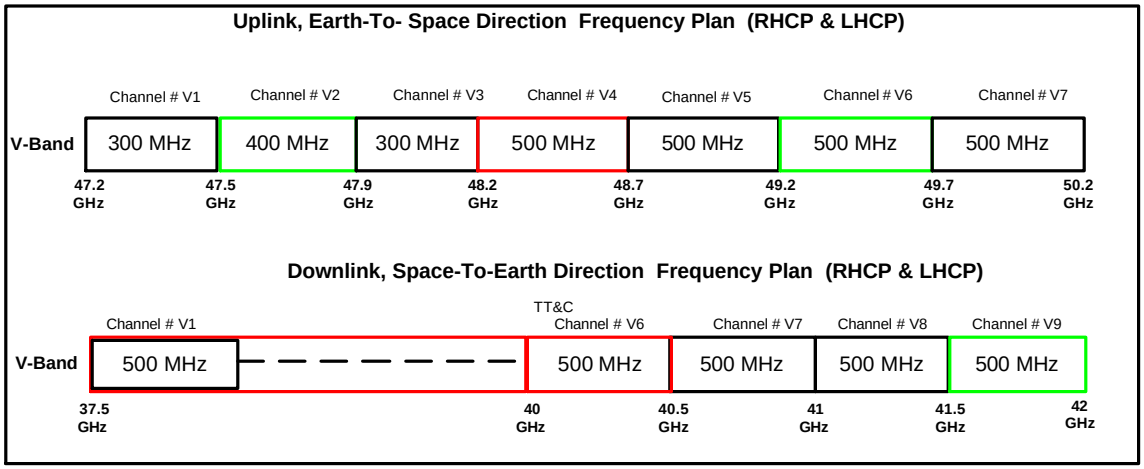

Figure 5C: GSO Satellite Located at 15ºE – Frequency and Polarization Plan

- **Center frequencies and polarizations**: The center frequencies and polarizations for the Non-GSO (HEO and Geosynchronous-Circular) and GSO satellites are summarized in Tables 1A, 1B, and 2, respectively.

Table 1A: Non-GSO Satellite (HEO) - Center Frequencies and Polarization

Parameters	Center Frequencies	Polarization
Uplink (Earth-to-Space Direction)		
Standard service links	28.6625 GHz, 28.7875 GHz, 28.9125 GHz, 29.0375 GHz, 29.5625 GHz, 29.6875 GHz, 29.8125 GHz, 29.9375 GHz, 47.35 GHz, 47.7 GHz, 48.05GHz, 48.45 GHz, 48.95 GHz, 49.45 GHz, 49.95 GHz	RHCP & LHCP
Beacon	29.096 GHz	CP
TT&C (Telecommand) • Transfer orbits & on-orbit emergency modes • On-orbit operations	 2 MHz spectrum of the 6425 – 6525 MHz band 29.098 GHz	 Linear CP
Downlink (Space-to-Earth Direction)		
Standard service links	18.925 GHz, 19.175 GHz, 19.825 GHz, 20.075 GHz 37.75 GHz, 38.25 GHz, 38.75 GHz, 39.25 GHz, 39.75 GHz, 40.25 GHz, 40.75 GHz, 41.25 GHz, 41.75 GHz	RHCP & LHCP (In the 37.5-42 GHz band, only six 500 MHz channels will be used)
Beacon	19.296 GHz	CP
TT&C (Telecommand) • Transfer orbits & on-orbit emergency modes • On-orbit operations	 2 MHz spectrum of the 3650-3700 MHz band 19.298 GHz	 Linear CP

Table 1B: Non-GSO Satellite (Geosynchronous, Circular-Orbit) - Center Frequencies and Polarization

Parameters	Center Frequencies	Polarization
Uplink (Earth-to-Space Direction)		
Standard service links	28.6625 GHz, 28.7875 GHz, 28.9125 GHz, 29.0375 GHz, 47.35 GHz, 47.7 GHz, 48.05GHz, 48.45 GHz, 48.95 GHz, 49.45 GHz, 49.95 GHz	RHCP & LHCP
Beacon	29.096 GHz	CP
TT&C (Telecommand) • Transfer orbits & on-orbit emergency modes • On-orbit operations	 2 MHz spectrum of the 6425 – 6525 MHz band 29.098 GHz	 Linear CP
Downlink (Space-to-Earth Direction)		
Standard service links	18.925 GHz, 19.175 GHz, 37.75 GHz, 38.25 GHz, 38.75 GHz, 39.25 GHz, 39.75 GHz, 40.25 GHz, 40.75 GHz, 41.25 GHz, 41.75 GHz	RHCP & LHCP (In the 37.5-42 GHz band, only six 500 MHz channels will be used)
Beacon	19.296 GHz	CP
TT&C (Telecommand) • Transfer orbits & on-orbit emergency modes • On-orbit operations	 2 MHz spectrum of the 3650-3700 MHz band 19.298 GHz	 Linear CP

Table 2: GSO Satellite - Center Frequencies and Polarization

Parameters	Center Frequencies*	Polarization
Uplink (Earth-to-Space Direction)		
Standard service links	28.4125 GHz, 28.5375 GHz, 29.3125 GHz, 29.4375 GHz, 29.5625 GHz, 29.6875 GHz, 29.8125 GHz, 29.9375 GHz, 47.35 GHz, 47.7 GHz, 48.05GHz, 48.45 GHz, 48.95 GHz, 49.45 GHz, 49.95 GHz	RHCP & LHCP
TT&C (Telecommand) • Transfer orbits & on-orbit emergency modes • On-orbit operations	2 MHz spectrum of the 6425 – 6525 MHz band 28.354 GHz	Linear CP
Downlink (Space-to-Earth Direction)		
Standard service links	18.425 GHz, 18.675 GHz 19.825 GHz, 20.075 GHz 37.75 GHz, 38.25 GHz, 38.75 GHz, 39.25 GHz, 39.75 GHz, 40.25 GHz, 40.75 GHz, 41.25 GHz, 41.75 GHz	RHCP & LHCP
TT&C (Telecommand) • Transfer orbits & on-orbit emergency modes • On-orbit operations	2 MHz spectrum of the 3650-3700 MHz band 18.304 GHz	Linear CP

** The 15ºE satellite will not include any GSO primary spectrum at Ka-band, and will include only six 500 MHz channels, on a flexible assignment basis, in the 37.5-42 GHz band. The 89ºW satellite will not include any channels in the 29.5-30 GHz and 19.7-20.2 GHz bands. The 15ºE satellite will share the on-orbit operations TT&C frequencies of the geosynchronous satellite in the non-GSO component of GESN (see Table 1B, above).*

- **Emission designators and allocated bandwidth of emission**

Emission designators and allocated bandwidth of emission are shown in Table 3:

Table 3: Emission Designators and Allocated Bandwidth of Emission

Parameters	**Emission Designators**	**Allocated Bandwidth**
Uplink (Earth-to-Space Direction)		
Standard service links • Ka-Band • V-band	 7M0G7W, 3M5G7W, 700K0G7W 491M8G7W, 175M6G7W, 87M8G7W, 35M1G7W	 7 MHz, 3.5 MHz, 700 kHz 491.8 MHz, 175.6 MHz 87.8 MHz, 35.1 MHz
Beacon	10K7G7D	10.7 kHz
TT&C (Telecommand) • Transfer orbits & on-orbit emergency modes • On-orbit operations	 4K0F9D, 1M0FXD 1M0G7D	 4 kHz, 1 MHz 1 MHz
Downlink (Space-to-Earth Direction)		
Standard service links • Ka-band • V-band	 250M0G7W, 125M0G7W, 500M0G7W, 250M0G7W 125M0G7W	 250 MHz, 125 MHz 500 MHz, 250 MHz 125 MHz
Beacon	334K0G7D	334 kHz
TT&C (Telemetry) • Transfer orbits & on-orbit emergency modes • On-orbit operations	 4K0F9D, 600KG7D 2M0G7D	 4 kHz, 600 kHz 2 MHz

- **Amplifier output power, EIRP and connectivity:** The satellite transmit EIRPs are shown in Table 4:

Table 4: Transmit Power and EIRP

Parameters	**Tx power**	**Circuit loss**	**Antenna gain**	**EIRP (peak)**
Standard service links • Ka-band • V-band - 37.5-40 GHz - 40 – 42 GHz	 50 W 20 W 40 W	 2 dB 2 dB 2 dB	 48 dBi 53 dBi 53 dBi	 63 dBWi 64 dBWi 67 dBWi
Beacon (Ka-band only)	50 W	2 dB	18.5 dBi	33.5 dBWi
TT&C • Transfer orbits or on-orbit emergency modes • On-orbit operations	 2 W 0.5 W	 3 dB 3 dB	 -3 dBi 48 dBi	 -3 dBWi 42 dBWi

- **Satellite receive system noise temperature and G/T**: Table 5 summarizes the satellite receive G/T:

Table 5: Satellite G/T

Parameters	**Receive Antenna peak gain**	**System noise temperature**	**G/T**
Standard service links • Ka-band • V-band	 46.5 dBi 54.4 dBi	 504 k 520 k	 19.5 dB/k 27.2 dB/k
Beacon (Ka-band only)	18.5 dBi	504 k	-8.5 dB/k
TT&C • Transfer orbits or on-orbit emergency modes • On-orbit operations	 -2 dBi 46.5 dBi	 1154 k 504 k	 - 32.6 dB/k 19.5 dB/k

- **Maximum transmit power and e.i.r.p. density and pfd**

Table 6 summarizes the satellite transmit power density and downlink pfd.

Table 6: Maximum Transmit Power and e.i.r.p. Density and pfd on the Earth

Parameters	**Max transmit power density (dBW/Hz)**	**Max e.i.r.p. density (dBW/Hz)**	**Max pfd (dB(W/m2/MHz)) (Nadir)**
Standard service links			
• Ka-band			
o HEO satellite	- 69.0	-21.0	-116.1
o GSO satellite	- 69.0	-21.0	-120.1
• V-band			
o HEO satellite			
o 37.5-40 GHz	- 76.0	- 23.0	-118.1
o 40-42 GHz	- 66.9	- 13.9	-109.0
o GSO satellite			
o 37.5-40 GHz	-76	-23.0	-125
o 40-42 GHz	-67.0	- 14.0	-116.0
Beacon (Ka-band only)			
• GSO satellite	-40.2	-21.7	- 123.8
• HEO satellite	-40.2	-21.7	- 116.9
TT&C (On-orbit operation)			
• GSO satellite	-69	-21.0	- 123.1
• HEO satellite	-69	-21.0	- 116.0

3. Orbital Locations for Satellites in Geostationary Orbit (Section 25.114(c)(5)(i))

- **Orbital location:** The GESN system includes four satellites in geostationary orbit. The desired orbital locations of these satellites are: 119ºW, 89ºW, 15º E, and 116.5º E. These locations were selected to optimize constellation coverage of the world's populated landmasses (in conjunction with the HEO satellites). These locations also are available (to the extent requested) in both Ka-band and V-band for assignment to a U.S. licensee – a prerequisite for NGST's proposed hybrid operation. Considering the foregoing, NGST has only limited flexibility to consider any alternative locations, and it would have to consider alternatives in the context of its coverage requirements for GESN.

- Service areas: These four satellites provide service to any user almost everywhere around the world as shown in Figure 2.

- Longitude tolerance or east-west station-keeping capability: 0.05 degrees

- Inclination incursion or north-south station-keeping capability: 0.05 degrees

4. Satellites in Non-Geostationary Orbits (Section 25.114(c)(6))

The orbital parameters of the GESN HEO satellites are shown in Table 7 below:

Table 7: Orbital parameters (3 HEO satellites)

Orbital Information For Non-geostationary Satellites

Orbital Plane No.	No. of Satellites in Plane	Inclination Angle (degrees)	Orbital Period (Seconds)	Apogee (km)	Perigee (km)	Right Ascension of the Ascending Node (Deg.)	Argument of Perigee (Degrees)	Active Service Are Range (Degrees)
1	1	63.4	43064	39352	1111	0	270	360
2	1	63.4	43064	39352	1111	120	270	360
3	1	63.4	43064	39352	1111	240	270	360

Initial Satellite Phase Angle

Orbital Plane No.	Satellite Number	Initial Phase Angle (Degrees)
1	1	0 (Mean Anomaly)
2	2	120 (Mean Anomaly)
3	3	240 (Mean Anomaly)

5. Description of Services to be Provided, Areas to be Served, Transmission Characteristics, Performance Objectives, Details of Link Noise Budget, Baseline Earth Station Parameters, Modulation Parameters, and Overall Link Performance Analysis (Section 25.114(d)(4))

- **Description of service**: The GESN system will provide service almost everywhere in the world as shown in Figure 3. Each satellite will be equipped with 48 active transmit (24 Ka-band and 24 V-band beams) and 60 active receive beams (30 Ka- band and 30 V-band beams), for standard communications, between the ground terminal users and satellites. Each non-GSO satellite also has a transmit and receive beacon beam for the order wire to allow the setup and tear down of the communication paths. All GESN satellites will be self-relay, and/or able to communicate with other satellite systems or space vehicles via their three laser heads.

- **Performance objectives**: The GESN system will provides good link availability for most locations around the world. The link availability will depend on the user types. There are four common types of user terminals: 0.7 m and 1.2 m diameter terminals for Ka-band, and 1.5 m and 2.7 m terminals for V-band. The users operating with 0.7m and 1.2 m earth terminal antennas can achieve up to 10 dB rain fade margin in the downlink and 12 dB fade margin in the uplink. In the V-band, the users operating with 1.5 m earth terminal antennas could achieve up to 18 dB rain fade margin. In order to achieve higher link availability, and

to meet the system capacity objectives, adjustable coding, modulation and data rate will be utilized. In general, the users will reduce their transmit data rates, use heavy coding and/or operate with lower order modulation during the rain fade conditions. The links operate at 2E-10 BER or lower.

- **Modulation Parameters:** 8PSK(8-Phase Shift Keying) and QPSK (Quadrature Phase-Shift Keying) will be used for communications links and order wire.

  - Downlink:
    - Modulation: 8PSK, QPSK
    - Coding:
      - 8PSK: RS (236,212) and convolution code, r = 5/6 and r = 2/3
      - QPSK: RS (236, 212) and convolution code, r= ¾ and r = ½
  - Uplink
    - Modulation: QPSK
    - Coding:
      - Light code: RS (236,212)
      - Heavy code: RS (236,212) and Reed-Muller (8,4,4)

- **Link Budgets:** See Attachment B to this Technical Appendix

- **Typical baseline Earth Stations**

The earth terminal parameters are summarized in Table 8 below:

Table 8: Baseline Earth Terminal Parameters

Parameters	**Ka-Band**		**V-Band**	
Antenna size	0.7 m	1.2 m	2.7 m (37.5-40 GHz)	1.5 m (40-42 GHz)
Max. transmit EIRP	47.4 dBWi	54.3 dBWi	75.9 dBWi	68.6 dBWi
Max transmit data rate	2.52 Mbps	10.1 Mbps	706 Mbps	252 Mbps
Receive G/T	16.0 dB/k	20.7 dB/k	33.5 dB/k	28.8 dB/k
Max receive data rate	224 Mbps	374 Mbps	748 Mbps	748 Mbps

6. Downlink power flux density (Section 25.114(d)(5))

The power flux density levels of the GESN HEO and GSO satellites shown in Figures 6 and 7 are below the limits in Sections 25.208(c), (d), (e), (p), (q), (r), (s), (t), and 25.138(a)(6).

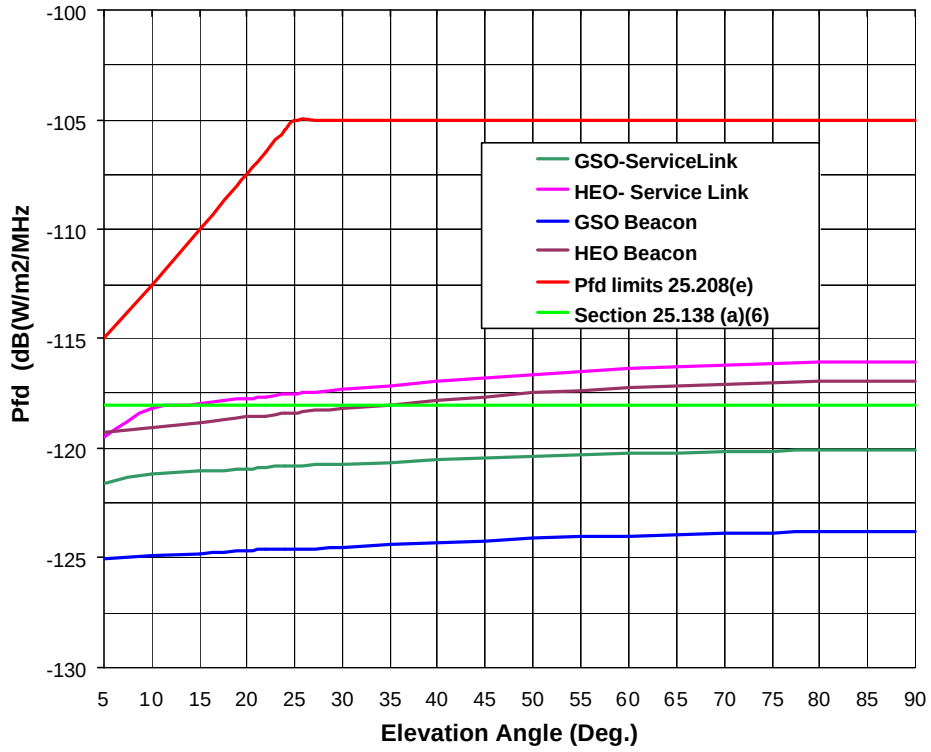

Figure 6: GESN Ka-Band Downlink Power Flux Density Levels

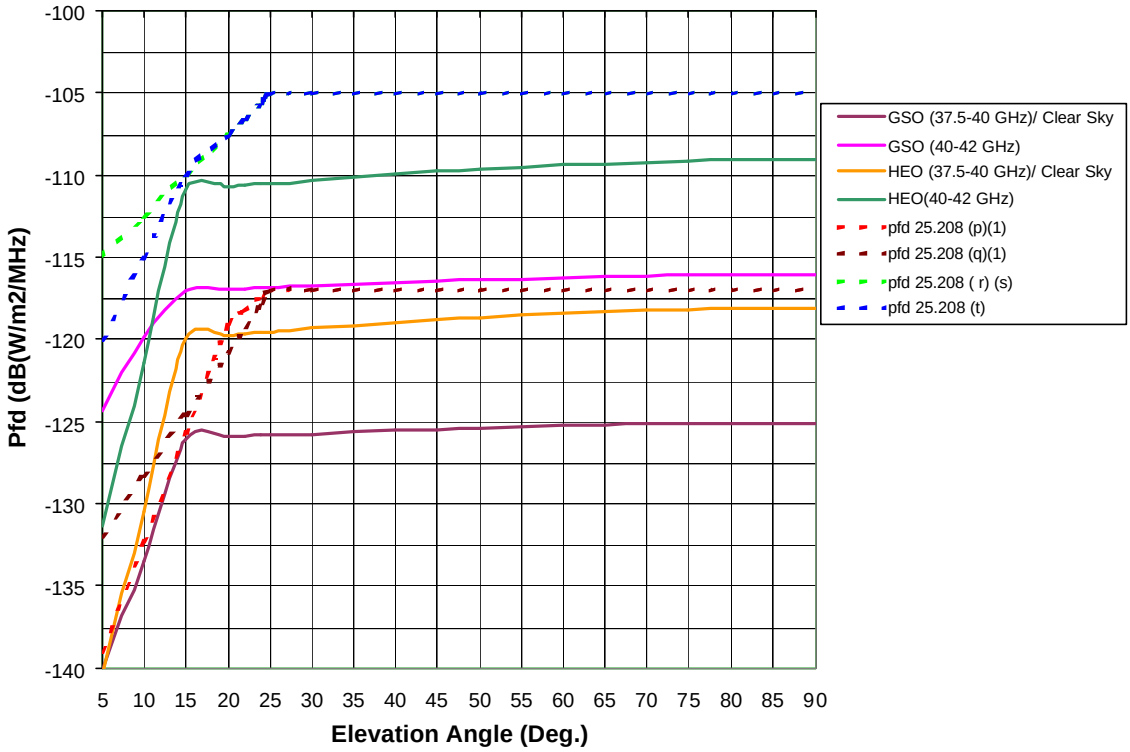

Figure 7: GESN V-Band Downlink Power Flux Density Levels

The maximum downlink power flux density level of the GSO satellites, located 119ºW and 116.5ºE operating in the 19.7-20.2 GHz band is –120 dB(W/m^2/MHz) as shown in Figure 6 (GSO service link), which complies with Section 25.138(a)(6). In addition, the power flux density level of satellites operating in the 18.6-18.8 GHz band is –97dB(W/m^2/200 MHz), which meets the power flux density limits shown in Section 25.208(d).

Section 25.138(a): The off-axis EIRP spectral density levels of the GESN GSO satellites operating in the 28.35 –28.6 GHz and 29.25-30 GHz bands shown in Figure 8 are at least 6 dB lower than the values required in Section 25.138(a).

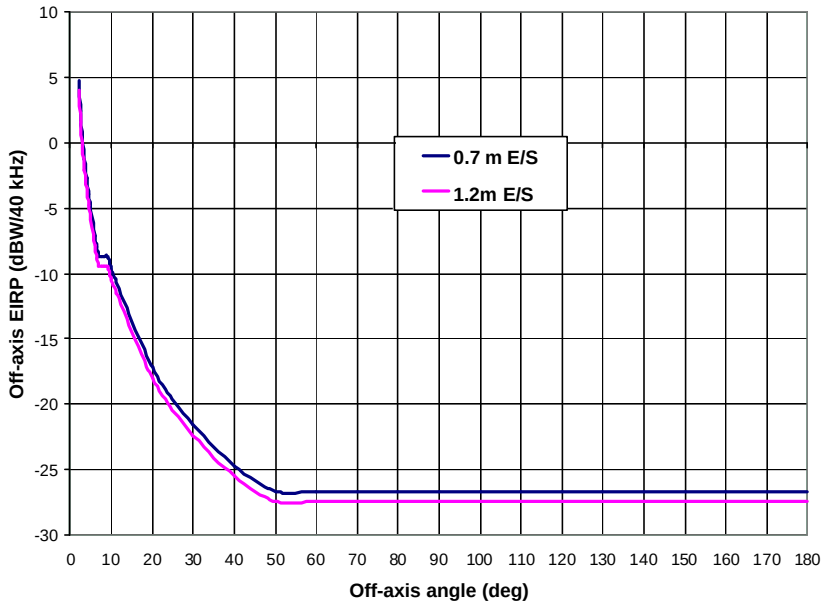

Figure 8: The off-axis EIRP Spectral Density Levels (Clear Sky Conditions)

Figures 6 and 8 also serve as satisfaction of NGST's requirement to provide an interference analysis with respect to GSO satellite networks operating in the 18.3-18.8 GHz, 19.7-20.2 GHz, 28.35-28.6 GHz and 29.25-30 GHz (none exist at V-band), under Sections 25.114(d)(7) and 25.140(b)(2) of the Commission's Rules.

Section 25.202(f): Emission Limitations

The out-of-band emissions will be at least attenuated with respect to the mean output power of transmitters as shown in Table 9:

Table 9: Emission Mask

Percentage of the authorized bandwidth	Attenuation of unwanted emissions with respect to the mean power of the transmitter, p (In any 4 kHz band
50 % to 100 %	25 dB
100% to 250%	35 dB
> 250%	43+10Log(p)

7. TT&C System Parameters (Section 25.114(c)(9))

Table 10 summarizes the TT&C subsystem:

Table 10: TT&C Subsystem Arrangements

Parameters	Transfer Orbits and On orbit Emergency Modes		On Orbit Operation	
	Uplink	**Downlink**	**Uplink**	**Downlink**
Frequency band • Bandwidth • Polarization	6425-6525 MHz • 2 MHz • Linear	3650-3700 MHz • 2 MHz • Linear	29.095-29.097 GHz * 28.353-28.255 GHz ** • 2 MHz • Circular (CP)	19.295-19.297 GHz * 18.303-18.305 GHz ** • 2 MHz • Circular (CP)
Emission designator • Bandwidth	4K0F9D, 1M0FXD • 4 kHz, 1 MHz	4K0F9D, 600K0G7D • 4 kHz, 600 kHz	1M0G7D • 1 MHz	2M0G7D • 2 MHz
Transmit EIRP • Tx power into ant. (W) • Tx antenna gain (dBi)	73.9 dBWi (E/S) • 63 W • 55.9 dBi	-3dBWi (Satellite) • 1 W • -3 dBi	76 dBWi (E/S) • 50.5 W • 59 dBi	42 dBWi (satellite) • 0.25W • 48 dBi
Receive G/T • System noise temp (k) • Rx antenna gain (dBi)_	-33.6 dB/k (satellite) • 1154 k • -3 dBi	26 dB/k (E/S) • 311 k • 50.98 dBi	19.5 dB/k (satellite) • 504 k • 46.5 dBi	28.9 dB/k (E/S) • 448 k • 55.5 dBi
Modulation`	FM	BPSK	BPSK	BPSK
Notes: * These bands will be used for non-GSO satellites (including both HEO and geosynchronous) ** These bands will be used for GSO satellites located at 119°W, 89°W and 116.5°E				

8. Physical characteristics of the space station including weight and dimensions of spacecraft (Section 25. 114(c)(10))

The GESN payload consists of eight major elements: an V-band subsystem, a Ka-band subsystem, a digital processor, a crosslink subsystem, a payload computer, a beacon access control and timing subsystem, a telemetry, tracking and command (TT&C) subsystem and a timing and frequency generation subsystem as shown in Figure 9. The GESN satellite depicted in Figure 10 consists of a three-axis stabilized bus and a communication payload. Tables 11 and 12 summarize the GESN satellite characteristics:

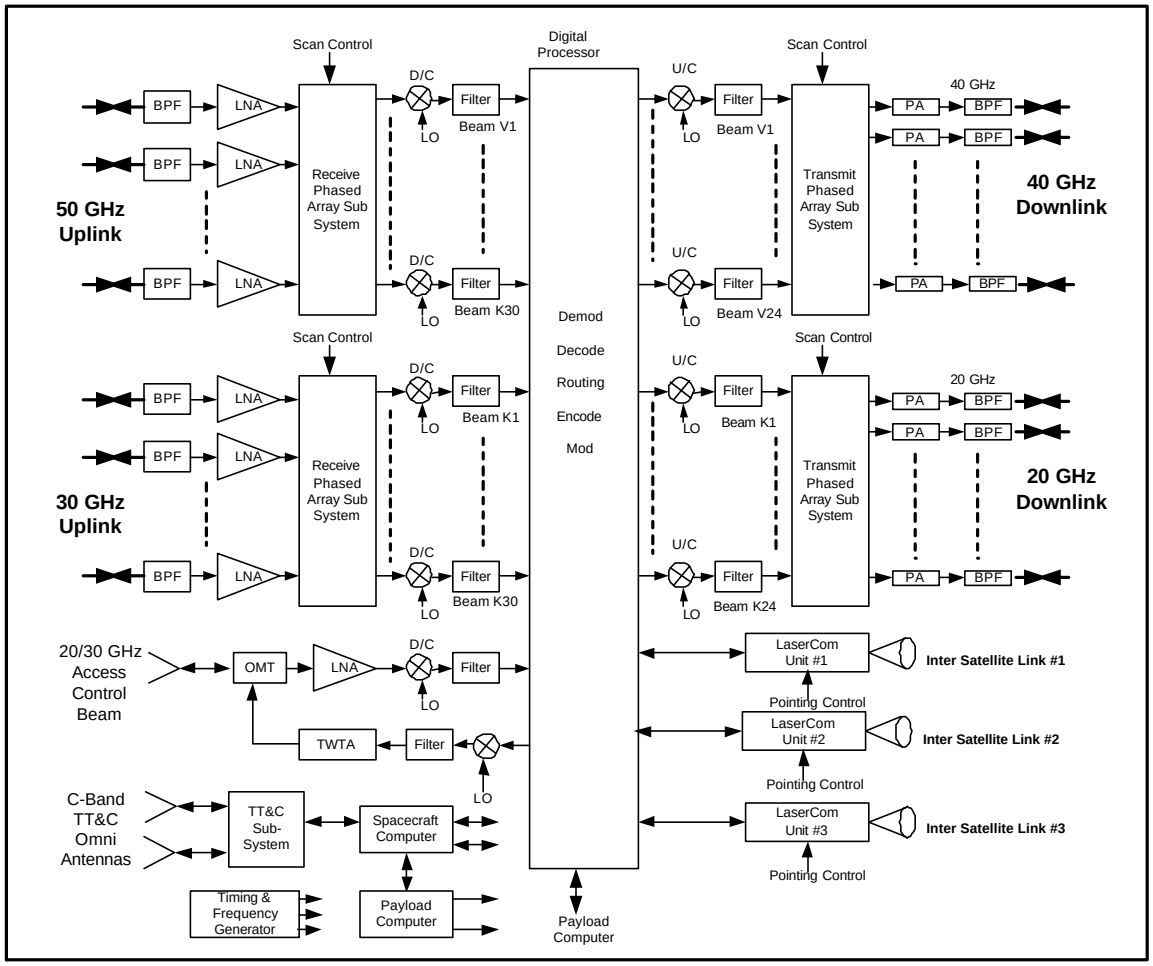

Figure 9: GESN Payload Conceptual Block Diagram

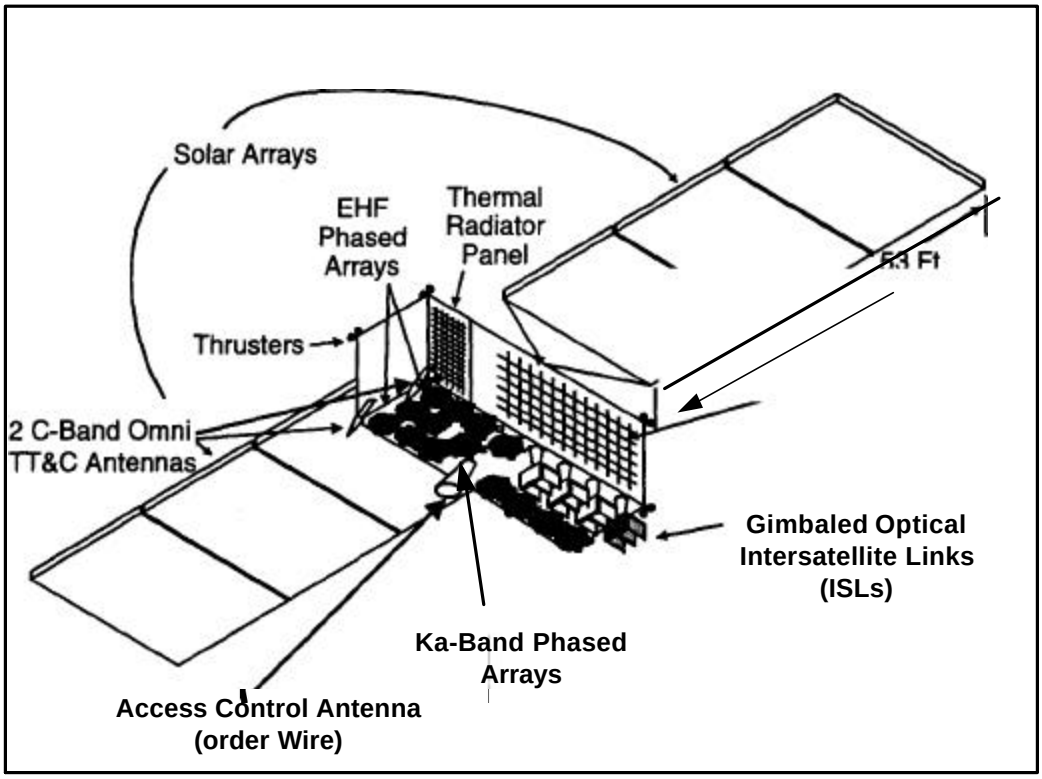

Figure 10: GESN Satellite Configuration

Table 11: GESN GSO Satellite Characteristics

Design life	15 years
Stabilization	3 Axis sensors with the use of reaction wheels and thrusters
DC Power	~ 10.7 kW
Eclipse capability	100%
Deployed length	Approximately 90 ft
Deployed height	Approximately 20 ft
TT &C sub system	2 C-band omni antennas
Number of beams - Ka-band - V-band - Inter-satellite links	 24 transmit and 30 receive beams 24 transmit and 30 receive beams 3 laser heads
Number of command carriers	2
Number of telemetry carriers	2
Spectrum re-use	Uplink: ~4; Downlink: ~8
Inclination	0.05 degrees
East-West station-keeping	+/- 0.05 degrees
Antenna beam pointing tolerance	0.05 degrees
Total weight - Payload - Spacecraft - Propellant	5500 kg 1100 kg 1600kg 2800
Total power - Payload - Spacecraft	10.7 kW 8.6kW (including 3 laser heads) 2.1kW

Table 12: GESN HEO Satellite Characteristics

Design life	15 years
Stabilization	3 Axis sensors with the use of reaction wheels and thrusters
DC Power	~ 10.7 kW
Eclipse capability	100%
Deployed length	Approximately 90 ft
Deployed height	Approximately 20 ft
TT &C sub system	2 C-band omni antennas
Number of beams - Ka-band - V-band - Inter satellite links	 24 transmit and 30 receive beams + 1 beacon beam 24 transmit and 30 receive beams 3 laser heads for inter satellite links
Number of command carriers	2
Number of telemetry carriers	2
Number of tracking beacon	1
Spectrum re-use	Uplink: ~4; Downlink: ~8
Orbital parameters - Number of satellites - Number of planes - Number of satellites per plane - Inclination angle - Perigee - Orbital period	 3 3 1 63.4 degrees 1111 km ~ 12 hours
Total weight - Payload - Spacecraft - Propellant	3154 kg 906 kg 1602 kg 646 kg
Total power - Payload - Spacecraft	10.7kW 8.6 kW (including 3 laser heads) 2.1 kW

ATTACHMENT A

FCC Form 312, Schedule S
(Filed Electronically)

ATTACHMENT B

Link Budgets

The link budgets are presented here as examples.

The GESN GSO and HEO Ka-band link budgets are shown in Tables B1-B8.

The TT&C link budgets are shown in Tables B9 and B10.

Tables B11- B14 summarize the GESN V-band GSO and HEO link budgets.

Table B1: GSO- Ka-Band Uplink

Uplink Budgets- GSO				
Elevation angle (deg)	15.0			
Slant range (km)	40153.8			
Uplink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	28.9	28.9	28.9	28.9
Earth station transmit EIRP (dBW)	**54.3**	**54.3**	**47.4**	**47.4**
* Antenna gain (dBi)	49.3	49.3	44.6	44.6
* Transmit power (W)	5.0	5.0	3.0	3.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**10.10**	**2.52**	**2.52**	**0.50**
Code rate	0.9	0.4	0.4	0.4
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	7.0	3.5	3.5	0.7
Space loss (dB)	213.7	213.7	213.7	213.7
Atmospheric & Scintillation Losses (dB)	2.1	-	2.1	-
ITU Combined Loss (dB)		12.0		10.6
Link availability (%)	-	99.40	-	99.20
Aggregate pointing loss (dB)	0.61	0.61	0.61	0.61
Polarization loss/degradation (dB)	0.2	0.1	0.1	0.1
Total Channel losses (dB)	**216.7**	**226.4**	**216.6**	**225.1**
Satellite Receive G/T (dBi) @ EOC	**16.5**	**16.5**	**16.5**	**16.5**
* Satellite receive antenna gain (dBi)	46.5	46.5	46.5	46.5
* Receive system noise temp (k)	504.0	504.0	504.0	504.0
* EOC (dB)	3.0	3.0	3.0	3.0
Potential interference degradation (dB)	**1.0**	**1.0**	**1.0**	**1.0**
Received Eb/No (dB)	11.7	7.9	10.9	9.4
Required Eb/No (dB)	9.3	7.1	7.1	7.1
System margin (dB)	**2.4**	**0.8**	**3.8**	**2.3**

Table B2: GSO- Ka-band Downlink

Downlink Budgets- GSO				
Elevation angle (deg)	15.0			
Slant Range	40153.8			
Downlink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	19.1	19.1	19.1	19.1
Satellite transmit EIRP (dBW)	**63.0**	**63.0**	**63.0**	**63.0**
* Antenna gain (dBi)	48.0	48.0	48.0	48.0
*** EOC (dB)**	**3.0**	**3.0**	**3.0**	**3.0**
* Transmit power (W)	50.0	50.0	50.0	50.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**374.0**	**112.0**	**224.0**	**74.0**
Coding	0.75	0.67	0.67	0.45
Modulation	8PSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	250.0	125.0	250.0	125.0
Space loss (dB)	210.1	210.1	210.1	210.1
Atmospheric & Scintillation Losses (dB)	1.7	-	1.7	-
ITU Combined Loss (dB)		8.1		6.6
Link availability (%)	-	99.70	-	99.50
Aggregate pointing loss (dB)	0.68	0.68	0.69	0.69
Polarization loss/degradation (dB)	0.2	0.1	0.1	0.1
Total Channel losses (dB)	**212.7**	**219.0**	**212.6**	**217.4**
Earth terminal Receive G/T (dBi)	**20.7**	**19.1**	**16.0**	**14.6**
* Earth station receive antenna gain (dBi)	45.7	45.7	41.0	41.0
* Receive system noise temp (k)	315.9	454.0	316.1	436.7
Potential interference degradation (dB)	**0.5**	**0.8**	**0.8**	**0.8**
Received Eb/No (dB)	10.4	7.5	7.7	6.3
Required Eb/No (dB)	8.6	5.4	5.4	4.2
System margin (dB)	**1.8**	**2.1**	**2.3**	**2.1**

Table B3: GSO – Ka-Band Beacon Uplink

Beacon Uplink Budgets- GSO				
Uplink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	28.9	28.9	28.9	28.9
Earth station transmit EIRP (dBW)	**47.3**	**54.3**	**47.4**	**47.4**
* Antenna gain (dBi)	49.3	49.3	44.6	44.6
* Transmit power (W)	1.0	5.0	3.0	3.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**0.005**	**0.005**	**0.005**	**0.005**
Code rate	0.4	0.4	0.4	0.4
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	0.008	0.008	0.008	0.008
Space loss (dB)	213.7	213.7	213.7	213.7
Atmospheric & Scintillation Losses (dB)	2.1	-	2.1	-
ITU Combined Loss (dB)		12.9		8.0
Link availability (%)	-	99.50	-	98.50
Aggregate pointing loss (dB)	0.12	0.12	0.12	0.12
Polarization loss/degradation (dB)	0.1	0.1	0.1	0.1
Total Channel losses (dB)	**216.0**	**226.7**	**216.0**	**221.8**
Satellite Receive G/T (dBi)	**-8.5**	**-8.5**	**-8.5**	**-8.5**
* Satellite receive antenna gain (dBi)	18.5	18.5	18.5	18.5
* Receive system noise temp (k)	504.0	504.0	504.0	504.0
**System noise figure (dB)	2.4	2.4	2.4	2.4
* EOC (dB)	3.0	3.0	3.0	3.0
Potential interference degradation (dB)	**1.0**	**1.0**	**1.0**	**1.0**
Received Eb/No (dB)	10.6	6.9	10.6	4.9
Required Eb/No (dB)	4.2	4.2	4.2	4.2
System margin (dB)	**6.4**	**2.7**	**6.4**	**0.7**

Table B4: GSO Ka-band Beacon Downlink

Beacon Downlink Budgets- GSO				
Average elevation angle (deg)	15.0			
Downlink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	19.296	19.296	19.296	19.296
Satellite transmit EIRP (dBW)	**33.5**	**33.5**	**33.5**	**33.5**
* Antenna gain (dBi)	18.5	18.5	18.5	18.5
*** EOC (dB)**	**3.0**	**3.0**	**3.0**	**3.0**
* Transmit power (W)	50.0	50.0	50.0	50.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**0.2**	**0.2**	**0.2**	**0.2**
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	0.334	0.334	0.334	0.334
Space loss (dB)	210.2	210.2	210.2	210.2
Atmospheric & Scintillation Losses (dB)	1.8	-	1.8	-
ITU Combined Loss (dB)		8.4		5.3
Link availability (%)	-	99.70	-	99.00
Aggregate pointing loss (dB)	0.12	0.12	0.12	0.12
Polarization loss/degradation (dB)	0.1	0.1	0.1	0.1
Total Channel losses (dB)	**212.3**	**218.7**	**212.3**	**215.6**
Earth terminal Receive G/T (dBi)	**20.8**	**19.2**	**16.1**	**14.9**
* Earth station receive antenna gain (dBi)	45.8	45.8	41.1	41.1
* Receive system noise temp (k)	320.7	456.9	320.9	416.5
Potential interference degradation (dB)	**0.8**	**0.8**	**0.8**	**0.8**
Received Eb/No (dB)	13.8	5.9	9.1	4.7
Required Eb/No (dB)	4.2	4.2	4.2	4.2
System margin (dB)	**9.6**	**1.7**	**4.9**	**0.5**

Table B5: HEO Ka-Band Uplink

Uplink Budgets- HEO				
Satellite altitude (km)				
* Maximum operational altitude (km)	39500.0			
Average elevation angle (deg)	15.0			
Slant Range - Max (km)	43811.7			
Slant Range - Min (km)	18820.3			
Uplink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	29.7	29.7	29.7	29.7
Earth station transmit EIRP (dBW)	**54.6**	**54.6**	**47.7**	**47.7**
* Antenna gain (dBi)	49.6	49.6	44.9	44.9
* Transmit power (W)	5.0	5.0	3.0	3.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**10.1**	**2.5**	**2.5**	**0.5**
Code rate	0.9	0.4	0.4	0.4
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	7.0	3.5	3.5	0.7
Space loss - max altitude (dB)	214.7	214.7	214.7	214.7
Atmospheric & Scintillation Losses (dB)	2.1	-	2.1	-
ITU Combined Loss (dB)		10.5		10.1
Link availability (%)	-	99.10	-	99.00
Aggregate pointing loss (dB)	1.99	1.99	1.99	1.99
Polarization loss/degradation (dB)	0.2	0.1	0.1	0.1
Total Channel losses (dB)	**219.0**	**227.4**	**218.9**	**226.9**
Satellite Receive G/T (dBi)	**19.4**	**19.5**	**19.5**	**19.5**
* Satellite receive antenna gain (dBi)	46.5	46.5	46.5	46.5
* Receive system noise temp (k)	515.7	504.0	504.0	504.0
* EOC (dB)	3.0	3.0	3.0	3.0
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	10.0	7.8	9.3	8.3
Required Eb/No (dB)	9.3	7.1	7.1	7.1
System margin (dB)	**0.7**	**0.7**	**2.2**	**1.2**

Table B6: HEO Ka-Band Downlink

Downlink Budgets- HEO				
Satellite altitude (km)				
Average elevation angle (deg)	15.0			
Slant Range - Max (km)	43811.7			
Slant Range - Min (km)	19862.5			
Downlink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	19.9	19.9	19.9	19.9
Satellite transmit EIRP (dBW)	**63.0**	**63.0**	**63.0**	**63.0**
* Antenna gain (dBi)	48.0	48.0	48.0	48.0
*** EOC (dB)**	**3.0**	**3.0**	**3.0**	**3.0**
* Transmit power (W)	50.0	50.0	50.0	50.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**374.0**	**224.0**	**224.0**	**149.0**
Code rate	0.75	0.67	0.67	0.45
Modulation	8PSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	250.0	250.0	250.0	250.0
Space loss - max altitude (dB)	211.3	211.3	211.3	211.3
Atmospheric & Scintillation Losses (dB)	2.2	-	2.2	-
ITU Combined Loss (dB)		7.6		5.0
Link availability (%)	-	99.50	-	98.50
Earth terminal pointing capability	10%	10%	10%	10%
Aggregate pointing loss (dB)	0.87	0.87	2.52	2.52
Polarization loss/degradation (dB)	0.2	0.1	0.1	0.1
Total Channel losses (dB)	**214.5**	**219.8**	**216.1**	**218.9**
Earth terminal Receive G/T (dBi)	**20.9**	**19.6**	**16.2**	**15.3**
* Earth station receive antenna gain (dBi)	46.1	46.1	41.4	41.4
* Receive system noise temp (k)	333.9	449.0	334.1	412.2
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	11.0	6.7	7.0	5.3
Required Eb/No (dB)	8.6	5.4	5.4	4.2
System margin (dB)	**2.4**	**1.3**	**1.6**	**1.1**

Table B7: HEO Ka-band Beacon Uplink

Uplink Budgets- HEO				
Satellite altitude (km)				
Average elevation angle (deg)	15.0			
Slant Range - Max (km)	43811.7			
Slant Range - Min (km)	18820.3			
Uplink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	29.7	29.7	29.7	29.7
Earth station transmit EIRP (dBW)	**47.6**	**52.3**	**47.7**	**47.7**
* Antenna gain (dBi)	49.6	49.6	44.9	44.9
* Transmit power (W)	1.0	3.0	3.0	3.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**0.005**	**0.005**	**0.005**	**0.005**
Code rate	0.4	0.4	0.4	0.4
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	0.0080	0.0080	0.0080	0.0080
Space loss - max altitude (dB)	214.7	214.7	214.7	214.7
Atmospheric & Scintillation Losses (dB)	2.1	-	2.1	-
ITU Combined Loss (dB)		11.7		7.3
Link availability (%)	-	99.30	-	98.00
Aggregate pointing loss (dB)	0.12	0.12	0.12	0.12
Polarization loss/degradation (dB)	0.1	0.1	0.1	0.1
Total Channel losses (dB)	**217.0**	**226.5**	**217.0**	**222.1**
Satellite Receive G/T (dBi)	**-8.6**	**-8.5**	**-8.5**	**-8.5**
* Satellite receive antenna gain (dBi)	18.5	18.5	18.5	18.5
* Receive system noise temp (k)	515.7	504.0	504.0	504.0
* EOC (dB)	3.0	3.0	3.0	3.0
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	10.2	5.6	10.4	5.4
Required Eb/No (dB)	4.2	4.2	4.2	4.2
System margin (dB)	**6.0**	**1.4**	**6.2**	**1.2**

Table B8: HEO Ka-Band Beacon Downlink

Downlink Budgets- HEO				
Satellite altitude (km)				
Average elevation angle (deg)	10.0			
Slant Range - Max (km)	44338.5			
Slant Range - Min (km)	20370.9			
Downlink	**1.20 m E/S Antenna- User**		**0.70 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	19.29	19.29	19.29	19.29
Satellite transmit EIRP (dBW)	**33.4**	**33.4**	**33.4**	**33.4**
* Antenna gain (dBi)	18.4	18.4	18.4	18.4
*** EOC (dB)**	**3.0**	**3.0**	**3.0**	**3.0**
* Transmit power (W)	50.0	50.0	50.0	50.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**0.2**	**0.2**	**0.2**	**0.2**
Code rate	0.4	0.4	0.4	0.4
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	0.334	0.334	0.334	0.334
Space loss - max altitude (dB)	211.1	211.1	211.1	211.1
Atmospheric & Scintillation Losses (dB)	2.8	-	2.8	-
ITU Combined Loss (dB)		10.2		6.3
Link availability (%)	-	99.60	-	98.50
Earth terminal pointing capability	10%	10%	10%	10%
Aggregate pointing loss (dB)	0.12	0.12	0.12	0.12
Polarization loss/degradation (dB)	0.1	0.1	0.1	0.1
Total Channel losses (dB)	**214.1**	**221.4**	**214.1**	**217.5**
Earth terminal Receive G/T (dBi)	**20.3**	**19.1**	**15.6**	**14.8**
* Earth station receive antenna gain (dBi)	45.8	45.8	41.1	41.1
* Receive system noise temp (k)	355.0	470.1	355.2	433.3
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	14.3	5.8	9.6	5.3
Required Eb/No (dB)	4.2	4.2	4.2	4.2
System margin (dB)	**10.1**	**1.6**	**5.4**	**1.1**

Table B9: GSO TT&C Link budgets

		TRANSFER ORBITS		ON ORBIT OPERATION	
Elevation Angle (Deg.) =	5	UPLINK	DOWNLINK	UPLINK	DOWNLINK
Satellite Altitude (Km) =	35878	(Command)	(Telemetry)	(Command)	(Telemetry)
Frequency (GHz)		6.475	3.675	29.098 or 28.354	19.298 or 18.304
Transmit RF power (W)		100.00	2.00	80.00	0.50
Circuit Loss (dB)		2.00	3.00	2.00	3.00
Transmit antenna gain (dBi)		55.90	-3.00	59.01	48.00
EIRP		73.90	-2.99	76.04	41.99
Path Loss (dB)		200.97	196.05	214.03	210.46
Pointing error (dB)		0.50	0.50	0.50	0.50
Atmospheric + Scintillation loss (dB)		2.10	1.60	8.62	7.50
Polarization loss (dB)		0.40	0.40	0.40	0.40
Total channel loss (dB)		203.98	198.56	223.54	218.86
Receive antenna gain (dBi)		-2.00	50.98	46.50	55.44
Receive power (dBW)		-132.07	-145.56	-101.00	-104.63
Receive system noise temperature (k)		864.51	225.70	213.96	225.70
Total system noise temperature (k)		1154.5	311.0	504.0	448.2
G/T		-32.62	26.06	19.48	28.93
C/No		65.90	58.11	100.57	97.46
Carrier modulation		FM	PHASE	Phase	PHASE
Data modulation		FSK	BPSK	BPSK	BPSK
Data rate (kbps)		4.00	4.00	500.00	1000.00
Received Eb/No		29.88	22.09	43.58	37.46
Required Eb/No, including implementation loss (dB)		18.00	15.00	18.00	15.00
System Margin , Clear sky (dB)		11.88	7.09	25.58	22.46
RAIN		(Command)	(Telemetry)	(Command)	(Telemetry)
Link availability (%)		99.98	99.98	99.40	99.40
ITU Combined Loss (dB)		8.69	4.10	28.55	24.50
System noise temp./ Rain (k)		-	391.93	-	494.75
Receives Eb/No, Rain (dB)		23.29	18.58	23.65	20.03
System Margin in rain (dB)		5.29	3.58	5.65	5.03
Earth Terminal Antenna Parameters		(Command)	(Telemetry)	(Command)	(Telemetry)
Wavelength (cm)		4.615	8.131	1.027	1.548
Antenna gain (dBi)		55.90	50.98	59.01	55.44
3 dB beamwidth (deg)		0.29	0.52	0.21	0.31
Antenna efficiency (%)		70%	70%	70%	70%
Antenna size		11.0	11.00	3.5	3.50

Table B10: HEO TT&C Linkbudgets

		TRANSFER ORBITS		ON ORBIT OPERATION	
Elevation Angle (Deg.) =	5	UPLINK	DOWNLINK	UPLINK	DOWNLINK
Satellite Altitude (Km) =	39500	(Command)	(Telemetry)	(Command)	(Telemetry)
Frequency (GHz)		6.475	3.675	29.098	19.298
Transmit RF power (W)		100.00	2.00	80.00	0.50
Circuit Loss (dB)		2.00	3.00	2.00	3.00
Transmit antenna gain (dBi)		55.90	-3.00	59.01	48.00
EIRP		73.90	-2.99	76.04	41.99
Path Loss (dB)		201.71	196.79	214.77	211.20
Pointing error (dB)		0.50	0.50	0.50	0.50
Atmospheric + Scintillation loss (dB)		2.10	1.60	8.62	7.50
Polarization loss (dB)		0.40	0.40	0.40	0.40
Total channel loss (dB)		204.72	199.29	224.28	219.60
Receive antenna gain (dBi)		-2.00	50.98	46.50	55.44
Receive power (dBW)		-132.81	-146.30	-101.74	-105.37
Receive system noise temperature (k)		864.51	225.70	213.96	225.70
Total system noise temperature (k)		1154.5	311.0	504.0	448.2
G/T		-32.62	26.06	19.48	28.93
C/No		65.16	57.37	99.83	96.72
Carrier modulation		FM	PHASE	Phase	PHASE
Data modulation		FSK	BPSK	BPSK	BPSK
Data rate (kbps)		4.00	4.00	500.00	1000.00
Received Eb/No		29.14	21.35	42.84	36.72
Required Eb/No, including implementation loss (dB)		18.00	15.00	18.00	15.00
System Margin , Clear sky (dB)		11.14	6.35	24.84	21.72
RAIN		(Command)	(Telemetry)	(Command)	(Telemetry)
Link availability (%)		99.98	99.98	99.40	99.40
ITU Combined Loss (dB)		8.69	4.10	28.55	24.50
System noise temp./ Rain (k)		-	391.93	-	494.75
Receives Eb/No, Rain (dB)		22.55	17.84	22.91	19.30
System Margin in rain (dB)		4.55	2.84	4.91	4.30
Earth Terminal Antenna Parameters		(Command)	(Telemetry)	(Command)	(Telemetry)
Wavelength (cm)		4.615	8.131	1.027	1.548
Antenna gain (dBi)		55.90	50.98	59.01	55.44
3 dB beamwidth (deg)		0.29	0.52	0.21	0.31
Antenna efficiency (%)		70%	70%	70%	70%
Antenna size		11.0	11.00	3.5	3.50

Table B11: GSO V-Band Downlink

Downlink Budgets- GEO			
Elevation angle (deg)	15.0		
Downlink	**2.7 m E/S Antenna - Hub**	**1.50 m E/S Antenna- User**	
	37.5-40 GHz Band	**40 - 42 GHz Band**	
		Clear sky	**Rain**
Frequency (GHz)	38.8	41.0	41.0
Satellite transmit EIRP (dBW)	**64.0**	**67.0**	**67.0**
* Antenna gain (dBi)	53.0	53.0	53.0
*** EOC (dB)**	**3.0**	**3.0**	**3.0**
* Transmit power (W)	20.0	40.0	40.0
* Circuit loss (dB)	2.0	2.0	2.0
Information data rate (Mbps)	**748.0**	**748.0**	**74.0**
Code Rate	0.749	0.749	0.449
Modulation	8PSK	8PSK	QPSK
Symbol rate (Msps)	333	333	83
Required bandwidth (MHz)	500.0	500.0	125.0
Space loss (dB)	216.3	216.8	216.8
Atmospheric & Scintillation Losses (dB)	2.5	2.9	-
ITU Combined Loss (dB)			16.3
Link availability (%)	-	-	99.00
Pointing loss (dB)	0.53	0.53	0.53
Aggregate pointing loss (dB)	0.55	0.55	0.55
Polarization loss/degradation (dB)	0.2	0.2	0.1
Total Channel losses (dB)	**219.6**	**220.4**	**233.7**
Earth terminal Receive G/T (dBi)	**33.5**	**28.8**	**27.4**
* Earth station receive antenna gain (dBi)	58.9	54.3	54.3
* Receive system noise temp (k)	346.6	358.2	489.5
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	14.3	11.7	7.1
Required Eb/No (dB)	8.6	8.6	4.2
System margin (dB)	**5.7**	**3.1**	**2.9**

Table B12: GSO V-band Uplink

Uplink Budgets- GSO				
Elevation angle (deg)	15.0			
Uplink	**2.70 m E/S Antenna- User**		**1.50 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	48.7	48.7	48.7	48.7
Earth station transmit EIRP (dBW)	**75.9**	**75.9**	**68.6**	**68.6**
* Antenna gain (dBi)	60.9	60.9	55.8	55.8
* Transmit power (W)	50.0	50.0	30.0	30.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**706.0**	**63.0**	**252.0**	**25.0**
Code rate	0.9	0.4	0.9	0.4
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	491.8	87.8	175.6	35.1
Space loss (dB)	218.3	218.3	218.3	218.3
Atmospheric & Scintillation Losses (dB)	5.6	-	5.6	-
ITU Combined Loss (dB)		19.2		17.0
Link availability (%)	-	98.50	-	98.00
Aggregate pointing loss (dB)	2.92	2.92	2.92	2.92
Polarization loss/degradation (dB)	0.2	0.1	0.2	0.1
Total Channel losses (dB)	**227.0**	**240.5**	**227.1**	**238.4**
Satellite Receive G/T (dBi)	**27.2**	**27.2**	**27.2**	**27.2**
* Satellite receive antenna gain (dBi)	54.4	54.4	54.4	54.4
* Receive system noise temp (k)	520.0	520.0	520.0	520.0
* EOC (dB)	3.0	3.0	3.0	3.0
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	12.7	9.7	9.8	8.6
Required Eb/No (dB)	9.3	7.1	9.3	7.1
System margin (dB)	**3.4**	**2.6**	**0.5**	**1.5**

Table B13: HEO V-Band Downlink

Downlink Budgets- HEO			
Satellite altitude (km)			
Average elevation angle (deg)	15.0		
Slant Range - Max (km)	43811.7		
Slant Range - Min (km)	19862.5		
Downlink	**2.7 m E/S Antenna - Hub**	**1.50 m E/S Antenna- User**	
	37.5-40 GHz Band	**40 - 42 GHz Band**	
		Clear sky	**Rain**
Frequency (GHz)	38.8	41.0	41.0
Satellite transmit EIRP (dBW)	**64.0**	**67.0**	**67.0**
* Antenna gain (dBi)	53.0	53.0	53.0
*** EOC (dB)**	**3.0**	**3.0**	**3.0**
* Transmit power (W)	20.0	40.0	40.0
* Circuit loss (dB)	2.0	2.0	2.0
Information data rate (Mbps)	**748.0**	**748.0**	**74.0**
Code Rate	0.749	0.749	0.449
Modulation	8PSK	8PSK	QPSK
Symbol rate (Msps)	333	333	83
Required bandwidth (MHz)	500.0	500.0	125.0
Space loss - max altitude (dB)	217.0	217.5	217.5
Atmospheric & Scintillation Losses (dB)	2.5	2.9	-
ITU Combined Loss (dB)			13.5
Link availability (%)	-	-	98.50
Pointing loss (dB)	2.12	2.12	2.12
Aggregate pointing loss (dB)	2.12	2.12	2.12
Polarization loss/degradation (dB)	0.2	0.1	0.1
Total Channel losses (dB)	**221.9**	**222.6**	**233.2**
Earth terminal Receive G/T (dBi)	**33.5**	**28.8**	**27.5**
* Earth station receive antenna gain (dBi)	58.9	54.3	54.3
* Receive system noise temp (k)	346.6	358.2	483.8
**System noise figure (dB)	2.5	2.5	2.5
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	12.0	9.5	7.7
Required Eb/No (dB)	8.6	5.4	4.2
System margin (dB)	**3.4**	**4.1**	**3.5**

Table B14: HEO V-Band Uplink

Uplink Budgets- HEO				
Satellite altitude (km)				
Average elevation angle (deg)	16.0			
Slant Range - Max (km)	43708.5			
Slant Range - Min (km)	18722.0			
Uplink	**2.70 m E/S Antenna- User**		**1.50 m E/S Antenna- User**	
	Clear sky	**Rain**	**Clear sky**	**Rain**
Frequency (GHz)	48.7	48.7	48.7	48.7
Earth station transmit EIRP (dBW)	**75.9**	**75.9**	**68.6**	**68.6**
* Antenna gain (dBi)	60.9	60.9	55.8	55.8
* Transmit power (W)	50.0	50.0	30.0	30.0
* Circuit loss (dB)	2.0	2.0	2.0	2.0
Information data rate (Mbps)	**706.0**	**63.0**	**252.0**	**25.0**
Code rate	0.9	0.4	0.9	0.4
Modulation	QPSK	QPSK	QPSK	QPSK
Required bandwidth (MHz)	491.8	87.8	175.6	35.1
Space loss - max altitude (dB)	219.0	219.0	219.0	219.0
Atmospheric & Scintillation Losses (dB)	5.2	-	5.3	-
ITU Combined Loss (dB)		18.3		13.5
Link availability (%)	-	98.50	-	97.00
Aggregate pointing loss (dB)	2.92	2.92	2.92	2.92
Polarization loss/degradation (dB)	0.2	0.1	0.2	0.1
Total Channel losses (dB)	**227.4**	**240.3**	**227.4**	**235.6**
Satellite Receive G/T (dBi)	**27.2**	**27.2**	**27.2**	**27.2**
* Satellite receive antenna gain (dBi)	54.4	54.4	54.4	54.4
* Receive system noise temp (k)	520.0	520.0	520.0	520.0
* EOC (dB)	3.0	3.0	3.0	3.0
Potential interference degradation (dB)	**0.5**	**0.5**	**0.5**	**0.5**
Received Eb/No (dB)	12.4	9.9	9.5	11.4
Required Eb/No (dB)	9.3	7.1	9.3	7.1
System margin (dB)	**3.1**	**2.8**	**0.2**	**4.3**

ATTACHMENT C

Satellite Transmit and Receive Antenna Contours

Figure C1: GSO Ka-band Transmit Antenna Contours (Copol & Xpol)

Figure C2: GSO Ka-band Receive Antenna Contours (Copol & Xpol)

Figure C3: GSO V-band Transmit Antenna Contours (CoPol & XPol)

Figure C4: GSO V-Band Receive Antenna Contours (CoPol & Xpol)

Figure C5: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 119W) (CoPol & Xpol)
Figure C6: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 89W) (CoPol & Xpol)

Figure C7: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 15E) (CoPol & Xpol)

Figure C8: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 116.5 E) (CoPol & Xpol)

Figure C9: HEO (@129.6W, 63.4 N & 39254 km) Ka-band Transmit Antenna Beam (CoPol & Xpol)

Figure C10: HEO (@129.6W, 63.4 N & 39254 km) Ka-band Receive Antenna Beam (CoPol & Xpol)

Figure C11: HEO (@129.6W, 63.4 N & 39254 km) V-band Receive Antenna Beam (CoPol & Xpol)

Figure C12: HEO (@129.6W, 63.4 N & 39254 km) V-band Receive Antenna Beam (CoPol & Xpol)

Figure C13: HEO (@129.6W, 63.4 N & 39254 km) Ka-band Transmit and Receive Beacon Beam (CoPol & Xpol)

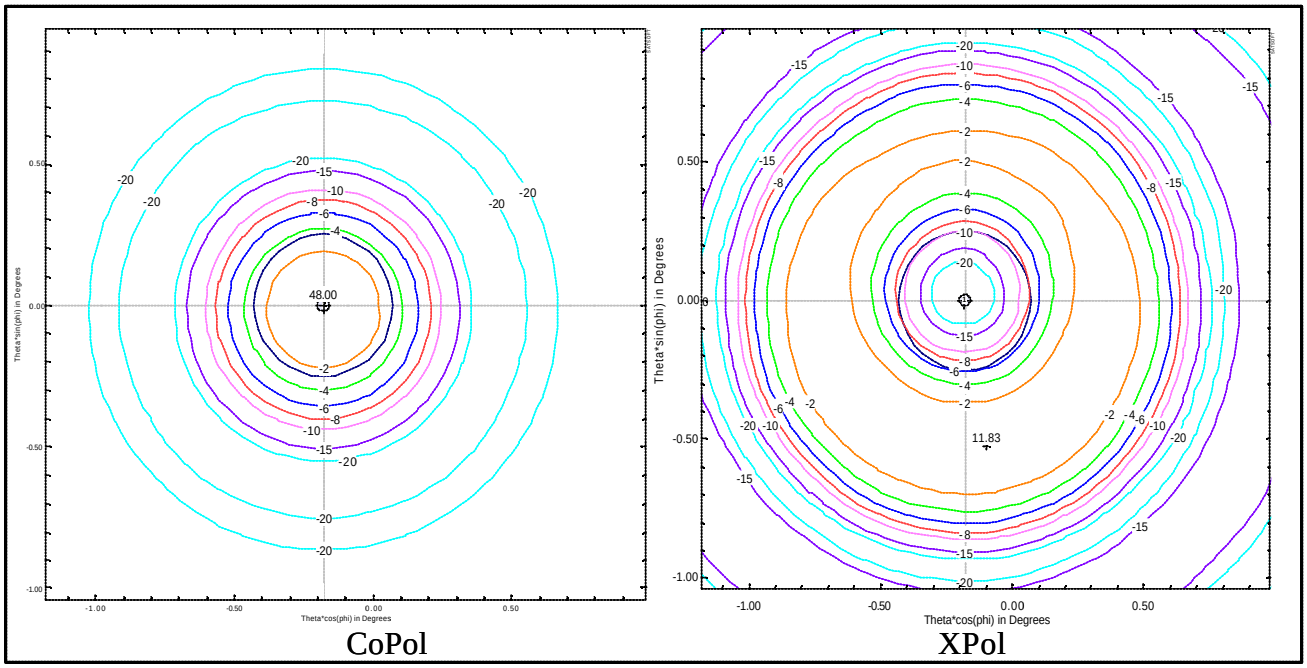

Figure C1: GSO Ka-band Transmit Antenna Contours (Copol & Xpol) (Contour levels: -2, -4, -6, -8, -10, -15, - 20 dB)

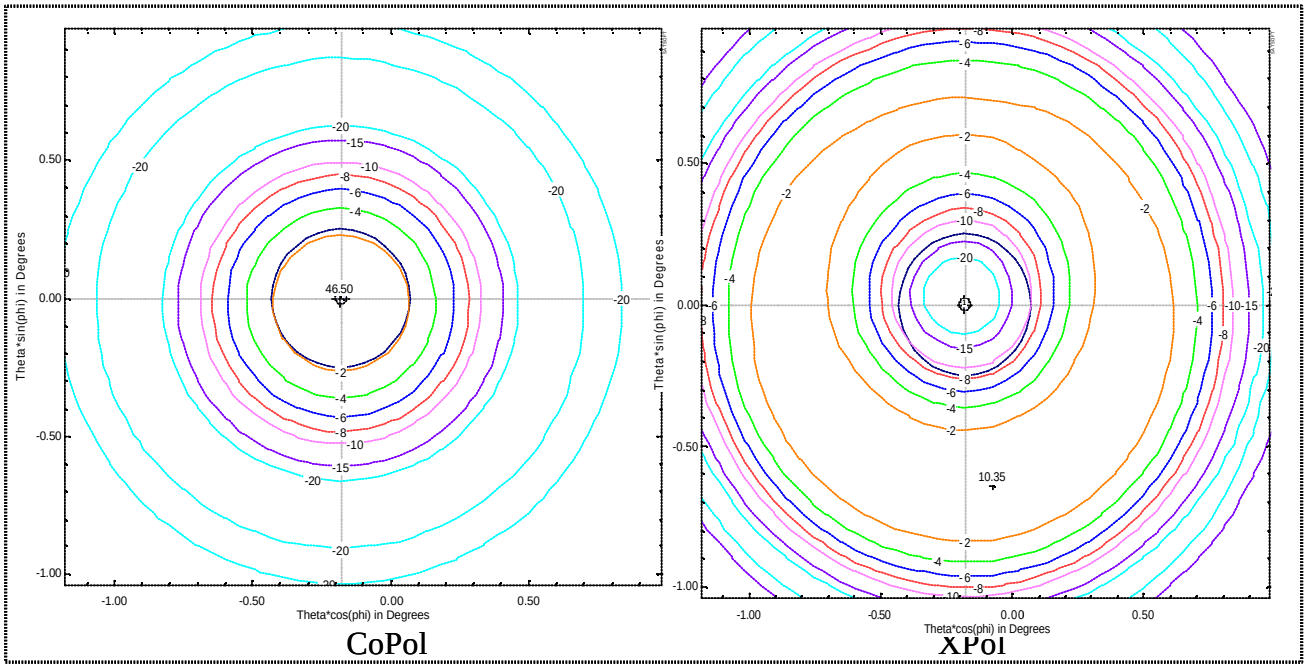

Figure C2: GSO Ka-band Receive Antenna Contours (Copol & Xpol) (Contour levels: -2, -4, -6, -8, -10, -15, - 20 dB)

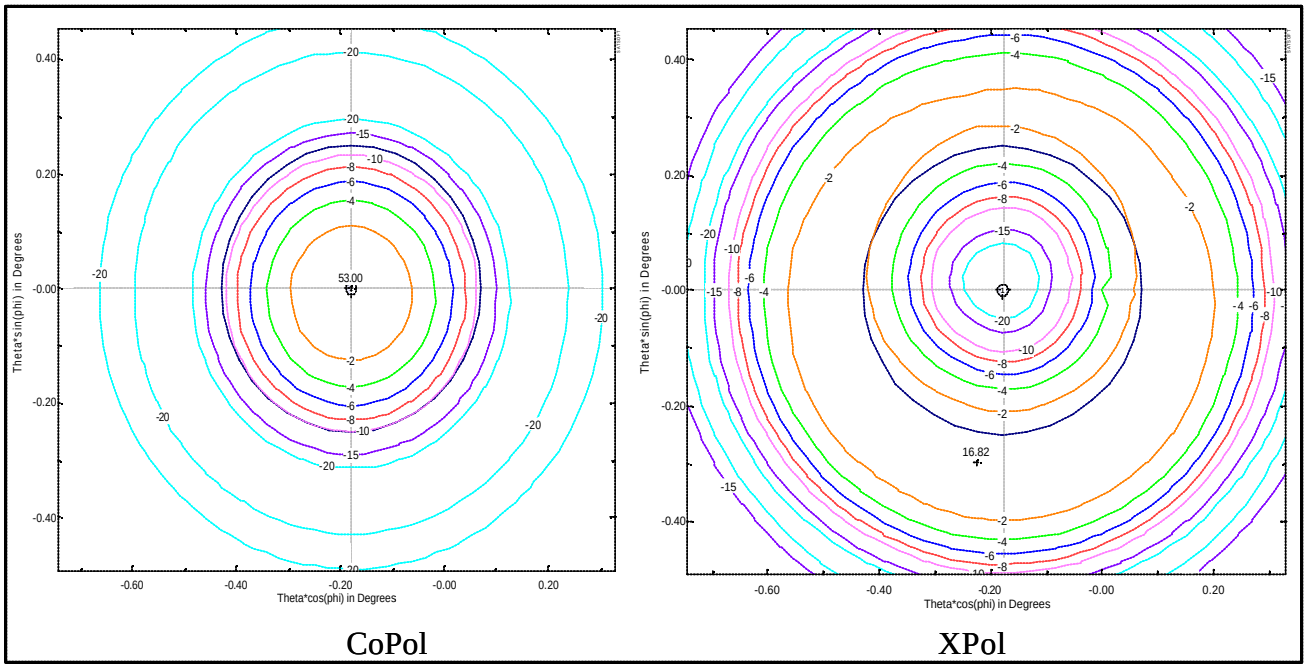

Figure C3: GSO V-band Transmit Antenna Contours (CoPol & XPol) (Contour levels: -2, -4, -6, -8, -10, -15, -20 dB)

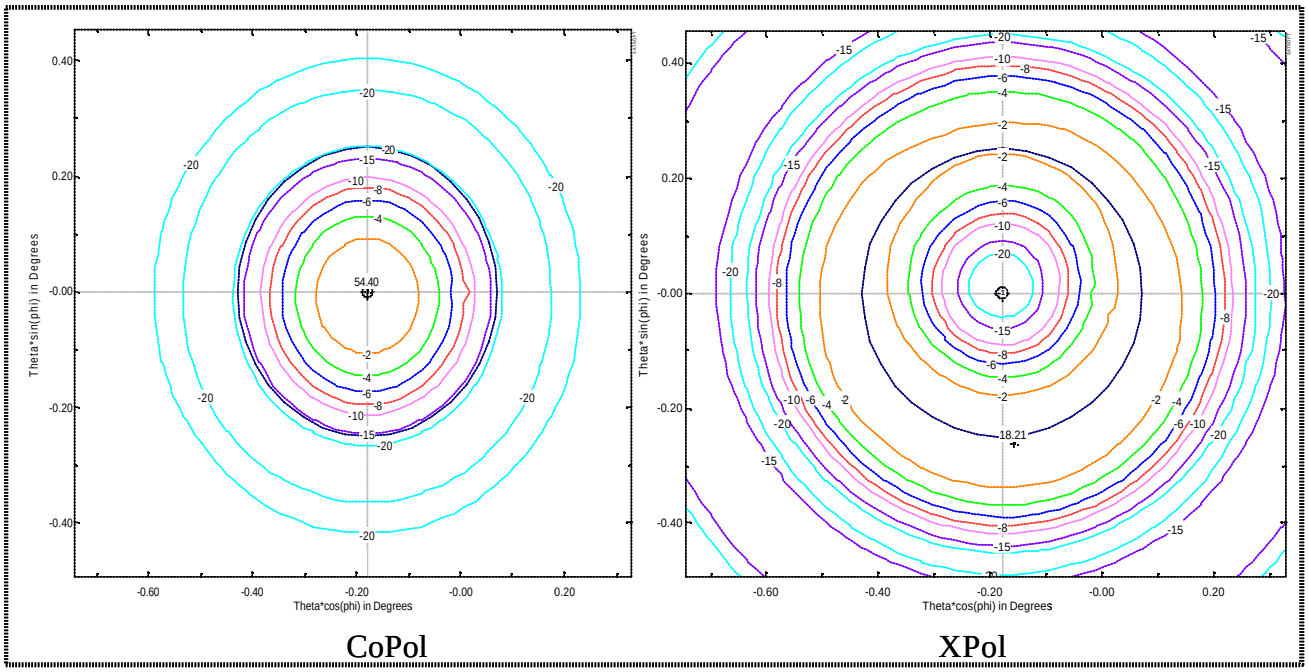

Figure C4: GSO V-Band Receive Antenna Contours (CoPol & Xpol) (Contour levels: -2, -4, -6, -8, -10, -15, -20 dB)

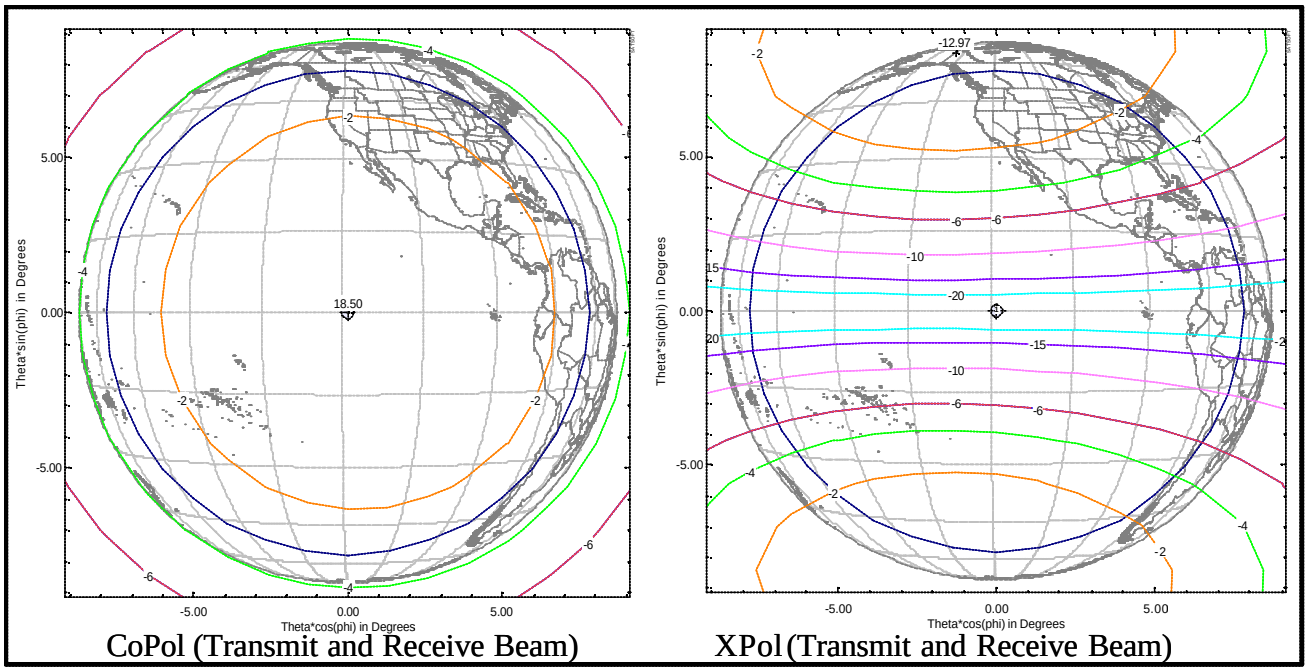

Figure C5: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 119W) (CoPol & Xpol)

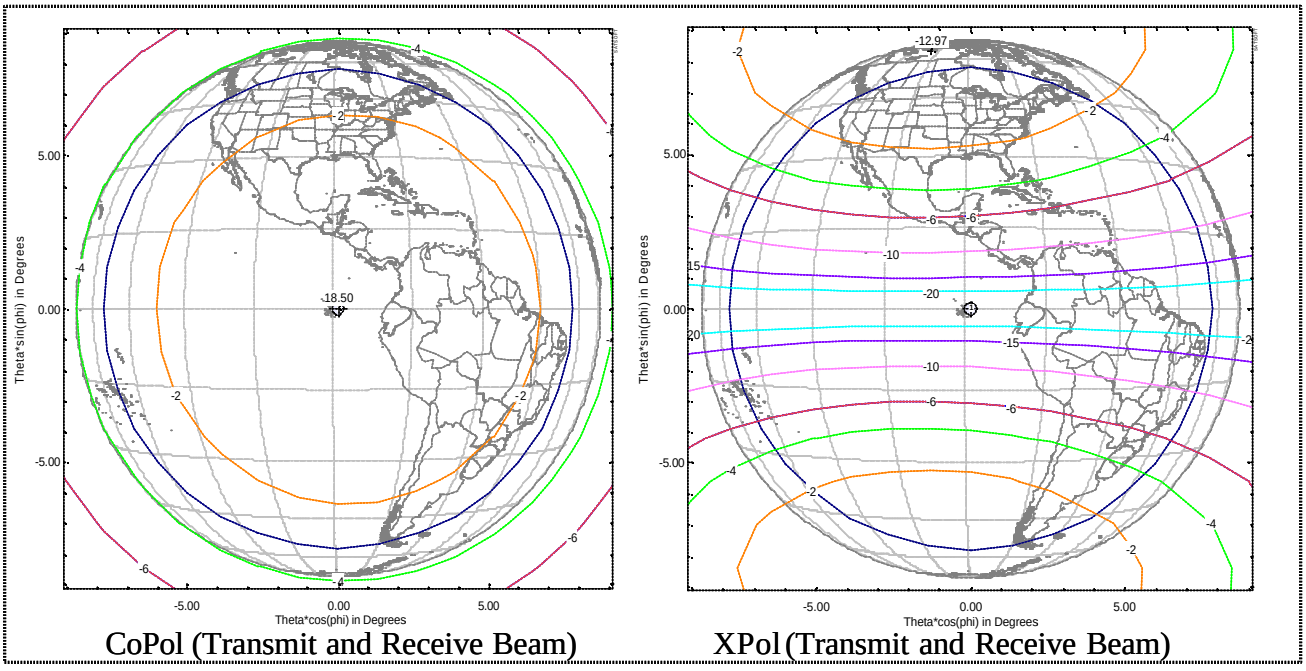

Figure C6: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 89W) (CoPol & Xpol)

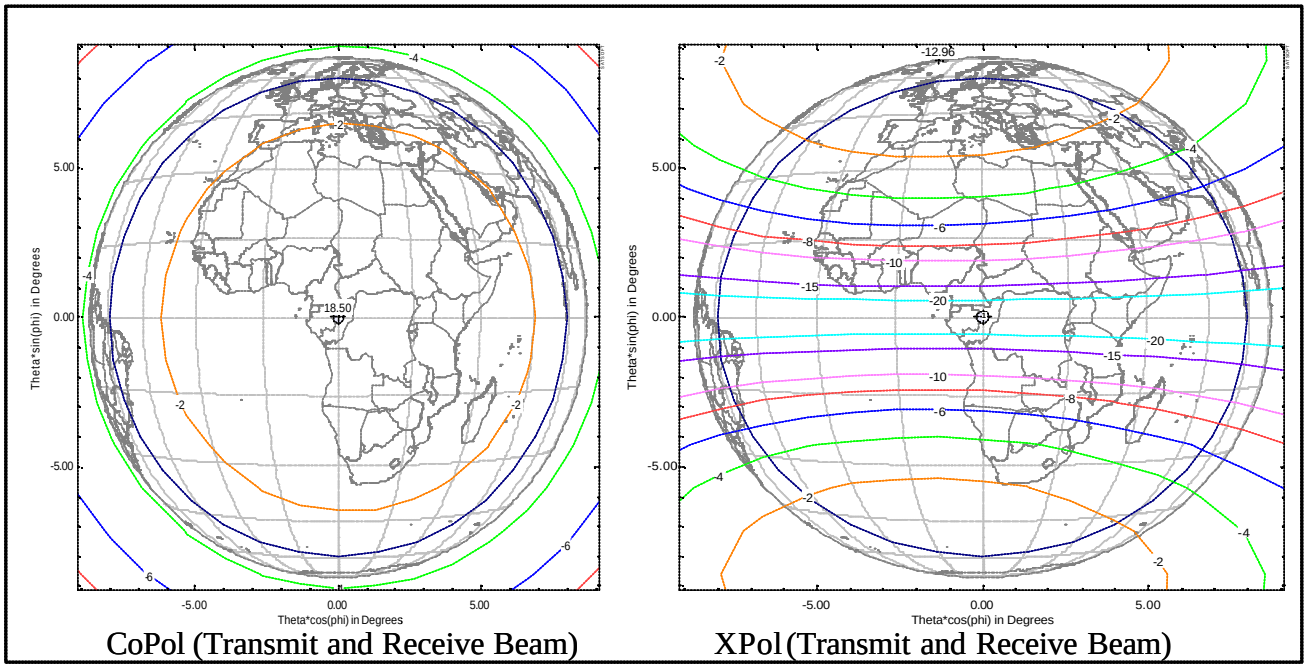

Figure C7: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 15E) (CoPol & Xpol)

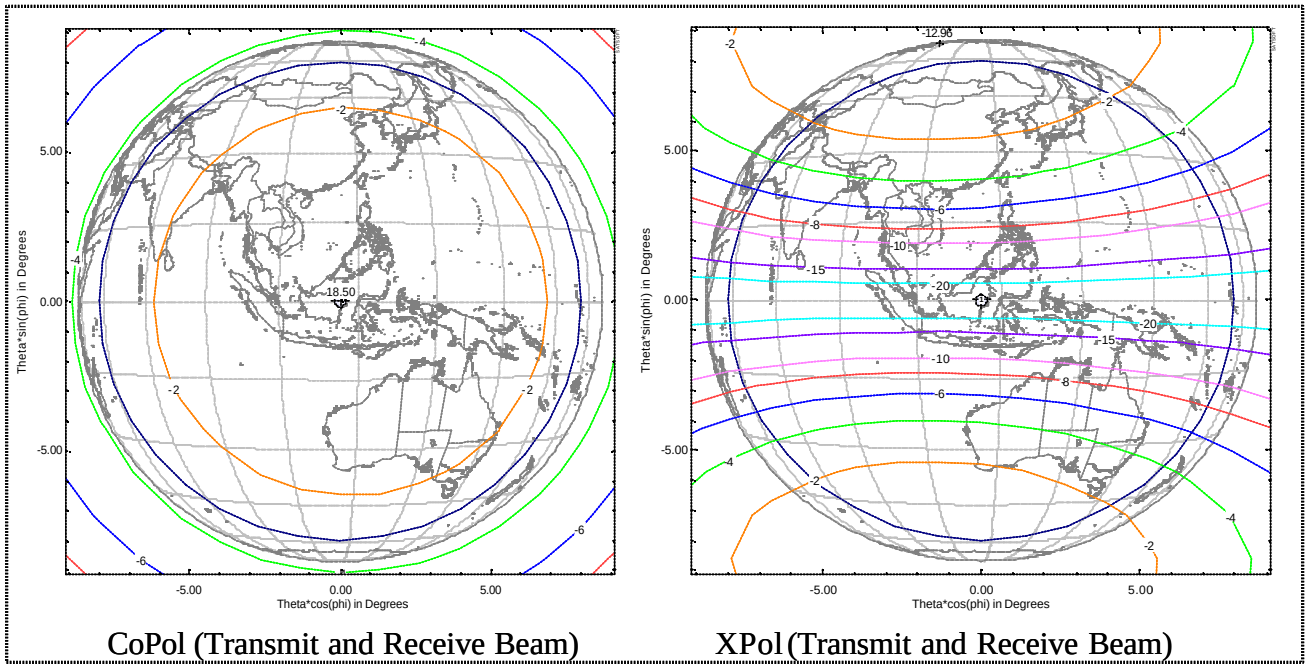

Figure C8: Transmit and Receive Ka-band Beacon Beam (from Satellite @ 116.5 E) (CoPol & Xpol)

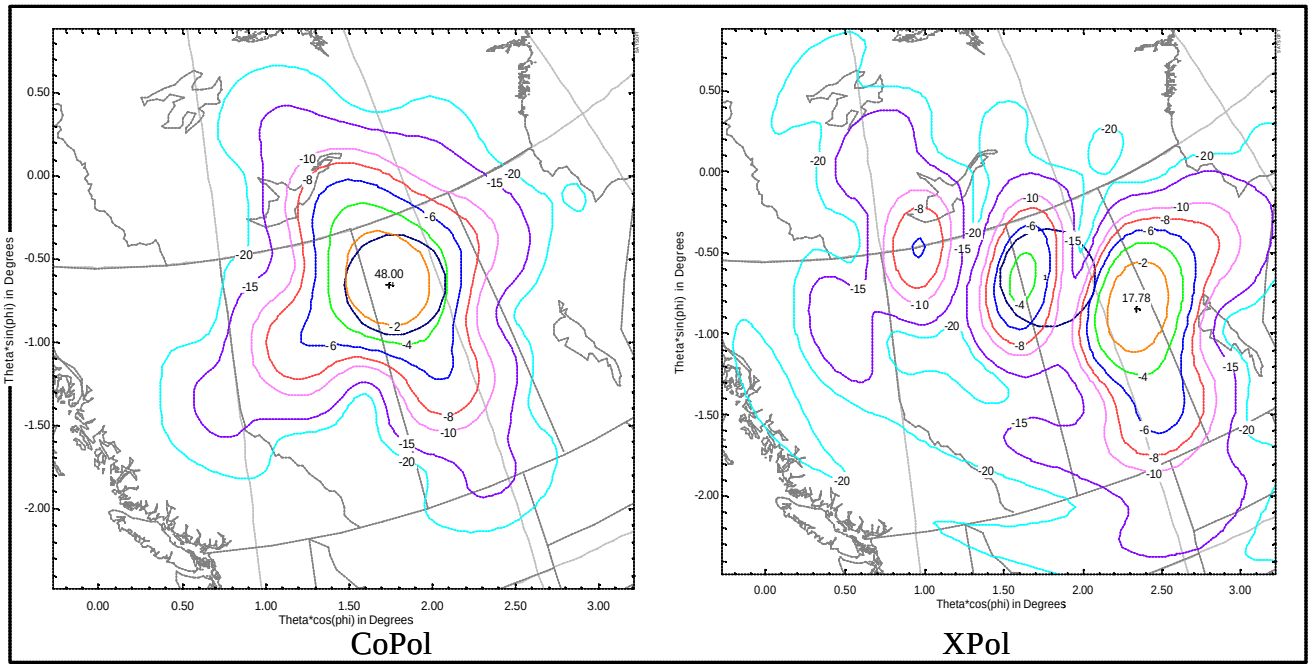

Figure C9: HEO (@129.6W, 63.4 N & 39254 km) Ka-band Transmit Antenna Beam (CoPol & Xpol) (Contour levels: -2, -4, -6, -8, -10, -15, -20 dB)

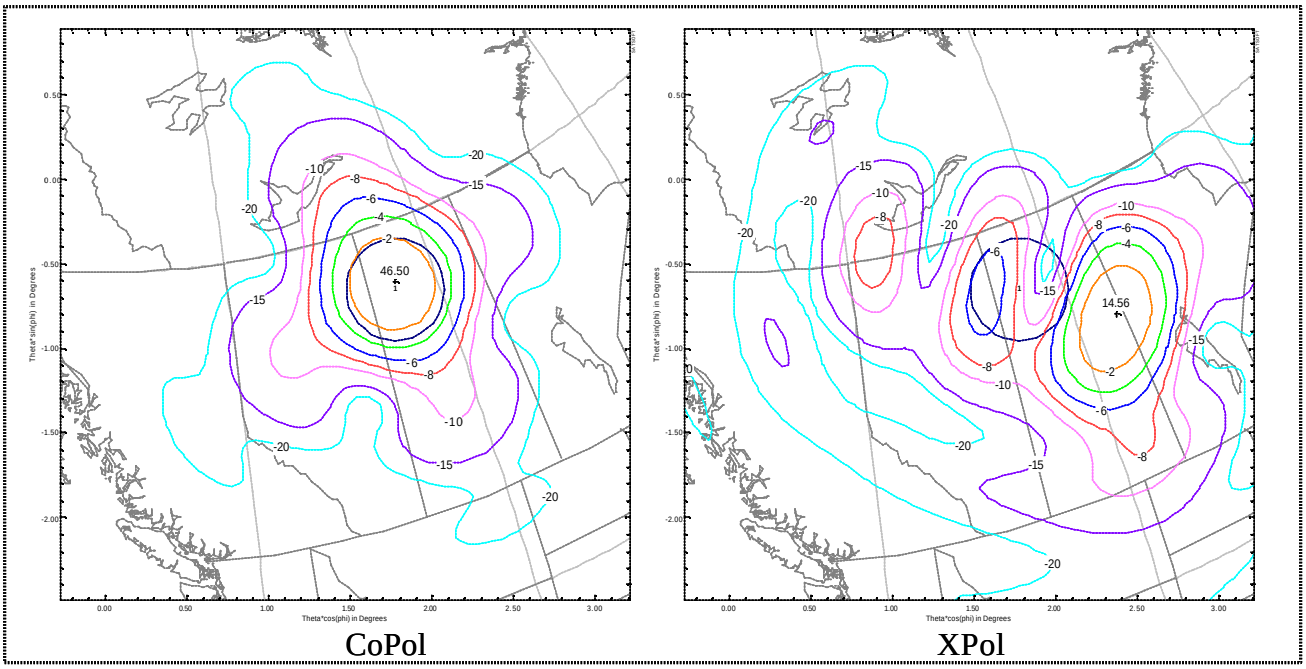

Figure C10: HEO (@129.6W, 63.4 N & 39254 km) Ka-band Receive Antenna Beam (CoPol & Xpol) (Contour levels: -2, -4, -6, -8, -10, -15, -20 dB)

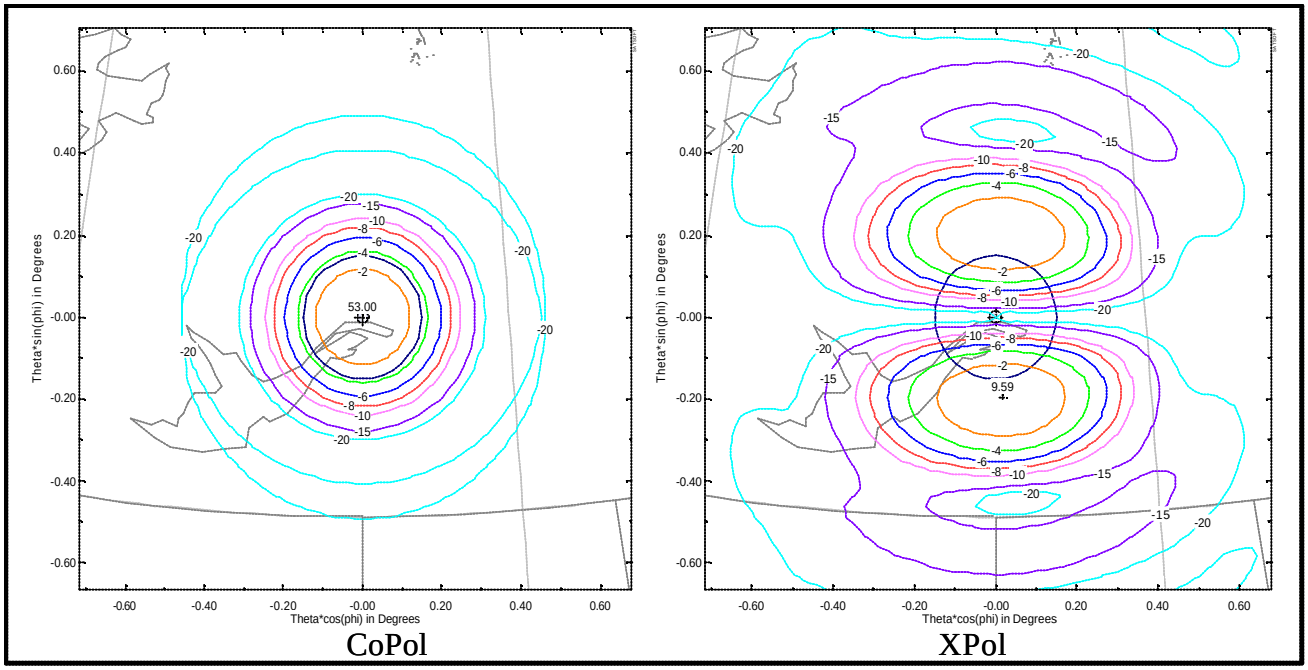

Figure C11: HEO (@129.6W, 63.4 N & 39254 km) V-band Receive Antenna Beam (CoPol & Xpol) (Contour levels: -2, -4, -6, -8, -10, -15, -20 dB)

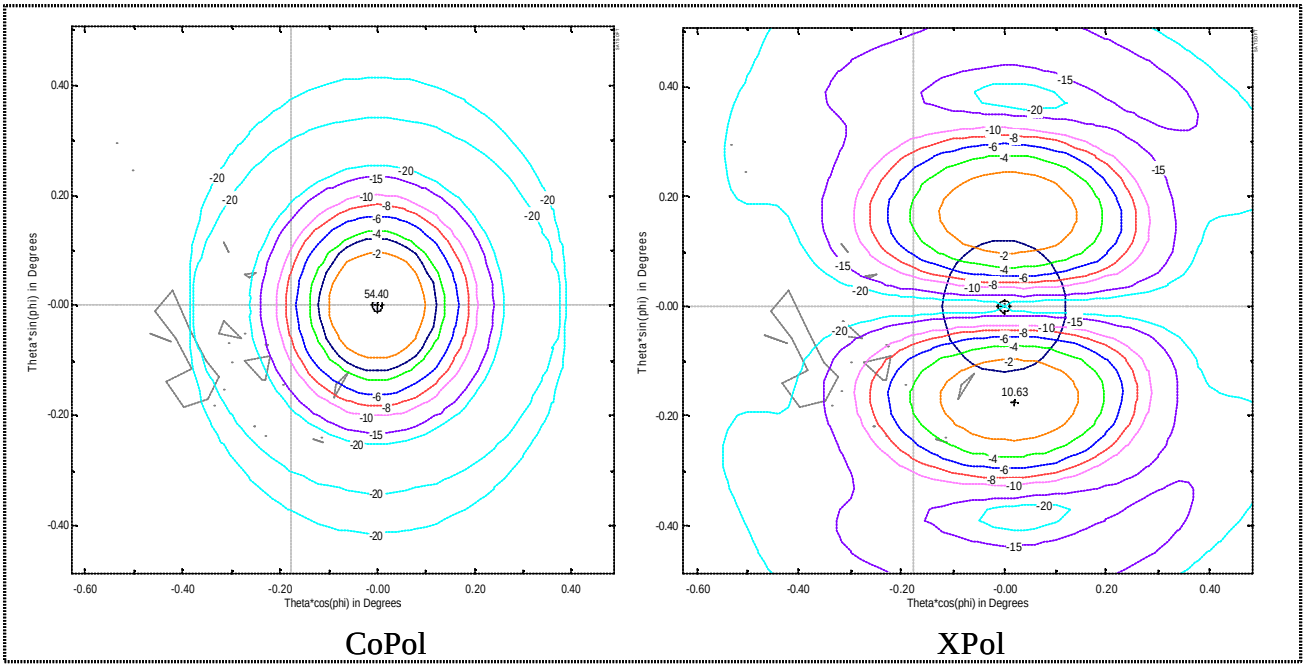

Figure C12: HEO (@129.6W, 63.4 N & 39254 km) V-band Receive Antenna Beam (CoPol & Xpol) (Contour levels: -2, -4, -6, -8, -10, -15, -20 dB)

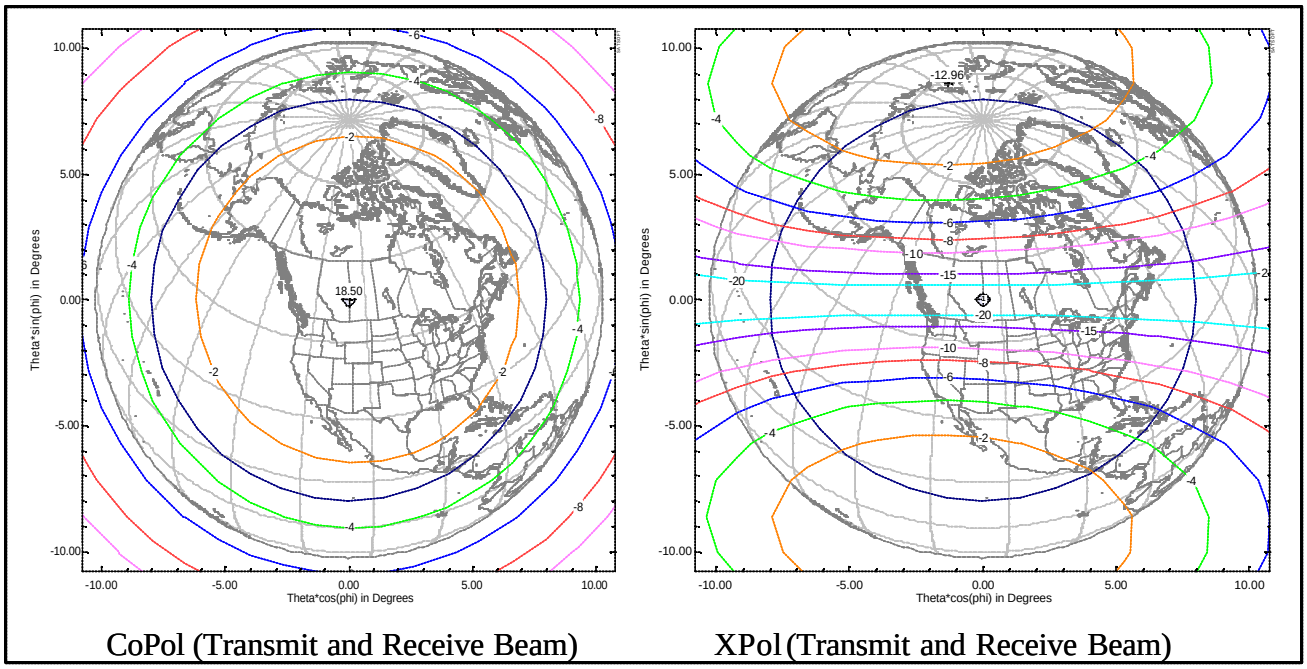

Figure C13: HEO (@129.6W, 63.4 N & 39254 km) Ka-band Transmit and Receive Beacon Beam (CoPol & Xpol)

ATTACHMENT D

GESN High Elliptical Orbit Satellite System In The 19.7-20.2 GHz and 29.5-30 GHz Bands Meets Both Downlink and Uplink epfd Limits In Table 22.

1 Introduction

This attachment presents simulation results related to both the uplink and downlink epfd levels of the GESN HEO satellites operating the 29.5-30 GHz and 19.7-20.2 GHz bands. The computer simulation was developed in accordance with the specification stipulated in a Rec. ITU-R S.1503.

2 System technical characteristics

- **GESN HEO Parameters**: The orbital characteristics of GESN HEO satellite system are given in Table C1. Tables 2 and 3 summarize the satellite and the Earth station transmit parameters, respectively.

TABLE 1

GESN HEO orbital parameters

Number of satellites	3
Number of orbital planes	3
Number of satellite per plane	1
Type of orbit	HEO (Highly-Elliptical Orbits) (Molniya type constellation)
Inclination angle	63.4 degrees
Period of orbit	43064 sec.
Apogee	39352 km
Perigee	1111 km
Minimum operational elevation angle	10 degrees
Minimum operational altitude	16000 km
Right Ascension of Ascending Node	0, 120, 240 degrees
Initial phase Angle (Mean Anomaly)	0, 120, 240 degrees

TABLE 2

Satellite and Earth Station Transmit Parameters

Parameters	**Satellite Transmit Parameters**	**Earth Station Transmit Parameters**
Frequency	19.7-20.2 GHz	29.5-30 GHz
Transmit power into the antenna	15 dBW	5 dBW (1.2 m); -2 dBW (0.7 m)
Antenna peak gain	48 dBi	49.6 dBi (1.2 m); 44.9 dBi (0.7m)
Antenna radiation patterns	Rec. ITU-R S.672-4	Rec. ITU-R S.1428-1
Transmit bandwidth	250 MHz	3.5 MHz (1.2 m); 0.7 m (0.7 m)

- **GSO Parameters**: The earth terminal 70 cm, 90 cm, 2.5 m and 5 m antennas are assumed to meet Rec. ITU-R S. 1428

3 Simulation results

In the simulation, the parameters were used:

GSO satellite location: 100^0 West longitude

- GSO Earth station location: 100^0 West longitude and 40^0 North Latitude
- GSO and GESN HEO earth station are assumed to be co-located

- **Downlink epfd**: The downlink epfd levels into the GSO earth station 70cm, 90 cm, 2.5 m and 5 m are shown in Figure 1
- **Maximum uplink eirp**: In this calculation, five NGSO users operating in the same frequency channel within the GSO 1.55 degrees beam was assumed. The maximum uplink epfd levels are:
  - 0.7 m: -176.2 dB (W/m2/40 kHz)
  - 1.2 m: -185.73 dB (W/m2/40 kHz)

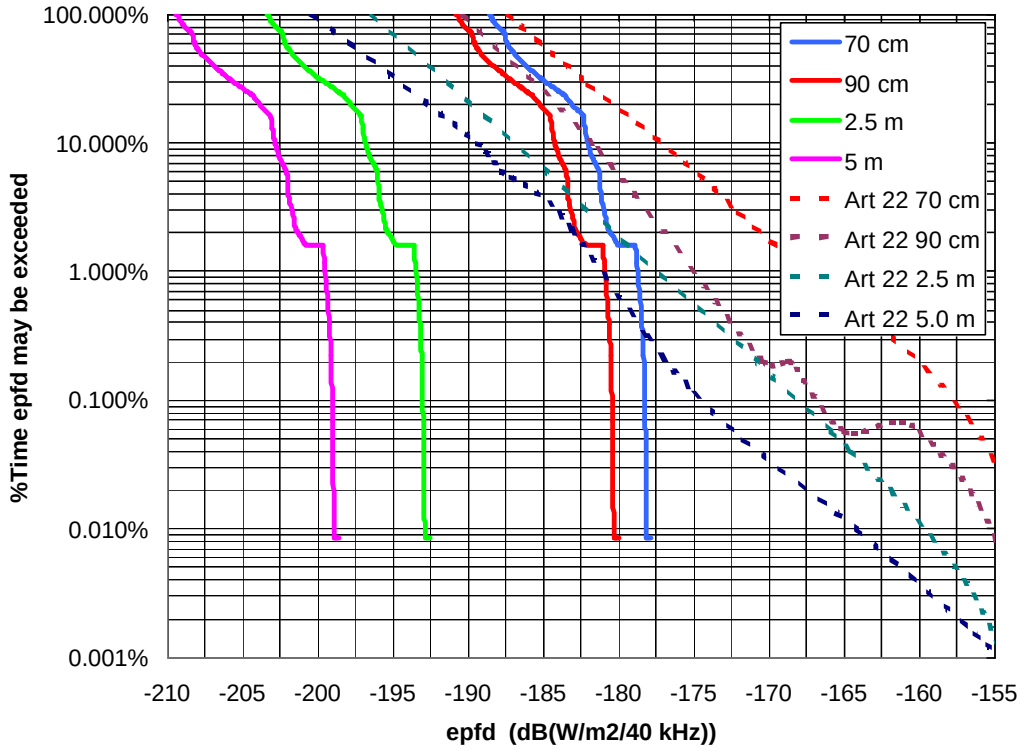

Figure 1: Downlink epfd Levels into GSO Earth Terminal Antennas

4 Conclusion

The simulation results shown in Section 3 indicate that the GESN HEO satellite system operating in the 19.7-20.2 GHz and 29.5-30 GHz bands meets the downlink and uplink epfd limits in Tables 22-1C (Limits to the downlink epfd), 22-4B (operational limits to the downlink epfd) and 22-2 (Limits to the uplink epfd).

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ATTACHMENT E: SUMMARY OF GESN FEATURES/PARAMETERS

- **GESN Non-GSO Component**
    - **Orbit:** Highly-Elliptical (HEO) and Geosynchronous Circular (GC)
    - **Number of satellites:** 3 HEO and 4 GC
    - **Frequency bands:**
        - Ka-band HEO:
            - Uplink: 28.6-29.1 GHz, 29.5-30 GHz
            - Downlink: 18.8-19.3 GHz, 19.7 – 20.2 GHz
        - Ka-band GC:
            - Uplink: 28.6-29.1 GHz
            - Downlink: 18.8-19.3 GHz
        - V-band (HEO and GC)
            - Uplink: 47.2-50.2 GHz
            - Downlink: 37.5-42 GHz (3 GHz spectrum of this band)
        - Earth terminal antenna size
            - Ka-band: 1.2 m and 0.7 m
            - V-band: 2.7 m and 1.5 m
        - Data rate
            - Ka-band
                - Uplink: 0.5 Mbps to 10.1 Mbps
                - Downlink: 74 Mbps to 374 Mbps
            - V-band
                - Uplink: 25 Mbps to 700 Mbps
                - Downlink: 75 Mbps to 750 Mbps
    - **Number of beams:** 48 (24 Ka-band + 24 V-band) Transmit and 60 (30 Ka + 30 V-band) Receive beams

- **GESN GSO Component**
    - **Locations:** 119ºW, 89ºW, 15ºE and 116.5ºE
    - **Number of satellites:** 4
    - **Frequency bands:**
        - Ka-band
            - Uplink: 28.35-28.6 GHz (all except 15ºE)
            - Uplink: 29.25-29.5 GHz (all except 15ºE)
            - Uplink: 29.5-30 GHz (119ºW and 116.5ºE only)
            - Downlink: 18.3-18.8 (all except 15ºE)
            - Downlink: 19.7-20.2 GHz (119ºW and 116.5ºE only)
        - V-band
            - Uplink: 47.2-50.2 GHz
            - Downlink: 37.5-42 GHz (all except 15ºE)
                - 15E: only 3 GHz spectrum of this band
        - Earth terminal antenna size
            - Ka-band: 1.2 m and 0.7 m
            - V-band: 2.7 m and 1.5 m
        - Data rate

        - Ka-band
            - Uplink: 0.5 Mbps to 10.1 Mbps
            - Downlink: 74 Mbps to 374 Mbps
        - V-band
            - Uplink: 25 Mbps to 700 Mbps
            - Downlink: 75 Mbps to 750 Mbps
    - **Number of beams:** 48 (24 Ka + 24 V-band) Transmit and 60 (30 Ka + 30 V-band) Receive beams

- **Capacity:** ~24 Gbps per satellite/ ~165 Gbps/ system

- **Bus DC power:** 10.7 kW

TECHNICAL CERTIFICATE

I hereby certify, under penalty of perjury, that I am the technically qualified person responsible for the preparation of the engineering information contained in the technical portions of the foregoing amendment and the related attachments, that I am familiar with Part 25 of the Commission's Rules, and that the technical information is complete and accurate to the best of my knowledge and belief.

Hau H. Ho

Hau H. Ho
Senior Communications Systems Engineer
Northrop Grumman Space &
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Dated: March 11, 2004