555 Eleventh Street, N.W., Suite 1000
Washington, D.C. 20004-1304
Tel: +1.202.637.2200 Fax: +1.202.637.2201
www.lw.com

LATHAM & WATKINS LLP

FIRM / AFFILIATE OFFICES

Beijing	Moscow
Boston	Munich
Brussels	New York
Century City	Orange County
Chicago	Paris
Dubai	Riyadh
Düsseldorf	Rome
Frankfurt	San Diego
Hamburg	San Francisco
Hong Kong	Seoul
Houston	Shanghai
London	Silicon Valley
Los Angeles	Singapore
Madrid	Tokyo
Milan	Washington, D.C.

August 29, 2018

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Viasat, Inc. *Ex Parte* Submission Responding to Global Mobile Suppliers Association, IB Docket No. 17-95

Dear Ms. Dortch:

Viasat, Inc. ("Viasat") submits the attached technical analysis responding to the June 11, 2018 *ex parte* submission of Global Mobile Suppliers Association in the above-referenced proceeding.[1] This technical analysis, like Viasat's previously submitted analysis,[2] demonstrates that ESIMs operating in the 28.35-28.6 GHz band segment subject to the existing Section 25.202(f) limits for out-of-band emissions would not cause unacceptable interference to terrestrial mobile operations in the adjacent 27.5-28.35 GHz band.

If you have any questions regarding this submission, please contact the undersigned.

Respectfully submitted,

/s/

John P. Janka
Elizabeth R. Park

---

[1] *See* Global Mobile Suppliers Association, Notice of *Ex Parte* Submission, IB Docket No. 17-95 (filed June 11, 2018).

[2] Viasat, Inc., *Ex Parte* Submission, IB Docket No. 17-95 (filed Mar. 23, 2018).

Enclosure

cc: International Bureau
Thomas Sullivan
Troy Tanner
Jennifer Gilsenan
Jose Albuquerque
Cindy Spiers
Kathyrn Medley
Diane Garfield
Joseph Hill
Sankar Persaud
Paul Blais
Michael Mullinix
Dante Ibarra

Office of Engineering and Technology
Julius Knapp
Ron Repasi
Bruce Romano
Michael Ha
Nicholas Oros
Bahman Badipour

ESIM vs 5G Out-of-band Interference Analysis

This analysis responds to the June 11, 2018 *ex parte*[1] submission by the Global Mobile Suppliers Association (GSA) in which the GSA responded to Viasat's *ex parte* submission of March 23, 2018.[2]

Viasat's March 23rd *ex parte* included an analysis demonstrating that ESIMs operating in the 28.35-28.6 GHz band segment with emissions complying with the Section 25.202(f) out-of-band emissions (OOBE) mask would not cause unacceptable interference into 5G systems operating at the upper edge of the adjacent 27.5-28.35 GHz band. That analysis examined land-based ESIMs (L-ESIMs) because the operating environment for these types of ESIMs presents scenarios with the closest and most consistent proximity to areas where 5G is most likely to be deployed and most prevalent, i.e., in urban areas where users are likely to be outdoors. As explained below, ESIMs deployed on aircraft, even when operating on the ground, would not likely have large numbers of 5G users operating in close proximity and would be even less likely than land-based ESIMs to impact 5G. Therefore, because the analyses show that OOBE at Section 25.202(f) levels from L-ESIMs are compatible with 5G, aeronautical ESIMs will also be compatible.

Enclosed as Exhibit A are the results of a dynamic and statistical analysis of ESIM compatibility in the 28.35-28.6 GHz band with mobile services (including relevant 5G parameters) in the adjacent 27.5-28.35 GHz band. Exhibit A reflects developments in the USWP4A and 5A process over the past few months. Specifically, Viasat submitted the Exhibit A analysis as part of an input to the July 2018 USWP4A process.[3]

Notably, the Exhibit A analysis uses the same MS system parameters specified by ITU WP5A, expressly factors in the relevant MS adjacent channel selectivity (ACS) and receiver noise values, evaluates both narrow-band and wide-band ESIM carriers at the edge of the 28.35 GHz FSS band, and uses the height/gain model option of P.2108 rather than the statistical clutter model option of the same P.2108 Recommendation.

Therefore, the parameters used in the Exhibit A analysis moot the issues that GSA raised in its June 11 *ex parte* with respect to a number of the parameters used in Viasat's March 23 analysis. Thus, Exhibit A serves as a complete substitute for the earlier March 23 analysis.

Critically, and unlike the static worst-case GSA analysis, this latest dynamic and statistical analysis shows that in all cases for the scenarios considered, the -6 dB I/N protection criteria

---

[1] GSA June 11, 2018 *ex parte.*

[2] Viasat March 23, 2018 *ex parte*.

[3] Changes subsequently were made to Viasat's input, incorrectly, and without its agreement; the modified document then was used as part of a US contribution to the ITU WP4A in Annex 2 of R15-WP4A-C-809!!MSW-E.docx.

recommended by ITU-R WP5A for sharing and compatibility studies of MS 5G systems is not exceeded by the operation of ESIMs in the 28.35-28.6 GHz frequency band segment.

Statistical vs. Deterministic Analysis

In item 1) in its June 11th *ex parte*, GSA suggests that a statistical analysis is not appropriate because there may be instances where certain ESIMs may be operating while not in motion. As an initial matter, this position is inconsistent with the one that both the Commission and the IMT community have taken in the ITU TG 5/1 study process for 5G, where they have insisted that 5G analyses must be statistical and not static, because 5G operations typically occur while in motion. Notably, that position has been taken even in the context of 26 GHz, 42.5 GHz and 50 GHz studies involving 5G compatibility with fixed earth stations in the FSS.

Contrary to what GSA implies, the statistical models in both versions of the Viasat analysis appropriately include realistic movement of the ESIM and Monte Carlo methods for user equipment (UE) station locations, which in turn drive the associated antenna pointing between the fixed base stations (BS) and the changing UE station locations. While GSA claims that static, deterministic analyses are appropriate for cases such as earth stations on aircraft parked at an airport gate, statistical analyses are in fact still appropriate because of the dynamic nature of the changing antenna pointing between the BS and UE stations.

GSA's static, deterministic analysis cherry-picks the pathological worst-case alignment between BS and the earth station on an aircraft parked at a gate, and likewise the UE and earth station. The results provided do not offer any insight as to how likely, how long, or how frequent such alignments might occur. In fact, they are likely very rare.

For instance, in an airport scenario, outdoor access is controlled with a limited number of personnel roaming around outside the area where an aircraft is parked. These personnel would frequently be moving about on the ground well below the height of the fixed earth station on the top of the aircraft and well off-axis of the radiating antenna pattern. The BS antenna pointing accordingly would be directed toward UE stations on the ground, well away from the earth station antenna on the aircraft. Further, the airframe offers significant blockage toward the terrestrial network users in the majority of these cases. In the case of users inside the aircraft, a 28 GHz 5G signal from a BS outside the aircraft would be severely blocked by the fuselage and likely unusable. GSA's static worst-case analysis fails to consider any of these factors and thus does not reflect a realistic analysis of the compatibility of ESIMs in the 28.35-28.6 GHz band with 5G operations in the adjacent 27.5-28.35 GHz band.

Further, GSA also fails to acknowledge the existing operating environment created by the fixed earth stations operating in the 28.35-28.6 GHz band around the U.S. and worldwide. Common applications for these fixed earth stations today include ATMs and gas stations, as well as installations at airports providing WiFi access to traveling public within airport terminals. These earth stations typically are roof mounted at airports in close proximity to gates where the

aircraft-mounted earth stations will park. These earth stations already operate with the same Part 25.202(f) emissions as ESIMs that may operate on aircraft parked at a gate.

Indeed, 5G receivers operating in the 27.5-28.35 GHz band will already need to be designed to account for these existing fixed earth station operations in the adjacent 28.35-28.6 GHz band. Like ESIMs, the existing fixed earth stations are designed to be compliant with Section 25.202(f), as well as with the ITU Radio Regulations (RR) and Recommendations ITU-R SM.329-12 and SM.1541-6 on out-of-band emissions. Additionally, the earth stations are designed in consideration of the elements of Article 3 of the RR, noting in particular Nos. 3.9, 3.12, and 3.13, which also apply to 5G operations.

> RR No. 3.9 states: "The bandwidths of emissions also shall be such as to ensure the most efficient utilization of the spectrum; in general this requires that bandwidths be kept at the lowest values which the state of the technique and the nature of the service permit. Appendix 1 is provided as a guide for the determination of the necessary bandwidth."
>
> RR No. 3.12 states: "Receiving stations should use equipment with technical characteristics appropriate for the class of emission concerned; in particular, selectivity should be appropriate having regard to No. 3.9 on the bandwidths of emissions."
>
> RR No. 3.13 states: "The performance characteristics of receivers should be adequate to ensure that they do not suffer from interference due to transmitters situated at a reasonable distance and which operate in accordance with these Regulations."

Unreasonable Worst-Case Assumptions

In items 2) and 3) in GSA's June 11th *ex parte*, GSA explains certain of its underlying assumptions. Specifically, GSA explains that it assumed that ESIM out-of-band emissions matched the Section 25.202(f) limits exactly without dropping off at frequencies well outside of the assigned channel (i.e., that out-of-band emissions remain constant beyond 250% of bandwidth), and that based on this assumption, GSA asserts that the necessary frequency separation is "infinite" because GSA claims that there is "no separation distance [that] could be calculated given the assumed OOBE mask." Based on this result, GSA argues for a "sloped, frequency-dependent terminal value" further from the assigned channel.[4]

These statements in GSA's *ex parte* were in response to Viasat's observation in its March 23rd *ex parte* that GSA had not specified the source of the values GSA used in its discussion of ESIMs. In Figures 2 and 3 of the GSA Reply Comments, GSA inexplicably shows that its receiver passband is centered at 28.5 GHz, showing absolutely no offset from the in-band transmissions of an ESIM. This cannot be the case, because the 28.35-28.6 GHz band segment is not available for 5G/MS purposes in the United States. The pass band center would have to be separated by at least 150 MHz plus an appropriate guardband.

[4] See GSA Reply Comments at 14 (filed Aug. 30, 2017).

The MS base station receive ACS mask from Figure 2 of GSA's Reply Comments, clearly showing 5G operation outside the spectrum available for 5G, is reproduced below.

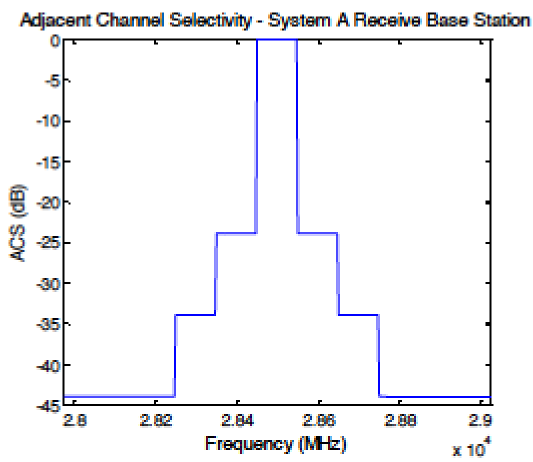

Figure 2 of GSA Reply Comments

The co-frequency masks for the ESIM and MS stations in Figures 2 and 3 of the GSA Reply Comments are used to model the frequency dependent rejection. It is unclear whether the calculation uses the above figure showing the MS receiver improperly centered at 28.5 GHz as the functions F(*f*) and S(*f*) are not shown in the GSA comments, but if so, this would certainly lead to incorrect results such as the 'inf' entries in GSA's analysis results.

What is clear is that, according to its comments, GSA has affirmed that it performs the FDR calculation on frequency values from minus infinity to plus infinity. As a matter of fact, evaluating for frequency values less than 0 Hz (DC) are absurd. Similarly, GSA takes its calculation above the terahertz frequency range to ultraviolet light and beyond.

Real-world transmitters and real-world receivers do not have infinitely wide bandpass and in reality, the out-of-band response rolls off due to practical constraints of hardware.

Despite being provided spectral plots of typical ESIM modem output by Viasat in August 2017[5] prior to filing its Reply Comments, GSA continues to assert that the ESIM emissions would be tangent to the 25.202(f) mask limits for frequencies from minus infinity to plus infinity when performing their calculations. This assertion is belied by the facts. Figure 2 in the attached Exhibit A shows a typical Viasat carrier (same modem used for both existing fixed earth stations and ESIM). It is clear that the carrier emissions continue to fall off at frequencies beyond 250%

[5] Intel, which is a member of GSA, requested this information from Viasat prior to GSA's Reply Comments, but this information was not reflected in GSA's analysis.

of the assigned channel bandwidth and do not remain tangent to the Section 25.202(f) mask indefinitely as GSA assumes in its calculations.

GSA's assertion also assumes that the receive bandpass of the MS equipment also extends out to frequencies from minus to plus infinity according to their mask – which is similarly unrealistic given the performance of actual RF hardware in the real world.

Recommended I/N Criterion

GSA asserts in item 4) of its *ex parte* that "I/N protection criterion for the terrestrial Mobile Service *as defined in ITU-R* is not associated with a percentage of time, location, or cases, and should be considered as instantaneous." (emphasis added). As an initial matter, there is no I/N protection criterion for 5G in the ITU-R in the bands at issue. There is merely a draft recommended criterion for purposes of preparing compatibility studies in the ITU process.

Regarding percentage of time and I/N statistics, it bears emphasis that the ITU-R WP5A recommended I/N criterion (-6 dB) for sharing and compatibility studies of MS 5G systems is never exceeded in this simulation. ***That should be the end of the analysis.***

Nevertheless, in response to GSA's argument that this criterion "should be considered as instantaneous," it is worth noting that no short- or long-term protection criteria have yet been developed for IMT in ITU Study Group 5, and that the ITU decided not to study use of the 27.5-29.5 GHz band for IMT. As discussed above, the operational characteristics of mobile wireless and ESIMs are inconsistent with the use of an instantaneous, time-invariant protection criterion. Significantly, the Commission has acknowledged in other contexts that when evaluating interference when mobile systems are involved, a time-invariant analysis is inappropriate.[6]

Viasat Analysis Parameters

In response to GSA's "other comments" in item 5) of its *ex parte* regarding parameters used in Viasat's analysis, the revised analysis in Exhibit A attached here reflects the 5G parameters that the U.S. has agreed and submitted to ITU-R. The revised analysis using these parameters does not change the validity of Viasat's original demonstration that out-of-band emissions from ESIMs operating in the 28.35-28.6 GHz band would not cause unacceptable interference into 5G receivers in the adjacent 27.5-28.35 GHz frequencies.

---

[6] *See, e.g., Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Order on Reconsideration and Second Report and Order, 31 FCC Rcd 5011, ¶ 267 (2016) (rejecting time invariant interference analyses as inapplicable to interference generated by terrestrial mobile services into the fixed satellite service).

GSA questions the validity of Viasat's analysis because it claims that the exact locations of ESIMs operating in an urban area cannot be predicted with certainty. Viasat modeled a land ESIM based on an urban environment representative of the use cases discussed during the Spectrum Frontiers proceeding as well as the majority of general discussion of 5G deployment scenarios in the press.[7] As rural deployments do not seem to get as much focus as urban from the 5G community, Viasat chose to model an urban setting. The area modeled in Washington, D.C. is representative of many downtown locales, near Viasat's DC office where ESIM testing could reasonably be expected to occur.

The scenario modeled, though fairly conservative, is more representative of real-world operations than GSA's static deterministic analysis that relies only on pathological worst-case values. The Viasat scenario is conservative in that, while real-world driving speeds are used for the ESIM, it is very unlikely that an ESIM would continue to drive around a path continuously 7/24, rather it would drive by and be gone until eventually another ESIM would drive by. By having the ESIM follow the path continuously throughout the simulation period, as GSA suggests, the number of potential interference events is greatly and artificially increased over likely real-world operation.

Further, GSA claims that Viasat's notional channel plan figures in its March 23rd analysis show a 20 dB difference in out of band emissions depending on the symbol rate of the carrier and suggests that the Commission may need to dictate a channel plan for ESIMs. This is incorrect.

As noted above, the notional channel plan included in Viasat's previous analysis as an illustration has been removed from the analysis in Exhibit A, which demonstrates that multiple channels can be used. In the revised analysis in Exhibit A attached, multiple different carrier configurations have been analyzed where a narrower bandwidth low symbol rate carrier at the band edge was evaluated and then a wider bandwidth high symbol rate carrier was evaluated at the band edge. The narrow bandwidth low symbol rate carrier represents a high power density carrier typically employed during worst case rain fade events, which depending upon location would not be expected more than about 3% of the time. The wider bandwidth high symbol rate carrier is more representative of normal use. While the roll-off of the wider bandwidth carrier is slower than the narrower bandwidth carrier in terms of dB/MHz and extends further into the UMFUS portion of the band, the power density of the wider bandwidth carrier is also considerably lower than that of the narrow bandwidth ESIM carrier.

Ignoring any gains from the use of OFDMA in the 5G system (robustness against narrow band interference), the total interfering power of the high power density narrow bandwidth carrier into the adjacent 100 MHz 5G channel is about the same as the total interfering power into the adjacent 100 MHz 5G channel from the low power density wide bandwidth ESIM carrier, not 20 dB difference as GSA indicates.

---

[7] https://www.comsoc.org/ctn/anyone-out-there-5g-rural-coverage-and-next-1-billion.

By analyzing both the narrow bandwidth carrier at band edge and wide bandwidth carrier at band edge, the results for any possible channel plan have been covered.

Moreover, while GSA notes that it "stands ready" to provide additional analysis, including statistical simulations once it receives detailed information on the operation of ESIM transmissions, it bears emphasis that GSA has long had all of the information that it needs to perform its analysis. ESIMs operate with exactly the same emissive characteristics as the millions of fixed earth stations already licensed to operate in the 28.35-28.6 GHz band and for which ample technical information is already publicly available. In addition, Viasat is authorized to operate aeronautical ESIMs in the Ka band, and the parameters for these earth stations are also publicly available.[8]

Finally, the fallacy of relying on GSA's static deterministic worst-case analysis with impractical infinite limits of integration across frequencies from below DC (minus infinity) to above X-ray (plus infinity) is made clear when it is taken to its logical conclusion: under that scenario, 5G is incapable of operating even with infinite separation distances not only from an ESIM in the Ka band, but also from a similar earth station operating 14 GHz away in the Ku band. Furthermore, there has been no dispute in this proceeding or in the ITU process internationally that 5G/IMT are in fact able to operate harmoniously adjacent to the out-of-band emissions from millions of fixed earth stations ubiquitously deployed across America and elsewhere in the world in the 27.5-30 GHz range.

[8] See Viasat, Inc., IBFS File No. SES-LIC-20180123-00055, Call Sign E180006 (granted Apr. 17, 2018).

Exhibit A

Sharing and compatibility between earth stations in motion operating with geostationary FSS networks and current and planned stations of the MS in the frequency band 27.5-29.5 GHz

1 Introduction

This analysis considers an earth station in motion (ESIM) operating at the lower end of the 28.35-28.6 GHz band with emissions complying with the USA National regulation FCC Part 25.202(f) out-of-band emissions (OOBE) mask and adjacent in frequency to MS systems operating at the upper edge of the 27.5-28.35 GHz band.

More specifically, this analysis considers a land-based ESIM (an earth station onboard an aircraft at an Airport while moving on the ground in the taxiing phase could also be considered a L-ESIM) operating at the lower end of the 28.35-28.6 GHz GSO FSS band in close proximity to a MS network operating at the upper edge of the 27.5-28.35 GHz band. Use of an L-ESIM versus an aeronautical ESIM (A-ESIM) or maritime ESIM (M-ESIM) represents a more likely worse-case scenario, as the L-ESIMs can operate in closer proximity to MS base stations (BS), and also because the operational antenna height of the L-ESIM is lower than that of the A-ESIM and M-ESIM and closer to the height of MS end user terminals (UE) and is more likely to result in the MS BS antenna pointing toward the L-ESIM than in the case of either the A-ESIM or M-ESIM. Further, access near A-ESIMs is generally restricted in airports resulting in very few outdoor MS end-users near the A-ESIM.

The results show that for even the worst-case link, the -6 dB I/N protection criterion is never exceeded during the simulation period (30 days) for the L-ESIM carrier closest to the band edge.

The simulation for the analysis was developed using the Visualyse Pro interference analysis software available from Transfinite Systems, Ltd, which implements methods and formulae found in the book "*INTERFERENCE ANALYSIS, Modeling Radio Systems For Spectrum Management*" by John Pahl.[1] The Visualyse software provides facilities for generating dynamic scenarios and capturing statistics as the simulation runs and for performing Monte Carlo operations at each time step of the simulation.

Use of a dynamic and statistical approach to model the interaction of the L-ESIM and the MS network, both dynamic systems, was chosen to model coexistence and properly reflect the dynamic nature of these systems.

---

[1] "Interference Analysis, Modeling Radio Systems For Spectrum Management", by John Pahl, © 2016 John Wiley & Sons, Ltd.

Accordingly, this analysis uses an approach including Monte Carlo simulations and dynamic movement of stations, both MS and ESIM, as well as realistic emission mask data for the ESIM. The simulation, run in Visualyse, produces statistics for the frequency with which a given I/N value was observed over the simulation period. During the simulation, the L-ESIM is moved continuously around a typical MS base station and user population while I/N calculations and associated statistics are accumulated over the duration of the simulation run.

In this analysis, to calculate the effects of out-of-band emissions (OOBE) from the ESIM, an emissions mask needs to be defined. Likewise, a notional carrier channel plan is used to establish the adjacency of the MS and FSS satellite networks.

While nominal carrier spacing for many currently operational satellite networks is in the range of 1.2 to 1.3 times the carrier symbol rate (see Figure 1), in this study, modern modems designed to operate at a lower spacing of 1.125 times the carrier symbol rate are considered.

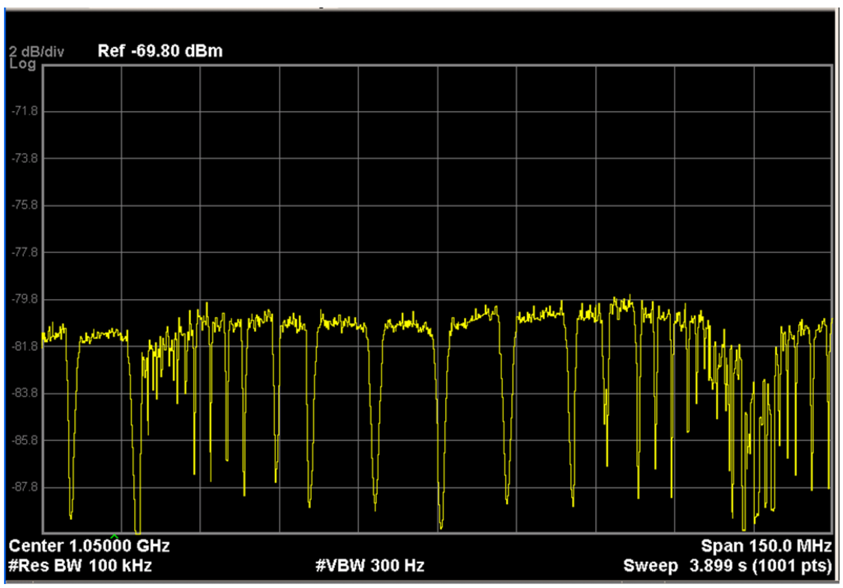

Figure 1, Capture of operational downlink carriers on WildBlue-1 from ESIM and FSS earth stations

Figure 2 is a simulated plot depicting two typical modern modems operating at 160 MBd and at the nominal 1.125 times the symbol rate carrier spacing.

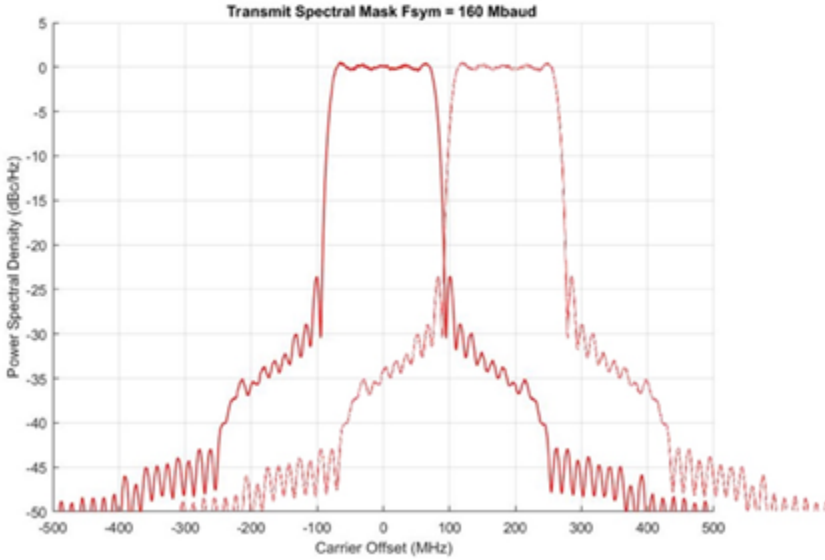

Figure 2, Simulation of typical modern modems operating at nominal carrier spacing.

From Figures 1 and 2 it can be seen that in normal operation the FSS earth station equipment functions as desired with channels assigned immediately to either side in very close spacing with some OOBE energy from the adjacent channel falling inside the desired carrier's receiver passband. As this energy is 25 to 30 dB reduced in amplitude from the desired carrier, it results in a small, but manageable, reduction of the total C/(N+I).

A representative spectral mask was created for modems employed by one operator, which are compliant with the FCC OOBE mask, as well as for the MS system. The operating characteristics of the L-ESIM considered in this analysis are summarized in Table 1.

Table 1, ESIM parameters

Parameter	Unit	Value
Frequency range	GHz	28.35-28.6
Carrier symbol rates	MBd	5 – 320, in x2 steps
Duty cycle	%	0.6
20 dB Carrier bandwidth	MHz	1.142 x symbol rate
Channel spacing	MHz	1.125 x symbol rate
Antenna input power	W	25
Antenna type	–	Elliptical
Antenna beamwidth (major, minor) axis	°	0.95 x 6.7
Peak transmit antenna gain	dBi	40.5
Antenna gain pattern	–	Bessel
Antenna polarization	–	Circular
Nominal antenna elevation angle	°	44.3
Antenna height	M	2.0

The development of the MS IMT simulation and the characteristics of the MS equipment are based on technical notes from Transfinite[2], and ITU-R Document 5A/650-E as referred to in a liaison statement from WP5A to WP4A. The relevant characteristics are given in Table 2 and are representative of MS System A.

Table 2, MS system parameters

Parameter	**Unit**	**Value (BS)**	**Value (UE)**
Frequency range	GHz	27.5-28.35	27.5-28.35
Carrier bandwidth	MHz	100	100
Channel spacing	MHz	100	100
TDD transmit allocation	%	80	20
Adjacent Channel Selectivity (ACS) (first adjacent)	dB	24	23
Noise Figure	dB	6.5	8.5
Antenna type	–	Visualyse IMT-Model 28 GHz BS	Visualyse IMT-Model 28 GHz UE
Peak transmit antenna gain	dBi	29	14
Antenna polarization	–	Linear	Linear
Antenna down-tilt angle (mechanical)	°	-10	+90 to -90
Antenna azimuth angle (mechanical)	°	0, 120, -120	+60 to -60
Antenna height	M	10.0	1.5
I/N Protection criterion	dB	-6	-6

The FSS modems contemplated in this simulation are capable of operating any one of the following symbol rates: 5 MBd, 10 MBd, 20 MBd, 40 MBd, 80 MBd, 160 MBd, or 320 MBd. Typically, in clear sky conditions, ESIM traffic will be carried on the 80 MBd and higher symbol rates. The lower symbol rates of 40 MBd down to 5 MBd are used for increasingly degraded link conditions, with 5 MBd representing the most faded links. It is important to note that the maximum antenna input power is the same regardless of symbol rate, so the power density per MHz is progressively reduced as the symbol rate increases.

To examine the impact of operating an ESIM uplink carrier on frequencies adjacent to an MS network, two scenarios were considered. Use of the 5 MBd symbol rate carrier representing worst case faded conditions and a nominal 160 MBd symbol rate carrier representing clear sky conditions. The same 25 W maximum input power is assumed for both carriers.

Figures 3 and 4 show the spectral masks as implemented in Visualyse of the upper 100 MHz MS channel centered at 28299 MHz compared with the 5 MBd symbol rate ESIM carrier centered at 28353 MHz.

---

[2] Technical Notes: "Building a MS Network in Visualyse Professional", and "Building a MS Reference System in Visualyse Professional". See: https://www.transfinite.com/content/downloadsvisualyse

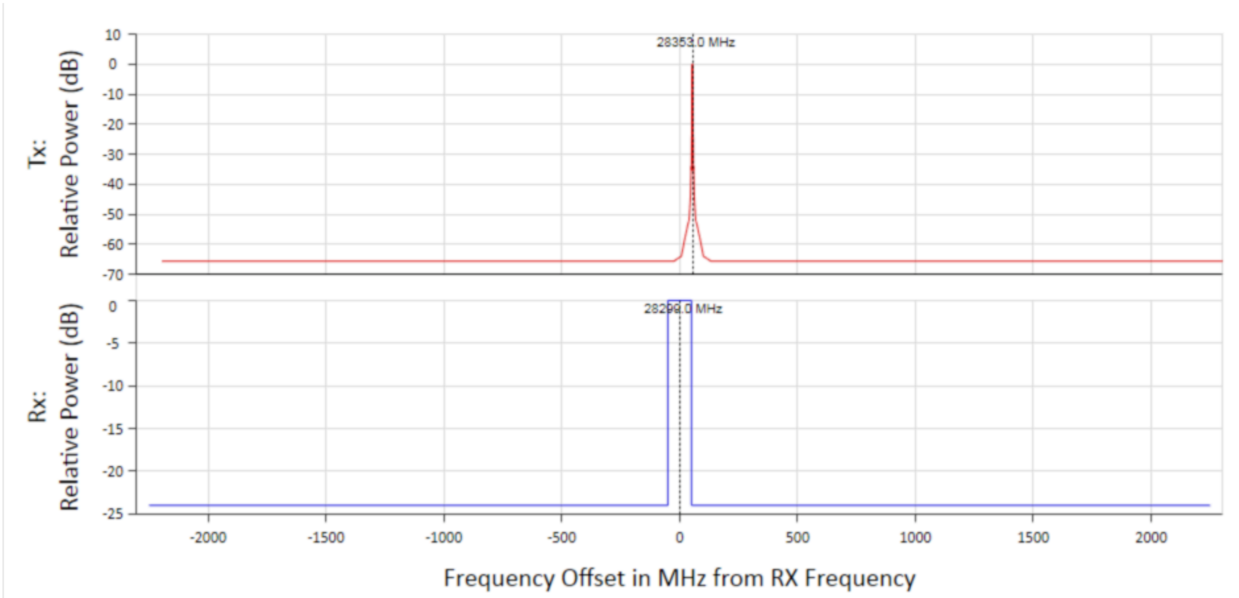

Figure 3, MS receive and ESIM 5 MBd carrier filter masks

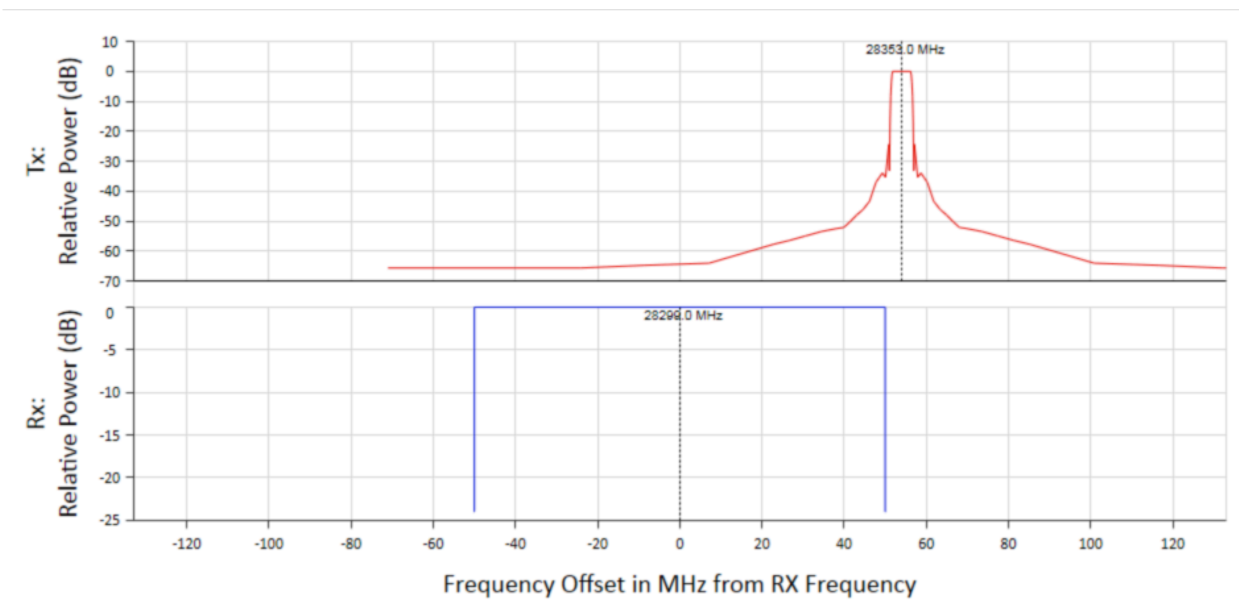

Figure 4, MS receive and ESIM 5 MBd filter masks – zoomed view

Figures 5 and 6 show the 160 MBd ESIM carrier centered at 28445 MHz. From the figures it can be observed that the MS station receive filter masks will capture not only OOBE from the

ESIM but also will receive energy from the in-band emissions of the ESIM operating in its assigned frequency allocation.

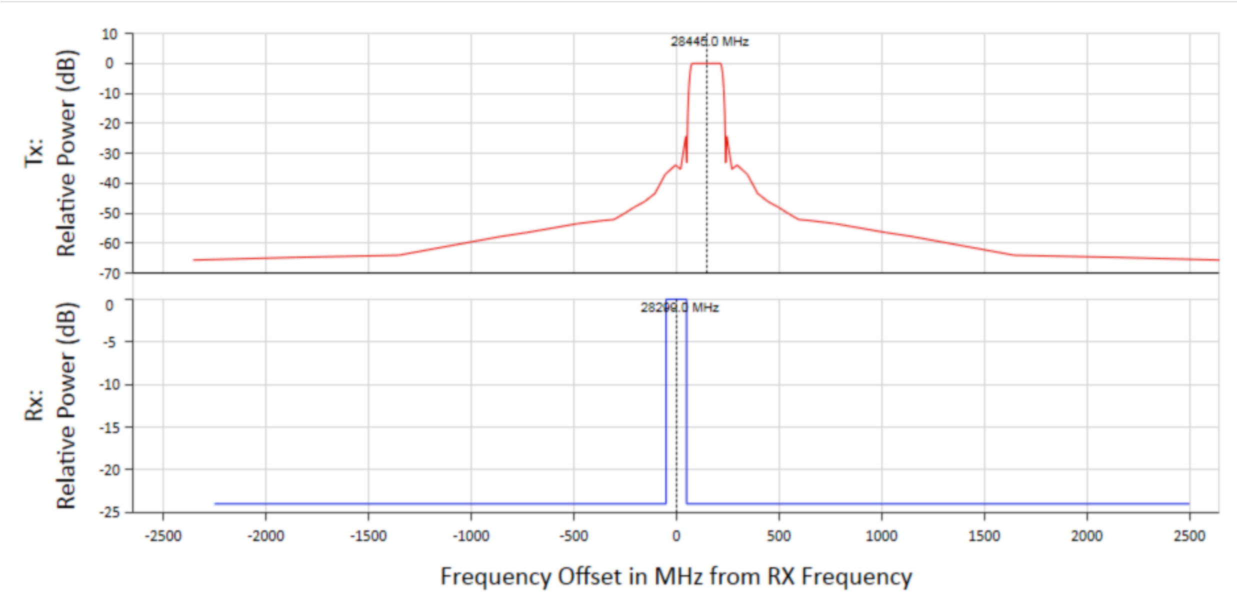

Figure 5, MS receive and ESIM 160 MBd carrier filter masks

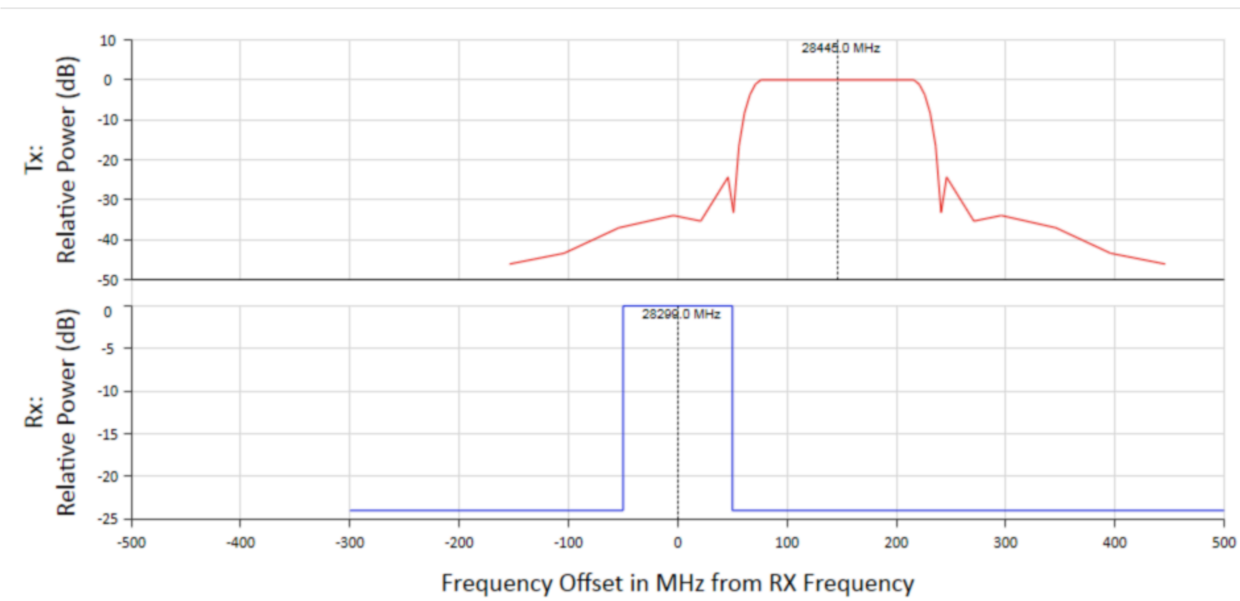

Figure 6, MS receive and ESIM 160 MBd carrier filter masks – zoomed view

As the simulation runs, to establish realistic antenna pointing angles for the L-ESIM as well as for the MS IMT equipment, a notional three sector MS BS was set up in Washington, D.C. Each MS BS sector has three UE devices assigned to communicate with it. The L-ESIM location was

initially set at Waypoint 1 as shown in Figure 8 and assigned to communicate with a GSO satellite located at 69.9° W.L. The Visualyse define variable feature is used to move the L-ESIM continuously throughout the during of the simulation. The L-ESIM moves at a constant 35 MPH (56.3 km/h) on a loop around the surface streets near the MS network. As the simulation runs, the L-ESIM moves from waypoint to waypoint until the loop is completed. The L-ESIM continuously repeats the loop throughout the duration of the simulation.

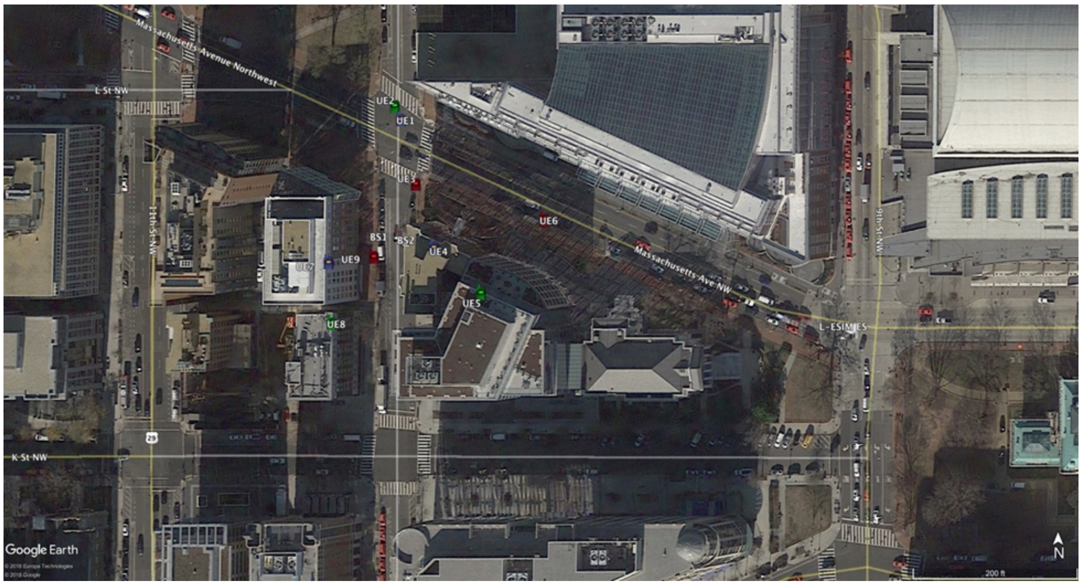

Figure 7, Station configuration near 901 K St, NW, Washington, D.C.

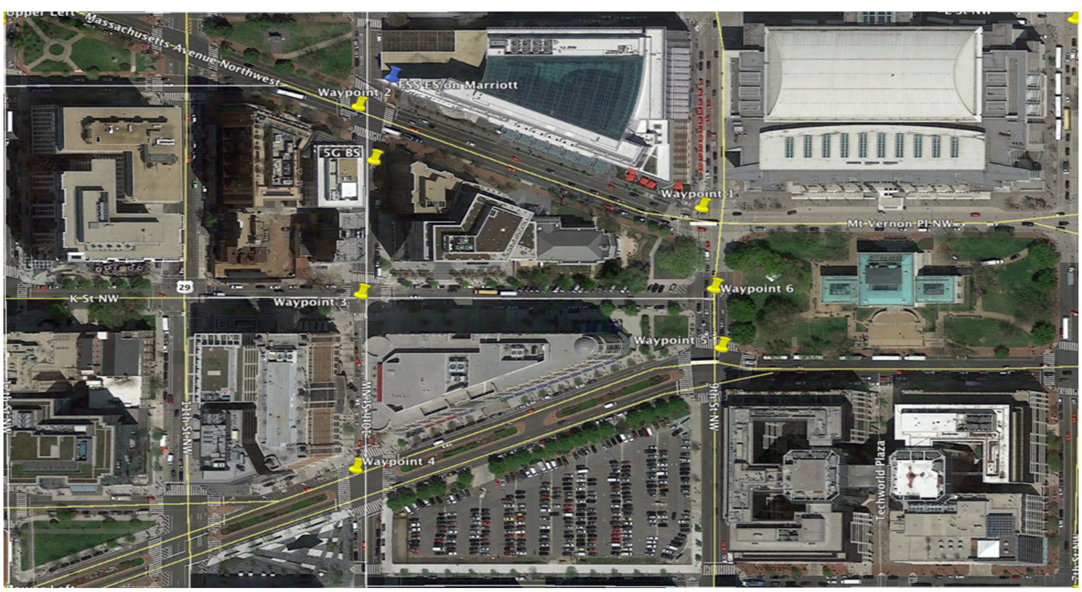

Figure 8, L-ESIM path following waypoints

Examining Figure 8, it should be clear that significant blockage of emissions from the L-ESIM will occur towards the MS IMT system when the L-ESIM travels between waypoint 4, 5, and 6,

due to the multi-story building between the MS equipment and L-ESIM along this path. In this simulation, the Visualyse ITU P.Clutter propagation model is set to for the Use Height/Gain Clutter Model option with the clutter type set to Urban/Trees/Forest for both Tx and Rx, which sets the representative clutter height to 15 m for each, and which is reasonable for this location.

In the simulation, the location of the MS UE stations and the L-ESIM are updated each time step. The MS BS location remains fixed as does the mechanical pointing of the BS antenna array. The mechanical pointing of the UE devices is randomly set within the limits and then the electronic pointing of the BS and UE devices is updated to point at each other. This occurs each time step in the simulation as the UE devices move to ensure the BS and UE stations keep pointing at each other.

When the simulation is running, the calculation of the received I/N takes into account the receive characteristics of the MS equipment, including the forward/return TDD traffic ratio, and the antenna pointing of MS and the L-ESIM for each time step of the Monte Carlo simulation in addition to the ESIM transmit characteristics. The Traffic module in Visualyse tracks when the transmitter and receiver of each station is on according to the duty cycle values configured. If a receiver is active at a given time step and the L-ESIM does not transmit, then that receive would not register any interfering power. Similarly, if the L-ESIM transmits and a MS station receiver is not active, that time step would also not register any interfering power for that station. In time steps where the L-ESIM is transmitting, and MS receivers are active, the recorded interfering power would be calculated using the relevant link parameters.

Figure 9 shows the cumulative distribution of percentage for the I/N measured for each of the MS links between the various UE and BS sectors when the L-ESIM is operating using the 5 MBd symbol rate carrier. In the Figure legends, the start to end link is configured as the BS transmitting to the UE and the end to start link is the UE transmitting to the BS.

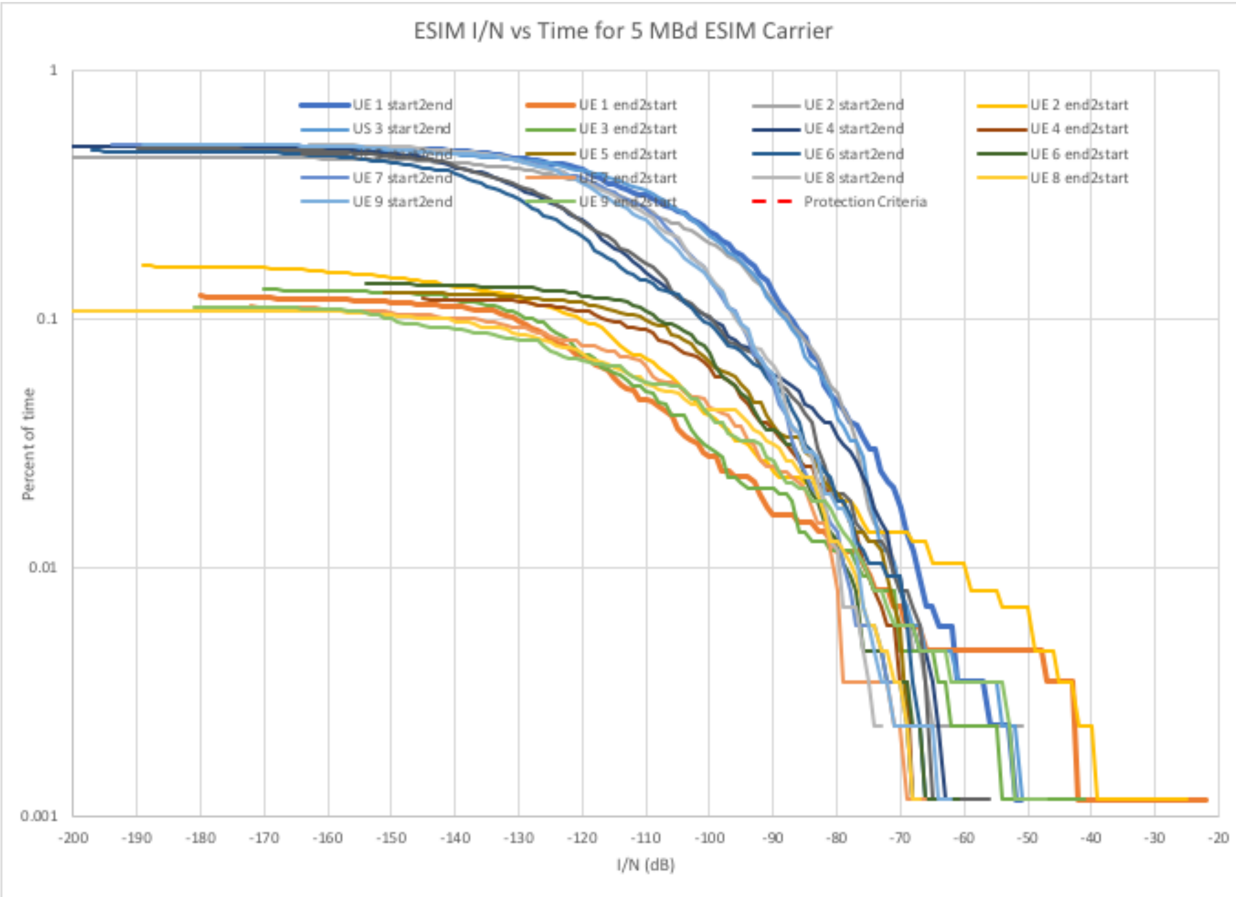

Figure 9, I/N statistics for 5 MBd ESIM carrier

The I/N curves for the start to end and end to start links of UE 1 represent the worst-case links of the nine UE devices. This result was generally true for each of the various ESIM return channel frequencies evaluated. UE devices 1, 2, and 3 are associated with BS sector 1, which is the sector pointed in a northern direction in the simulation. These UE devices are typically closest to the path of the L-ESIM as it passes, and this BS sector is looking north at them while the L-ESIM is transmitting toward the south, resulting in more direct antenna alignments than the other BS sectors.

The result show that for the 5 MBd ESIM carrier, for either a BS to UE link or a UE to BS link, the -6 dB I/N criterion was not exceeded during the simulation period. Over a 24 hour simulation run, the worst case link was the UE 1 to BS link with an I/N of -21.6 dB.

Figure 10 shows the results for the 160 MBd ESIM carrier. Again, the -6 dB I/N criterion is never exceeded during the simulation for both BS to UE and UE to BS links. The worst case I/N observed over the 24 hour simulation period for the 160 MBd carrier was -19.6 dB.

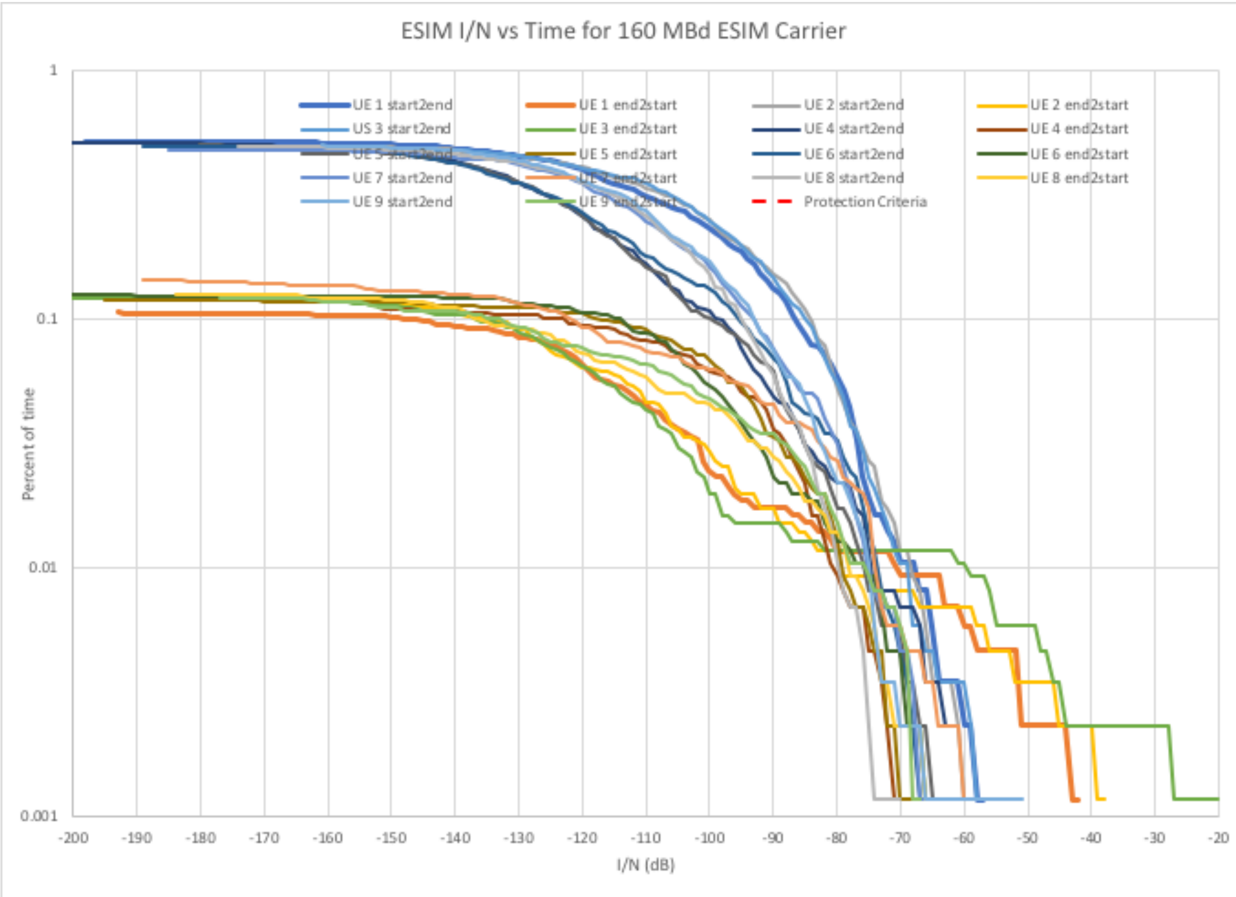

Figure 10, ESIM 160 MBd carrier I/N plot

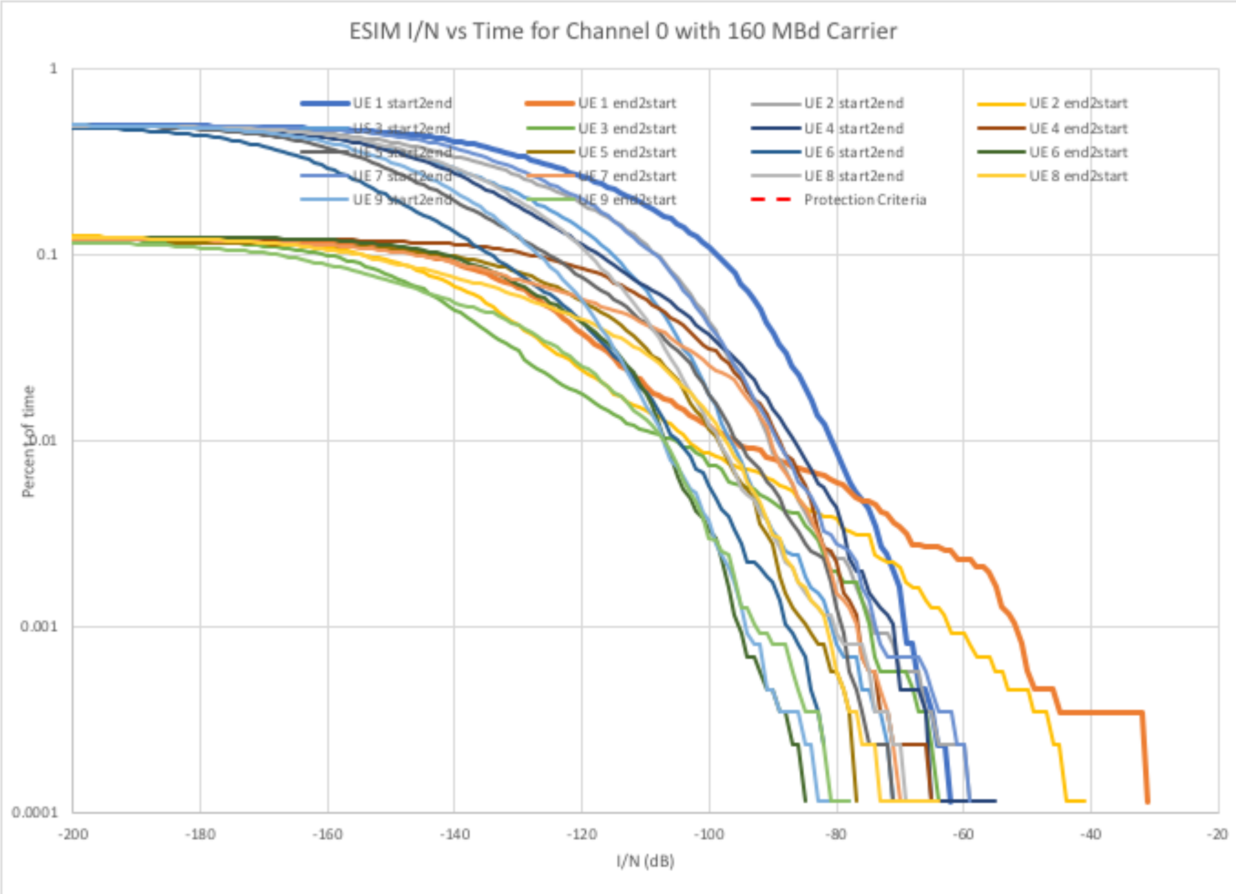

Figure 12, ESIM return channel 0 with 160 MBd carrier I/N plot

Conclusions

This analysis evaluates the impact of an L-ESIM station employing a modern satellite modem while operating near a network of MS stations. Monte Carlo simulation of UE station locations around a fixed set of BS stations and associated dynamic pointing of MS antennas to reflect MS station movement as well as dynamic movement of an ESIM station around the MS network deployment were used to reasonably simulate the sharing environment. The simulation results show that the -6 dB I/N protection criterion for the MS network was not exceeded during the simulation period when operating an L-ESIM on frequencies directly adjacent to a MS network and while traveling in close proximity to the MS BS and UE devices.

The simulation used the P.Clutter (P.2108) propagation model available in Visualyse to model clutter between the L-ESIM and MS stations. At very close separation distances this model may not accurately account for line of sight (LOS) conditions where no blockage is present.

In this analysis the L-ESIM is moving and quickly passes through the potential LOS area on each loop. The L-ESIM also transmits at a low duty cycle of 0.6% of the time, so the frequency of L-ESIM transmissions when in a potential LOS area is also very low. Accordingly, the probability that the L-ESIM has LOS, is transmitting, and MS UE or BS stations have their antennas pointed at the L-ESIM while MS

station receivers are actively receiving is low. Nevertheless, such instances would result in increased I/N values, potentially exceeding the MS protection criterion in some cases.

<u>**DECLARATION**</u>

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing *Ex Parte* Response of Viasat, Inc. to Global Mobile Suppliers Association in IB Docket No. 17-95 ("*Ex Parte* Response"), that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted with this *Ex Parte* Response, and that it is complete and accurate to the best of my knowledge, information and belief.

REGISTERED PROFESSIONAL ENGINEER
DARYL T HUNTER
E 16610
ELECTRICAL
STATE OF CALIFORNIA

Daryl T. Hunter, P.E.
Chief Technical Officer, Regulatory Affairs
ViaSat, Inc.
6155 El Camino Real
Carlsbad, CA 92009

August 29, 2018