Attachment 1

Technical Description

With this technical description, Viasat demonstrates that the operation of the G-12 antenna will be compatible with other services authorized in these bands. For ease of reference, Viasat includes technical descriptions of the network and the ESIM terminal relevant to the sharing discussions

Network

The G-12 ESIM antennas operate in the same WildBlue-1, ANIK-F2, ViaSat-1 and ViaSat-2 Ka-band networks, using the same frequencies and access method, as Viasat's residential customers using the fixed VSAT equipment authorized under call signs E170088 and E100143. In addition to supporting residential customers, this satellite network also incorporates the functions necessary to support mobility into the management functions of the both the SurfBeam (E100143) and Afterburner (E170088) multi-frequency time division multiple access (MF-TDMA) waveform technology operating on each of the respective networks. The design of each network allows the aircraft to fly across the service area and seamlessly switch from spot beam to spot beam within the current operational satellite and to switch between satellites as coverage dictates. The transmitted bursts from the ESIMs use the same return link channels as used by the residential terminals and represent just another burst out of many on any given return channel frequency.

Because the SurfBeam and Afterburner architecture each employ adaptive coding and modulation, the terminals could transmit at any code and modulation point within the library of available choices. For SurfBeam the available symbol rates range from 625 kBd to 40 MBd and for Afterburner the symbol rates range from 5 MBd to 320 MBd. Additionally, direct sequence spread spectrum (DSSS) may be employed at lower symbol rates to reduce the effective power density. The use of DSSS in this case is solely for power density reduction and not part of a multiple access method such as CDMA.

The SurfBeam and Afterburner architectures are designed to operate at the lowest power density modulation and code point that allows the link to close. The network employs adaptive power control and reduces power when conditions permit, typically keeping the Es/No margin at 1 dB or less above the intended operating point. When the modem has sufficient excess transmit capability, it will automatically switch to the next higher modulation and coding (MODCOD) point or symbol rate and increase data rate, keeping the e.i.r.p. density at the minimum. This further reduces the likelihood that the system will impact traffic on other satellites.

The maximum clear sky e.i.r.p. density for the G-12 will be limited to ensure that the off-axis e.i.r.p. density remains compliant with the relevant FCC rule Part (25.138 or 25.218). In the cases where use of a lower symbol rate, such as 10 MBd or less, would result in the off-axis e.i.r.p. density being above the FCC (25.138 / 25.218) limit, spreading will be used as necessary to reduce the power density as required to achieve a compliant value during clear sky operations.

The individual G-12 terminals are self-monitoring and capable of automatically ceasing or reducing emissions within 100 milliseconds if the transmitter exceeds the relevant off-axis e.i.r.p. density limits.

Antenna Patterns

The G-12 antenna transmit emissions comply with the off-axis e.i.r.p. density mask of FCC Part (25.138 / 25.218). Viasat is providing a set of antenna patterns in the license application for this earth stations in Exhibit B. In the receive patterns, the antenna gain of the G-12 exceeds the 25.209 gain mask over a portion of the envelope. To the extent that the antenna patterns do not comply with 25.209 Viasat understands that protection from interference is limited only to that provided by the 25.209 gain mask.

GSO Sharing

As noted above, the G-12 will transmit at off-axis e.i.r.p. density levels which are compliant with the relevant FCC rule Part (25.138 / 25.218) and therefore is compatible with the FCC's 2-degree spacing policy. Viasat has also coordinated the use of ESIMs with each of the adjacent GSO operators as well as other GSO operators in the region. The G-12 antenna complies with the limits in these coordination agreements.

NGSO Sharing Analysis

Viasat conducted an interference analysis for the various NGSO systems that participated in the recent Ka band processing round to demonstrate compatibility with these systems. This analysis is consistent with that provided and approved by the Commission in Viasat's license application (SES-LIC-20180123-00055) to demonstrate that the M40 and GM40 aeronautical earth stations could operate without causing harmful interference into these NGSO systems authorized or pending in the bands in which GSO FSS is designated as primary. As the G-12 antenna operates at a maximum EIRP and EIRP density which are lower than that of the M40 and GM40, and the transmit beamwidth is also narrower in the elevation plane (perpendicular to the GSO plane), the analysis results for the M40 and GM40 are equally applicable to the G-12 antenna operating either on ViaSat-1 or ViaSat-2.

Of these NGSO systems, the technical parameters of both Mantarray antennas are within the scope of Viasat's existing coordination agreement with OneWeb, and Space Norway does not have coverage over the license area.

Analyses were performed for Audacy, Boeing, Karousel, Leosat, O3b, Theia, Telesat, and SpaceX using the information in the Schedule S and technical narratives of the applications of the NGSO operators and using the technical characteristics of the Mantarray from this application including the antenna pattern with grating lobes. The analysis for each system was conducted using the Visualyse Pro analysis software available from Transfinite Systems Ltd.

In the software simulation, an ESIM was placed at the center of the NGSO's receiving beam next to a presumed gateway earth station of the NGSO system. The orbit of the

NGSO was propagated over a 30 day period while the ESIM transmitted using a typical duty cycle, as required to support commercial aircraft services in order to generate I/N statistic over time.[1] While parked aircraft are technically temporary-fixed earth stations, not ESIMs, the emissions are the same as if the aircraft were flying a holding pattern around the NGSO gateway station. This simulation was performed to develop worst-case I/N and interference statistics.

When the aircraft are in flight, they will normally transit through a typical NGSO receiving beam in a relatively short period of time. A nominal cruising speed of 250 m/s represents a cruising speed of 560 miles (902 km) per hour. Accordingly, an aircraft typically spends less than an hour in any given NGSO receiving beam. To simulate the effects of an ESIM transiting an NGSO receiving beam, an ESIM was configured in the simulation to travel between two points on either side of the receiving beam. The ESIM then was then flown forth and back repeatedly throughout the simulation duration.

While long- and short-term interference criteria have not yet been established for these NGSO systems, a reasonable benchmark to check for the presence of interference is the 6% ΔT/T coordination trigger. This value is equivalent to an I/N of -12.2 dB and represents an increase in the noise floor of the receiver of just 0.25 dB. In the case of GSO networks, this is also the long-term criterion for interference from an adjacent satellite network that could be received 100% of the time. So, if received I/N levels are less than the -12.2 dB, coordination is not required in the case of GSOs. If received I/N is greater than -12.2, but only for brief intervals and for a very small percentage of time, the brief noise floor increases are generally considered short-term interference, which are typically acceptable.

The results show that for the NGSO system most sensitive to the elevation beam of the Mantarray, the time statistics for percent of time less than -12 dB I/N increases from 99.995% to 99.9994%, and the worst case I/N is reduced 3 dB in this scenario where the aircraft is flying at normal cruising speeds through the receiving beam. This is as reasonably expected because the aircraft is not in the beam full time, and when it is in the beam, it is not always at the beam center when transmitting. Received interference is reduced by the roll-off of the receiving beam pattern over the coverage area.

Table 2: Simulation Results for the Various NGSO systems

System	-12.2 dB I/N Exceeded	% Time	% of time meeting -12.2 dB	Worst I/N (dB)	Total Exceeded (s) / month	Longest Event (s)	Separation Angle (deg)
Audacy	No	0	100.000	-60.00	0	0	NA
Boeing	No	0	100.000	-19.00	0	0	6
Karousel	No	0	100.000	-23.00	0	0	20
Leosat	Yes	0.000965	99.9990	-2.72	26	1	7

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[1] Due to the large number of similar orbital planes, the SpaceX simulation was only run for 24 hours.

O3b	Yes	0.000116	99.9999	-1.13	3	1	7.6
SpaceX	Yes	0.000579	99.9994	-4.68	15	1	22
Telesat	Yes	0.000270	99.9997	-6.70	8	1	11.9
Theia Holdings	Yes	0.000154	99.9998	-7.46	4	1	10

These simulations use a single ESIM in either the stationary or moving scenarios, which is a realistic representation of the actual operation of a larger number of ESIM terminals in the entire network, because these networks use MF-TDMA as described below. As described above, the Viasat GSO satellite networks employs MF-TDMA as an access method for the various residential user terminals and for the ESIMs accessing the satellite. In a time-division multiple access system, only one station may transmit on a given frequency and polarization within a beam at a given time. Each station transmits for a brief time and then another station transmits and so on. There may be gaps or pauses between transmissions depending upon network loading, but two stations never transmit on the same frequency at the same time.

In the case of multi-frequency TDMA, a given station may dynamically change frequencies as directed by the network controller and transmit on frequency A for burst 1, frequency B for burst 2, and so on, or the station may transmit on frequency A for burst 1 and burst 2, and remain on that frequency indefinitely—choice of frequency allocation and time slots are up to the network management system. As with the residential earth stations which operate under E170088 or E100143, regardless of how many aircraft are flying through the same ViaSat-2 or ViaSat-1 beam at a given time, only one earth station, residential or ESIM, will transmit on the same return link channel frequency at a time. Therefore, having a single ESIM in the simulation co-located with an NGSO gateway 24/7 is representative of the highest possible interfering power because no two earth stations, and certainly no two aircraft, will burst at the same time and aggregate their energy. Thus, the I/N recorded in the simulation for an aircraft in the beam center of the NGSO receiving beam represents the highest expected at any time

While each of the Viasat satellites have many beams, these beams employ a frequency and polarization reuse pattern such that it is unlikely that any two adjacent beams which might fall inside the area of a given NGSO receiving beam will be both co-frequency and co-polarization. While there maybe be two ESIMs transmitting, one in one Viasat satellite beam and one in another Viasat satellite beam, the two ESIMs will not be operating on the same frequency and polarization due to the frequency reuse pattern of Viasat satellites. Therefore, it is very unlikely that transmissions from adjacent Viasat satellite beams will result in the aggregation of interference into the receiving beam of an NGSO satellite.

Lastly, as described above, while only a single ESIM may transmit at any given time, multiple ESIMs may transmit one after the other, effectively increasing the percentage of time interference is received on a given frequency—this does not, however, increase the I/N, just the percentage of time in which it might occur. With the exception of operation near airports, ESIMs are generally well distributed throughout a satellite receiving beam. The alignment between the ESIM antenna on each aircraft and the NGSO satellite will be different give the various geographic locations of the ESIMs. Accordingly, even though multiple stations may burst one after the other in a receiving beam, the elevation and azimuth beam pointing of each ESIM will not align with the NGSO satellite and some of those bursts will not contribute toward effectively increasing the duty cycle. As noted in Table 2 above, several NGSO systems have worst case I/N values much lower than -12 dB I/N, and where a NGSO network's worst case I/N is -12 dB or greater, the percentage of time for a single aircraft is very low—in the region of < 99.999% of the time. In those cases, even a theoretical hundredfold increase in the number of aircraft transmitting one after the other still only raises the likelihood of hitting a -12 dB I/N to < 99.9% of the time.

In addition, the ESIMs operate under control of a Network Management System (NMS) that coordinates the real-time operations of the TDMA scheduler for each beam on the satellite, cease transmission commands can be sent to individual earth stations for the duration of the brief period when the separation angle identified below falls below the specified minimum as calculated by the NMS using data from Space Track or the NGSO operators.

UMFUS Sharing Analysis

The G-12 antenna is capable of operation across the 27.5-28.35 GHz band. To assess compatibility with the UMFUS in the 27.5-28.35 GHz band, an analysis was performed using Visualyse to determine compliance with the power flux density (PFD) limit at a 10 m reference height above ground level from an aircraft flying at 10,000 ft above ground level.

The analysis considered an aircraft flying at 10,000 ft above ground level rather than an aircraft operating on the ground because Viasat is not seeking authority in this application to operate below 10,000 ft in the UMFUS band. Communications below 10,000 ft, on the ground, and at the gate will be conducted in the 28.35-29.1 GHz and 29.5-30 GHz bands.

The Visualyse analysis uses the measured G-12 antenna pattern and assumes the maximum antenna input power of 20 W is being applied in the 80 MBd symbol rate setting which in clear sky conditions complies with the FCC off-axis e.i.r.p. density mask. The aircraft in the simulation is set to fly at 10,000 ft above ground level directly over a reference antenna located at 10 m above ground level. The flight starts approximately 230 km away from the airport and flies at 250 knots until it passes over the airport and continues until it is approximately 230 km away in the other direction. The operating elevation angle from the aircraft to the satellite is 43.6 degrees. As the aircraft is flying at 10,000 ft, the UMFUS PFD reference antenna is always below the aircraft and accordingly the angle downward from the aircraft toward the UMFUS PFD reference is always negative and ranges from -1.8 degrees relative to the horizon to -89 degrees as the aircraft passes over the top of the reference antenna on the ground and back up to -1.8 degrees at the end of the simulation run. The total off-axis angle is the difference of the elevation angle towards the satellite (43.6 degrees) minus the angle downward toward the UMFUS reference antenna (-1.8 to -89 degrees), or 45.4 to 132.6 degrees.

The simulation takes into consideration fuselage attenuation (airframe blockage) according to Figure 3 and normal path and atmospheric losses but does not assume any clutter losses between the aircraft and the antenna on the ground. At long distances, fuselage attenuation is minimal but path loss is higher. At closer distances, the downward angle toward the UMFUS PFD reference angle on the ground increases, as does the related fuselage attenuation. As the airplane banks in flight the amount of fuselage attenuation varies but at no point during the simulation run does the PFD exceed the -77.6 dBmW/(m^2 * MHz) limit at the reference antenna location on the ground.

Figure 3
Fuselage Attenuation (Aircraft Shielding) from Report ITU-R M.2221

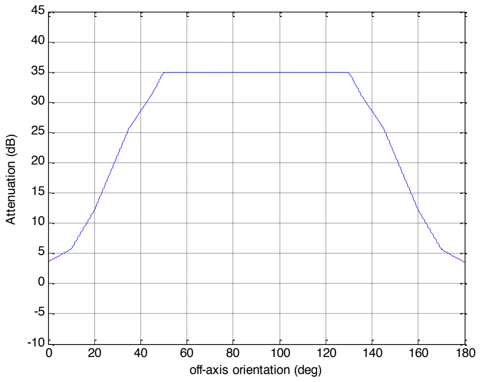

Table 3 shows the values taken from the Visualyse simulation at a snapshot of the point when the worst-case PFD value at the 5G reference measurement location occurred in the simulation. The maximum observed PFD value was -123.8 dBW/(m^2 * MHz), which is 15.4 dB below the -77.6 dBmW/(m^2 * MHz) limit in 25.136.

Table 3: Visualyse simulation snapshot results

Aero ESIM		
Antenna Input power	20.0	W
Modulated bandwidth	80.0	MHz
Input power density	-6.0	dBW/MHz
Antenna on-axis gain	35.8	dBi
Antenna relative gain toward 5G	-63.0	dB
Antenna off-axis gain toward 5G	-24.2	dBi
EIRP density toward 5G	-30.2	dBW/MHz
Path and atm loss toward 5G	106.1	dB
Fuselage attenuation	35.0	dB
Power density at 5G ref location	-174.3	dBW/MHz
Gain of m^2 area	50.5	dB/m^2
Power flux density at 5G ref loc	-123.8	dBW/(m^2*MHz)
Power flux density at 5G ref loc	-93.8	dBmW/(m^2*MHz)

The analysis shows that the PFD limit for protection of UMFUS stations will be met even at the highest potential clear-sky operational EIRP density for the G-12.