Your response

Question	Your response
Question 1: Are there other trends in the space sector (or the broader spectrum environment) that we should monitor	Confidential? – N Amazon thanks Ofcom for this timely consultation on a range of evolving developments, and welcomes the opportunity to respond.

and/or take account of in our strategy?	Amazon plans to launch and operate Project Kuiper, a constellation of 3,236 non-geostationary ("NGSO") satellites in low earth orbit ("LEO") that will provide high-speed, low-latency broadband services to households, businesses, and other customers, connecting unconnected and under-connected communities around the globe. NGSO fixed-satellite service ("FSS") systems can achieve higher throughput and lower latency than their predecessors, enabling widescale deployment of fiber-like satellite connectivity to hard-to-reach places. The operation of NGSO satellite systems is global and dynamic in nature, particularly in comparison to an earlier generation of satellite systems. This requires a coordinated approach to regulation, and an approach which fosters competition between satellite systems and ensures efficient use of spectrum. The ITU is currently developing a framework for the global deployment of NGSO Earth Stations in Motion (ESIMs) in the Ka-band, which would provide NGSO operators with opportunities similar to those currently available to GSO systems. Amazon encourages Ofcom to support these initiatives to foster competition between all satellite systems (including NGSO systems and legacy satellite systems). Such support will ensure that the UK can benefit from all satellite service offerings, regardless of the technology or system used to provide it.
Question 2: Do you agree with the broad areas we have prioritised for our work?	Confidential? – N Yes, Amazon generally agrees with the areas of work which Ofcom has prioritised in the proposed Space Spectrum Strategy ("Strategy").
Question 3: Are there other issues and actions that are likely to be important over the next 2 – 4 years?	Confidential? – N The deployment of ESIMs as part of NGSO systems in various frequency bands means that Ofcom's action to facilitate licensing of these terminals will be important. Amazon's views in respect of this matter are incorporated into sections 5 and 6 of this consultation response.
Question 4: Do you have any evidence on whether specific actions should be a high priority?	Confidential? – N No comment.
Question 5: Do you have any other issues you wish to comment on?	Confidential? – N **Licensing of ESIMs** ESIMs are a critical aspect of NGSO system commercial offerings, and will help enable broadband connectivity in sectors where low latency, high throughput mobile connectivity is required.

As part of Ofcom's "*Non-geostationary satellite systems, Licensing updates*" statement published in December 2021, Ofcom foreshadowed that it would include aeronautical and maritime ESIMs/ESOMPs operating in the Ka-band under the *Satellite (Earth Station Network) Licence* type as part of work to be undertaken in 2022/2023, and consider amendments to ship and aircraft radio licenses. Amazon urges Ofcom to proceed with extending the scope of the *Satellite (Earth Station Network) Licence* type so that NGSO ESIMs can operate in the same parts of the Ka-band that are already available for GSO use, including on UK-registered vessels.

The European Communications Committee (ECC) Decision (15)04 sets standards for the use of all categories (land, maritime, and aeronautical) of NGSO FSS ESIM in the Ka-band under a blanket licensing regime (i.e., exempt from individual licensing). Amazon advocates a blanket licensing approach as is enabled by ECC Decision (15)04 and prioritization of a global outcome at World Radio Conference 2023 ("WRC-23"), and welcomes consultation from Ofcom in respect of any such changes to the licensing of ESIMs/ESOMPs in the Ka-band to enable these important services.

Protection criteria for Fixed-Satellite Services

At section 5.22 of the Strategy, Ofcom states that there is value in developing updates to international recommendations in respect of protection criteria for the FSS, and that Ofcom will work towards proposing protection criteria that ensures the continued provision of FSS while not unnecessarily constraining the introduction of new services in the same bands.

Amazon agrees this is important work, and draws Ofcom's attention to the proposals Amazon has made in ITU Working Party 4A ("WP4A") to achieve this aim, particularly in proposing permissible interference criteria for sharing between NGSO systems. This measure was also described in Amazon's consultation response to Ofcom's "*Non-geostationary satellite systems: Licensing updates*" consultation dated 26 July 2021. Further discussion on this point is contained in section 6 of this consultation response.

Amazon understands that Ofcom is considering extending "recognised spectrum access" to 26.5-27 GHz, while taking account of Ministry of Defence use and future 5G authorisations in the band; and that Ofcom has now published a consultation about making 24.25-27.5 GHz (the "26 GHz band") available for 5G and other wireless broadband services titled "*Enabling mmWave spectrum for new uses*", published 9 May 2022 ("mmWave Spectrum Consultation").

Satellites play a major role in communications. Ofcom notes at section 3.12 of the Strategy, that this includes providing internet access, providing broadband to homes and communities in remote locations,

	as well as connectivity for maritime and air passengers. Amazon welcomes Ofcom's mmWave Spectrum Consultation, and notes that any 5G operations in the 26 GHz band or the 40 GHz band (40.5-43.5 GHz), should not in any way constrain satellite operation (such as through out-of-band interference) in the 28 GHz band (27.5-29.5 GHz) or any other bands used by the satellite industry, recognising the role of satellite in communications used by the public. **Safe use of space** Space safety and sustainability are key priorities for Project Kuiper. Amazon appreciates Ofcom's forward-leaning approach to considering space safety spectrum requirements, such as spectrum for radars that play a vital role in space situational awareness.
Question 6: Are there other issues and actions specifically relating to NGSO communication systems that are likely to be important over the next 2 – 4 years?	Confidential? – N Amazon supports Ofcom's drive toward ensuring that NGSO systems have an effective means of coexisting with other operators, and resolving interference where it occurs. We would like to raise the following issues and actions relating to NGSO communication systems which we consider will be important over the next 2 - 4 years. **Operation of ESIM by NGSO systems** At sections 6.21 and 6.22 of the Strategy, Ofcom notes that WRC-23 Agenda Item 1.16 addresses a regulatory framework for the operation of ESIMs by NGSO FSS systems (in the frequency bands under study by Agenda Item 1.16 i.e. various parts of the Ka-band) and that there are existing decisions on GSO ESIM as made by WRC-19, i.e. Resolution 169. The creation of a global framework for ESIMs operating with NGSO systems in the frequency bands under study by Agenda Item 1.16 (which are already open to use by ESIMs operating with GSO networks) would help to foster a competitive environment for satellite services. Amazon supports the operation of ESIMs with NGSO FSS systems in the Ka-band, as is being considered under WRC-23 Agenda Item 1.16, and has been contributing to the sharing studies and development of Conference Preparatory Meeting ("CPM") text for WRC-23 Agenda Item 1.16 at WP4A. These have concluded that the provisions in Resolution 169 can be used in developing the regulatory framework for ESIM operating with NGSO satellite systems (in the frequency bands under study by Agenda Item 1.16). Amazon encourages Ofcom to continue to support Agenda Item 1.16 and global NGSO ESIM operation. At section 6.22 of the Strategy, Ofcom notes that it is generally supportive of international work considering NGSO use, provided that incumbent services (e.g. UK fixed links) remain adequately protected. Amazon notes that studies submitted to WP4A under Agenda Item 1.16 have taken into account the UK's fixed links in sharing and

compatibility analyses. These studies have shown that, with appropriate measures, incumbent terrestrial services (i.e. fixed links in the UK) are adequately protected.

Capabilities for handling NGSO to GSO interference

At section 6.49 of the Strategy, Ofcom states it is aiming to specify a measurement method which operators can use when providing relevant evidence to Ofcom of NGSO to GSO interference.

Amazon notes that there is on-going work at the ITU as part of WP4A to define procedures to evaluate aggregate equivalent power flux-density ("epfd") from NGSO systems into GSO networks, specifically in respect of the space-to-earth segment of operation.

As Ofcom notes at section 6.52 of the Strategy, the methodology used in Recommendation ITU-R S.1503 to model NGSO systems places some unnecessary constraints on NGSO systems. Amazon appreciates that Ofcom supports improvements to the way NGSO systems are modelled in Recommendation ITU-R S.1503 and encourages Ofcom to support the adoption of revisions to Recommendation ITU-R S.1503 in 2022 that would implement these improvements as well as the use of other software that could evaluate single-entry epfd that take into account better modelling of NGSO systems. For the Q/V band, the use of other software to evaluate single-entry epfd that takes into account better modelling of NGSO systems has been enabled in accordance with Resolution 769 (WRC-19). Amazon encourages Ofcom to support the ability for administrations and operators to use software other than Recommendation ITU-R S.1503 in the evaluation of aggregate epfd from non-GSO systems.

Power-Flux Density ("PFD") scaling equations in Article 21.16.6 of the Radio Regulations

Amazon notes that there is currently work underway in WP4A to evaluate the appropriateness of the PFD scaling equation in Article 21.16.6 of the ITU Radio Regulations when applied to NGSO systems with more than 1,000 satellites in the constellation.

The PFD scaling equation in Article 21.16.6 scales the PFD limit in Article 21, Table 21-4, based on the number of satellites (i.e. "N"), in the relevant NGSO constellation to which the equation is applied. WRC-19 invited the ITU-R to investigate the appropriateness of these equations to satellite constellations with N>1,000.

Studies and inputs to WP4A have concluded that the PFD scaling equation is not appropriate when applied to NGSO constellations with N>1,000. This is because the equation in Article 21.16.6 assumes many more satellites are contributing to the interference to a terrestrial station than exist in the constellation itself. These inaccurate calculations lead to severe limitations to the PFD allowed to be transmitted from any satellite in the NGSO constellation. Given that scaling equations are applied to more satellites than are actually

	in the constellation, the additional scaling applied to satellites that are not in view of a terrestrial station does not give any benefits of more protection of fixed services in these bands. This also directly leads to spectral inefficiencies for NGSO systems. A change to the PFD scaling equation for satellite constellations with N>1000 has been proposed at WP4A that will improve the spectral efficiency for NGSO constellations and will not impact the sharing environment between satellite and terrestrial services. Amazon encourages Ofcom to support studies at WP4A, and any underlying solutions that are proposed, and finalize the solution by WRC-23. Amazon notes that a solution has been identified at ITU-R WP4A that would evaluate the scaling of satellites in the NGSO constellation based on a parameter of the number of visible satellites, Nv, from a NGSO constellation to a terrestrial station. Amazon supports this solution. However, if a solution cannot be resolved by WRC_23, Amazon encourages Ofcom to support the extension of the qualified favourable finding provision for filings of non-GSO systems with a number of satellites greater than 1000 until such time as the PFD scaling equation is corrected. **Licensing regime for Q/V band** At section 5.11 to 5.14 of the Strategy, Ofcom states that it will look to develop its approach to licensing gateway earth stations in parts of the Q/V band (37.5-42.5, 47.2-50.2, 50.4-51.4 GHz). Amazon supports the actions by Ofcom to incorporate the FSS Q/V band into their licensing regime for NGSO systems, and for such licences to be available in the near term. As other frequency bands become congested, the Q/V band is an important expansion band for NGSO systems. Amazon has made applications for future operation in the Q/V band to enable expansion of system capability, and Amazon is aware that other systems have also made such applications. The importance of the Q/V band for NGSO systems was reflected at WRC-19, where WRC-19 evaluated and created a new type of epfd sharing environment between NGSO systems and GSO networks in the Q/V band that is more spectrally and operationally efficient than the epfd environments in lower frequency bands. With regards to sharing of these frequency bands with terrestrial services (as is being considered by Ofcom at section 6.63 of the Strategy), Amazon encourages Ofcom to support sharing environments that can contribute to optimal spectral efficiency for both satellite and terrestrial services. At section 6.63 of the Strategy, Ofcom notes the possibility of overlapping Q/V band spectrum with 5G systems. Amazon encourages Ofcom to ensure that gateway use in the Q/V band in particular is protected at the same time as enabling other uses.

	Amazon welcomes the opportunity to comment on any proposals being considered by Ofcom, including any sharing conditions which Ofcom would seek to impose as between satellite earth stations and 5G terrestrial mobile services, in these bands. **Additional NGSO spectrum to harmonize FSS worldwide FSS spectrum use** WRC-19 allocated the frequency bands 51.4-52.4 GHz to the FSS, but limited this allocation to GSO feeder links as a result of WRC-19 Issue 9.1.9. Further study should be undertaken at the ITU to evaluate whether FSS use of this band can be expanded to NGSO systems. As these bands were limited to GSO feeder links as part of the underlying Agenda Item at WRC-19, Amazon supports the consideration of the use of the 51.4-52.4 GHz frequency bands for NGSO systems.
Question 7: Do you have any evidence on whether specific actions relating to NGSO communication systems should be a high priority?	Confidential? – N **NGSO systems sharing with other NGSO systems** Amazon agrees with Ofcom about the need to develop a globally harmonised approach to handle NGSO-NGSO interference. The issue of co-existence between NGSO systems will be a high priority in the near future, because unlike the position for GSO networks, there is no existing ITU-R guidance that defines permissible interference criteria between two NGSO systems. The development of an internationally agreed permissible interference criteria between two NGSO systems would aid administrations in completing coordination, and would give the ITU Radiocommunication Bureau tools to evaluate claims of harmful interference. Amazon notes that there is currently on-going work as part of WP4A to define permissible interference criteria between NGSO FSS systems. Amazon supports developing such permissible interference criteria based on dynamic operations of NGSO systems that reflect operational objectives of these systems. Amazon recommends Ofcom adopt such an internationally-developed and global standard as a baseline, to support coordination and for use as a threshold to evaluate compatibility between NGSO systems in case an interference event cannot be solved with discussions between operators. Amazon further supports work to develop interference management techniques to investigate NGSO-NGSO interference, and agrees with Ofcom that, in any investigation of NGSO-NGSO interference, there is a need for clear evidence from operators regarding the impact of interference. Amazon welcomes further consultation from Ofcom in

respect of the information it will seek from UK NGSO operators to establish the impact of NGSO-NGSO interference.

NGSO systems sharing with GSO satellites

Amazon supports the UK's engagement in international discussions to ensure the evolution of regulations for NGSO-GSO sharing to promote an appropriate balance between assurance of the benefits of GSO networks and efficient sharing of spectrum with NGSO systems.

As an NGSO system operator, Amazon commits to comply with all applicable regulations that provide protection to GSO network operators. However, Amazon notes that many of the applicable regulations were developed over two decades ago based on NGSO systems that are no longer in operation and which do not accurately model the operational performance of modern NGSO systems. As such, Amazon notes, the methodology used by Recommendation ITU-R S.1503 (which is used to validate single-entry epfd compliance) favors GSO networks, results in unnecessary constraints on modern NGSO systems, and leads directly to an overly conservative calculation of epfd and limitations on the operations of NGSO systems. These limitations impact the performance and spectral efficiency of NGSO systems.

In the case of any reports of interference from NGSO systems into GSO network downlinks, Amazon encourages Ofcom to require substantiation of interference to the GSO network's operations through technical evidence of interference. Currently, the methodology used by the ITU is based on an examination under Recommendation ITU-R S. 1503, which is overly conservative.

Amazon agrees with Ofcom's view at section 6.52 of the Strategy that the way NGSO systems are modelled when assessing their interference potential towards GSO networks (including some aspects of the methodology in Recommendation ITU-R S. 1503) results in unnecessary constraints to NGSO systems. Amazon has seen these constraints directly impact both the ability for NGSO systems to provide service, and the spectral efficiency of the frequency bands allocated to FSS and shared between NGSO systems and GSO networks.

Amazon therefore supports Ofcom's work to improve the way NGSO systems are modelled when assessing their interference potential towards GSO networks. Amazon has been working with administrations, including with Ofcom on behalf of the UK, as part of WP4A to try to develop improvements to Recommendation ITU-R S.1503, and Amazon supports the proposals that have been put forward by the UK to WP4A.

	Amazon encourages continued participation and advocacy by the UK as part of WP4A to incorporate further changes to Recommendation ITU-R S.1503. Given the critical nature of Recommendation ITU-R S.1503 for the operation of NGSO systems, Amazon encourages the support of Ofcom in establishing regulatory procedures for continuous improvements to Recommendation ITU-R S.1503, such as was discussed at the May 2022 meeting of WP4A.
Question 8: Do you have any other comments relating to NGSO systems?	Confidential? – N **Adoption of ECC Decision (05)01** Currently, under Ofcom's Satellite (Earth Station Network) licence, uplink operation is only permitted in the following parts of the 28 GHz band: 27.5-27.8185, 28.4545-28.8265 and 29.5-30 GHz. The current licensing arrangements mean that satellite operators needing 28 GHz access must obtain agreement for spectrum access from an existing license holder. This may not always be feasible. To aid in realising the potential of broadband communication by satellite, Ofcom should consider full implementation of ECC/DEC (05)01, and permit use of the remaining parts of the 28 GHz band opened to FSS (i.e. 28.8365-28.9485 GHz). **Access to guard bands in the 28 GHz Band** In the Strategy, Ofcom notes that there are four guard bands in the Ka-band, between 28 GHz and 29.5 GHz which are currently not authorised for satellite earth station (or other) use and ask respondents whether there is any demand for access to such spectrum. Amazon notes that making such guard bands available would be beneficial to the satellite industry, as many modern satellite systems are using or plan to use the Ka-band for gateways and/or earth station terminals, including Amazon. Making guard bands available would increase the capacity available to such systems and provide for greater flexibility in planning for the use of the 28 GHz Band. **Access to the Ka-band by NGSO ESIM** Regarding ECC Decision (15)04, for NGSO ESIM, we underline the importance of a uniform regulatory framework for the blanket licensing and operation of NGSO ESIM in the Ka-band. For this reason, Ofcom should preserve this uniformity by refraining from partial application of ESIM-related ECC decisions.