Your response

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Question 1: Are there other trends in the space sector (or the broader spectrum environment) that we should monitor and/or take account of in our strategy?	Confidential? – N Trends: • Spectrum sharing: time-based spectrum use, spectrum monitoring • Higher frequencies • Higher fidelity modelling • Other NGSO concerns **Spectrum sharing:** The demand for spectrum is increasing and will continue to increase. As Ofcom has stated, management of the spectrum will require carefully balancing user needs and public interests. Frequency bands that are the most popular and therefore contested today clearly need to be used in the most effective manner, and a time-based component to spectrum policy should be considered in addition to frequency, geography, and power levels. Proliferation of more cost-effective spectrum monitoring from bespoke systems, RAN edge applications, and space-based RF mapping can be inputs to time-based spectrum sharing. **Higher frequencies:** Spectrum use is trending toward wider bandwidths and therefore higher frequencies. Although there is less congestion today in Q-band than sub-6 GHz, for example, technology advances will make higher frequency components and applications more realizable, and adding Q-band and V-band gateways will increase available bandwidth for satellite communications. Measuring the impact of 5G in Q- and V-bands as 5G user density and orientations change can inform policy about the proximity of 5G cell sites to satellite gateways. **Higher fidelity modelling:** Both terrestrial and space-based communications are pushing toward a greater need for higher accuracy/higher resolution modelling of communication systems. Improvements in terrestrial 3D data and advanced spectrum monitoring systems can provide data that will aid in network planning and optimization, spectrum sharing and co-use, and alleviating interference while providing for better customer qualification. **Other NGSO concerns:** Ofcom has clearly highlighted the importance of managing NGSOs. In particular, new, high bandwidth communications

	NGSOs in the form of fixed broadband and "base stations in space" pose the most complicated regulatory concerns in their demand for high bandwidth, extensive and varying geographic coverage, and time-based demand. Communications NGSOs serve very different use cases than legacy GSOs and they also dominate spectrum requirements when compared to NGSOs used for IoT and PNT. For example, even Spire and Planet, with 100's of LEO satellites, do not require the bandwidth and flexibility of spectrum access that communications NGSOs do. That being the case, IoT, sensing, and PNT applications, along with terrestrial uses and GSOs, need to be protected as "mega constellations" are deployed. While the NGSO focus today is certainly necessary and appropriate, Ofcom should consider that there will be other applications, in addition to communications, IoT, and PNT that have not yet been put into practice, such as different modalities of earth observation and remote sensing. Additionally, other wide-coverage area technologies could become more popular, such as high-altitude airships.
Question 2: Do you agree with the broad areas we have prioritised for our work?	Confidential? – N Yes, we agree with the broad areas that have been prioritized, with specific emphasis on the importance of spectrum sharing/co-use, preservation of incumbent applications, and system resilience to interference.
Question 3: Are there other issues and actions that are likely to be important over the next 2 – 4 years?	Confidential? – N Three areas merit attention over the next 2 to 4 years: ● Protection criteria ● National vs. international spectrum use ● Spectrum sharing **Protection criteria:** Legacy/incumbent systems may have been designed and fielded many years before NGSO mega-constellations were even considered a possibility. Thus, legacy systems were not designed for resilience and co-existence with NGSO constellations. Issues include addressing protection of incumbent systems and clarity on requirements for new systems. High bandwidth communications NGSOs complicate these protections. RF emissions from NGSOs are highly dynamic as a result the orbiting nature of a very large number of transmitting satellites. Furthermore, user terminals on the ground can be spatially diverse, large in number, and demand

	high bandwidths. This variability makes the possibility for widespread but inconsistent impact from NGSO RF emissions on other systems. As such, there is a need for more advanced monitoring of these constellations of NGSOs and their emissions to provide better understanding of both their operations and their impact. As a second topic related to protection criteria, regulations have been geared toward transmitters with specifications on parameters such as out-of-band emissions and in-band power levels. Ofcom has addressed policy related to receiver performance in Section 5.50 for PNT receivers, and Ofcom should consider extending this to other applications. **National vs. international spectrum use:** Inconsistencies/incongruence in national spectrum use versus international spectrum use can cause issues when national systems are used internationally. The US is experiencing this in 3-4 GHz (US military systems are colliding with mid-band 5G across the world). As Ofcom assesses new developments in technologies, applications, and spectrum policy, Ofcom should consider actual worldwide use in addition to allocations. **Spectrum sharing:** Ofcom stressed spectrum sharing and the resolution of harmful interference. In our experience, measurement of spectrum use is an essential input to spectrum modelling efforts. Measurements enable a comprehensive, accurate understanding of spectrum use over frequency, geography, and time, and new technologies and commercial services can be leveraged for cost- and time-effective spectrum monitoring that serves as truth data for models. Understanding how the spectrum is actually being used worldwide, in addition to expectations based on spectrum regulations, is important for assessing the complicated trade-space associated with enabling spectrum access and lowering barriers for new entrants, while maintaining international compatibility. Space-based RF mapping can be a relatively low-cost way to obtain measurements of global spectrum use, and commercial companies are entering this marketplace.
Question 4: Do you have any evidence on whether specific actions should be a high priority?	Confidential? – N There is evidence that policies around receiver performance and the use of spectrum sharing approaches should be high priority considerations. **Receiver performance:**

	An example of the importance of addressing receiver performance in spectrum policy is 5G C-band (3.7-3.98 GHz) interference with Radar Altimeters in the US. 5G C-band is limited in in-band emissions, limited in out-of-band emissions, and has a 200 MHz guard band, yet there is on-going concern of 5G affecting performance of Radar Altimeters. **Spectrum sharing:** Evidence about the importance of investigating technology approaches to spectrum sharing can also be found in US examples in 3-4 GHz. While C-band (3.7-3.98 GHz) is dedicated to mobile services, the CBRS band (3.55-3.7 GHz) is a shared access system that requires spectrum monitoring and active management. As new bands are being considered for 5G in the US, spectrum monitoring and active spectrum management techniques are being considered. Spectrum sharing will become a necessity in the future, and investigating technology approaches now and as developments occur will benefit future policy decisions.
Question 5: Do you have any other issues you wish to comment on?	Confidential? – N Spectrum repurposing requires a combination of policy and technology considerations. Historically, blending of policy and technical expertise has been difficult due to the complexities of each field. Advocating for spectrum policy in engineering curriculum at the university level could be an approach to train the future workforce.
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 Ofcom has identified many ways that NGSOs can interfere with GSOs, terrestrial links, etc. Spectrum monitoring and measuring NGSO spectrum use could be important for the purposes of spectrum sharing and ensuring compliance – measuring actual spectrum use so that the spectrum can be used the most efficiently and effectively.
Question 7: Do you have any evidence on whether specific actions relating to NGSO communication systems should be a high priority?	Confidential? – N New high-bandwidth communications NGSOs with 100's or 1000's of satellites are technically complicated in that they serve many users in an area with high bandwidth communications and require seamless handoff as the satellites come in and out of a service area. Restrictions on the number of simultaneous downlink beams that are active in an area and the maximum power flux density exist, and compliance should be measured and monitored to avoid interference issues especially as the number of high-

	bandwidth communications NGSOs will drastically increase in the coming years.
Question 8: Do you have any other comments relating to NGSO systems?	Confidential? – N None.