Your response

Question	Your response
Question 1: Do you anticipate this licence variation will pose coexistence challenges to existing NGSO services? **Question 2:** Are the measures set out by the applicant to enable coexistence with future NGSO systems reasonable?	Confidential? – N Viasat appreciates the opportunity to provide input to Ofcom on the application of SpaceX to seek a variance of its gateway license. In our detailed response[1] on the original request for license, Viasat raised various concerns including, but not limited to, the preclusive effects of SpaceX's first generation (Gen1) and second generation (Gen2) iterations of its non-geostationary satellite orbit (NGSO) system on shared access to space and the potential to interfere with geostationary (GSO) networks and other NGSO systems. The license variation request by SpaceX to add 24 more antennas at three different gateway sites and 32 additional antennas at one particular gateway site significantly exacerbates the concerns raised with respect to the prior licence application. Naturally, with more antennas being requested in the UK, the number of active Starlink satellites transmitting and receiving to and from the UK would increase. The use of 1.8 m antennas for the Starlink gateways would add further constraints on the sharing situation and availability of look angles. Ofcom, in their original NGSO licensing consultation, concluded that sufficient sites will be available in UK on the basis that not all systems will technically depend on a gateway in the UK in order to be able to offer services in the UK, and those that do would need only a limited number of gateways (depending on their system architecture). The number of gateways sites and the number of antennas at those gateway sites requested by SpaceX are certainly not limited and this request for license variation requires careful consideration by Ofcom to ensure that other operators can also effectively provide services in UK by deploying both smaller user terminals and gateways. With nine gateway sites in the UK, SpaceX gateway links through its 150+ antennas can consume significant portions of the "look angles" toward space and low Earth orbit (LEO) orbits as well, preventing use of the sharing

[1] https://www.ofcom.org.uk/__data/assets/pdf_file/0029/243776/viasat.pdf.

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	tools that have been employed successfully for decades among NGSO systems. This license variation request represents a threat to NGSO spectrum sharing within the UK as SpaceX gateway links have the potential to "blanket the sky," causing many in-line interference events, limiting and sometimes completely blocking, other NGSO systems from sharing the same spectrum. While Ofcom prefers bilateral cooperation between operators to achieve coordination in good faith, there are various reasons why coordination may not be achieved. For example, as explained in a recent contribution to ITU WP4A[2], when a small NGSO constellation is required to protect a large NGSO constellation by implementing an avoidance angle, if the information of active satellites of the large constellation is not known a priori or not provided in real-time, the impact to the small constellation is severe, blocking any possibility for the small constellation to provide service at that location. Even if that information is provided, the size of the required avoidance angle can still impose significant constraints on the ability of to the small NGSO constellation to provide service. To avoid this result, it is critical, at a minimum, to adopt a condition requiring "look angle" splitting, for example, requiring NGSO systems serving a country in overlapping frequencies to divide the range of satellite azimuths as seen from a location on the Earth whenever the potential for NGSO/NGSO interference exists at that location[3]. Notably, the same level of "look angle" splitting would occur regardless of the number of satellites in a given NGSO constellation. Each operator would bear the same "splitting" burden by default, in the absence of some other coordinated outcome. This approach would allow multiple NGSO systems to access available spectrum resources on a more equitable basis.

[2] See document 4A/89 from Intelsat, *studies related to the working document towards preliminary draft new recommendation/report ITU-R S.[INTERFERENCE-NGSO],* https://www.itu.int/md/R23-WP4A-C-0089/en.

[3] In similar cases, the United States imposes spectrum-splitting constraints on "foreign" NGSO systems that seek U.S. market access. *See, e.g., In re Kinéis, Petition for Declaratory Ruling to Access the U.S. Market Using a Low-Earth Orbit Satellite System,* FCC 21-118 (rel. Dec. 19, 2021) at ¶¶ 2, 12 (French LEO system granted U.S. market access under the following condition: "Absent a coordination agreement, spectrum will be divided among licensees and grantees of U.S. market access pursuant to section 25.157 of the Commission's rules."), https://www.fcc.gov/document/fcc-grants-market-access-kineis-low-earth-orbit-satellites-0. The US approach, however, disproportionately disadvantages smaller NGSO systems for the reasons explained in here.

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	Specifically, Ofcom should condition licenses for large NGSO constellations to ensure they do not hinder equitable access to shared and limited NGSO orbital resources by requiring NGSO systems authorized to serve the UK to: • Operate with only 1/*n* of the look angles in a given country, where *n* is the number of NGSO systems authorized to serve that country in the same frequency band, and • Coordinate in good faith and in advance with other NGSO systems so that all *n* look angles may be used to serve that country by those different NGSO systems. With this approach, NGSO systems would be on a more equal footing, regardless of system size, incentivizing all NGSO systems to coordinate, preserving and promoting new opportunities for industry growth in the country.
Question 3: Do you expect that granting this variation request would adversely affect competition? If so, please explain why.	Confidential? – N Efforts to "blanket the sky" with a large number of earth stations in the UK communicating with a large number of Starlink NGSO satellites can have direct and harmful consequences for other NGSO systems and operators – and can harm innovation, industry growth, and the broader public interest. NGSO systems like SpaceX (especially when supplemented by Gen2) would have little incentive to avoid in-line interference events. The large NGSO system itself would never be "blocked," or suffer any reduction in available capacity, as a result of the operation of smaller NGSO systems. This is because it would be able to leverage the satellite diversity afforded by the extremely large number of satellites in the system; in the event of an in-line interference event involving one satellite, it could simply reroute through another satellite. As a result, the large NGSO system could hinder other satellite operators, including new entrants, from accessing and using shared spectrum and orbital resources in the public interest.
Question 4: Do you have any additional concerns or comments regarding the variation request?	Confidential? – N

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	The license variation request by SpaceX to add 24 more antennas at three different gateway sites and 32 additional antennas at one particular gateway site significantly worsens the issues raised previously regarding the potential to interfere with GSO operations. Viasat notes that the additional antennas requested by SpaceX are to connect both the first generation (Gen1) and second-generation (Gen2) iterations of its constellation. As recognized by SpaceX in their license variation request, the Federal Communications Commission (FCC) in the United States has authorised 7500 satellites to be deployed under SpaceX's Gen2 iteration. The authorisation is limited to deployment of satellites at 525 km, 530 km and 535 km altitude orbital shells. In addition, the FCC has precluded operations above the 580 km altitude. The relevant ITU filing, USASAT-NGSO-3X, that was submitted on 3rd April 2023, consists of 29,988 satellites in 9 orbital shells from altitudes of 340 km to 614 km. No technical analysis has been provided by Space X to demonstrate the capability of the 'as authorised' Gen2 satellites to meet the Article 22 equivalent power flux density (EPFD) limits to protect GSO networks from unacceptable interference. As noted below, those satellites do not meet those EPFD limits. The ITU Bureau has not yet conducted its EPFD examination to determine whether the relevant Gen2 filing, USASAT-NGSO-3X, complies with the Article 22 EPFD limits. The ITU alone cannot effectively check all of the ways an NGSO system operator may try to "game" the system, by contriving EPFD inputs in a way designed to "pass" the ITU's spot checks regarding EPFD without regard to the actual operation of the NGSO system that affects every nation. Notably, that responsibility falls on individual administrations and regulators that consider authorizing, or granting market access to, NGSO system operations[4]. In such a scenario, without an independent EPFD assessment from Ofcom, and for the reasons outlined below, there is no basis for expecting that Starlink will comply with the limits in Article 22 of the Radio Regulations. On

[4] The U.S. Federal Communications Commission (FCC) has indicated that it did not and will not conduct any such analysis of an NGSO system, deferring instead to an ITU evaluation processes for the underlying filings, despite the known shortcomings as discussed in here.

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	the contrary, significant issues have already been raised about the USASAT-NGSO-3X filing at the ITU, most recently in a document submitted to Working Party 4A (4A/94)[5]. The analysis in document 4A/94 for the SpaceX Gen2 ITU filing demonstrates that one of its PFD masks, for the 604 km orbital shell has been artificially designed, to force the current ITU-R S.1503 algorithm to select a specific and favourable, but non-representative, 'worst-case geometry' (WCG) for the entire non-GSO system. The artificial design of one particular PFD mask for a single orbital shell conceals the interference produced by all other PFD masks of the Gen2 filing that actually contain higher PFD levels outside the WCG, leading to large exceedances of the EPFD limits at geometries other than WCG. When the unauthorized 604 km shell is included, these other EPFD limit exceedances are not identified in the examination based on S.1503-2. In fact, no orbital shell at any altitude other than 604 km (which has not been authorized) passes EPFD assessment. And it would defy common sense to conclude that an ITU filing meets EPFD limits when removing 144 satellites from the analysis results in higher calculated EPFD for the rest of the constellation. Furthermore, as demonstrated in the contribution, the ITU filing for Gen2 has material inconsistencies between the input parameters used for EPFD assessment, namely alpha angle. The so-called "alpha angle" utilized by an NGSO system is critical to estimating EPFD levels of the NGSO system. Alpha angle determines the extent of GSO arc avoidance and defines the resulting NGSO exclusion zone on the ground in the field of view on an NGSO space station (which moves as a function of the latitude of the NGSO sub-satellite point). Interference mitigation techniques like GSO arc avoidance are implemented in creating the PFD mask.

[5] *See* ITU WP4A contribution 94, *Working document towards a preliminary draft revision of Recommendation ITU-R S.1503-4 - Underestimation of non-GSO interference arising from the use of worst-case geometry in S.1503 and necessity to supplement it with grid-based epfd analysis*; https://www.itu.int/md/R23-WP4A-C-0094/en

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	The alpha angle utilised by an NGSO system is relevant to an S.1503-2 evaluation as that angle defines how many NGSO satellites are deemed to contribute to an EPFD calculation. The S.1503-2 software considers the effect of (i) all the NGSO satellites within the exclusion zone determined by the alpha angle, and (ii) only the "Nco" satellites outside that zone. S.1503-2 clearly provides that the "use of α or X angle pfd masks implies that the same definition of GSO angle is used for the exclusion zone in the calculation of epfd↓". In the USASAT-NGSO-3X filing, an alpha angle of 4° is claimed. The PFD masks, however, indicate that the actual alpha angle for this NGSO system is at least 18°. Ignoring the 18° alpha angle represented by the PFD mask and instead utilizing the claimed alpha angle of 4° would artificially reduce the number of satellites contributing towards the EPFD calculation under the software. For a system as large as the USASAT-NGSO-3X system with 29,988 satellites, such artificial reduction in the number of satellites within the exclusion zone would significantly reduce the EPFD estimated by the software. Additionally, the specific request for 24 additional antennas at three gateway sites and 32 additional antennas on the Isle of Man is inconsistent with the data provided for a) earth station density, b) average distance between cells, and c) the number of co-frequency satellites transmitting at the same location in the USASAT-NGSO-3X filing for EPFD assessment. These inconsistencies are explained in detail below: a) The earth station density is defined as the average number of NGSO earth stations active at the same time per km^2. The data provided for earth station density in the USASAT-NGSO-3X filing is 1.37e-5/km^2. According to publicly available data[6], the surface area of UK is 243,610 km^2. With nine gateway sites licensed for SpaceX in the UK and assuming 160 gateway antennas in total, the average SpaceX earth station density within UK is 6.5679e-04/km^2, ***higher by a factor of 15*** in comparison to the declared earth station density in the USASAT-NGSO-3X filing

[6] Data from worlddata.ino https://www.worlddata.info/europe/united-kingdom/index.php

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	b) Similarly, the average earth station distance provided in the USASAT-NGSO-3X filing is 270 km. The distance between two SpaceX gateway sites in the UK, Woodwalton and Wherstead, is a mere 90 km – lower ***by a factor of 3.*** c) Finally, the maximum number of NGSO satellites that provide co-frequency service at a specific location on the Earth' surface is declared as 32 in the USASAT-NGSO-3X filing in the frequency band used for Starlink gateway links. The license variation request to deploy a total of 40 gateway antennas on the Isle of Man does not commit to maintaining an NCO of 32 for gateway links and thus can result in higher EPFD levels in practice than what would be calculated by the ITU during their EPFD assessment of the filing. All the above parameters are utilised in the evaluation of EPFD levels towards GSO networks and the discrepancy between the information provided for the license request and data provided in the ITU filing for the EPFD examination can result in higher EPFD levels produced by Starlink gateways or Starlink satellites communicating to those gateways in practice than what may be calculated by the ITU BR using ITU-R S.1503 for the USASAT-NGSO-3X filing. Ofcom introduced its new NGSO licensing process in December 2021 designed mainly to help manage the risk of interference and enhance transparency. Therefore, as part of the consideration of SpaceX's license variation request, and given the issues raised above, we urge Ofcom to conduct its own EPFD analysis with realistic and consistent input parameters to ascertain the potential of interference from Starlink's Gen2 system towards GSO networks operating in, and GSO filings of, the UK before approving this variation request. And we also encourage Ofcom to recognize that EPFD exceedances also consume more of the aggregate EPFD budget that must be shared among all NGSO systems, and thus also can impair the operations of other NGSO systems as well.

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	In addition, while we welcome Ofcom's requirement on all NGSO operators using the same frequencies to cooperate in order to meet the aggregate EPFD limits in Resolution 76, Viasat would like to emphasize that Ofcom has already licensed three NGSO systems, excluding Starlink, to operate in Ka band. Moreover, SpaceX Gen1 and Gen2 NGSO systems have been treated by the FCC as two separate systems. The single-entry EPFD limits that every NGSO system has to meet individually was derived from aggregate EPFD limits on the basis of 3.5 NGSO systems operating in the same frequency band. With five NGSO systems licensed to be operated in the UK, and multilateral administration consultation meetings not scheduled to begin before year 2027, it is now critical for Ofcom to assess the potential of all the currently licensed NGSO systems in the UK to exceed aggregate EPFD limits in Resolution 76.
Question 5: Do you agree with our assessment of the potential impact on specific groups of persons?	Confidential? – N No Comment
Question 6: Do you agree with our assessment of the potential impact of our proposal on the Welsh language?	Confidential? – N No Comment

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