ONEWEB NON-GEOSTATIONARY SATELLITE SYSTEM
V-BAND COMPONENT
PHASE 1: MODIFICATION TO AUTHORIZED SYSTEM

TECHNICAL ATTACHMENT A
Technical Information to Supplement Schedule S

A.1 SCOPE AND PURPOSE

In March 2017, OneWeb filed a petition for declaratory ruling seeking a Federal Communications Commission ("Commission" or "FCC") grant of market access to provide service in the United States with the OneWeb V-band non-geostationary satellite orbit ("NGSO") system ("OW-V").[1] The OW-V system consisted of two sub-constellations—a 720 satellite Low Earth Orbit ("LEO") component and a 1,280-satellite Medium Earth Orbit ("MEO") component operating across the same range of V-band frequencies.[2] In August 2020, the Commission granted OneWeb's petition.[3]

OneWeb now seeks to modify its V-Band Market Access Grant by: (a) removing the MEO component in its entirety, and (b) making a small reduction in the total number of authorized LEO satellites, while making related adjustments to the orbital architecture and satellite payload

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[1] *See WorldVu Satellites Limited, Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb V-Band System*, IBFS File No. SAT-LOI-20170301-00031 (filed Mar. 1, 2017) ("V-Band Market Access Petition").

[2] The term "V-band" is used throughout this document to refer to the FSS allocations between 37.5 and 51.4 GHz.

[3] *WorldVu Satellites Limited, Debtor-in-Possession, Petition for Declaratory Ruling Granting Access to the U.S. Market for the OneWeb V-Band System*, Order and Declaratory Ruling, 35 FCC Rcd 10150 (2020) ("V-Band Market Access Grant").

designs.[4] These proposed Phase 1 modifications of the OW-V system parallel the orbital configuration of the pending modification of the OneWeb Ku/Ka-band system.[5]

The first aspect of this Phase 1 modification is the deletion of all 1,280 satellites in the MEO component of the OW-V system.

The second aspect of this Phase 1 modification consists of a decrease in the number of LEO satellites to be deployed (from 720 to 716), and associated changes to the orbit plane spacing, orbit inclination, and number of satellites per plane for some of the orbit planes. The orbit altitude of all the satellites in the LEO component of the OW-V system remains the same as authorized in the V-Band Market Access Grant. The proposed Phase 1 modifications to the orbital parameters of the LEO component are as follows:

- Reducing the number of satellites operating in orbits with 87.9° inclination from 720 to 588 and redistributing these 588 satellites in these orbit planes in an optimal manner for uniform global service. Specifically, this involves changing the number of 87.9° inclined orbit planes from 18 to 12 and increasing the number of satellites in each of these planes from 40 to 49. These satellites will be referred to as the "87.9° inclined satellites";

- Changing the orbit inclination for 128 of the satellites originally in the 87.9° inclined orbits to now be 55° inclination. These satellites will be distributed around the globe with eight evenly spaced orbit planes and 16 satellites in each plane. These satellites will be referred to as the "55° inclined satellites"; and

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[4] This Attachment A addresses only the Phase 1 implementation of the OW-V system, which is a modification of OneWeb's V-Band Market Access stemming from the 2017 V-Band Processing Round. OneWeb is simultaneously applying to the Commission for a Phase 2 implementation that will be processed as a newly-filed application in the 2021 V-Band Processing Round. The Phase 2 implementation of the OW-V system is described in a separate technical narrative, Attachment B.

[5] *See Modification Application of WorldVu Satellites Limited*, IBFS File No. SAT-MPL-20200526-00062, Call Sign S2963 (filed May 26, 2020) *as amended by Amendment to Modification Application for U.S. Market Access Grant for the OneWeb Ku- and Ka-Band System*, IBFS File No. SAT-APL-20210112-00007, Call Sign S2963 (filed Jan. 12, 2021).

- Removing the remaining four satellites from the original 87.9° inclined orbit planes.

Although the RF performance parameters of the LEO satellites remain the same as currently authorized, the satellite payloads have been further optimized by the inclusion of more steerable beams per satellite. The number of gateway beams will increase from two to three and the number of user beams will increase from 20 to 32.

There are no other technical changes to the OW-V system being requested as part of these proposed Phase 1 modifications.

This document contains the information required for the Phase 1 modification request by §§ 25.117(d), 25.114(d), and other sections of the FCC's Part 25 rules that cannot be captured by the Schedule S software. A complete Schedule S is also being submitted with this Phase 1 modification which contains all the relevant technical data for the OW-V system to date, including the unchanged data from the existing authorization as well as the modified data related to this request. The accompanying Schedule S therefore contains identical information to that submitted in the V-Band Market Access Petition, except as explained further in this document.

The Schedule S associated with this application also includes data related to the Phase 2 implementation of the OW-V system, which is described in more detail in Attachment B. Certain data in the Schedule S is common to both Phase 1 and Phase 2, while other data is unique to Phase 1 or Phase 2. This is addressed in detail in Section A.10 below.

A.2 OVERALL DESCRIPTION OF SYSTEM FACILITIES, OPERATIONS AND SERVICES, AND EXPLANATION OF HOW UPLINK FREQUENCY BANDS ARE CONNECTED TO DOWNLINK FREQUENCY BANDS (§25.114(d)(1))

The only changes to the orbital configuration in Phase 1 are that the MEO sub-constellation has been deleted and the total number of LEO satellites to be deployed has decreased from 720 to 716. The orbit altitude remains the same. The satellites are now distributed between a total of 20 (rather than 18) orbital planes, including both 87.9° and 55° inclinations. There will be a total of 588 satellites operating in the 87.9° inclined planes (12 planes of 49 satellites per plane) and 128 satellites operating in the 55° inclined planes (8 planes of 16 satellites per plane).

The OW-V system will be generally deployed as stated in the V-Band Market Access Petition, whereby the V-band payloads will be added to next generation OneWeb satellites.

OneWeb's proposed Phase 1 architecture, which relies on a slightly decreased number of satellites in the OW-V system from that already authorized by the Commission (716 instead of 720), will mean no additional gateway earth station antennas will be required at each gateway site compared to the currently authorized system. The current plan is therefore to maintain at least five gateway sites in the United States.

The proposed changes to the orbital parameters of the OW-V system will have negligible impact on the necessary elevation angles from the communicating earth stations.[6] Although the orbit plane spacing of the 87.9° inclined satellites is increased by this proposed Phase 1 modification, this is offset by the increased number of satellites in each of these orbit planes and by the presence of the 55° inclined satellites, as far as the elevation angle of visible satellites is concerned. For the V-band gateway links, there will be no change at all as the minimum elevation angle for the gateway links is a parameter that is set by the planned operations of the OW-V system and is a function of the number and location of the deployed gateway earth stations. For the V-band user links, the result is that there is very little difference in terms of necessary minimum elevation angles for links to OW-V user terminals between the existing authorized OW-V system and the modified OW-V system proposed in Phase 1. This is demonstrated in Figure A.2-1 below which compares the time statistics of the elevation angle of the highest OW-V satellite from various latitudes (25°, 50°, and 75°), which are representative of U.S. locations.[7]

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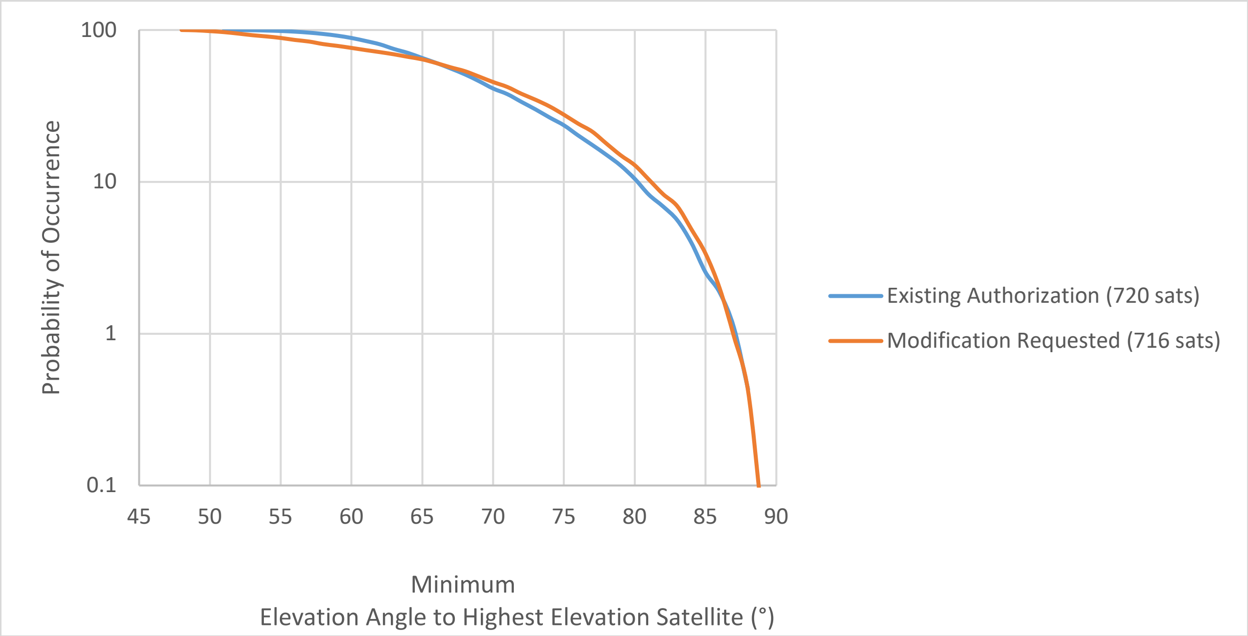
[6] The term "necessary elevation angle" used here refers to the lowest elevation angle of the highest elevation satellite at any point in time as the satellites move through their orbits.

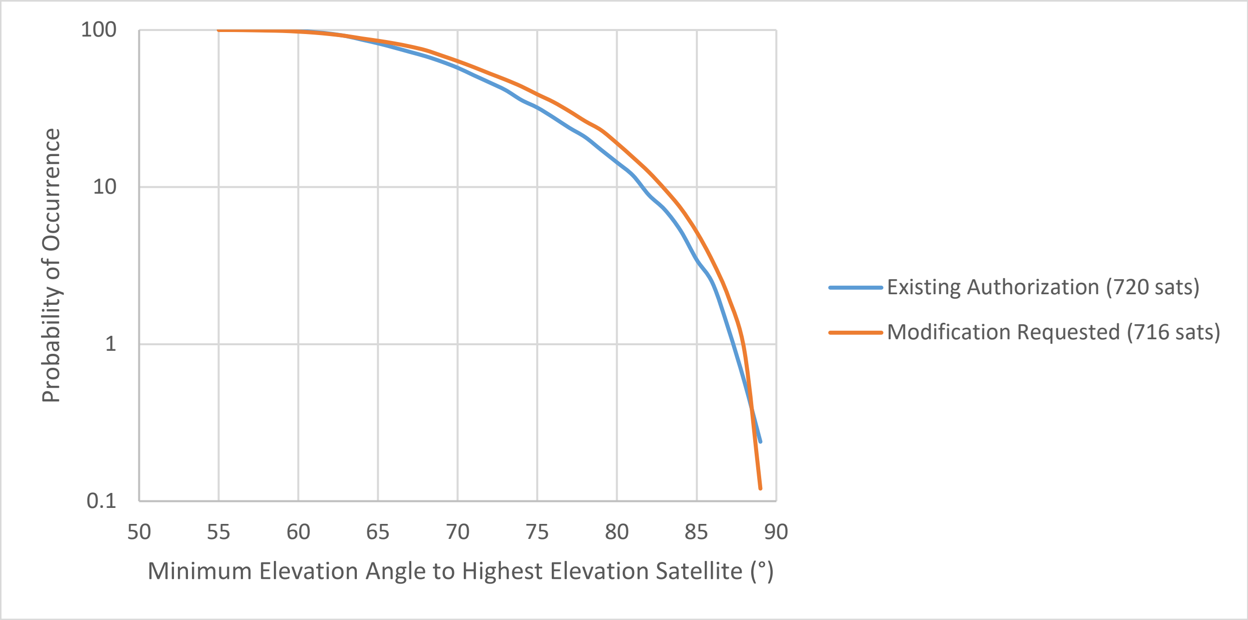
[7] 25° and 50° latitude are representative of the most southern and northern extremes of CONUS, while 75° is representative of the most northern extreme of Alaska.

Figure A.2-1: Comparison of the Statistics of the Highest Elevation Angle to the OW-V LEO NGSO constellation Before and After the Proposed Modification

(a) 25° Latitude Earth Location



(b) 50° Latitude Earth Location



(c) 75° Latitude Earth Location

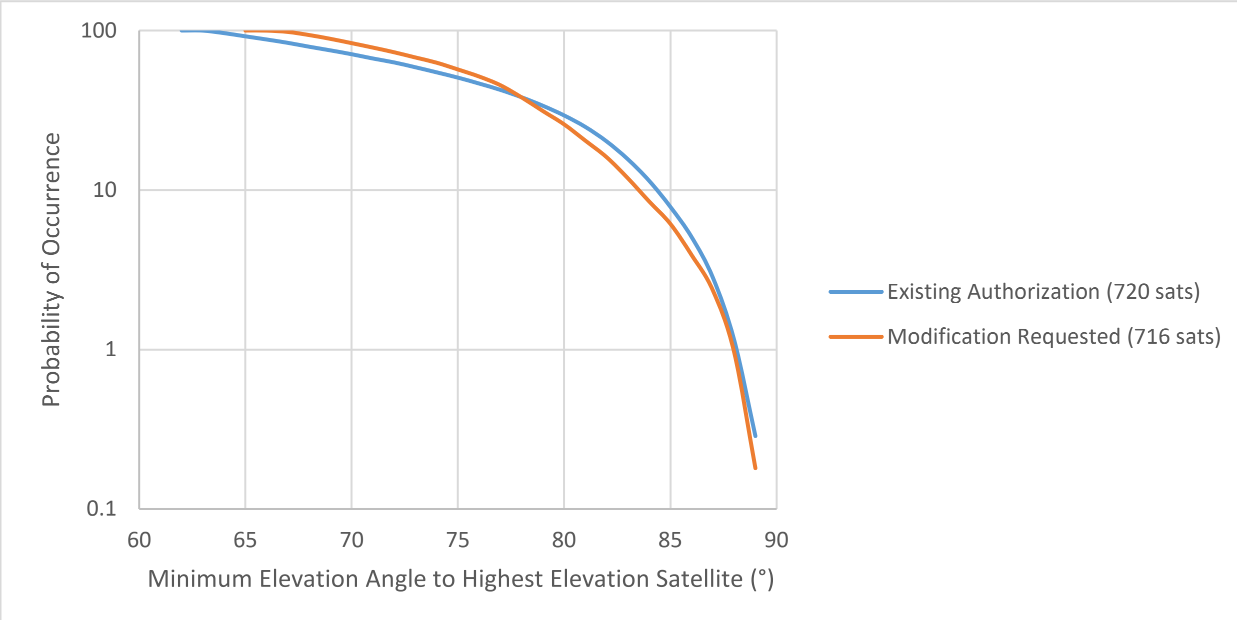


Figure A.2-1 above also demonstrates how the necessary elevation angle for the user terminal links in the OW-V system is somewhat dependent on the latitude of the Earth location. The lower the latitude, the lower the necessary minimum elevation angles, with a value of greater than approximately 50° applying in the worst case to the most southerly extent of CONUS (i.e., ~25° latitude) and values up to 15° higher for more northernly latitudes.

The minimum elevation angles to be used operationally in the OW-V system will remain the same: approximately 15° for gateway links and approximately 45° for user links.

The increase in the number of gateway beams per satellite (from two to three) will provide increased frequency re-use of the existing gateway spectrum. The increase in the number of user beams per satellite will provide greater geographic flexibility in the service provision to the users.

The frequency plan of the OW-V system has generally not changed as a result of this modification request. This is addressed in summary form in Section A.2 of Attachment A to the V-Band Market Access Petition and in detail in the Schedule S being submitted with this modification request.

The main changes in this regard relate to the decisions made by the Commission in the grant of the OW-V system, as explained below:

- OneWeb is no longer requesting use of the 42.0-42.5 GHz downlink band (for Phase 1 or Phase 2) which was deferred by the Commission prior to the V-Band Market Access Grant. Therefore, channels that would fall into this frequency range are no longer included in the Schedule S.

- OneWeb is no longer requesting use of the 42.5-43.5 GHz uplink band (in Phase 1) which was deferred by the Commission prior to the V-Band Market Access Grant. OneWeb is, however, requesting authorization for this band in its Phase 2 system implementation. Refer to Section A.10 for details of the beams in the associated Schedule S which are related to this frequency range.

While not part of its Phase 1 modification request, OneWeb is also applying for E-band frequency ranges in its associated Phase 2 implementation. These bands are reflected in the Schedule S. Refer to Section A.10 for details of the beams in the associated Schedule S which are related to this frequency range.

A.3 PREDICTED SPACE STATION ANTENNA GAIN CONTOURS (§25.114(c)(4)(vi)(B))

This information is available in Attachment A to the V-Band Market Access Petition for all the beams of the OW-V satellites as these have not been altered by this proposed Phase 1 modification. This beam information is included in the associated Schedule S.

A.4 TT&C AND PAYLOAD CONTROL CHARACTERISTICS (§25.202(g))

This information is available in Attachment A to the V-Band Market Access Petition and is not affected by the proposed modification to the OW-V system.

A.5 CESSATION OF EMISSIONS (§25.207)

This information is available in Attachment A to the V-Band Market Access Petition and is not affected by the proposed modification to the OW-V system.

A.6 COMPLIANCE WITH PFD LIMITS (§25.208)

Compliance of the OW-V system with the FCC and ITU PFD limits, which vary across the different portions of the 37.5-42.0 GHz band, is fully addressed in Attachment A to the V-Band Market Access Petition. Compliance is determined on a per-satellite basis, assuming the maximum satellite EIRP density levels and the pointing of the satellite beams according to the minimum elevation angle constraints applicable to the bands and services considered. The proposed changes to the Phase 1 OW-V system do not impact in any way this demonstration of PFD limit compliance.

A.7 INTERFERENCE ANALYSES

Refer to Section A.8 of Attachment A to the V-band Market Access Petition for a discussion and analysis, where appropriate, of the sharing issues with respect to other users of the V-band spectrum. Each of these sharing scenarios, and to what extent they are impacted by this proposed modification of the OW-V system, is addressed in the following sub-sections.

A.7.1 Interference Protection for GSO Satellite Networks (§25.289)

The same GSO avoidance techniques to protect GSO V-band satellite networks from unacceptable interference will be used in the modified OW-V system as originally proposed, and the impact of the changes to the orbit parameters of the LEO satellites in the OW-V system do not impact this protection scheme.

Since the original 2017 application for the OW-V system, Section 25.289 has come into effect, essentially paralleling Nos. 22.2 and 22.5I of the ITU Radio Regulations. In addition, the ITU has made progress towards quantifying the protection levels for GSO satellite networks from NGSO systems. WRC-19 added two new provisions to Article 22 of the Radio Regulations, namely Nos 22.5L and 22.5M, which quantify the GSO protection levels. Although the full software and methodology to implement these provisions are not yet available, OneWeb hereby commits to meeting these GSO protection levels so there will be no unacceptable interference to co-frequency GSO satellite networks from the transmissions in the OW-V system pursuant to Section 25.289 of the Commission's rules.

A.7.2 Interference with Respect to Other NGSO Satellite Systems

The proposed Phase 1 modification to the OW-V system proposed here will not cause significant interference issues for any other non-GSO satellite system, for the following reasons:

- The total number of LEO OW-V satellites has decreased from 720 in the existing authorization to 716 in this proposed Phase 1 modification. The Commission has concluded that a reduction in the total number of satellites is a "fundamental element" in its analysis of whether a proposed modification would cause increased interference to other NGSO FSS systems;[8]

- The nominal altitude of the proposed OW-V satellites has not been altered from the value of 1,200 km for the existing authorization;

- The maximum transmit EIRP density from the proposed OW-V satellites, and hence the maximum PFD at the Earth's surface, has not been altered from the values of the existing authorization;[9]

- The elevation angle statistics for the Phase 1 modified OW-V system, as shown in Section A.2 above, have not changed significantly from those for the already authorized OW-V system;

- The visibility statistics for the Phase 1 modified OW-V system are similar to those of the existing authorization insofar as it affects potential interference to other non-GSO systems. Figure A.7-1 below plots the percentage of time that varying numbers of OW-V satellites can be simultaneously seen by a particular Earth latitude, above the elevation angle corresponding to that latitude at which there is always a visible satellite. The main points arising from this are:

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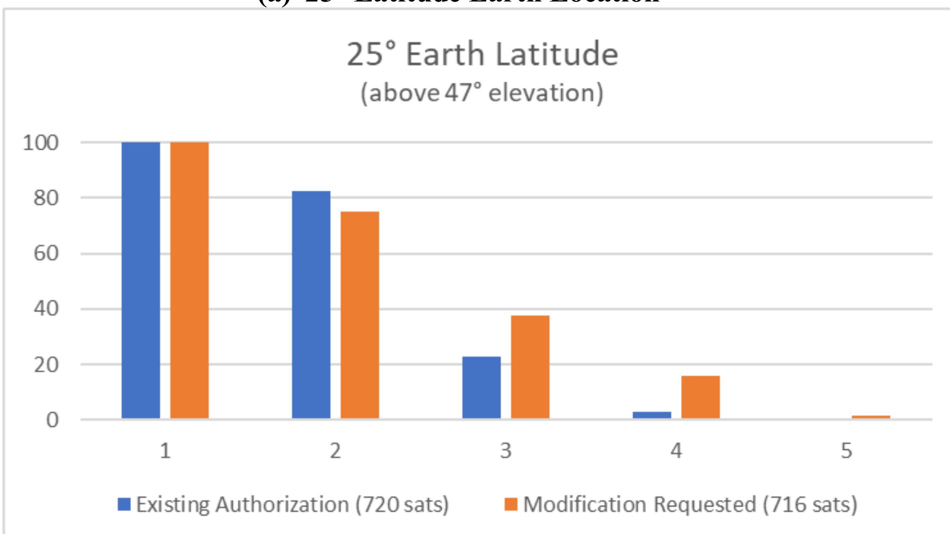
[8] *See Space Exploration Holdings, LLC; Request for Modification of the Authorization for the SpaceX NGSO Satellite System*, 34 FCC Rcd 2526, ¶ 11 (IB 2019).

[9] Neither has the maximum transmit EIRP density of the corresponding earth stations been altered, although this parameter is addressed by the Commission only for the earth station licensing applications.

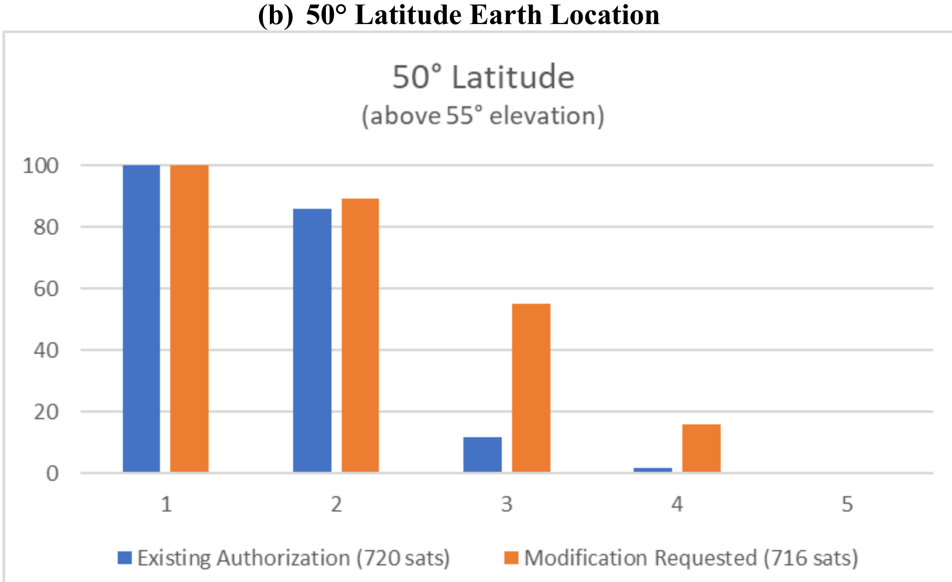
- No more than one satellite is visible for 100% of the time, for all the Earth latitudes shown, both before and after the modification; and
- The percentage of time that two satellites are visible is not significantly altered by the modification.

Figure A.7-1: Visibility statistics for the OW-V LEO satellites above certain elevation angle for various Earth latitudes

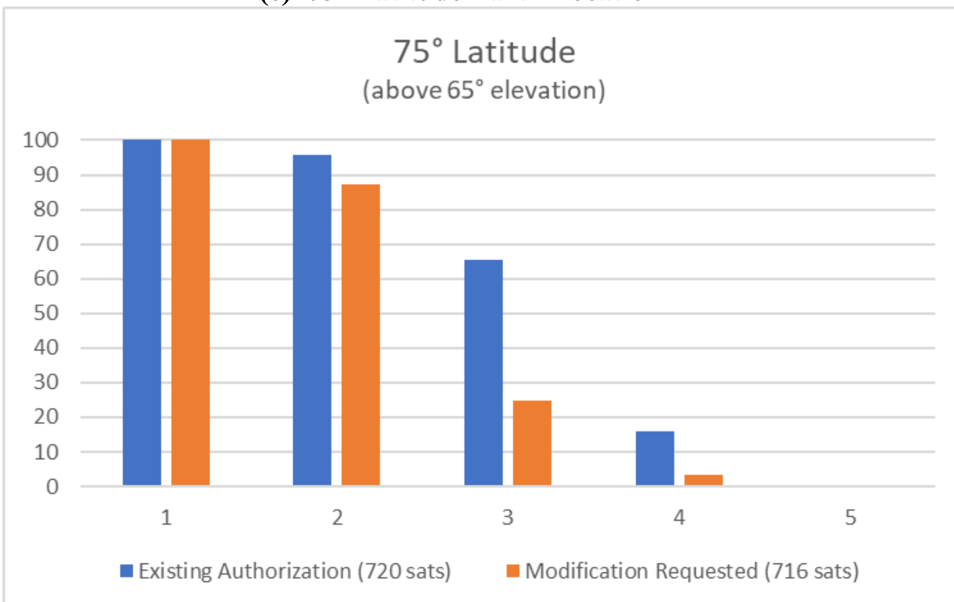
(a) 25° Latitude Earth Location



(b) 50° Latitude Earth Location



(c) 75° Latitude Earth Location



In addition, analyses of the I/N (Interference-to-Noise ratio) statistics for some representative victim NGSO systems from the first processing round have been performed. The other NGSO systems considered below represent a broad set of NGSO system configurations, including both LEO and MEO systems, and with wide-ranging numbers of satellites from 12 to more than 7,500 satellites per system. The results further confirm that there is no significant increase in interference to other NGSO FSS systems resulting from this Phase 1 modification.

The methodology used here is to first assess whether the interference levels in the resulting CDF of the I/N, after the modification, are significantly different from those prior to the modification. These results should be viewed in the context of the FCC criterion relevant to a proposed modification of an NGSO system which is that it should not present significant additional interference problems to other NGSO systems in the same processing round.[10]

The initial other NGSO system considered is the relatively small V-band O3b constellation ("O3b") consisting of 12 satellites in a single equatorial orbital plane with an altitude of 8,062 km. Figure A.7-2 below shows the downlink results for this O3b system, for test locations on the Earth at latitudes of 20° and 40°, at which the OW-V and O3b earth stations are assumed to be collocated.[11] Each result compares the I/N statistics for the currently authorized OW-V system (solid lines) with those resulting from the proposed Phase 1 modification requested here (dotted lines). The different sets of curves in each diagram represent different victim receiving earth station sizes, as indicated by the legend on the diagram.[12]

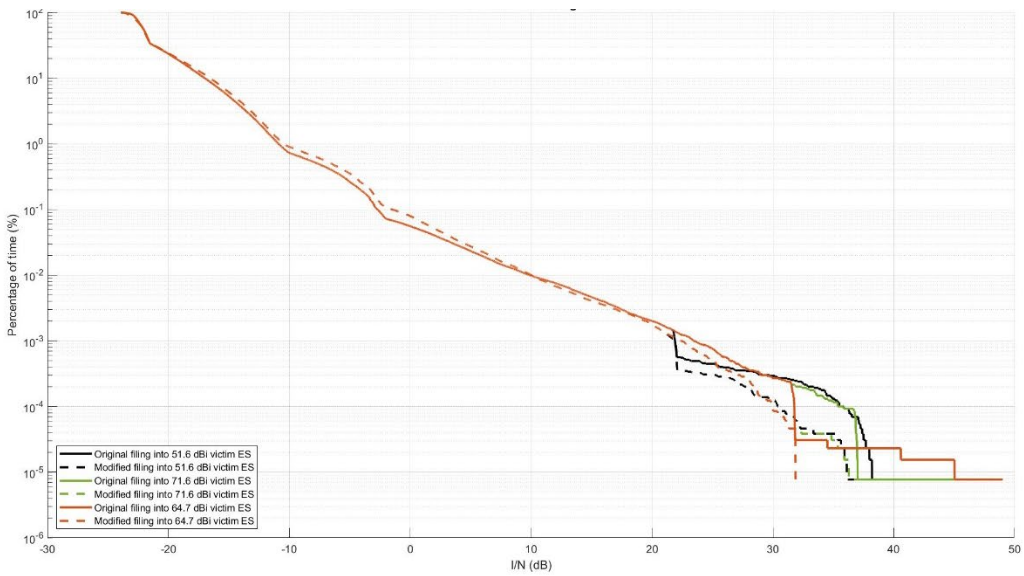
[10] *See In the Matter of Space Exploration Holdings, Inc.*, Order and Authorization and Order on Reconsideration, FCC 21-48, at ¶ 1 (April 27, 2021).

[11] O3b satellites are not visible from 60° latitude, which is the additional test latitude used for some of the other NGSO systems later in this document.

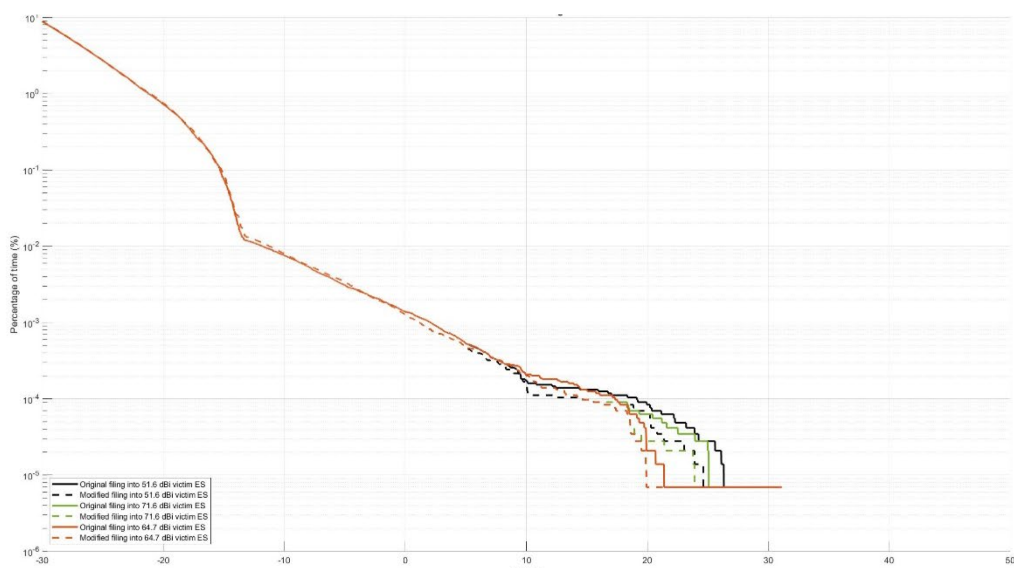
[12] In cases where only one color is shown the results for all earth station sizes are superimposed and are the same due to the interference being attributed to sidelobe effects only. This effect also occurs in some of the subsequent results for the other NGSO systems.

Figure A.7-2: I/N Statistics for downlink interference into the O3b V-band NGSO system for various earth station (ES) latitudes

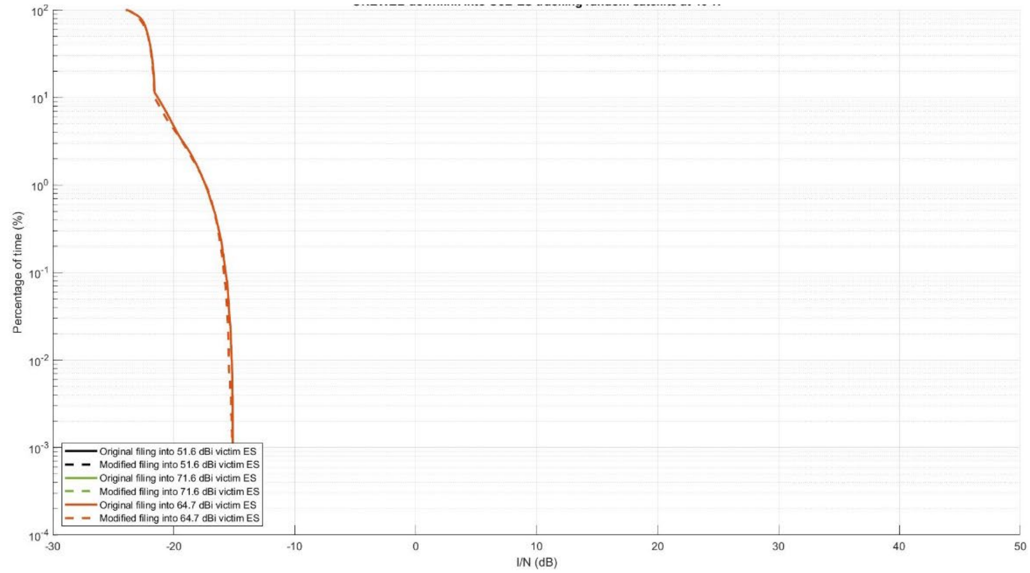
(a) ES at 20° latitude; OW-V User Links



(b) ES at 20° latitude; OW-V Gateway Links



(c) ES at 40° latitude; OW-V User Links[13]



(d) ES at 40° latitude; OW-V Gateway Links

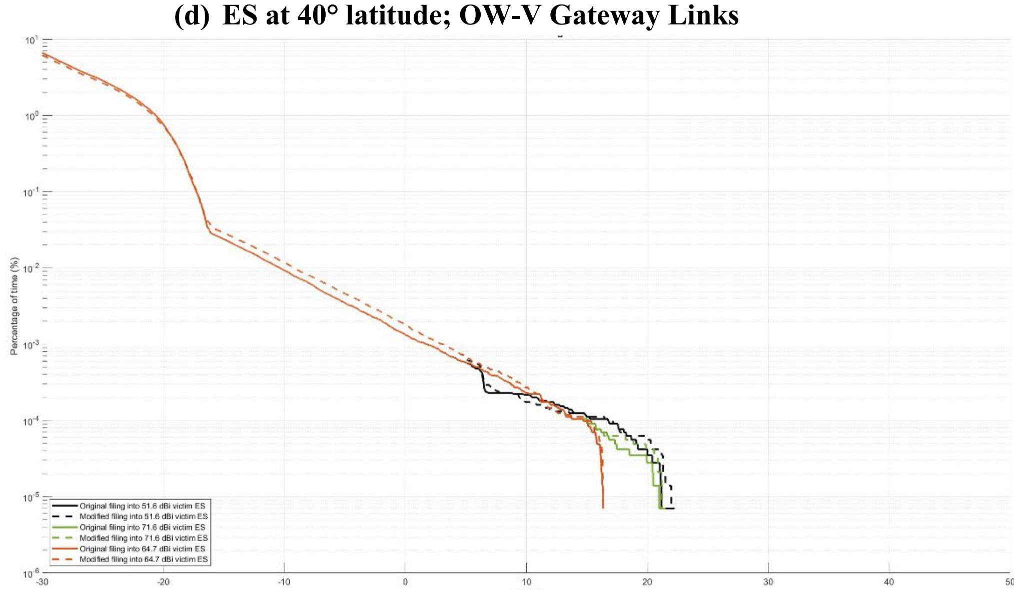
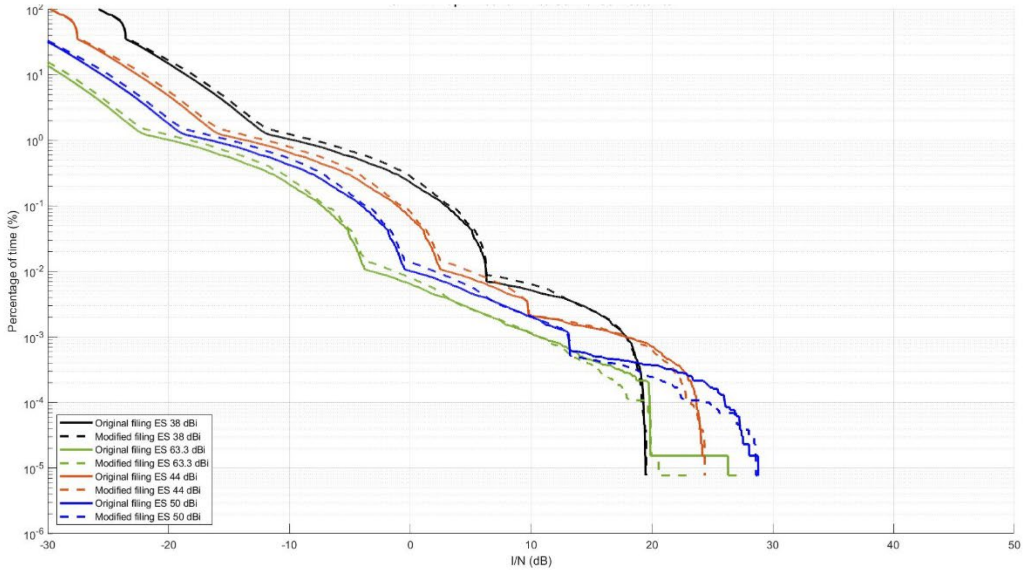


Figure A.7-3 below shows the corresponding uplink results for the O3b V-band system, also for earth latitudes of 20° and 40°, where the OW-V and O3b earth stations are assumed to be collocated. In these results the different colored lines represent the different sizes of transmitting earth station antennas in the OW-V system.[14]

Figure A.7-3: I/N Statistics for uplink interference into the O3b V-band NGSO system for various earth station (ES) latitudes

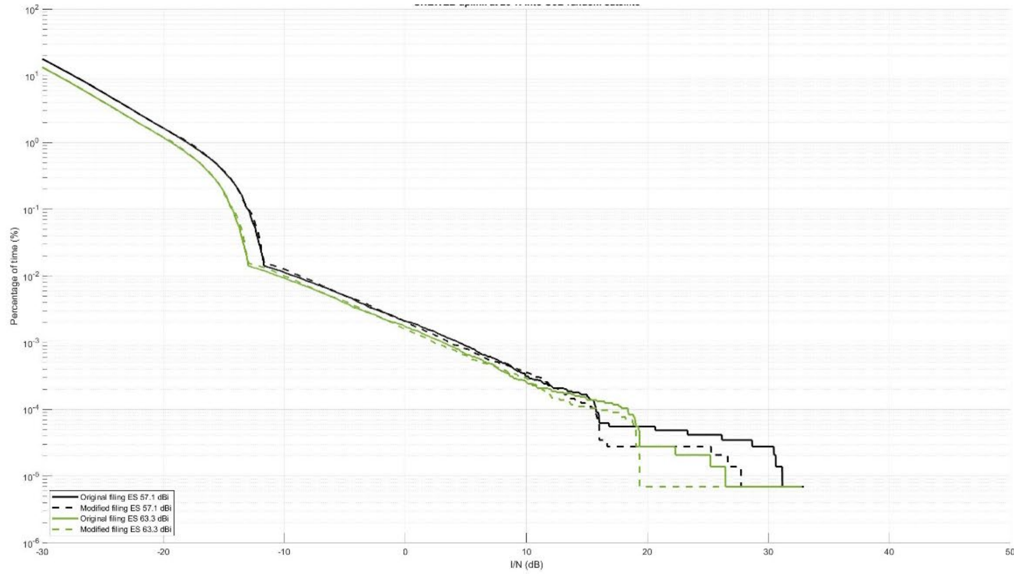
(a) ES at 20° latitude; OW-V User Links



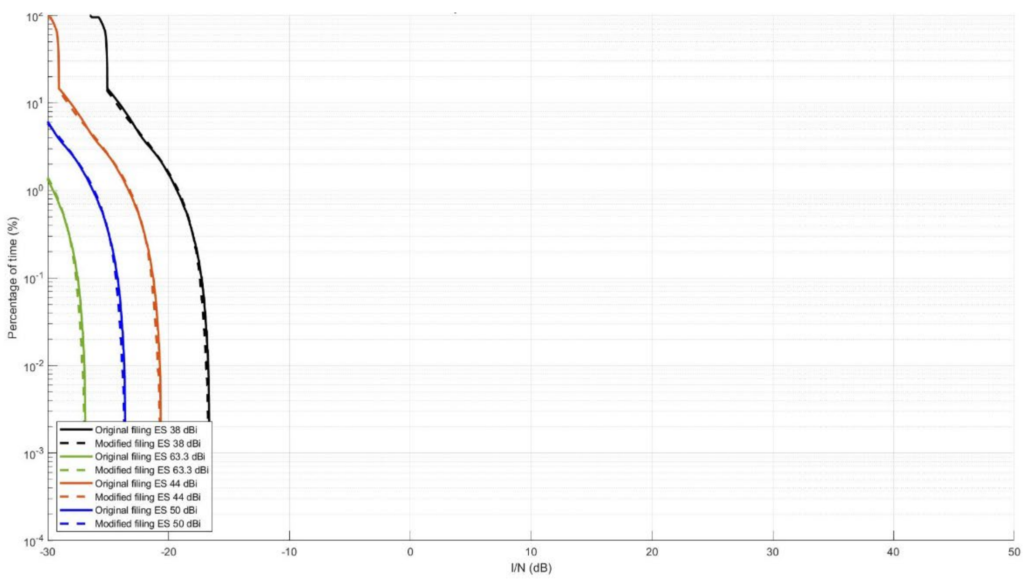
[13] The very low I/N levels into O3b at 40° latitude for the Phase 1 OW-V *user* downlinks is due to the relatively high minimum elevation angle (45°) of those OneWeb links. At this latitude there are no inline events because the O3b satellites are visible only at significantly lower elevation angles than 45°.

[14] As for the downlink, in cases where only one color is shown the results for all earth station sizes are superimposed and are the same due to the interference being attributed to sidelobe effects only. This effect also occurs in some of the subsequent results for the other NGSO systems.

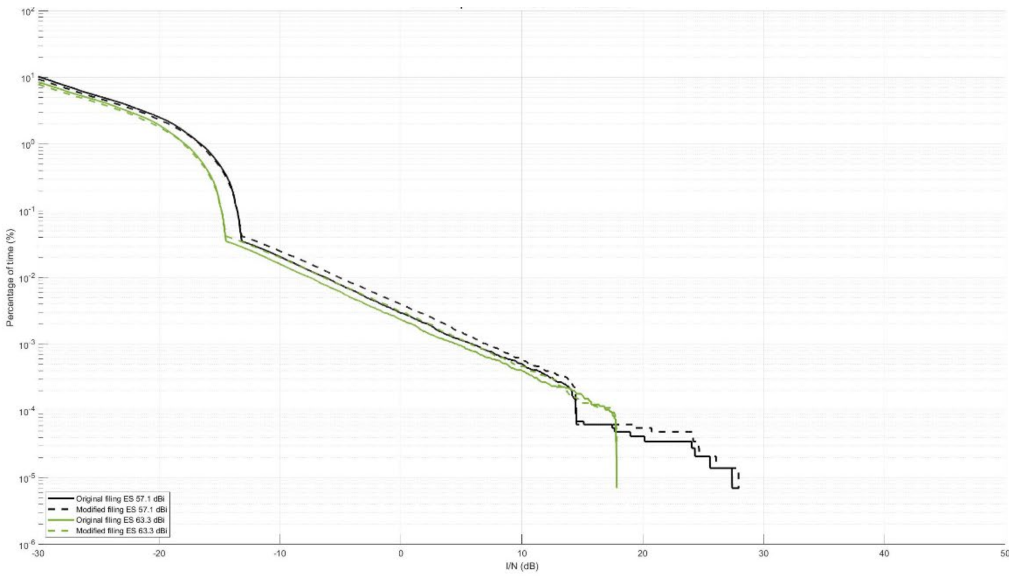
(b) ES at 20° latitude; OW-V gateway links



(c) ES at 40° latitude; OW-V User Links[15]



(d) ES at 40° latitude; OW-V Gateway Links



The next representative NGSO system to be considered is the large SpaceX VLEO system consisting of 7,518 satellites with orbit inclinations ranging from 42° to 53° and altitudes of between 335.9 km and 345.6 km. Figure A.7-4 below shows the downlink results for this SpaceX V-band system, for earth latitudes of 20° and 40°, using the same assumptions as above.

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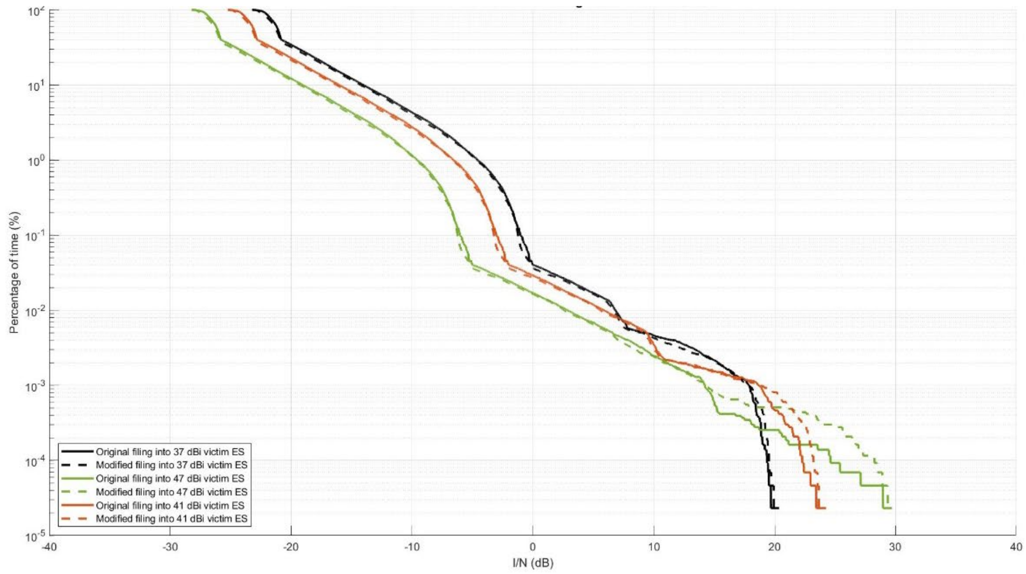
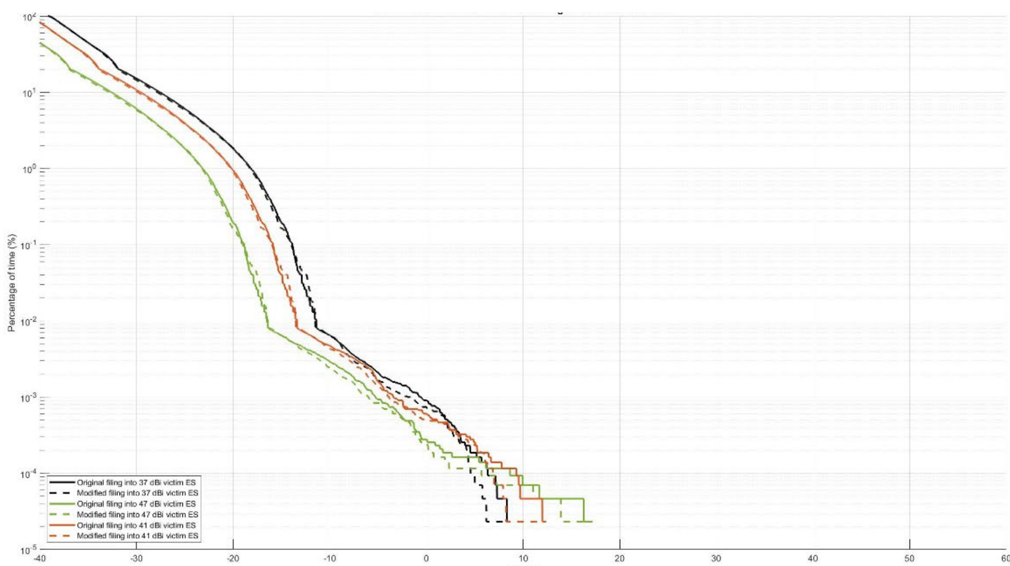
[15] The very low I/N levels into O3b from 40° latitude for the Phase 1 OW-V *user* uplinks is due to the relatively high minimum elevation angle (45°) of those OneWeb links. At this latitude there are no inline events because the O3b satellites are visible only at significantly lower elevation angles than 45°.

Figure A.7-4: I/N Statistics for downlink interference into the SpaceX V-band NGSO system for various earth station (ES) latitudes

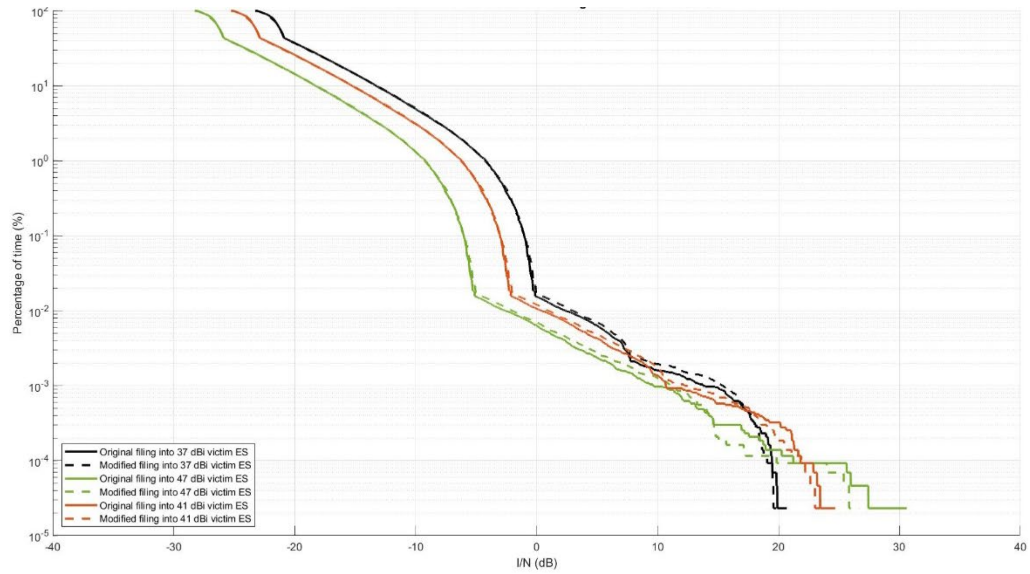
(a) ES at 20° latitude; OW-V User Links



(b) ES at 20° latitude; OW-V Gateway Links



(c) ES at 40° latitude; OW-V User Links



(d) ES at 40° latitude; OW-V Gateway Links

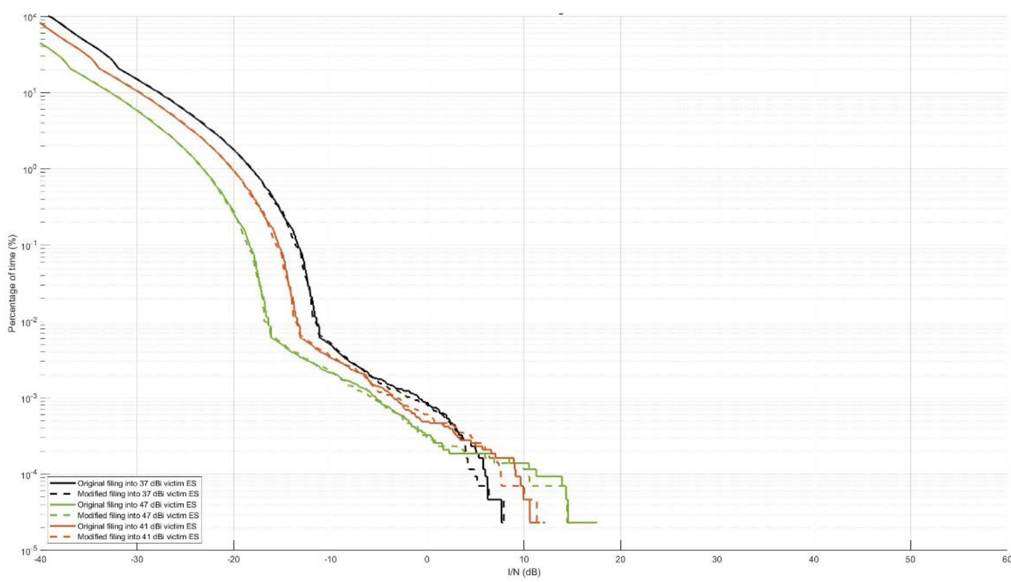
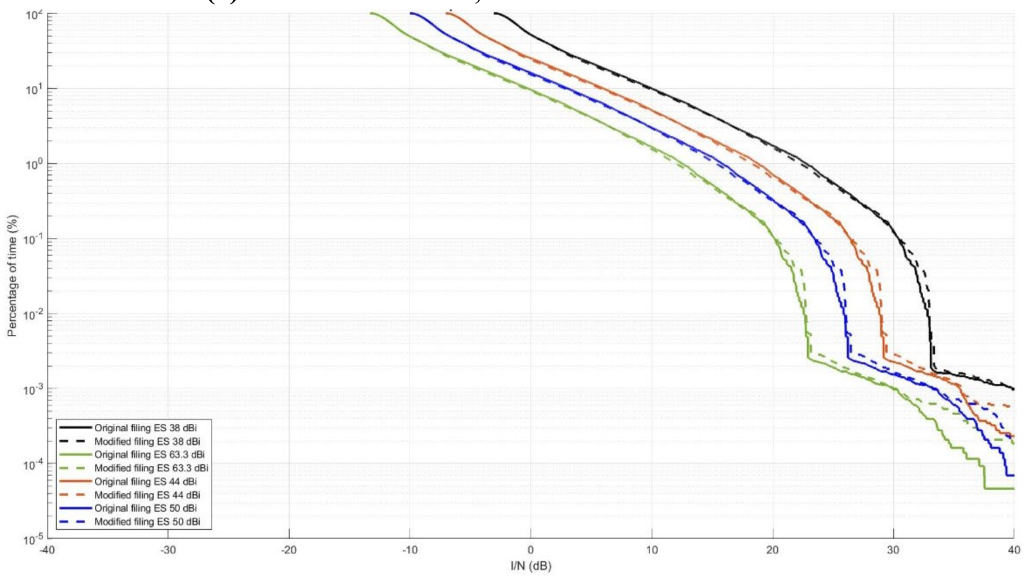


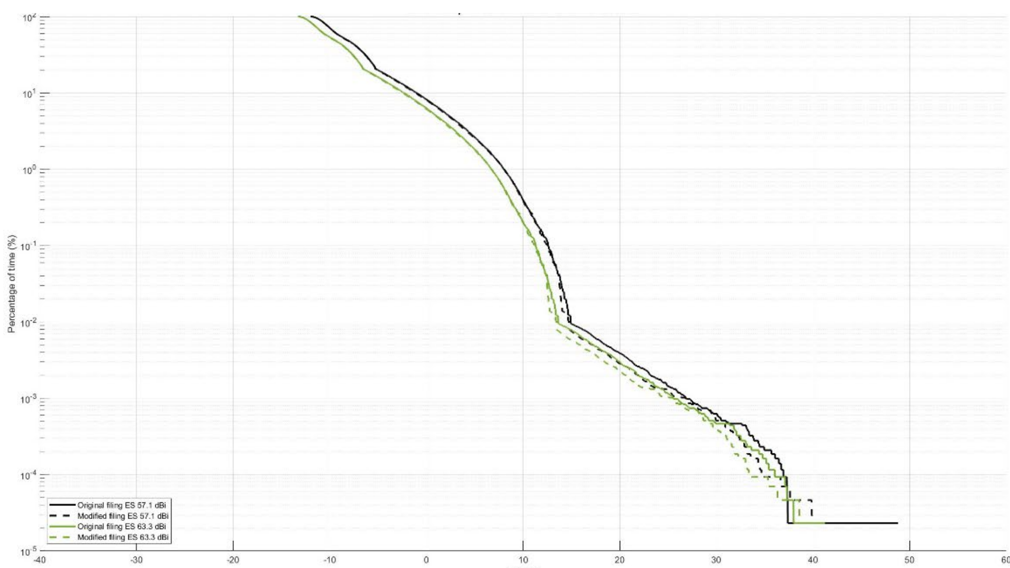
Figure A.7-5 below shows the corresponding uplink results for the SpaceX VLEO system, also for earth latitudes of 20° and 40°, using the same assumptions as above.

Figure A.7-5: I/N Statistics for uplink interference into the SpaceX V-band NGSO system for various earth station (ES) latitudes

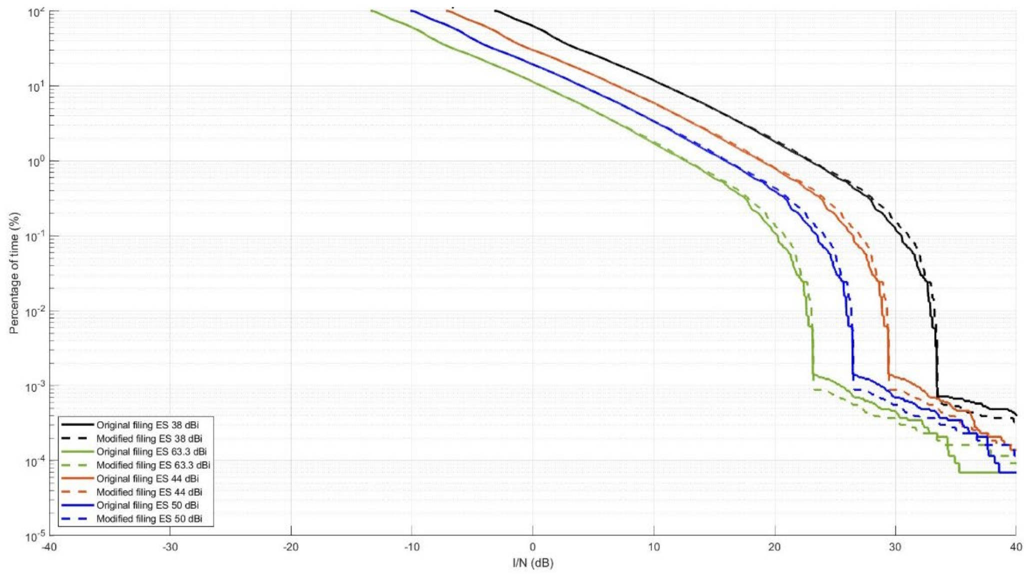
(a) ES at 20° latitude; OW-V User Links



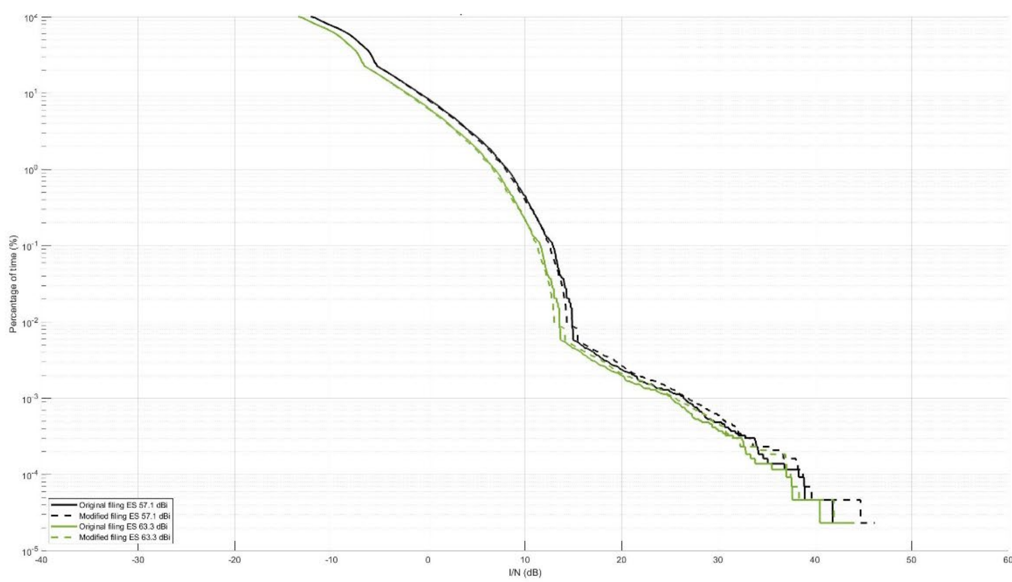
(b) ES at 20° latitude, OW-V Gateway Links



(b) ES at 40° latitude; OW-V User Links



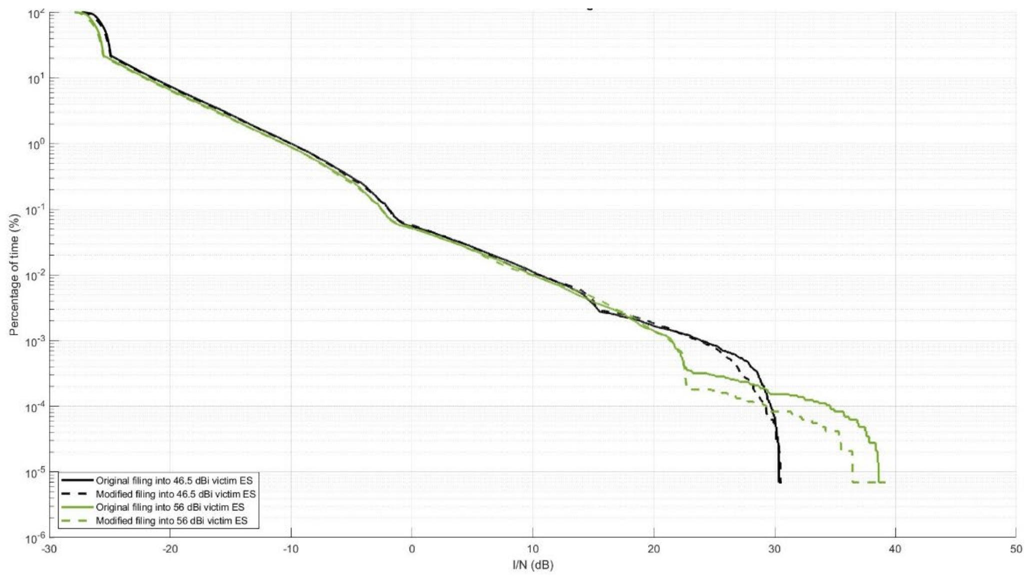
(c) ES at 40° latitude, OW-V Gateway Links



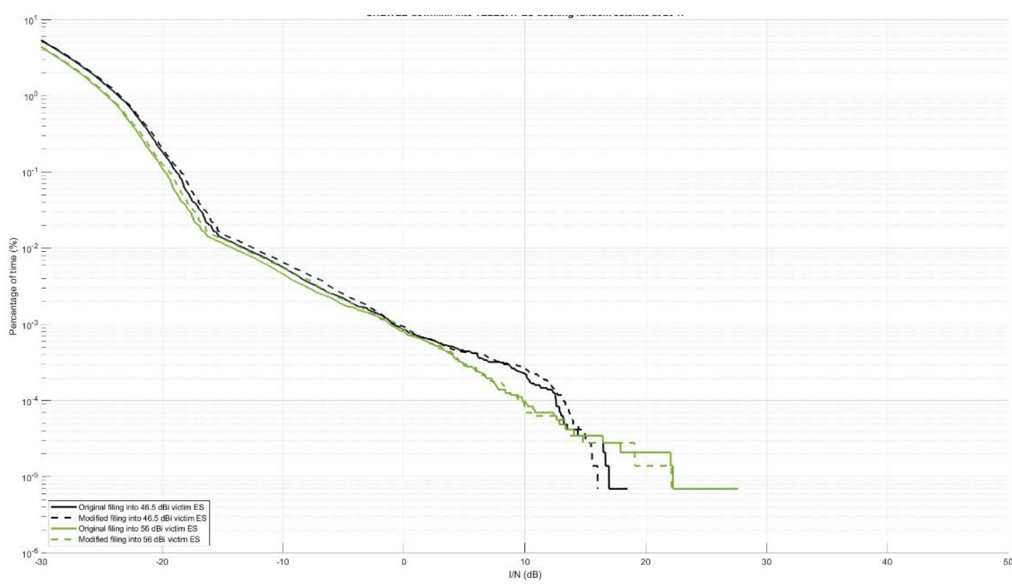
The third representative NGSO system to be considered is the Telesat V-band system which has a total of 117 satellites in two different orbit altitudes. The first orbit is at an altitude of 1,000 km with an inclination of 99.5°, with 72 satellites in six orbital planes. The second orbit is at an altitude of 1,248 km with an inclination of 37.4°, with 45 satellites in five orbital planes. Figure A.7-6 below shows the downlink results for this Telesat V-band system, for earth latitudes of 20°, 40°, and 60°, using the same assumptions as above.

Figure A.7-6: I/N Statistics for downlink interference into the Telesat V-band NGSO system for various earth station (ES) latitudes

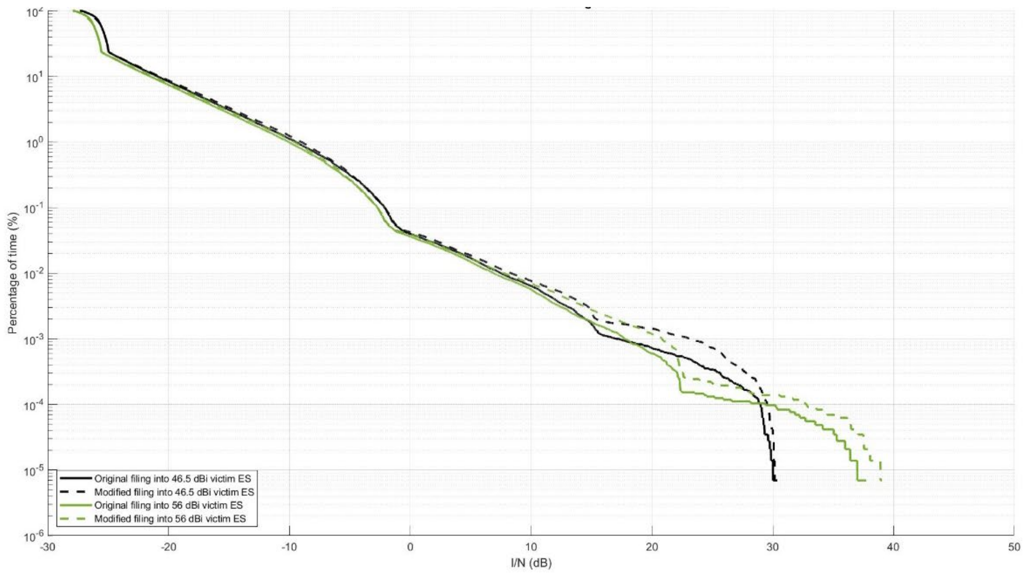
(a) ES at 20° latitude; OW-V User Links



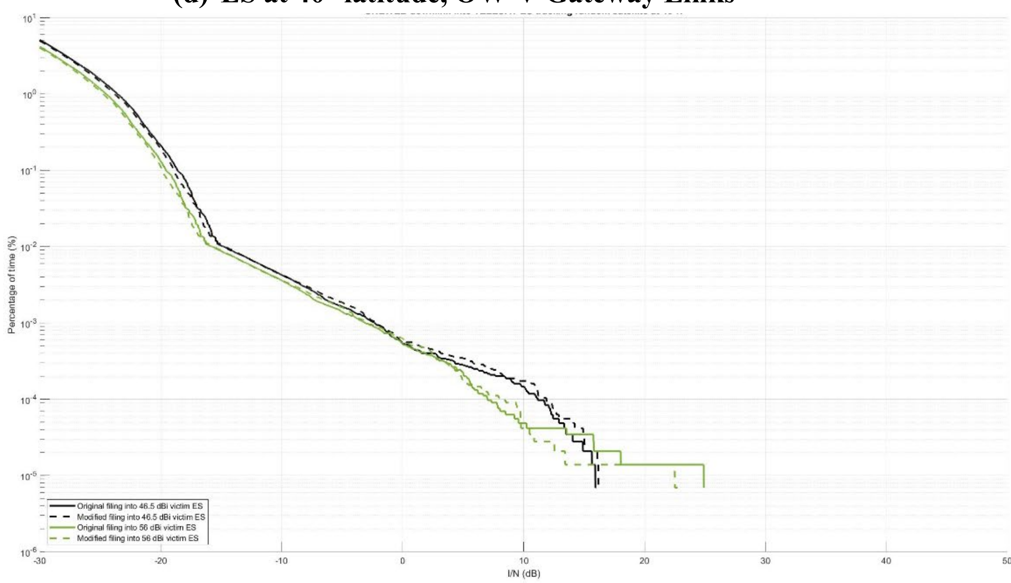
(b) ES at 20° latitude, OW-V Gateway Links



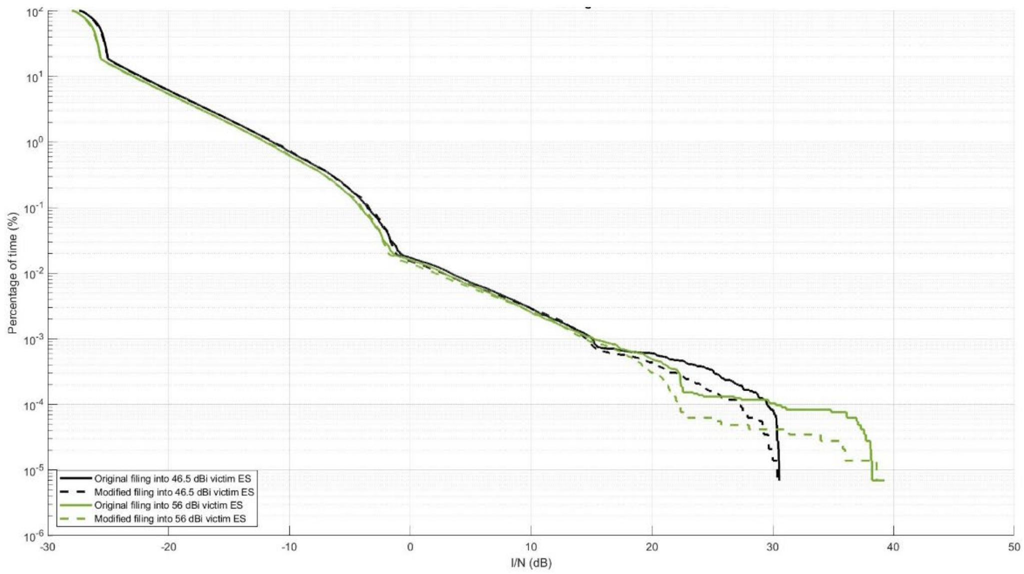
(c) ES at 40° latitude; OW-V User Links



(d) ES at 40° latitude, OW-V Gateway Links



(e) ES at 60° latitude; OW-V User Links



(f) ES at 60° latitude, OW-V Gateway Links

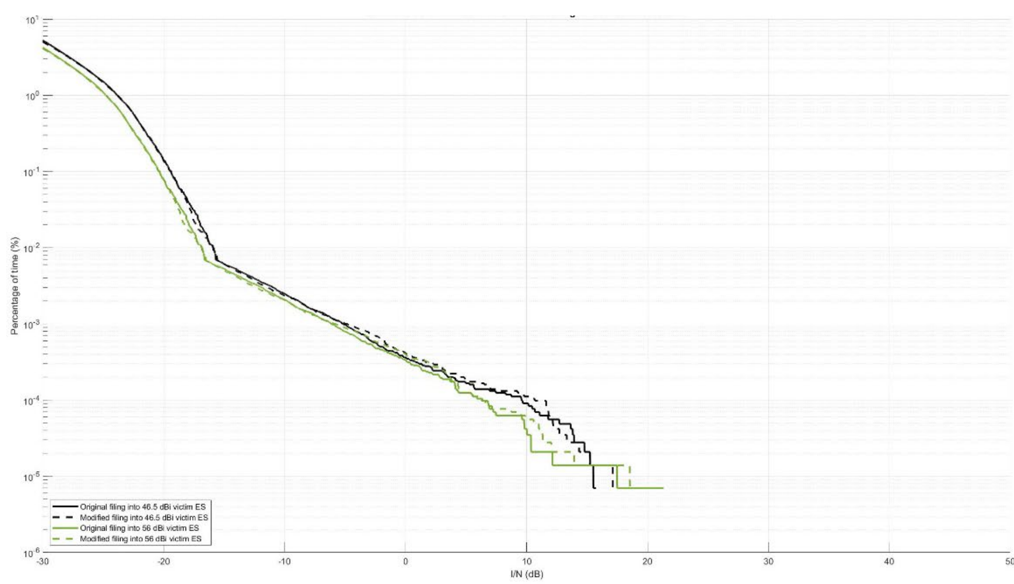
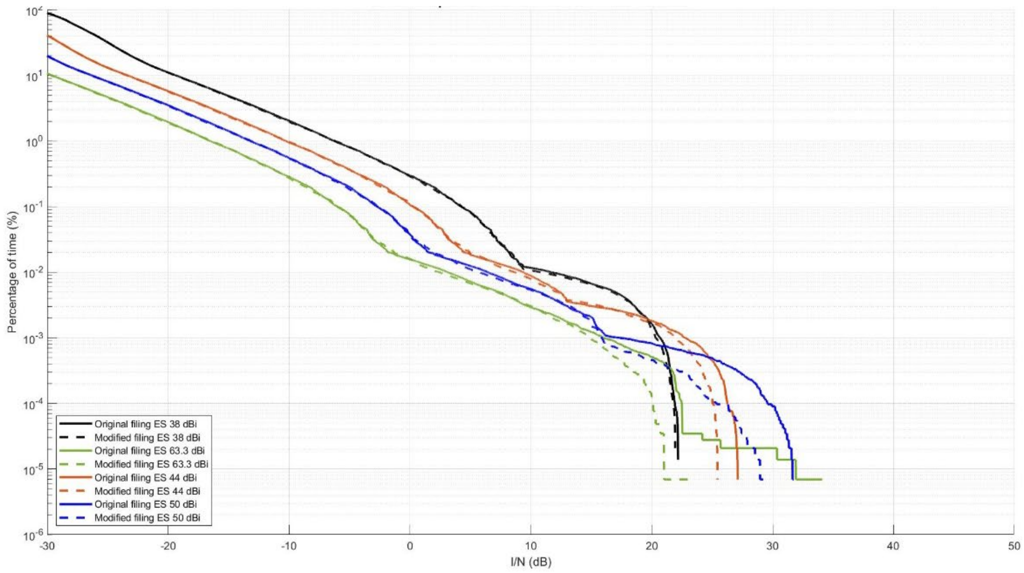


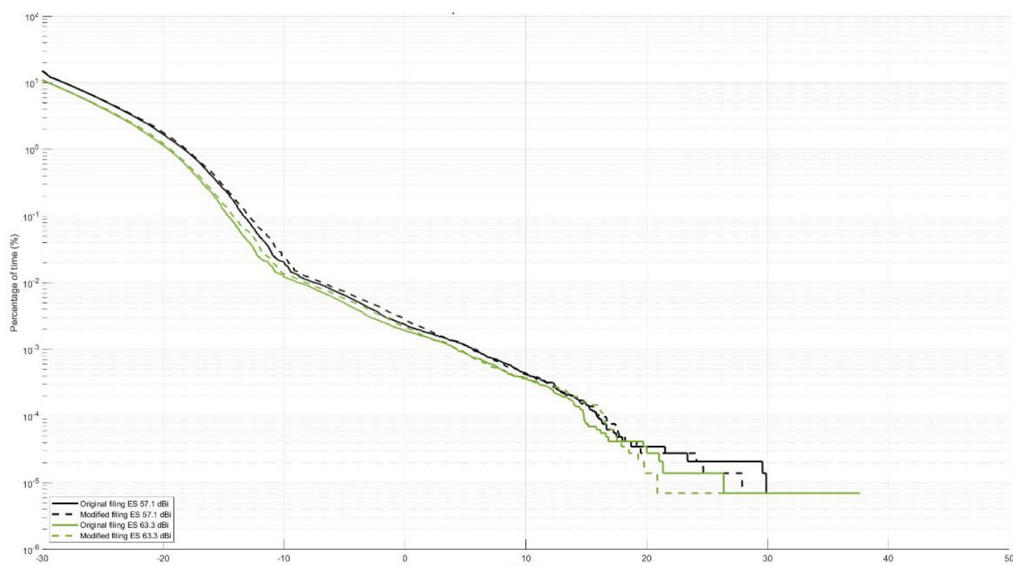
Figure A.7-7 below shows the corresponding uplink results for the Telesat V-band system, also for earth latitudes of 20°, 40°, and 60°, using the same assumptions as above.

Figure A.7-7: I/N Statistics for uplink interference into the Telesat V-band NGSO system for various earth station (ES) latitudes

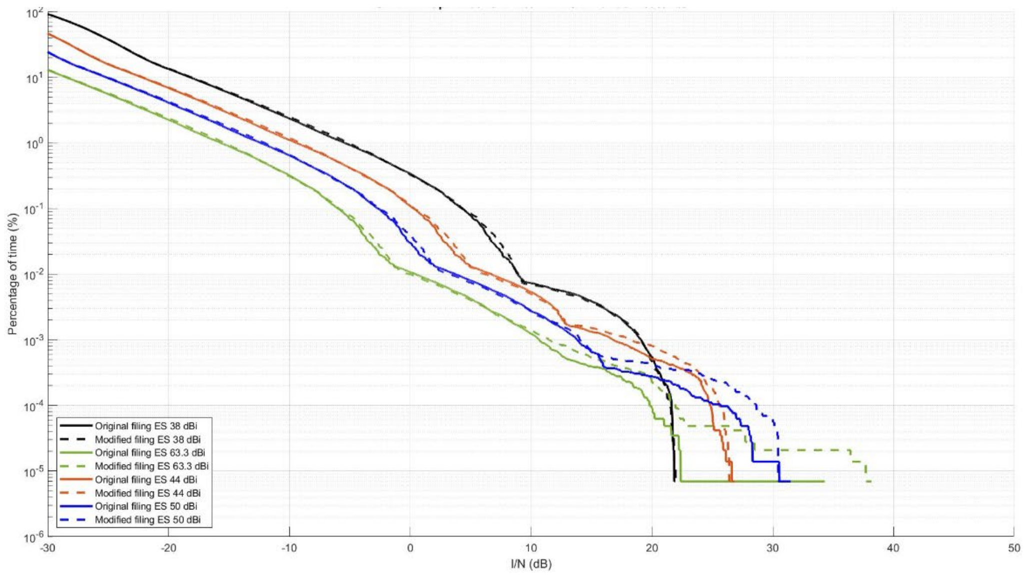
(a) ES at 20° latitude; OW-V User Links



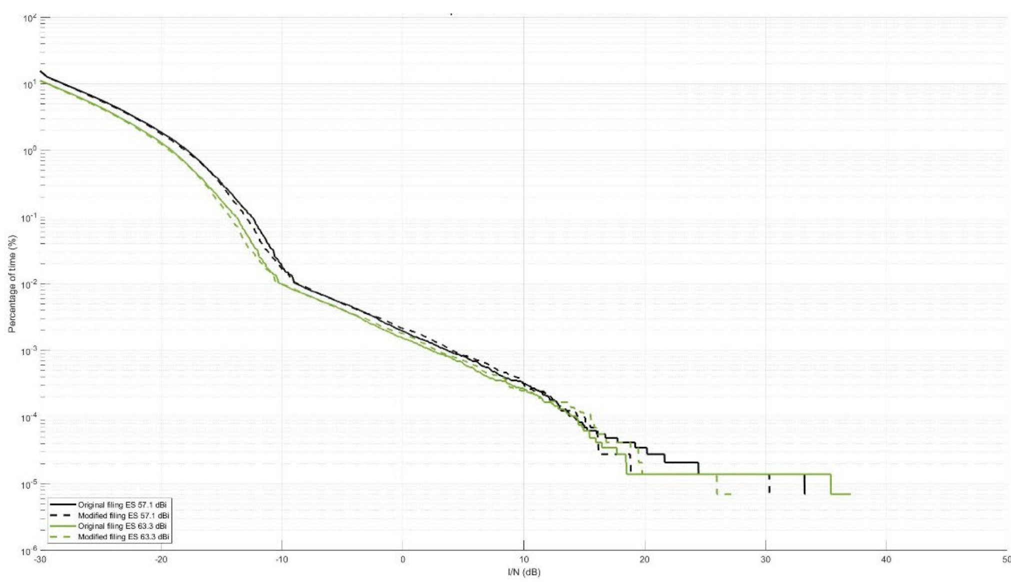
(b) ES at 20° latitude, OW-V Gateway Links



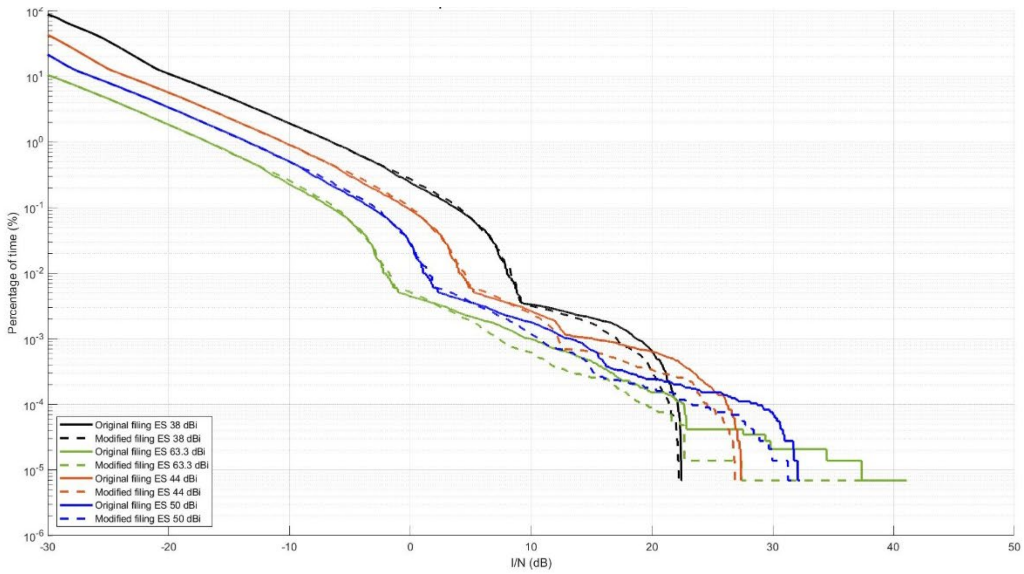
(c) ES at 40° latitude; OW-V User Links



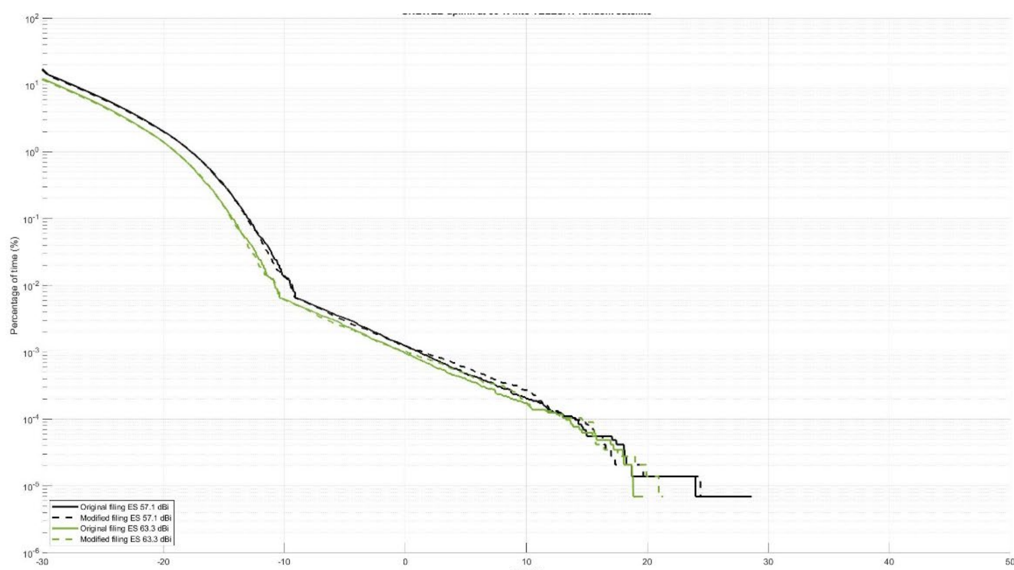
(d) ES at 40° latitude, OW-V Gateway Links



(e) ES at 60° latitude; OW-V User Links



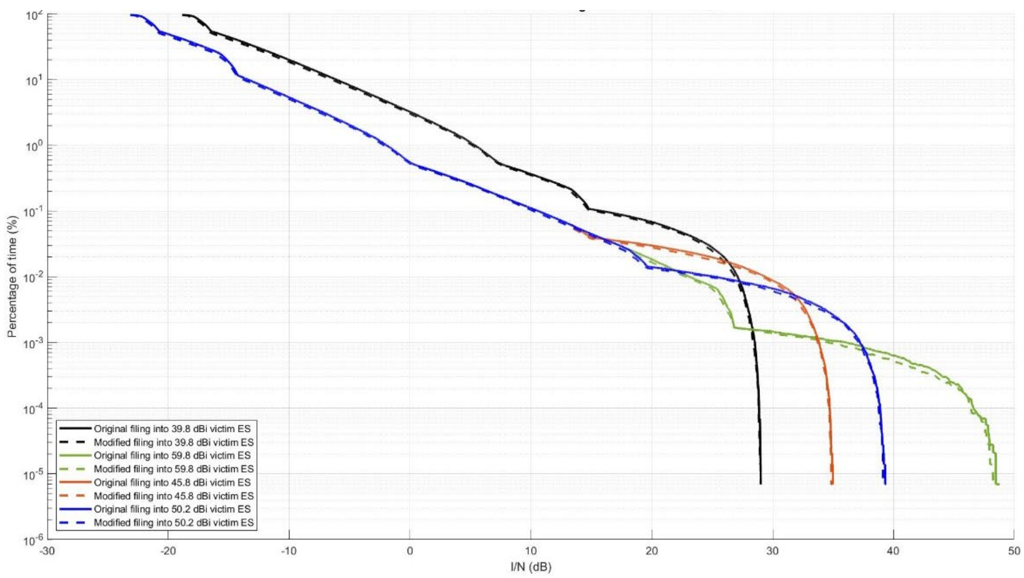
(f) ES at 60° latitude, OW-V gateway links



The last example NGSO system to be assessed is the Viasat V-band MEO system called VIASAT-NGSO, consisting of a total of 20 satellites split between four 87° inclined and evenly spaced planes (five satellites per plane) with an altitude of 8,200 km.[16] Figure A.7-8 below shows the downlink results for the Viasat V-band system, for earth latitudes of 20°, 40°, and 60°, using the same assumptions as above.

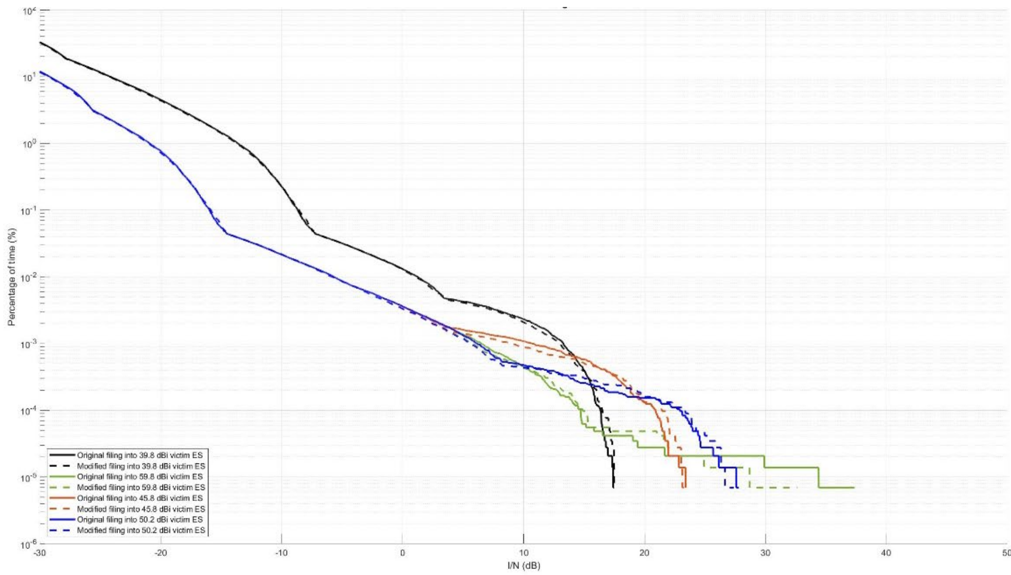
Figure A.7-8: I/N Statistics for downlink interference into the Viasat V-band NGSO system for various earth station (ES) latitudes

(a) ES at 20° latitude; OW-V User Links

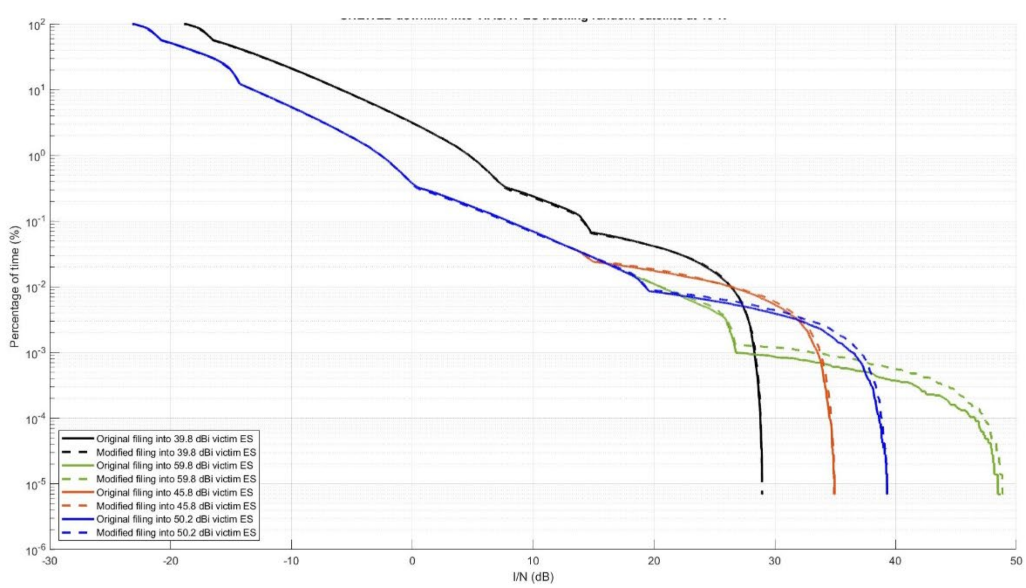


[16] Viasat has a modification request pending before the Commission for a smaller configuration of satellites. *See* Viasat, Inc., *Modification of VIASAT-NGSO*, File No. SAT-MPL-20200526-00056, Call Sign S2985 (filed May 26, 2020).

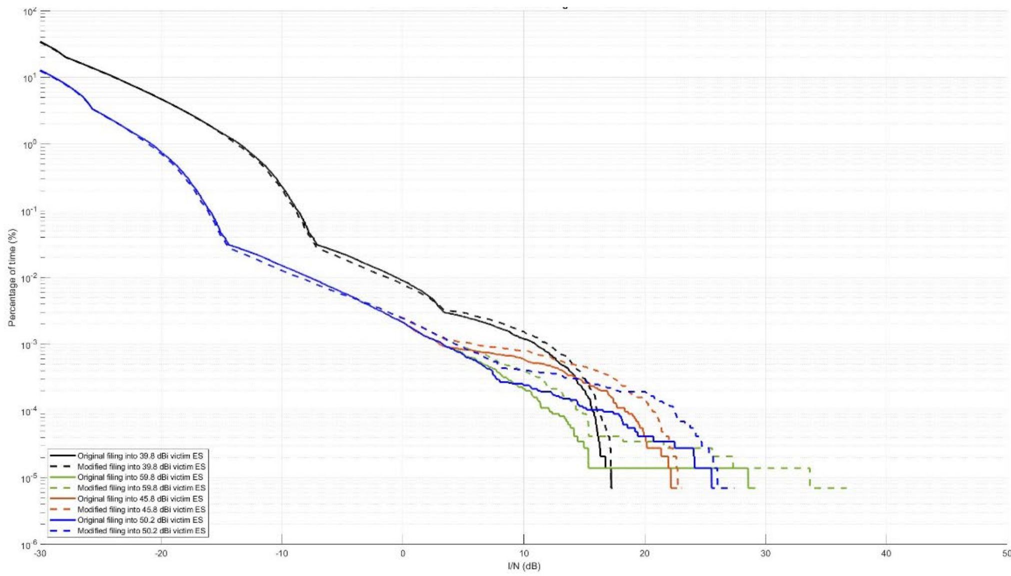
(b) ES at 20° latitude, OW-V Gateway Links



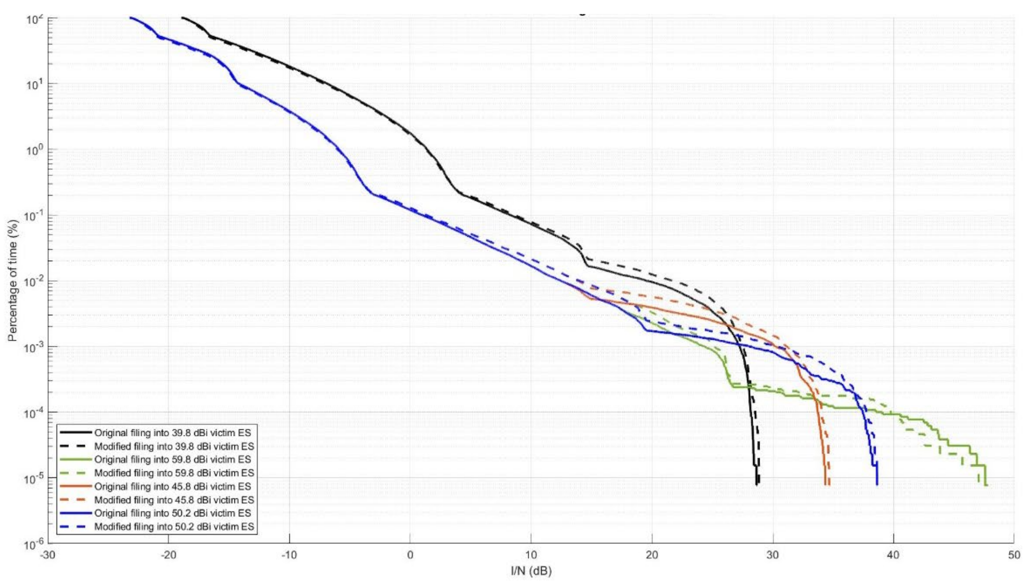
(c) ES at 40° latitude; OW-V User Links



(d) ES at 40° latitude, OW-V Gateway Links



(e) ES at 60° latitude; OW-V User Links



(f) ES at 60° latitude, OW-V gateway links

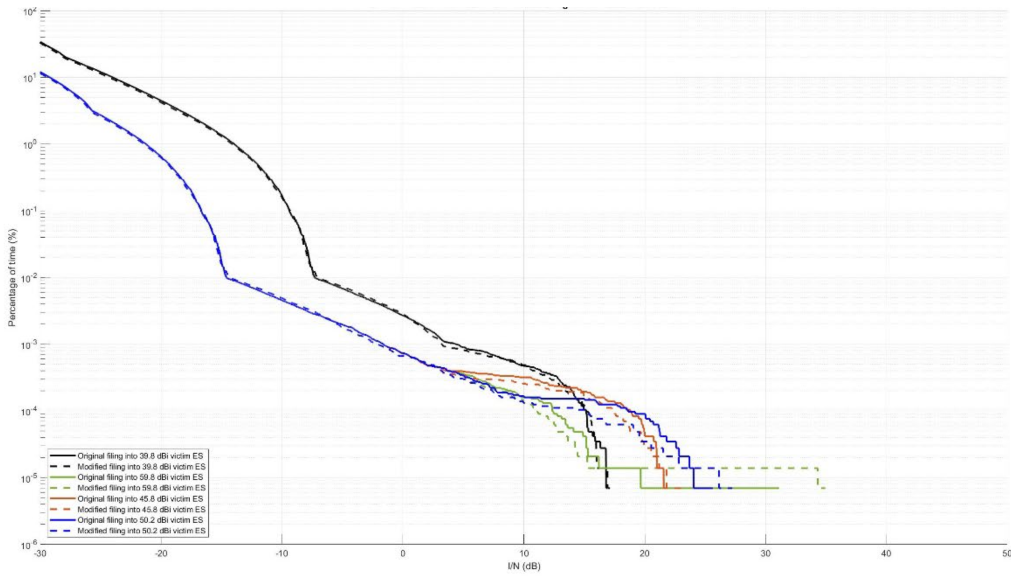
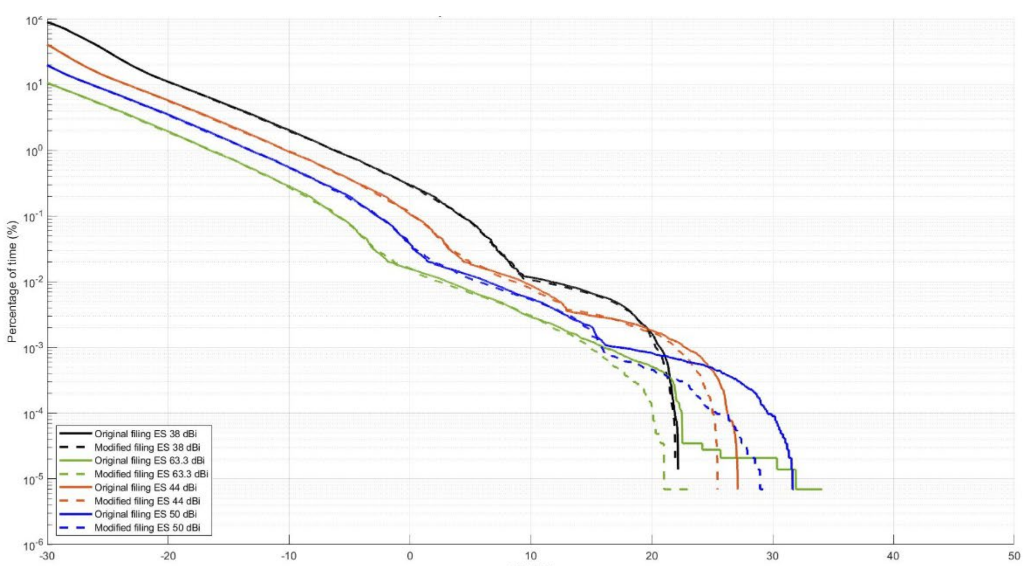


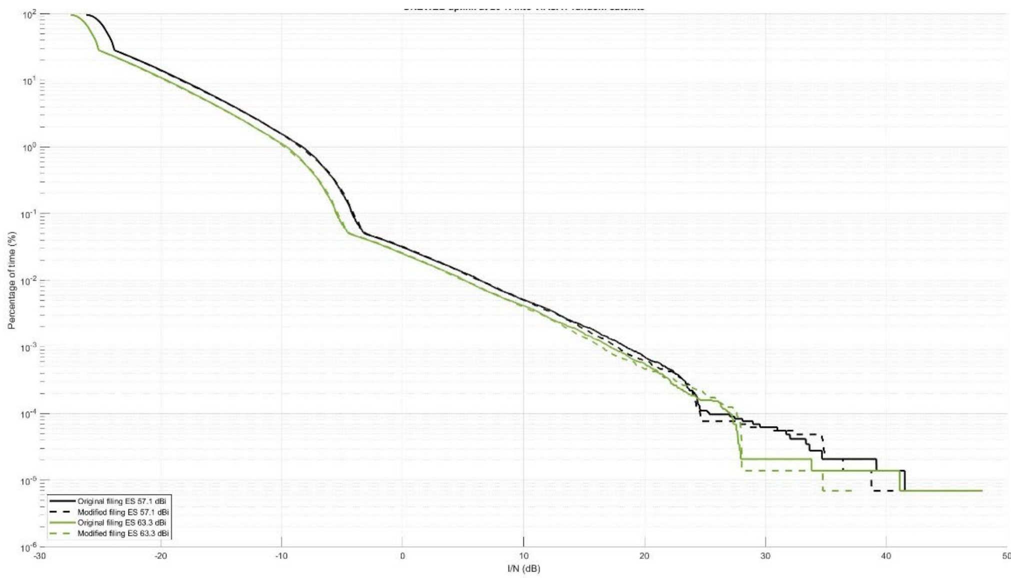
Figure A.7-9 below shows the corresponding uplink results for the Viasat V-band system, also for earth latitudes of 20°, 40°, and 60°, using the same assumptions as above.

Figure A.7-9: I/N Statistics for uplink interference into the Viasat V-band NGSO system for various earth station (ES) latitudes

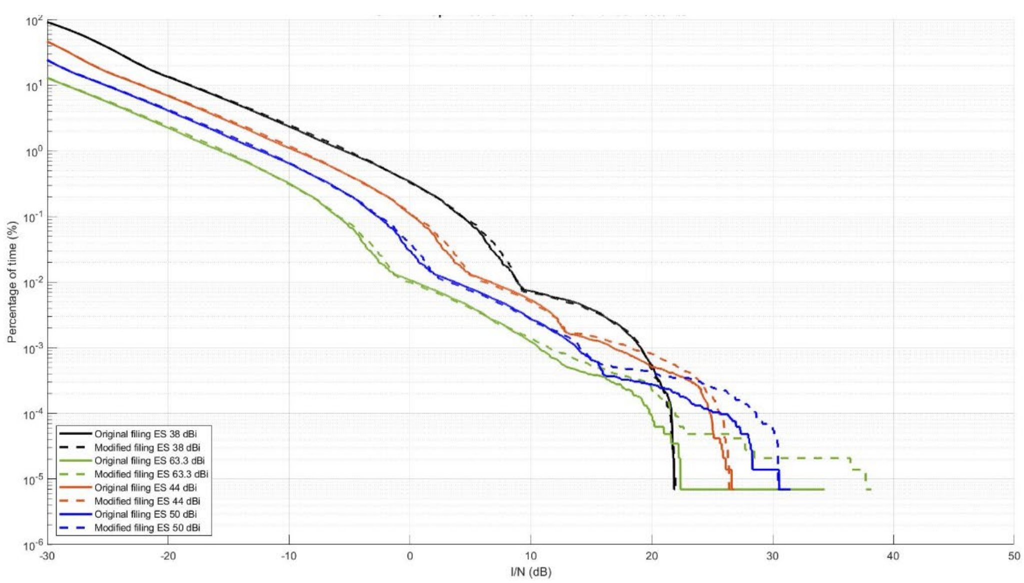
(a) ES at 20° latitude; OW-V User Links



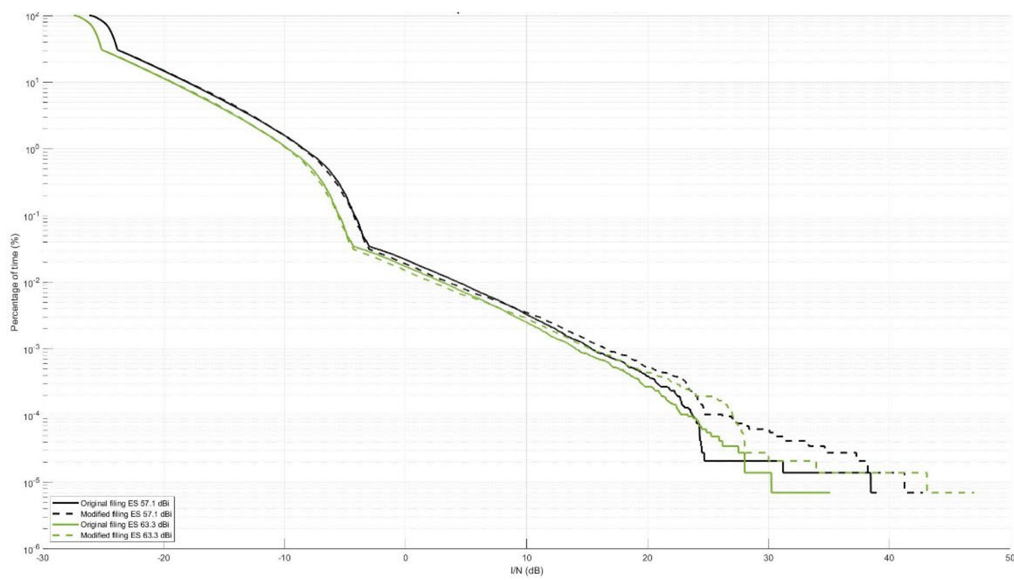
(b) ES at 20° latitude, OW-V Gateway Links



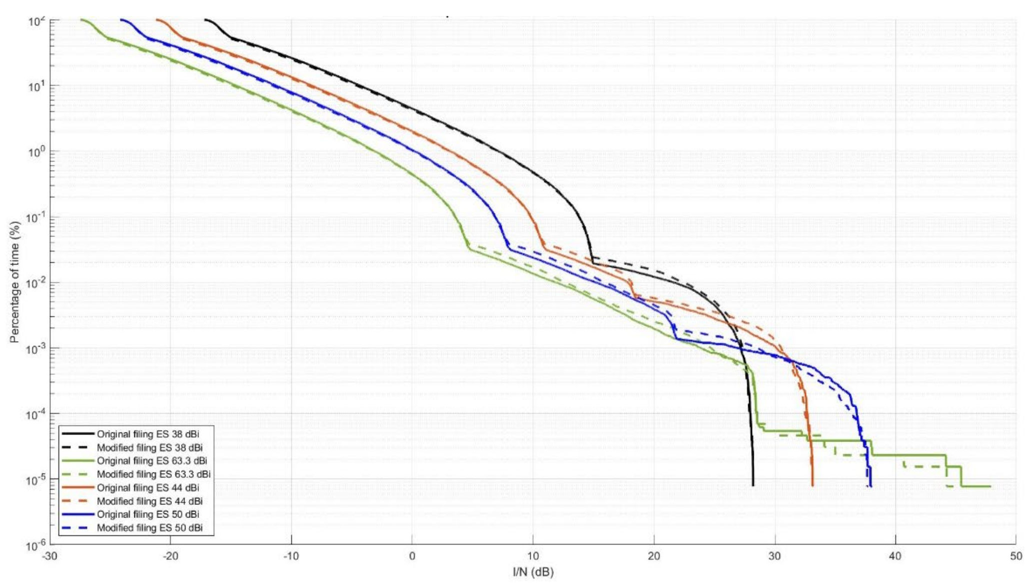
(c) ES at 40° latitude; OW-V User Links



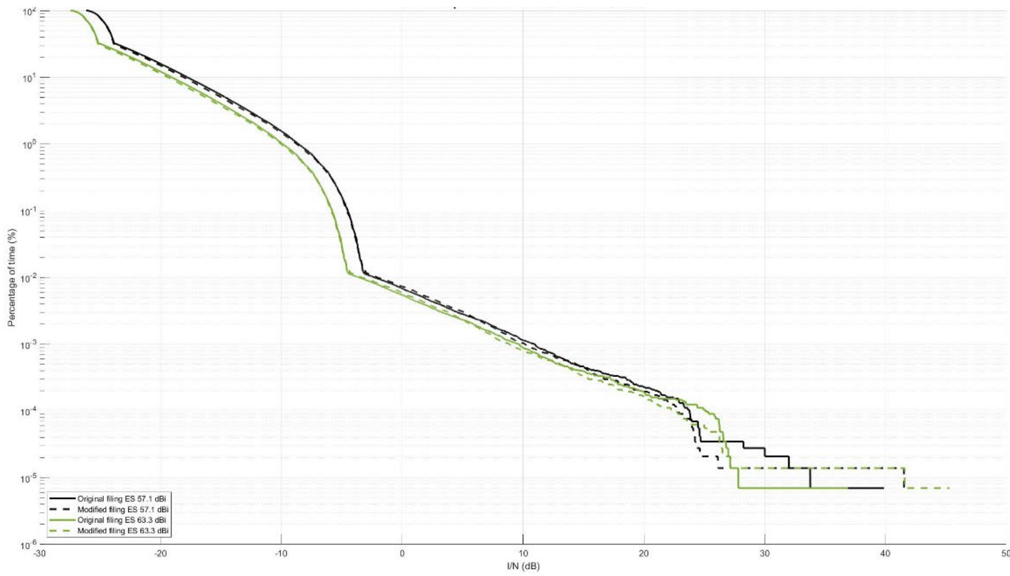
(d) ES at 40° latitude, OW-V Gateway Links



(e) ES at 60° latitude; OW-V User Links



(f) ES at 60° latitude, OW-V Gateway Links



The results shown in Figures A.7-2 to A.7-9 above generally show that there is little difference between the I/N curves for the already authorized OW-V system and those for the modified Phase 1 OW-V system, as far as the interference into other NGSO systems is concerned. In some of the examples there is an apparent small difference at the short-term end of the CDF where the I/N levels, both before and after the proposed OW-V modification, are very high (typically +20 to +40 dB). In practice, interference mitigation measures would have to be employed between the operators for these very infrequent and short-term situations, well before such a high I/N is reached as these levels are too high to permit viable RF links. Therefore, they do not represent real-world increases in interference that would be of concern. These representative interference results further demonstrate that the overall interference environment with respect to other NGSO systems is not impacted by the proposed Phase 1 modification of the OW-V system.[17]

A.7.3 Interference with Respect to Terrestrial Networks in the OW-V Downlink Frequency Bands

This information is available in Attachment A to the V-Band Market Access Petition and is unchanged by the proposed Phase 1 modification. As explained in Section A.6, the modified OW-V system will continue to comply with all applicable FCC and ITU PFD limits which have been established to protect terrestrial systems from unacceptable interference resulting from the satellite downlink transmissions. In addition, OneWeb acknowledges that its gateway operations in 37.5-40 GHz will be subject to the siting restrictions in Section 25.136 of the Commission's rules.

A.7.4 Interference with Respect to Terrestrial Networks in the OW-V Uplink Frequency Bands

This information is available in Attachment A to the V-Band Market Access Petition and is unchanged by the proposed Phase 1 modification. In addition, OneWeb acknowledges that its gateway operations in 47.2-48.2 GHz and 50.4-51.4 GHz will be subject to the siting restrictions in Section 25.136 of the Commission's rules.

[17] OneWeb acknowledges that on November 3, 2021, the Commission granted a license to The Boeing Company to operate in portions of the V-band. *See* The Boeing Company, *Application for Authority to Launch and Operate a Non-Geostationary Satellite Orbit System in the Fixed-Satellite Service*, Order and Authorization, FCC 21-115 (rel. Nov. 3, 2021). To the extent necessary, OneWeb will supplement the record here to provide additional analyses demonstrating that grant of the Modification Application will not cause significant interference problems for Boeing's proposed operations.

A.7.5 Interference with Respect to the Radio Astronomy Service and Earth Exploration Satellite Service

This information is available in Attachment A to the V-Band Market Access Petition and is unchanged by the proposed Phase 1 modification. OneWeb acknowledges that since 2017 changes were made to Resolution 750 at WRC-19 regarding protection of the Earth exploration satellite service in 50.2-50.4 GHz from transmitting earth stations in the immediately adjacent frequency bands. OneWeb expects that its gateway earth station licenses will be conditioned on compliance with these revised limits.

A.8 ITU FILINGS FOR THE OW-V SYSTEM

The OW-V system will operate pursuant to French and U.K. ITU filings.

A.9 ORBITAL DEBRIS (§25.114(d)(14))

This matter is addressed in the Legal Narrative included with the Modification Application.

A.10 ADDITIONAL INFORMATION CONCERNING DATA IN THE ASSOCIATED SCHEDULE S (§25.114(c))

As a single Schedule S is being submitted with this modification request (Phases 1 and 2), the associated Schedule S includes some data relevant to Phase 1, some data relevant to Phase 1 and Phase 2, and some data relevant to Phase 2 only. A detailed explanation concerning which data in the Schedule S (and the accompanying Excel spreadsheet) is unique to one or the other phases of the OW-V system is given below. Other data in the Schedule S, not mentioned below, is common to both Phase 1 and Phase 2.

- Orbit details embedded in the Schedule S provide a complete orbit constellation definition only for Phase 1 as it is not feasible to enter manually the large number of satellite phase angles required for Phase 2 into the online Schedule S software. The required orbit details for Phase 2 are being provided to the Commission in the form of an Excel spreadsheet (in PDF format) that is attached to this application which is structured in the same way as the Schedule S format for orbit data. Note, however, that the orbit data in the separate spreadsheet also includes the satellites whose orbit data is embedded in the Schedule S;

- Certain satellite beams and their associated frequency ranges contained in the Schedule S are associated only with satellites in Phase 2. These frequency ranges and beams exclusive to Phase 2 are as follows:
    - 42.5-43.5 GHz (Beams VGR1 and VGR4);
    - 71.0-76.0 GHz (Beams EGTL and EGTR);
    - 81.0-86.0 GHz (Beams EGRL and EGRR).
- The following beams are exclusive to Phase 2, even though they operate in frequency ranges common to both Phase 1 and Phase 2:
    - Beams LURL, LURR, LUTL and LUTR;
    - Beams UTLH and UTRH.
- The following beams are exclusive to Phase 1, even though they operate in frequency ranges common to both Phase 1 and Phase 2:
    - Beams HUTL and HUTR.
- The following channels, all of 500 MHz bandwidth, are exclusive to Phase 2:
    - GUBA, GUBB and GUB1 through GUB8;
    - GDB1 through GDB9;
    - EU1 through EU10;
    - ED1 through ED10;
    - UUB1 through UUB4;
    - UDB1 through UDB4.

- The following channels, all of 490 MHz bandwidth (with the exception of GDAA and UDA5, which are 40 MHz bandwidth),[18] are exclusive to Phase 1:
    - GUA1 through GUA8;
    - GDA1 through GDA9;
    - UUA1 through UUA4;
    - UDA1 through UDA5.
- The following channels, all of 40 MHz bandwidth, are exclusive to Phase 1:[19]
    - GDAA and UDA5.

The associated Schedule S information for the Phase 1 modified OW-V system was prepared using the FCC's online Schedule S software.[20] The data provided in the Schedule S is consistent with the latest available FCC instructions.[21]

The following notes are provided related to the data provided in the accompanying Schedule S for the OW-V system:

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[18] The two 40 MHz channels (GDAA and UDA5) are necessary to fill in the small portion of spectrum below 42.0 GHz (41.960-42.000 GHz) which is assigned to OneWeb by the Commission, but which would otherwise have been excluded by the deletion of the previous channel that spanned 41.96-42.45 GHz which has now been deleted from both Phase 1 and Phase 2 of the OW-V system.

[19] The two 40 MHz channels (GDAA and UDA5) are necessary to fill in the small portion of spectrum below 42.0 GHz (41.960-42.000 GHz) which is assigned to OneWeb by the Commission, but which would otherwise have been excluded by the deletion of the previous channel that spanned 41.96-42.45 GHz which has now been deleted from both Phase 1 and Phase 2 of the OW-V system.

[20] Schedule S software is available at https://enterpriseefiling.fcc.gov/schedules/.

[21] *See* SPECIFIC INSTRUCTIONS FOR SCHEDULE S, April 2016, Available at https://enterpriseefiling.fcc.gov/schedules//resources/Instructions%20for%20Schedule%20S%20vApr2016.pdf .

1. Orbit adjustments of the OW-V system will be made to the orbit altitudes of the various orbital planes to ensure safe operation.

2. For satellite transmitting and receiving beams circular polarization is used, and therefore there is no polarization alignment angle. However, the Schedule S online software defaults to a value of 45° for the polarization angle when circular polarization is selected, and this value cannot be changed, so it should be ignored.

3. The Schedule S PDF printout software does not correctly list the satellite numbering and phase information that has been entered into the online system.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

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

/s/ *Kimberly M. Baum*

Kimberly M. Baum
Vice President, Spectrum Engineering and Strategy
WorldVu Satellites Limited

November 4, 2021