**Exhibit A**

**Technical Analysis**

Viasat submits the following showing to demonstrate that the proposed gateway-type earth station, or satellite access node ("SAN"), located in Iroquois County, IL, is compatible with Upper Microwave Flexible Use Service ("UMFUS") operations in accordance with Section 25.136(a)(4) and therefore should be authorized with the rights and protections afforded by Section 25.136(a).

The Viasat SAN antenna is configured to operate with the ViaSat-3 satellite at 88.9° W.L., and this configuration provides the relevant operational azimuth and elevation angles. In normal operation, the input power density is constant for all atmospheric conditions and is not increased during rain fade events and thus, the operations during clear sky conditions will be the same as worst-case operating scenarios.

The antenna parameters used in the analysis are identified in the FCC Form 312 application and supporting exhibits, and reflect measured gain patterns for the proposed earth station antenna.

| Description | Value | Unit |
|---|---|---|
| Antenna Diameter | 2.4 | m |
| Antenna Gain | 52.4 | dB(i) |
| Antenna Input Density | -19.2 | dB(W/MHz) |
| EIRP Density | 33.2 | dB(W/MHz) |
| Average Antenna Disc toward Horizon | 83.4 | dB |
| Density toward Horizon | -50.2 | dB(W/MHz) |
| Polarization Discrimination | 1.5 | dB |
| Gain of m^2 area (28.35 GHz) | 50.5 | dB(m^2) |
| Boundary Limit in flux density | -107.6 | dB(W/(m^2*MHz)) |
| Average free space distance to limit | 175.9 | m |

The above calculation provides a simple baseline estimate of the average required separation distance for all azimuths around the 2.4 meter antenna to meet the -77.6 dB(mW/($m^2$ * MHz)) power flux density ("pfd") limit based only on free space loss and 1.5 dB of polarization discrimination[1]. The minimum and maximum required free space distances for this antenna to meet the -77.6 dB(mW/($m^2$ * MHz)) pfd limit range from 35 meters to 446 meters but are typically much lower once terrain and clutter are considered, as described further below.

## A. Computation of pfd Contour

While the above table provides an estimate of the average distance around the earth station where the pfd at a height of 10 meters above ground level would be equal to or greater

[1] Use of 1.5 dB for polarization discrimination is a conservative value consistent with Appendix 8 Section 2.2.3 of the ITU-R Radio Regulations.

than -77.6 dB(mW/($m^2$ * MHz)) for a flat field with no obstructions nearby, in most cases, terrain and objects on the Earth's surface provide for some additional reduction of the region around the SAN antenna where the pfd value above is exceeded.

To determine whether terrain or surface obstructions around the SAN antenna would provide any further reduction of the pfd at a 10 meter reference height, an analysis was performed using the NTIA ITS Irregular Terrain Model.[2] In the computation of the contour, surface data with 1 meter resolution from Intermap was used to provide both clutter height and terrain information.

The computation of the contour around the antenna used the nominal input power density to the SAN antenna along with measured antenna gain information to determine the e.i.r.p. density along a particular azimuth. Next, path and clutter/terrain losses were taken into consideration for all the locations around a SAN site along with polarization discrimination to determine which blocks around the SAN site exceed the -77.6 dB(mW/($m^2$ * MHz)) limit at the 10 meter reference height.

For this SAN antenna, additional reduction in the pfd over and above that from terrain and clutter in the area around a SAN antenna was required to avoid coverage of locations restricted by Section 25.136(a)(4)(iii) and shielding was used. The attenuation from shielding was computed using the TICRA Tools antenna analysis program which is the latest version of the industry standard GRASP analysis software. The attenuation is computed for each degree of azimuth around the earth station antenna and ranges from 7 dB to 34 dB around the antenna with an average attenuation of 22 dB.

The approach uses a Geometrical Theory of Diffraction (GTD) analysis whereby the total RF energy in the direction of the interference source (or victim) antenna was computed for various wall dimensions and compared to the total RF energy when no shield wall was present. The shield wall was modeled as a perfect conductor and diffraction was allowed to occur on the top and sides of the wall. The bottom edge was assumed to be below grade so no bottom edge diffraction was included. The wall dimensions and position were adjusted until the required shielding level was reached. The wall height used with the 2.4 m antenna is 10 feet. The nominal shielding design uses solid corrugated steel walls in a rectangular configuration around the antenna. The standard enclosure is 25 feet long 12 feet wide as depicted below. The dimensions provide sufficient room for the antenna beam to clear the wall at the operating elevation angle and also provide room for ancillary equipment to be located behind the antenna.

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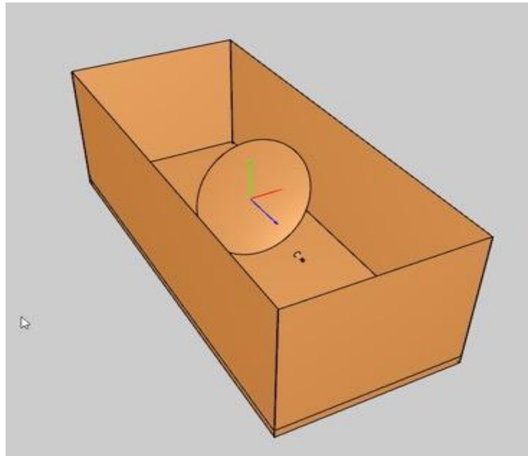
[2] *See* NTIA Report 82-100 (Apr. 1, 1982), available at: https://www.ntia.doc.gov/report/1982/guide-use-its-irregular-terrain-model-area-prediction-mode. A link to the particular implementation used can be found here: https://www.its.bldrdoc.gov/media/50674/itm.pdf.



Finally, once the analysis is completed, a GIS shape file of the resulting contour is created for import into Viasat's ArcGIS tool and can be examined with respect to population and other elements of Section 25.136. An illustration of the contour is included below as Figure 1, and is also included in a .kmz file attached separately in IBFS.

**B. Satisfaction of Section 25.136 Criteria**

**a. Section 25.136(a)(4)(i)**

The earth station location is in Iroquois County, IL. A search of the IBFS database indicates that there are no other earth stations licensed in the 27.5-28.35 GHz band segment in that county.

Therefore, the earth station satisfies the requirement in Section 25.136(a)(4)(1) that there be no more than two other earth stations operating or authorized to operate in the 27.5-28.35 GHz band within the county on a protected basis under Section 25.136.

**b. Section 25.136(a)(4)(ii)**

The total population covered by the -77.6 dB(mW/($m^2$ * MHz)) contour is below the applicable threshold specified in Section 25.136(a)(4)(ii).

Overlaying the -77.6 dB(mW/($m^2$ * MHz)) contour on a map depicting census blocks, Viasat has calculated an estimate of the population covered by the contour using 2010 census data and assuming that the population coverage within a partially covered census block is equal to the percentage of the geographic area of the census block covered by the contour.[3] Figure 1 below contains a diagram depicting the contour overlaid on a census block map.

[3] This approach to estimating population coverage using the most recently available decennial census block data and the actual area method is consistent with the recommended approach in

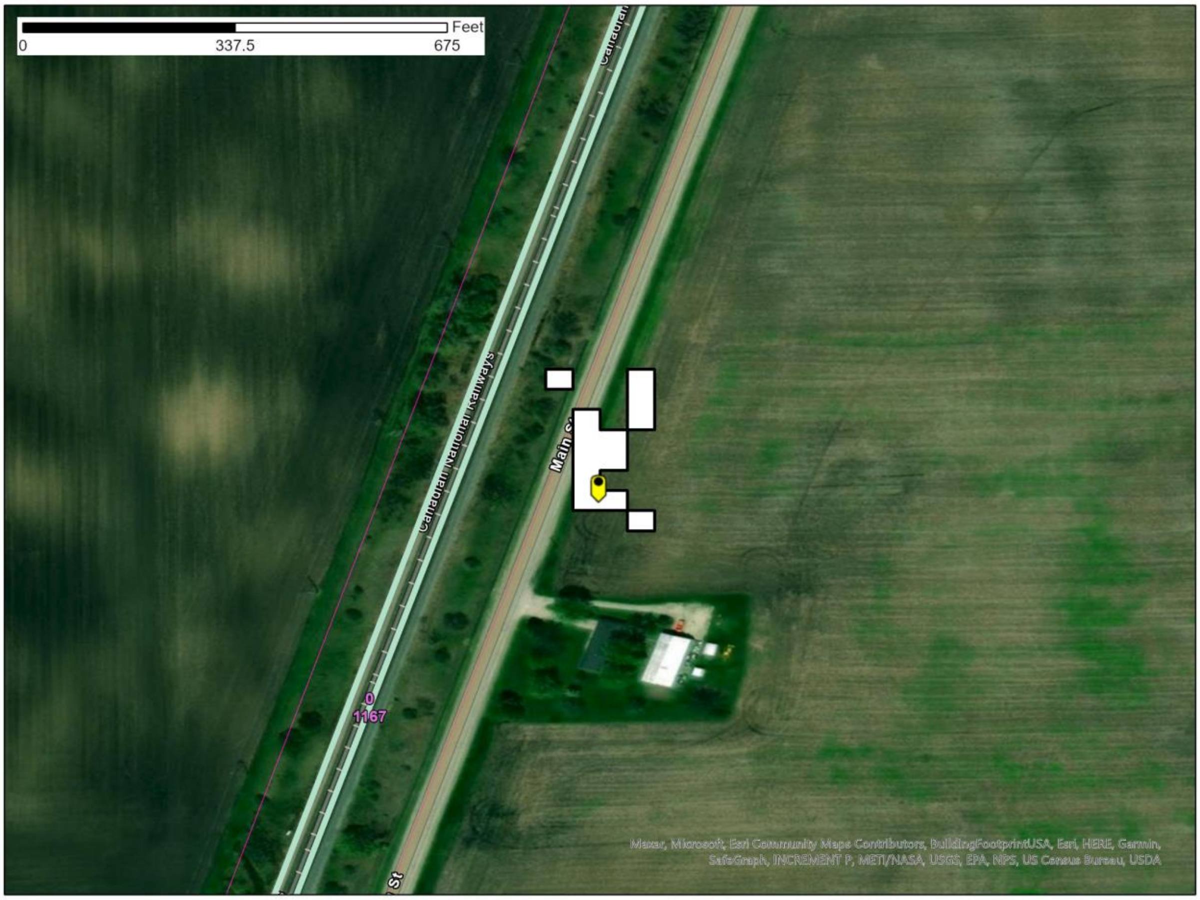



Figure 1 – Ashkum, IL SAN -77.6 dB(mW/(m2 * MHz)) pfd contour

The population of Iroquois County is 29718, and thus the applicable population limit under Section 25.136(a)(4)(ii) is 450.

The following identifies the census block, population and the population coverage estimate as determined by the actual area method.

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the International Bureau's guidance regarding earth station siting. *See International Bureau Issues Guidance on Siting Methodologies for Earth Stations Seeking to Operate in the 24.75-25.25 GHz, 27.5-28.35 GHz, 37.5-40 GHz, 47.2-48.2 GHz, and 50.4-51.4 GHz Frequency Bands to Demonstrate Compliance with Section 25.136*, 35 FCC Rcd 6347 (2020). Viasat notes that the Satellite Industry Association, of which Viasat is a member, has petitioned for reconsideration of this guidance. *See* Petition for Reconsideration of SIA, IB Docket. No. 17-172 (filed July 16, 2020). Nothing herein should be construed to prejudice that pending petition, or otherwise suggest that Viasat agrees with the Bureau's guidance.

| Census Block Number | Total Population of Census Block | Population Coverage Estimate | Percent of Block Covered by Pattern |
|---|---|---|---|
| 170759502001167 | 0 | 0 | 0.1062% |
| 170759502001167 | 0 | 0 | 0.1062% |
| 170759502001131 | 48 | 0 | 0.0409% |
| 170759502001131 | 48 | 0 | 0.0238% |
| Total Estimated Population Coverage: | | 0 | |

**Table 2 – Population Coverage Overview**

The total estimated population covered by the contour thus is below the applicable population limit.

### c. Section 25.136(a)(4)(iii)

The -77.6 dB(mW/(m$^2$ * MHz)) contour does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port, or any road identified as an Interstate, Other Freeway and Expressway, or Other Principal Arterial road in the Federal Highway Administration Office of Planning, Environment, and Realty Executive Geographic Information System map.[4] Viasat notes that roads that intersect the contour (if any) have not been designated by the relevant state agency as Other Freeways and Expressways, or Other Principal Arterials.

### d. Section 25.136(a)(4)(iv)

Viasat has completed frequency coordination with the UMFUS licensees within the area covered by the -77.6 dB(mW/(m2 * MHz)) contour with respect to existing facilities constructed and in operation by the UMFUS licensees. The Prior Coordination Notice (PCN) was sent by Comsearch on 11/13/2020 and no objections were received within the 30 day notice period. The Comsearch coordination report is attached as Exhibit C.

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[4] *See* Federal Highway Administration, Office of Planning, Environment, and Realty Executive Geographic Information System Map, *available at* https://hepgis.fhwa.dot.gov/fhwagis/#; *see also Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Second Report and Order, 32 FCC Rcd 10988, App'x B (2017) ("[T]he roads listed in the revision to Section 25.136 . . . can readily be identified by consulting the Federal Highway Administration (FHWA) Office of Planning, Environment, and Realty Executive Geographic Information System (HEPGIS) map . . . . HEPGIS allows the user to enter any street address in the U.S. and display an interactive map with a legend that identifies road classifications as they are defined by the Department of Transportation at 23 C.F.R. Section 470.105 pursuant to 23 U.S.C. Sections 101 and 103."); 47 C.F.R. § 25.136(a)(4)(iii).

## C. USE OF IRREGULAR TERRAIN MODEL (ITM) FOR COORDINATING EARTH STATIONS WITHIN 1 KM

Viasat has engaged RKF Engineering Solutions, LLC (RKF) to determine the model to calculate contours around each Satellite Access Node (SAN) earth station which exceeds a power flux density (PFD) of -77.6 dBW/m$^2$/MHz.

RKF relied upon the National Telecommunications and Information Administration (NTIA)'s Irregular Terrain Model (ITM)[5] to compute the power densities from these transmitting earth stations / SANs for distances greater than 100 m. The ITM model was selected in large part because it is an accepted Federal Communications Commission (FCC) model and was assessed to produce conservative results (low path loss) for propagation paths for the site-specific geometries analyzed, thereby building confidence in the ability to achieve successful spectrum sharing. For elevation and terrain data RKF relied upon the 5-meter NEXTMap[6] Elevation data suite.

In choosing ITM, there were several considerations. First, the Defense Information System's Agency (DISA) Spectrum Sharing Test and Demonstration (SSTD) working group, made up of many Government stakeholders, uses 2D terrain path loss models for predicting clutter in the band 1.755 to 1.780 GHz, for rural and suburban areas. These predictions were shown to be accurate when compared to measurements in the band. In the paper, *"What are the underlying calculations, parameters, and assumptions for the Longley-Rice (ITM) propagation model?*[7], the nominal frequency range for the ITM model is listed as 20 MHz to 40 GHz. While the upper limit was modified to 20 GHz in some later documentation, 28 GHz frequencies, within these topologies, conform to the model.

While the ITM doesn't explicitly account for loss within the first kilometer, the model's formulas were used in association with the NEXTMap data. Specifically, to improve the fidelity of the estimates, NEXTMap terrain and clutter data were calculated from 100 m from the SAN sites. In his doctoral thesis, Kasampalis Stylianos[8] reviews many diffraction models including ITM and observed that the ITM model can be used for distances as low as 200 meters.

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[5] Model available at https://github.com/NTIA/itm

[6] https://www.intermap.com/nextmap

[7] "What are the underlying calculations, parameters, and assumptions for the Longley-Rice (ITM) propagation model?" September 24, 2013, in RF Engineering Article, (https://www.softwright.com/knowledgebase/faq/underlying-calculations-parameters-assumptions-longley-rice-itm-propagation-model/)

[8] "Modelling and Coverage Improvement of DVB-T Networks," A thesis submitted for the degree of Doctor of Philosophy by Kasampalis Stylianos, March 2018

The probability of reflections in rural and suburban areas is low at higher frequencies and reflections tend to attenuate quickly at these frequencies if they aren't close to the direct path. Furthermore, an accepted 3D model that accurately predicts loss is not available and the 5-meter NEXTMap data does not have enough resolution to predict reflections accurately. Consequently, a 3D model was not employed.

To demonstrate the conservative nature of the ITM model used, simulations were performed with a series of single knife edge terrain path, where the knife edge height was assumed to be 2 m. The table below compares the knife edge diffraction loss to the ITM predicted loss (ITM path loss minus free space loss) for paths equal to or less than 1 km. In all but one case shown, the ITM model significantly underestimates the loss compared to the knife edge prediction.

| Frequency | Total Path Distance | Distance to Knife Edge | Knife Edge Loss | ITM Predicted Loss |
|---|---|---|---|---|
| GHz | meters | meters | dB | dB |
| 28 | 1000 | 250 | 19.02 | 16.2 |
| 18 | 1000 | 250 | 17.28 | 10 |
| 28 | 800 | 200 | 19.94 | 14 |
| 18 | 800 | 200 | 18.15 | 8.4 |
| 28 | 500 | 100 | 22.57 | 23.6 |
| 18 | 500 | 100 | 20.71 | 15.1 |
| 28 | 200 | 60 | 25.33 | 7.3 |
| 18 | 200 | 60 | 23.43 | 3.5 |

In summary, the ITM propagation model is well-accepted by regulators and has been used in many instances up to the frequencies associated with the SANs under consideration and down to distances below 1 km, where results were shown to be conservative for pathloss thereby helping to build confidence in successful sharing with these earth station nodes.