Your response

Question	Your response
Question 1: Have you identified an alternative use for the 14.25-14.5 GHz band which could lead to greater benefits for consumers and citizens than our proposal to extend satellite ESN authorisations? Please provide evidence to support your comments.	No comment.
Question 2: Do you agree with our proposal to extend access in the 14.25-14.5 GHz band for satellite connectivity, for future broadband, air, sea, energy and transport uses? Please provide evidence to support your comments.	*Is this response confidential? No.* Viasat has significant business interests in the Ku band—as a manufacturer of Ku-band equipment, a provider of Ku-band satellite connectivity, and a Ku-band ESIM licensee. Viasat has committed to tremendous capacity in space by utilizing bandwidth on multiple Ku-band satellites. As such, Viasat has the requisite interest to participate in this consultation. Viasat applauds Ofcom's aim to enable satellite systems to develop and grow as stated in section 4.1 of the consultation. Viasat broadly agrees with Ofcom's proposal to extend access to the 14.25-14.5 GHz band for satellite services which will help to serve the unmet connectivity needs of the UK. As Ofcom recognizes, the Ku and Ka bands are the two main bands used for providing satellite broadband services today. Significant opportunities for the UK are presented by both geostationary (GSO) networks and non-geostationary (NGSO) systems in the Ku band. These opportunities can only be realized if the threats posed by certain large NGSO systems in low Earth orbit (LEO) are appropriately regulated. These large NGSO constellations are launching tens of thousands individually or potentially hundreds of thousands of satellites collectively, that are fundamentally changing the interference environment and the ability for multiple satellite systems to share spectrum and orbital resources. Such unprecedented activity in space requires specific and tailored measures to i) ensure that spectrum and orbital resources are used efficiently, ii) mitigate the risk of interference between NGSO systems and GSO networks, and iii) preserve and promote competition. Viasat continues to urge Ofcom to build on the national licensing regime introduced recently for NGSO systems and consider additional licensing conditions recommended in our response to question 4, that would also apply to the proposed extended band 14.0-14.5 GHz, to ensure protection of GSO networks from NGSO systems and that the spectrum and orbital resources are shared equally amongst all NGSO systems.

	Unless an NGSO operator employs appropriate mitigation measures, interference events with GSO networks have the potential to degrade and disrupt services to end users of GSO networks, whether they provide direct-to-home television services or broadband services. Viasat has raised specific concerns regarding i) expected exceedances of equivalent power flux density (EPFD) limits by certain NGSO systems that are not considered in the ITU evaluation process, and ii) that there are no aggregate uplink EPFD limits to protect GSO satellite receivers from transmissions of multiple NGSO systems' earth stations. These issues are exacerbated when an NGSO operator artificially separates its system into multiple ITU filings in an attempt to avoid EPFD limits and generate more interference than otherwise would be permitted for a single NGSO system. Therefore, appropriate action must be taken by Ofcom to address the issues raised here as a critical first step towards addressing the risks of interference when authorizing NGSO systems in the Ku band and in order to provide a stable and certain interference environment for all satellite network operators. Specifically, Ofcom must ensure that any spectrum authorizations do not pose a threat to efficient spectrum use by multiple satellite networks.
Question 3: Do you agree with our proposed protection requirements for a) radio astronomy users of 14.47-14.5 GHz; b) remaining fixed link users (at specified frequencies and locations) and c) Crown users?	*Is this response confidential? No.* See response to question 5.
Question 4: Do you agree with our proposed authorisation approach and draft licence conditions for a) ESN licences, and b) other licensees wishing to take advantage of enhanced satellite connectivity (i.e. aircraft, ships, unmanned aircraft systems).	*Is this response confidential? No.* Viasat notes Ofcom's proposal to address coexistence between satellite systems and other spectrum users (Radio Astronomy and fixed links) in 14.25-14.5 GHz band in the UK by adopting specific technical conditions and requirements. To realise the full potential of the proposed additional spectrum for the benefit of UK citizens and consumers, Viasat urges Ofcom to adopt a similar approach to address coexistence between satellite systems and introduce further technical conditions and requirements for interference-free operation between GSO networks and NGSO systems. The frequency band 14.25-14.5 GHz is subject to provision Article No. 22.2 of the ITU Radio Regulations. This provision requires that NGSO systems not cause unacceptable interference to GSO networks by satisfying EPFD limits. A key operational requirement for complying with this non-interference requirement is for the NGSO system to greatly reduce the amount of unwanted energy it generates toward GSO networks, including by maintaining a suitable

avoidance angle with respect to the GSO orbital arc. Notably, angular separation imposes virtually no constraint on NGSO system capacity as large NGSO systems always have multiple options for assigning different satellites to serve different locations on the Earth. And they regularly hand-off traffic from one NGSO satellite to another as the satellites move rapidly across the sky. The mechanism of using angular separation as an interference mitigation technique to protect GSO networks from NGSO systems was depicted in our previous consultation responses to Ofcom.[1]

Although GSO arc avoidance has the potential to effectively mitigate some potential interference from NGSO systems into GSO operations, the effectiveness of this technique depends entirely on the avoidance angle that is specified. The sufficiency of that angle can be evaluated only in light of information about the radiofrequency design and EPFD performance of the relevant NGSO system. Moreover, the sufficiency of that angle must take into account the actual characteristics of the GSO networks that would be affected.

Currently, the necessary information regarding an NGSO system's characteristics is not readily available in the NGSO system application process at Ofcom. As such, it is impossible to ensure that any avoidance angle that an NGSO system may plan to employ would, in fact, be sufficient to protect GSO operations from interference.

For these reasons, Viasat urges Ofcom to require that, as part of the application process, NGSO system applicants demonstrate the existence of adequate measures to avoid interference with GSO networks before granting any authorization. Before granting any authorization for an NGSO system to serve the UK, Ofcom therefore should, at a minimum: (i) calculate the minimum GSO arc avoidance angle that would ensure that the NGSO system protects GSO networks, serving or planned to serve the UK, from interference; (ii) allow interested parties to evaluate and comment on the efficacy of the proposed avoidance angle value; and (iii) require NGSO systems to maintain a suitable GSO arc avoidance angle as a condition of any authorization that ultimately may be granted.

To assist in that analysis, Ofcom should require NGSO applicants to provide the following information as part of the initial application:

- Number of total beams on each satellite serving the UK;
- Number of co-frequency beams on each such satellite;
- Number and size of frequency channels on each such satellite;
- The number of satellite beams used for transmissions on the same frequency in the same or overlapping areas at any given time;

[1] *See* Figure 1 in Viasat response to Ofcom space spectrum strategy refresh consultation - https://www.ofcom.org.uk/__data/assets/pdf_file/0021/240195/Viasat.pdf.

	• Identification of whether the earth stations are user terminals or gateways and how many of each class will be deployed within the UK; and • How any given NGSO system avoids interference to GSO networks created by earth station and satellite sidelobes, and earth station backlobes, particularly when phased array antennas are employed. Moreover, Viasat has repeatedly provided evidence[2] of instances where an NGSO system operator "games" the system, by contriving EPFD inputs in a way that is designed to "pass" the ITU's spot checks regarding EPFD without reflecting how the NGSO system actually would operate, and the consequences of such misuse of rules to protect GSO network. The ITU has no way to effectively check and address such misuses where an NGSO operator relies on unrealistic system parameters of splits its system into multiple constituent components to avoid the application of "single entry" EPFD limits to the NGSO system as it actually is intended to operate. Notably, that responsibility falls on individual administrations and regulators, such as Ofcom, that consider authorizing NGSO system operations. In addition to causing far more interference into GSO networks than is permitted by ITU Radio Regulations, such practices could hinder opportunities for other parties to operate their own NGSO systems, because one NGSO system could consume more than its fair share of the aggregate interference "budget" towards GSO networks. That aggregate interference "budget" must be apportioned among *all* NGSO systems using the same or overlapping frequencies. Therefore, Viasat urges Ofcom to conduct a single-entry EPFD examination and verification of compliance against ITU Radio Regulations Article 22 EPFD limits on the *entire* NGSO system, irrespective of the number of ITU filings that make up that single system. Viasat also urges Ofcom to conduct its own analysis of the *aggregate* EPFD levels from *all* NGSO systems seeking to serve the UK to ensure that the aggregate EPFD levels do not cause interference to GSO networks. For assessing aggregate NGSO interference into GSO satellites in uplink bands, like the 14.25-14.5 GHz band, Viasat recommends that Ofcom apply an appropriate aggregate interference threshold (*e.g.*, ITU-R S.1323)[3] with respect to all NGSO systems that serve the UK.

[2] *See* Annex A of Viasat response to Ofcom space spectrum strategy refresh consultation - https://www.ofcom.org.uk/__data/assets/pdf_file/0021/240195/Viasat.pdf.

[3] *See* ITU-R Recommendation S.1323-2 (2002), "Maximum permissible levels of interference in a satellite network (GSO/FSS; non-GSO/FSS; non-GSO/MSS feeder links)* in the fixed-satellite service caused by other codirectional FSS networks below 30 GHz". (* The methodologies for determination of short-term interference criteria contained in this Recommendation are intended to address interference to GSO/FSS, non-GSO/FSS and non-GSO/MSS feeder links. However, the applicability of these methodologies for all such networks requires further verification).

	It is also necessary for Ofcom to equitably apportion the burden to resolve aggregate interference amongst all NGSO operators that serve the UK and that there is an effective mechanism in place so it can require the NGSO operators to reduce transmissions across multiple NGSO systems to prevent such interference to GSO satellite networks serving or planned to serve the UK. In sum, Viasat recommends Ofcom address the above issues by requiring: ● An NGSO system to maintain a suitable GSO arc avoidance angle when serving the UK; ● An NGSO system not to cause unacceptable interference into GSO networks and not to claim interference protection from GSO networks; ● An NGSO system to comply with all single-entry EPFD limits across the entirety of the system, with Ofcom again viewing all NGSO system filings under which the NGSO system operates as a collective; ● An NGSO system to have an operational feature that allows it to immediately interrupt radio frequency emissions to ensure satisfaction of this non-interference requirement, and to cease emissions upon notice of unacceptable interference; ● That if interference into GSO network occurs, an NGSO system must cease operations and not recommence operations until it addresses the cause of such interference by, among other things, increasing angular separation, reducing power, shaping antenna beams differently; and ● If aggregate interference to a GSO network from signals transmitted by multiple NGSO systems is detected, and it is not possible to identify the NGSO system generating the interference, require that the NGSO system operators cooperate with each other and take the technical measures necessary to eliminate the interference. In order to ensure that the bases on which Ofcom grants an NGSO authorization do not change by virtue of continuing iterations of its NGSO system design, Ofcom should also: (i) specify that the NGSO operator not modify the radiofrequency characteristics of its satellite system without prior consent from Ofcom with a period for public review and comment, and (ii) require that the NGSO operator provide a bi-annual report on iterations of its NGSO system design to ensure compliance with that condition.
Question 5: Do you have any other comments on our proposals?	*Is this response confidential? No* Viasat notes Ofcom's proposals intended to protect Radio Astronomy services from potential radio-frequency interference issues raised by co-frequency satellite services. A greater threat to Radio Astronomy, though, arises from the rapid development of large

	NGSO constellations operating in LEO that risks multiple tragedies of the commons, including harms to ground-based astronomy, safe and sustainable use of NGSO orbits, and Earth's upper atmosphere.[4] The increased use of space is not without cost to the environment. A growing number of scientific studies successively point to impediments to astronomy, increased risk of collisions and the creation of additional orbital debris, and changes to the chemistry of Earth's upper atmosphere. NASA too has recently expressed concerns about "the potential for a significant increase in the frequency of conjunction events and possible impacts to NASA's science and human spaceflight missions" explaining: "An increase of this magnitude into these confined altitude bands inherently brings *additional risk of debris-generating collision events based on the number of objects alone.*"[5] The environmental consequences of one large NGSO system operating in LEO—which is unprecedented in nature and would involve deploying approximately 90,000 (or more) satellites over 15 years, using a launch every six days--would be grave.[6] Among other things, the impact of depositing an estimated 156,000,000 pounds tons of alumina into the upper atmosphere when its satellites deorbit[7] would certainly have deleterious effects. And the facts (including those provided by NASA) reflect that this operator is not protecting astronomy or preserving the night sky, and this operator has not

[4] *See* Scientific Reports, "Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth," Article number 10642 (20 May 2021), https://www.nature.com/articles/s41598-021-89909-7.

[5] *See* Letter from Kathy Smith, Chief Counsel, U.S. Dept. of Commerce, National Telecommunications and Information Administration, attaching and submitting letters from Samantha Fonder, NASA Representative to the Commercial Space Transportation Interagency Group, Space Operations Mission Directorate, Launch Service Office, NASA and Jonathan Williams and Ashley Vander Ley, National Science Foundation, to Marlene Dortch, Secretary, U.S. Federal Communications Commission (8 Feb. 2022)(emphasis supplied), 20220208-NASA-NSF-letter-to-FCC-regarding-Starlink-Gen-2 (005).pdf, (8 February 2022).

[6] Jeff Baumgartner, "Starlink's daunting deployment plan 'leaves no margin for error' – analyst," BROADBAND WORLD NEWS (Jan. 18, 2022), https://www.broadbandworldnews.com/author.asp?section_id=733&doc_id=774668, *citing* "Starlink: Go Big or Go Home," MOFFETTNATHANSON (Jan. 18, 2022). "Even using Starship, at 100 satellites per launch, achieving a 30,000-bird constellation and sustaining it through, say, 2030, would require launching fifty thousand satellites, or five hundred rockets, between now and then," Moffett estimates. "That's a rocket launch roughly every six days... for nine years. Simply maintaining the constellation thereafter, if one assumes 20% annual attrition (de-orbiting), would require a new launch every six days. Forever."

[7] Based on SpaceX's prior representation that 1st generation Starlink satellites "consist of approximately 230 pounds of aluminium" and that there is a "52% mass fraction aluminium" in alumina (Al_2O_3)., then 29,988 x 230 / 0.52 = 13,263,923 pounds. Factoring in replacements for the Gen2 satellites over a 15-year license term and that Gen2 satellites are described as being over four times more massive, the proposed Starlink expansion could well result in SpaceX releasing over 156,000,000 pounds of alumina into the upper atmosphere.

	shown how it would do so with an expanded system incorporating an additional 30,000 satellites.[8] Moreover, an increase in the number of failed NGSO satellites, catastrophic collisions involving NGSO satellites (for any reason), and the resulting orbital debris fields, would make the orbital environment more crowded and dangerous, and risk the irreversible environmental disaster in space about which the OECD warns[9]. Viasat urges Ofcom to adopt suitable conditions to address the collision risk described above by requiring i) LEO applicants to disclose the mass and cross-sectional area of their LEO satellites, as well as the number of satellites in a constellation and the particular orbits they will employ so the aggregate risk presented by a constellation can be evaluated, and (ii) that an applicant not make changes that increase the mass or cross-sectional area of its satellites, the number of its satellites, or the orbits it plans to use, without providing notice to and obtaining approval from Ofcom. This information is essential to allow calculation and management of an NGSO constellation's total contribution to collision and orbital debris risk.

8 *See* Scientific Reports, "Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth," Article number 10642 (20 May 2021), https://www.nature.com/articles/s41598-021-89909-7.

9 *See* "Space Sustainability: The Economics of Space Debris in Perspective," OECD Science, Technology and Industry, Policy Papers, No. 87 (April 2020), https://www.oecd.org/fr/environnement/space-sustainability-a339de43-en.htm.