Your response (See attached document for responses)

Question	Your response
Question 1: Do you have comments on the overall approach to the review?	Confidential? – N Viasat commends Ofcom's overall approach to regular reviews of the UK's national spectrum strategy. Reliable access to sufficient spectrum is one of the key drivers in the ability of all wireless technologies, including satellite, to meet the evolving needs of consumers. By reviewing spectrum management on a regular basis, Ofcom can ensure that its policies keep pace with changes and innovations. One of the major changes that has been taking place is the development of a new generation of satellites known as Very High Throughput satellites (VHTS). VHTS have many new features, including increased spectrum reuse and the ability to use smaller end-user terminals, but the true innovation lies in the services that these satellites can provide including high-speed broadband to customers featuring speeds of 100 Mbit/s today, and even faster speeds in the next few years. Viasat would like to highlight the need for core spectrum access and a stable spectrum access environment. Satellite broadband can provide affordable connectivity across the entire country, no matter where the user may live, travel or work, but only if adequate spectrum is available. As the Consultation outlines, wireless technologies like satellite have the ability to meet UK national and local demand across a collection of diversified markets. Technologies like satellite are uniquely suited to provide ubiquitous broadband connectivity in urban, suburban, and rural areas alike, for both fixed and mobile applications. The Ka band is a critical satellite band, providing necessary capacity unavailable in other bands. Viasat's satellite systems use the 17.7-20.2 GHz and 27.5-30 GHz bands. Because of the size and advanced investment of capital required for satellite broadband connectivity, assured access to contiguous spectrum is critical to continued innovation. The Ka band, including the 27.5-29.5 GHz (28 GHz) band portion, is the spectrum that powers VHTS. When evaluating the introduction of new technologies, Viasat urges Ofcom to reserve the 28 GHz band for satellite and allocate separate spectrum for terrestrial IMT/5G so that both technologies can flourish and have access to the spectrum each needs to meet the demand today and for expansion in the future. Viasat would also like to comment on another topic that impacts spectrum policy and equitable access to shared spectrum but is not specifically addressed in the consultation. The unprecedented introduction of NGSO mega constellations consisting of thousands of satellites in low-Earth orbit (LEO) presents a number of significant and

	unanticipated threats including constraining access in the UK to the limited but shared spectrum and orbits. As such, Viasat urges UK Ofcom to consider these threats prior to granting market access to these mega constellations. This important topic is discussed in the response to question #2 of this consultation.
Question 2: Have we captured the major trends that are likely to impact spectrum management over the next ten years?	Confidential? – N Viasat would like to point out an important trend that impacts spectrum management today and will for the foreseeable future. That is satellite broadband technology advancement and its vastly improved ability to deliver affordable high-quality broadband across a wide geographic area. This ability to deliver broadband suits the broadband needs of the UK. As Viasat pointed out in our 5 June paper entitled *Satellite Broadband and Spectrum Policy* submitted to Ofcom, current UK market conditions indicate that satellite broadband is an important solution for serving unmet connectivity needs. The UK has a high number of geographically dispersed households and small businesses in both metropolitan and rural areas currently served with low speeds. The strains on traditional networks have become even more pronounced during the current pandemic. These UK households and small businesses are served with legacy Digital Subscriber Line (DSL) or are not served at all. Additional broadband needs in the UK include mobile and government customers. Satellite is uniquely suited to address this unmet UK demand. This Consultation cites the advances in new satellite broadband technologies. In particular, the Consultation discusses the introduction of NGSO satellite constellations consisting of thousands of satellites. These constellations are launching an unprecedented number of satellites that are fundamentally changing the interference environment and the ability for multiple satellite systems to share spectrum and orbits. As such Viasat outlines the issues herein that we believe Ofcom should address through this Consultation process and also address at the application stage, be the NGSO systems domestic or foreign, to ensure that everyone has equitable access to spectrum and an operating environment free from unacceptable interference. Constraining NGSO Interference into GSO networks. Newly introduced mega-constellations block other satellite operators from interference-free access to the spectrum they would otherwise share. Under Number 22.2 of the International Telecommunication Union (ITU) Radio Regulations, systems of NGSO satellites "shall not cause unacceptable interference to … geostationary networks in the fixed satellite service." Even a single NGSO system has the potential to cause harmful interference into multiple GSO networks, resulting in significant degradation and capacity losses for GSO networks that would serve

the UK. Multiple NGSO systems operating simultaneously pose an even greater risk to those GSO networks. This can impair the provision of critical GSO-based services across the UK.

Today's very high throughput GSO satellites are extremely efficient in how they use spectrum at the GSO arc, employing low total satellite receiver noise temperatures and high satellite receive antenna gains, to provide innovative services with smaller user terminals than ever possible before. Ensuring that those capabilities are unaffected by mega-constellations, as the ITU mandates, requires mega-constellations to limit the amount of unwanted energy they emit in the direction of those GSO networks, in the form of main beams and sidelobes from their satellites and their earth stations.

One way to ensure compatibility with GSO networks (as the ITU requires) is for mega-constellations to maintain a suitable level of angular separation from the GSO arc, with the requisite angle depending on the particular attributes of that mega-constellation. Certain mega-constellation operators have not committed to do so across all of the frequency bands they intend to use. Notably, maintaining adequate angular separation imposes virtually no constraint on NGSO system capacity.

Moreover, serious questions remain about precisely how certain mega-constellations actually will operate, which directly affects the required level of angular separation. That is, one mega-constellation operator appears to be relying on multiple ITU filings for the same NGSO system, so that it can impermissibly aggregate multiple so-called "single entry" EPFD limits and thereby generate more interference toward GSO networks than otherwise permitted. In addition, it has not been explained why, when a mega-constellation is designed to have many dozens of its satellites in sight of a given location on Earth at any given time, only one single co-frequency satellite will illuminate that location, and only that single illumination will contribute to interference into GSO networks at that location. Nor has anyone explained how a mega-constellation operator will be able to both calculate and actually manage the aggregate interference impact of the many millions of sidelobes created by millions of user terminals and dozens of beams on its many thousands of satellites. Furthermore, the aggregate impact on GSO networks from the operation of multiple NGSO systems would have to be limited and apportioned among these multiple systems in both the uplink and downlink directions.

Finally, NGSO operators are actively trying to weaken in the ITU study process the existing ITU rules that define certain protections they must provide GSO networks. And this does not even consider that the existing rules were not developed to address the new mega-constellations or their impact on today's GSO networks.

<u>Facilitating Equitable NGSO-NGSO Spectrum and Orbital Sharing</u>

Another concern is how unconstrained mega-constellations can consume significant portions of the look angles toward space, and essential LEO orbits, preventing use of the sharing tools that have been employed successfully for decades among NGSO systems. This threat to NGSO spectrum sharing arises because mega-constellations will “blanket the sky,” causing many in-line interference events limiting and sometimes completely blocking other NGSO systems from sharing the same spectrum. Mega-constellations will rarely experience this problem themselves because their far greater number of satellites that block spectrum use by smaller NGSO constellations provides them with alternative communications paths where the same spectrum remains available to the mega-constellation.

The spectrum-preclusive effect of these mega-constellations is depicted in the following table, which shows the probability of satellites in NGSO System B blocking all of the satellites in NGSO System A. Three constellation sizes are considered for each system: 300, 3,000, and 30,000 satellites. Typical orbital parameters were used, and the user terminal was modelled at a representative location of 51.5° N, 0.1°W (London, UK). Several observations can be made:

- A 30,000 satellite NGSO system will blanket the sky, blocking all other constellations, including other similarly sized constellations from serving the UK.
- Even 3,000-satellite NGSO systems have a significant blocking effect on many other constellations cutting over 2/3 the capacity of a 300-satellite system serving the UK.
- Conversely, 300-satellite NGSO systems *never* block 3,000 or 30,000-satellite NGSO systems.

	NGSO System B		
NGSO System A	300 Satellites	3,000 Satellites	30,000 Satellites
300 Satellites	4.8%	80.0%	100%
3,000 Satellites	0%	43.8%	100%
30,000 Satellites	0%	0%	100%

Probability that NGSO System B blocks a location from service by NGSO System A

This dynamic has the perverse effect of incentivizing a race in which mega-constellations deploy many more satellites than are actually needed, utilizing large numbers of spectrally-inefficient satellites and rejecting reasonable approaches that otherwise would enable

	spectrum sharing among all NGSO system types – even those operating at other altitudes. The threat to orbital sharing exists because LEO orbits are limited, and mega-constellation operators are in a race to populate a wide swath of the “best” orbits (in the 300 km to 650 km range) with huge numbers of satellites. And mega-constellations are doing so by planning to operate with unnecessarily wide orbital tolerances, and thus would effectively fill up hundreds of kilometers of orbits to the exclusion of other NGSO systems that otherwise could operate alongside them. Particularly when mega-constellations already must operate with much greater precision to avoid collisions, there is no good reason to allow mega-constellations to provide service utilizing overlapping shells of satellites in very wide orbits that unduly consume what other otherwise would be shared. Viasat recommends that Ofcom adopt rules for market access that ensure equitable access to the same spectrum by multiple NGSOs, ensure equitable access to shared and limited NGSO and orbits and ensure that NGSOs do not constrain access to the spectrum shared with GSO networks.
Question 3: Could any of the future technologies we have identified in Annex 6, or any others, have disruptive implications for how spectrum is managed in the future? When might those implications emerge?	Confidential? – N Annex 6 of the Consultation covers many of the areas that Viasat employs in its network to improve the user experience including Artificial Intelligence (AI) self-healing networks and automated network management. However, Viasat urges Ofcom to proceed with caution when applying these future technologies to spectrum management as they could present spectrum uncertainty that could disrupt service to customers. Viasat’s smart network employs advanced network automation to improve customer satisfaction, increase service provisioning, and reduce the cost of network operations by minimizing manual operations. Smart network automation techniques include: • Software-defined networks (SDNs) that enables the network to be centrally controlled, or 'programmed,' using software applications; • Intent based networking (IBN) that employs artificial intelligence and machine learning to perform routine tasks for every network phase including provisioning, deployment, management, troubleshooting, and remediation; and • Data driven networking (DDN) that allows the network to ‘learn’ using data analytics to optimize network traffic management. While the modern techniques described above work well when applied to network management, when applied to spectrum management they could introduce uncertainty as many of the technologies are nascent. At the present time, there is not enough experience with these potential spectrum management technologies to determine whether they will have a significant impact on spectrum

	management. Viasat urges Ofcom to keep examining new technologies but to be very cautious when considering the adoption of those technologies for spectrum management. Many of the systems that use spectrum today, including satellite services, provide critical connectivity to civilian and government users who require a high degree of reliability. Therefore, Ofcom should not take any changes with unproven spectrum management technologies and risk compromising those critical services.

Question 4: Do you agree that there is likely to be greater demand for local access to spectrum in the future? Do you agree with our proposal to consider further options for localised spectrum access when authorising new access to spectrum?	Confidential? – N
	Today's VHTS use the 27.5-30 and 17.7-21.2 GHz portions of the Ka band. These satellites co-exist with adjacent satellites in the geostationary arc and also with non-geostationary satellite through separation and avoidance techniques. These satellites also reuse spectrum on the same satellite platform with smaller beams. These techniques have evolved over time and allow higher-throughput and capacity and, ultimately, more affordable connectivity for consumers. Just like terrestrial wireless operators, however, these VHTS require access to large amounts of contiguous spectrum. In fact, some of today's technology is at or near Shannon's limit and the only input that will allow these systems to increase capacity is access to additional spectrum (see response to Question 5 for more information).
	
	Efforts to segment satellite spectrum into smaller, potentially non-contiguous blocks negatively impacts today's VHTS.
	
	The latest commercial satellite broadband networks use the Ka band spectrum range to provide broadband internet access to millions of end users, and hundreds of millions of personal electronic devices each year, around the world, whether at home, at work, or traveling in vehicles, on ships, or on aircraft.
	
	Ka band satellite systems provide services that are competitive with, and in some cases superior to, terrestrial service. Ka band spectrum "powers" satellite broadband services that:
	
	• Can be offered at speeds of 100 Mbit/s and higher.
	• Can be deployed to a given location almost immediately through a small antenna that can be mobile, transportable, or fixed in place, depending on end-user requirements, and that does not need to be individually licensed or coordinated.
	• Are extendable to anyone near that satellite antenna by using a wireless hot spot to distribute the satellite connection to smart phones and tablets—whether to entire communities or everyone on an airplane, ship, train or bus.
	• Meet needs that no other technology now addresses, or will address, including:
	    ○ Connecting otherwise unserved and underserved families, communities, and small businesses around the world, many of whom are located in pockets of heavily populated areas;
	    ○ Connecting widely dispersed government facilities;

	◦ Connecting passengers and crew on trains, buses, ferries, ships and aircraft; ◦ Supporting emergency responders, national defence and security; ◦ Enabling disaster recovery and relief operations; and ◦ Providing always-available global communications capabilities. Viasat respectfully requests Ofcom consider the potential adverse impacts on connectivity that results from the implementation of band segmentation. In the case of satellite technology that efficiently delivers nationwide broadband across a diversified universe of users, fragmented spectrum detracts rather than enhances the ability to connect UK users.
Question 5: Do you agree with the actual and perceived barriers identified for innovation in new wireless technologies, and our proposed ways of tackling those?	Confidential? – Y [✂ Redacted]

Question 6: Do you agree with Ofcom's proposals to improve our outreach and reporting activities, and spectrum information tools? • **Are there additional ways that Ofcom could better engage with existing and future users and providers of wireless communications?** • **Please explain any specific areas where you believe more or better provision of information**	Confidential? – N Viasat welcomes Ofcom's outreach as it refreshes its 2017 Space Spectrum Strategy. Given space sector developments including the rapid innovation in VHTS like the upcoming ViaSat-3 that will cover 100% of the UK and the advent of LEO mega constellations a refresh of the Space Spectrum Strategy is due.

could provide value to stakeholders	
Question 7: Do you agree that it is important to make more spectrum available for innovation before its long-term use is certain? Do you have any comments about our proposed approach to doing this?	Confidential? – N Making spectrum available for innovation has merit but should be considered on a longer-term basis only after new technologies demonstrate compatibility with the operation of existing users. An example is the use of terrestrial IMT/5G in the 26 GHz band, the band that is adjacent to the 28 GHz band used for delivering satellite services. Viasat has supported the study and development of reasonable operating parameters for new technologies like terrestrial IMT/5G in the 26 GHz band throughout the ITU WRC-19 process. To this end, Viasat urges Ofcom to ensure that terrestrial IMT/5G complies with operating parameters decided in Resolution 242 (WRC-19). Among several items, Viasat emphasizes the importance of the portion of Resolution 242 (WRC-19) that requires that terrestrial IMT/5G base stations within the 26 GHz frequency band with high power operations (e.i.r.p. per beam exceeding 30 dB (W/200 MHz) (i) not point their antenna beams upward at the geostationary satellite orbit and (ii) maintain a minimum separation angle of ≥ 7.5 degrees. These power and separation angle limitations are an example of how UK Ofcom could provide more specific conditions to protect satellite services operating is adjacent spectrum bands. Another example of making available spectrum for innovation while protecting existing users is the deployment of unmanned aircraft in the 26 GHz band because the IMT/5G base station antennas pointed upwards to communicate with the unmanned aircraft could transmit signals towards satellite receivers in space and potentially increasing out-of-band emissions in the adjacent 28 GHz band. Viasat urges UK Ofcom when considering making available more spectrum for terrestrial IMT/5G that it ensures out-of-band limits and pointing requirements are applied to terrestrial IMT/5G operations in order to protect adjacent-band 28 GHz satellite receivers in space. If Ofcom addresses the concerns of the examples addressed earlier, making spectrum available for innovation can result in significant advances. Earth stations in motion (ESIM) is a clear example. Viasat has pioneered mobile broadband services using innovative antenna designs for ESIM service to aircraft, ships and other land-based users. For example, passengers and crew on aircraft, use the 28 GHz band, in addition to the rest of the Ka band identified above, to meet demand for gate-to-gate, high-speed broadband for communications and entertainment, cabin support, and fleet digitization and maintenance. Global shipping and passenger vessels rely on the 28 GHz and the rest of the Ka band for navigation and broadband communications benefiting passengers and crew and facilitating the transportation of cargo. Trains, buses and other land-based vehicles also rely on satellite broadband services, operating in the 28 GHz band, for passenger connectivity, operations and maintenance

	support, and fleet tracking. Viasat urges Ofcom to ensure the operating parameters of new technologies do not impact existing technologies and users when making available spectrum for new technologies. As Viasat points out in the answer to question 5 of this Consultation, making spectrum available with certainty fosters the capital investment that results in innovation. With our answer here in question 7, Viasat highlights the need to ensure that new technologies do not disrupt existing users of the spectrum.
Question 8: Do you agree that it is important to encourage spectrum users to be 'good neighbours' to ensure more efficient use of the spectrum? Do you agree with our proposals to: **a) increase realism in coexistence analysis at a national and international level?** **b) encourage spectrum users to be more resilient to interference?** **c) ensure an efficient balance between the level of interference protection given to one service and the flexibility for others to transmit?** **Do you have any comments on which of these will be the most important?**	Confidential? – N Ofcom's 'good neighbors' approach to ensure more efficient use of spectrum has merit as it maximizes the use of spectrum that powers services like satellite broadband for UK citizens. Clear knowledge of antenna radiation patterns, power levels and modulation are all essential to assess levels of interference and compatibility. Viasat urges Ofcom to adopt a balanced approach where new systems are required to demonstrate the ability to conform with existing technical and regulatory requirements in order to assess compatibility with other systems.
Question 9: Are there any other issues or potential future challenges that should be considered as part of this strategy?	Confidential? – N n/a

Question 10: Do you agree that continued use of our existing spectrum management tools (as set out in sections 4-7) will be relevant and important for promoting our objectives in the future, in light of future trends?	Confidential? – N n/a
Question 11: Is there anything else we should be considering doing, or doing differently, to promote our objectives?	Confidential? – N n/a