Your response

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Question 1: Do you have any comments on our assessment of the interference challenges raised by NGSO systems and their potential impact on a) service quality; and b) competition?	Ofcom has conducted an assessment of the potential for increased interference arising from the rapid growth of multi-satellite NGSO constellation deployments servicing the UK.[1] Kepler agrees in principle with Ofcom's evaluation of the complexities arising from collocated operations of NGSO systems, particularly concerning the potential for interference between NGSO services. Ofcom correctly assesses the frequency of in-line events as an appropriate metric to determine the levels of potential interference occurring between two NGSO systems. Ofcom's intent to establish a regulatory framework as a means of mitigating the occurrence of in-line events may aid operators in maintaining a consistent quality of service and encourage competition in the satellite communications industry. However, many aspects of Ofcom's interference assessment methods remain ambiguous in the Consultation, resulting in a proposed framework that serves to increase regulatory and commercial uncertainty. The Consultation highlights that there are numerous factors which must be considered to determine the occurrence and severity of inter-operator interference, including the degree of user-impact, the design of each system, and the nature of the in-line events taking place.[2] While Kepler agrees with Ofcom's assertion that new NGSO systems introduce new interference management challenges, Ofcom has indicated that its core focus in this regard is tied to looking at the "practical impact" on a user's ability to "send and/or receive data."[3] However, such broad statements only serve to

[1] Ofcom, *Consultation: Non-geostationary satellite systems- Licensing updates*, at p. 12 (published July 26, 2021) ("Consultation").

[2] Consultation at p. 14 ("The exact nature of the disruption to the user will depend on a number of factors, including the design of each system and the robustness of user equipment").

[3] Consultation at p. 14-15.

	increase regulatory uncertainty for operators; they fail to identify any method by which Ofcom will evaluate and quantify the degree of disruption users may experience, or by which standards or metrics this disruption will be judged. For example, one can imagine situations in which a degree of "interference" has taken place, but only affecting a low volume of users. Under such circumstances, it remains unclear what threshold of affected users would trigger action from Ofcom, and consequently what action Ofcom would take, if any. The Consultation also identifies an underlying concern that competing satellite services may be deployed in the UK prior to the completion of coordination of their respective ITU filings.[4] However, ITU regulations already sufficiently impose limitations on such operations under Radio Regulations Article 11.42. Kepler also notes that NGSO system parameters will likely evolve as satellite technology improves and as satellite network designs are refined to better serve its customers; Ofcom ought to be aware that under its proposed framework it will be continuously burdened with the evaluation interference concerns as satellite constellations proceed through their development cycles. Nonetheless, if Ofcom desires to establish its own coordination framework independent of the ITU's, it is crucial that they develop the necessary technical expertise to evaluate interference issues and develop interference mitigation standards. Ofcom should consider, for example, if it has the appropriate resources to establish an interference threshold which, if surpassed, triggers the coordination requirement. If such aspects of Ofcom's framework remain unquantified, it will result in a significant reduction in the degree of certainty that operators can reasonably expect when operating under their NGSO network license.[5] Ofcom correctly

[4] Consultation at p. 15.

[5] Consultation at p. 15.

	identifies that instances of interference will vary according to "the nature of the service being provided," and that coordination amongst NGSO operators remains challenging "due to the dynamic nature of these systems." If the framework proposed by Ofcom cannot sufficiently keep pace with the varying and dynamic nature of such systems, the proposed rules may result in overly constraining the development of NGSO services in the UK, to the ultimate detriment of UK citizens.
Question 2: Do you have any comments on our approach to dealing with the interference challenges raised by NGSO systems?	While Kepler agrees with the intentions guiding the rule reform, the distinct lack of clarity and specificity in the terms of Ofcom's proposed rules leave vast room for interpretation. It remains unclear what will be achieved under Ofcom's proposed system beyond that which is already accomplished through the coordination of ITU filings. This in turn introduces a lack of clarity with how Ofcom's rules will be enforced. The primary basis for Ofcom's proposed coordination methodology appears to solely rely on all operators acting in good faith with other operators throughout coordination discussions, without providing an incentive for coordination nor a backstop were coordination discussions to falter. This creates an environment which would grant advantages to operators of the largest constellations, as they could rely on their satellite diversity to provide continuous service while claiming interference issues with smaller operators remain unresolved, thereby blocking potential competitors from providing service. Furthermore, it remains unclear on what technical bases Ofcom will evaluate interference to ensure viable co-frequency service provision between operators in the same band, resulting in an environment of uncertainty for all operators. There also remains a distinct lack of clarity pertaining to Ofcom's access to resources to conduct the necessary analyses to evaluate instances of interference. As such, it remains premature

	for Ofcom to introduce an explicit licensing condition requiring cooperation amongst NGSO operators.[6]
Question 3: Do you have any comments on the proposed updates to our process for NGSO gateway and network licences?	Despite introducing a new licensing process which is intended to establish greater certainty for NGSO operations in the UK, Ofcom has not provided substantive detail as to what information operators will be required to submit in their applications. For example, Ofcom specifies that new operators will be required to prove that coexistence with incumbent NGSO systems by providing a coexistence analysis, or by pre-emptively obtaining a coordination agreement with all other incumbent operators.[7] Such analyses and agreements may seem trivial under ideal circumstances, however they are wholly dependent on Ofcom's ability to evaluate such proofs as well as on operators providing technical proofs representative of their true systems. Such transparency is not necessarily a given. Furthermore, the new requirement of demonstrating a new system's flexibility to co-exist with future systems is far too broad a requirement to be enforceable.[8] Ofcom has provided no guidance in what an operator is substantively required to provide for such a demonstration. Given that technical coexistence between operators is inherently very system-dependent, it is also unclear how Ofcom expects aspiring operators to demonstrate the ability to coexist with systems which have yet to be designed. In the case of disagreements between operators over the validity of analyses provided, Ofcom has not provided any strategies or rules which clarify how such disputes would be resolved. While Ofcom has provided examples of the proposed technical

[6] Consultation at p. 17.

[7] Consultation at p. 24.

[8] Consultation at p. 24.

	demonstrations which operators may provide, Ofcom has not indicated how it intends to assess the quality and accuracy of these analyses.[9] Ofcom has merely identified an intent to carry out further analysis, however it remains uncertain if Ofcom has developed the necessary technical expertise to do so. If Ofcom intends to enforce coordination requirements it should ensure that it has developed the capacity to judge the analyses provided by competing operators and develop contingency rules to encourage the resolution of inter-operator conflicts. The Consultation also identifies that the proposed process for issuing a license is expected to take four weeks, dependent on whether further technical analysis is required.[10] While defining a precise service standard is commendable, this process will likely take far longer than four weeks as such analyses will not only require the sharing of detailed information between operators, but are also likely to involve complex technical analyses on coexistence and system flexibility. Additional time will be required for Ofcom to examine and resolve any conflicts over the validity of the technical analyses provided by competing operators. Were Ofcom to extend the time frame of its assessment by an indeterminate amount under the pretext of ensuring system coexistence, it would inevitably result in a barrier to new licensees. Ultimately, Kepler agrees with Ofcom's assertion that to achieve coexistence between various NGSO services, the discussion is best left to "the companies involved [and] through the established ITU process for coordinating satellite systems."[11] The existing methods of coordination render Ofcom's proposed license updates

[9] Consultation at note 21 ("comparison of the statistical distribution of the interference to noise ratio (I/N), impact on average spectral efficiency and availability").

[10] Consultation at p. 23.

[11] Consultation at p. 20.

	moot if Ofcom has not developed the ability to evaluate interference concerns and enforce its proposed rules.
Question 4: Do you have any comments on the proposed updates to existing and new NGSO network licences?	Ofcom proposes to update the conditions of NGSO licences by requiring existing licensees to cooperate with other NGSO licensees operating in the same bands in order to ensure coexistence.[12] Ofcom has also identified that they will take action in cases of interference between NGSO systems. As with the updated licensing process, Kepler agrees with the general intent of Ofcom's updates to existing licenses. However, Ofcom has omitted vital details which bring into question the enforceability of the proposals in practice. Ofcom established that if there are any concerns regarding cooperation or co-existence that they will facilitate discussions between the parties by ensuring that they are "progressing in a timely fashion, and that both parties are participating constructively."[13] Additionally, in cases of interference, Ofcom has identified that they will carry out analyses and deal directly with the operators that are causing harmful interference.[14] While this approach seems workable in theory, it remains unclear how Ofcom plans to enforce such a rule in practice, introducing greater uncertainty into the regulatory environment. A fundamental concern associated with Ofcom's proposed approach lies with the lack of qualification of what Ofcom constitutes as sufficient "harmful interference" to be actionable. Ofcom has identified that occurrences of interference will be dealt with on a case-by-case basis, dependent on the level of degradation caused to

[12] Consultation at p. 27.

[13] Consultation at p. 29.

[14] Consultation at p. 31 ("The specific action… may include changing the frequencies used by earth stations at specific location(s), changing the power levels used by a particular earth station, introducing an angular separation between satellite systems or – in the most extreme cases – switching off equipment").

	consumers.[15] As discussed above in Question 1, Ofcom has yet to detail how it plans to identify that such interference is occurring, and by which metrics it will judge interference levels.[16] If Ofcom plans on developing its ability to enforce its proposed rules, Kepler would be pleased to provide support in guiding the development of the necessary tools to model in-line events. For Ofcom's reference, Kepler has published an open-source software developed to simulate radio frequency interference for NGSO satellite constellations, known as the Kepler Open-Source Interference Analysis (KOSIA) tool. The intent of this tool is to improve the ability of satellite operators throughout the industry to assess the impacts of their own networks on those of their peers, and vice versa. The tool is subject to continual improvements by Kepler and is publicly available online.[17] Per the Consultation, it also remains unclear which actions Ofcom will undertake if inter-operator coordination cannot ultimately be achieved. Establishing a process which depends purely on discussions between competing parties is unlikely to result in an uncontentious discussion with simple, mutually agreeable solutions. Moreover, as Ofcom has identified throughout the Consultation, ensuring fair competition remains a priority; Ofcom should indicate if it intends to establish spectrum priority for competition when addressing these interference concerns. In order to provide greater regulatory certainty, Ofcom should also indicate if in cases where inter-operator coordination cannot be concluded, whether a default mechanism or sanctions will be employed. For example, in the United States, the Federal Communications Commission requires for the band under question to be split amongst NGSO operators if

[15] Consultation at p. 30.

[16] Ofcom should specify what the threshold requiring coordination is, such as the ΔT/T metric used by the Federal Communications Commission. See 47 C.F.R. § 25.261.

[17] KOSIA is available on Kepler's GitHub: https://github.com/kepler-space/kosia

	coordination cannot be concluded.[18] Such a rule encourages coordination amongst operators as a pure band-split is an undesirable outcome for all operators involved overall. When adopting its new rules, it is vital that Ofcom mandates a means to protect operators of smaller networks. It may not be feasible or realistic for Ofcom to independently determine proper interference protection criteria, which have long been debated at the ITU. Instead, Ofcom should opt for a simple, easily measurable metric. For example, in situations of interference between operators of two NGSO constellations, the operator of the larger constellation is at a distinct advantage, particularly in situations of band-splitting. A larger operator could effectively block out the smaller operator due to in-line events and rely on its satellite diversity to continue providing their own service with little to no detriment to their operations. In such instances of non-cooperation, therefore, Ofcom should simply use the number of satellites in a constellation as an interim means of determining who is responsible for avoiding interference. This metric is easily evaluated and enforced – the system with the higher average number of satellites in the sky over a 24-hour period, at a given location, should be required to use its satellite diversity to avoid causing interference into the smaller system. This resolution to interference scenarios would require limited resources and no input from either operator, as Ofcom would merely need to use Space-Track to determine the number of satellites in the sky over the point where interference is being claimed.
Question 5: Do you have any comments on the proposed updates to existing and new NGSO gateway licences?	Kepler's concerns relating to Ofcom's proposed updates to NGSO gateway licenses are in line with those stated above with

[18] See 47 C.F.R. § 25.261(c)(1).

	regard to the updates for NGSO network licenses.[19] As of yet, it remains unclear as to how Ofcom will ensure that they have the relevant technical expertise necessary to enforce its proposed rules. In situations of dispute - whether this is from stakeholders refuting the validity of the technical analysis provided in the licensing process, or in coordination disputes - Ofcom should provide further clarity on which party is required to provide further technical analysis, and what such analysis should entail.
Question 6: Do you agree with our proposal regarding NGSO terminals operating in Ka band?	Kepler agrees with Ofcom's proposal to require that NGSO Ka-band user terminals are operated under a network license.[20] This will harmonize the framework by ensuring that all NGSO systems operate under the same licensing conditions, thus ensuring that operators in the Ka-band will not be provided an inherent advantage over Ku-band operators due to differing regulatory burdens.

[19] Consultation at p. 34.

[20] Consultation at p. 37.