Your response

Question	Your response
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 SES welcomes UK Ofcom's continuous recognition of the satellite sector's importance to the UK's communications ecosystem, and Ofcom's efforts to engage with the private sector and all relevant stakeholders to develop well-informed policies and authorisations. SES notably commends Ofcom for considering providing additional "access to spectrum that could boost the capacity of a range of satellite services." As rightly addressed in the Space Strategy 2022, the satellite communications sector is going through several major innovation trends. **Multi-Orbit Systems** Geostationary orbit (GSO) satellites continue to innovate. Satellites launched today offer operators and customers the ability to dynamically assign spectrum bands and satellite capacity. Steerable spot beams using Ku, Ka and now Q/V frequency bands combined with the deployment of new ground antennas has increased spectrum efficiency and flexibility in geographical coverage and spectrum use. Additionally, the cloud services and artificial intelligence (AI) integrated in these new satellite systems are improving network management allowing operators to offer speeds of several 100 Mbps anywhere in the world. Our recently launched SES-17 satellite illustrates it best with its almost 200 spot beams, the power of which can be dynamically adjusted in step with our customers' changing requirements.[1] Non-Geostationary orbit (NGSO) satellites have also been in operation for many years and are used today for a broad set of space applications such as Earth observation, navigation and communications services. SES operates its O3b constellation at the medium earth orbit (MEO).[2] Made up of 20 satellites, it is designed to provide low-latency broadband connectivity to remote locations for mobile network operators and internet service providers, maritime, aviation, and government and defence. O3b has been offering service all over the world since March 2014. In 2022, SES will launch the next generation of O3b satellites, called O3b mPOWER, with terabit-scale capacity and even more flexibility than the current generation.[3]

[1] SES-17: Experience endless connectivity | SES

[2] https://www.ses.com/our-coverage/o3b-meo

[3] https://www.ses.com/o3b-mpower

GSO satellite constellations, thanks to their high altitude and wide field of view, can cover the entire globe with as few as three satellites, while NGSO satellites — being closer to the earth — will cover a much smaller area with each satellite. This requires NGSO satellite operators to build much larger constellations to achieve global, continuous coverage. That said, MEO constellations, made up of a small number of satellites (e.g. six spacecrafts flying at #8,000 kms are enough to cover the orbital arc), are able to support and serve applications with strict latency requirements.

A multi-orbit satellite network allows the advantages offered by one altitude to be combined with those of another, whilst mitigating each other's disadvantages. For example, the wide coverage of GEO can be combined with the ultra-high speed and lower latency offered by MEO to support lower latency and higher throughput demanding application, such as connectivity to the cloud, everywhere in the world from mobile platforms to hard-to-reach areas.

Therefore, different ICT applications may have distinctly different requirements which will make GSO or NGSO satellite solutions more appropriate and cost-efficient. NGSO satellites with their higher-throughput, low-latency characteristics will be well suited for latency-sensitive applications such as voice and videoconferencing or cloud computing while GEO satellites will be useful to ensure continuous connectivity over large areas for applications such as video or data multicasting and Internet-of-Things. As an operator of both GSO satellites and the O3b NGSO constellation, SES has been developing integrated GSO and NGSO networks combining the advantages of both.

For more information about the role and importance of orbits for satellite communications:
https://news.itu.int/seamless-connectivity-across-satellite-systems/

Satellite's Key Role in 5G and 6G

Satellites are already demonstrating their ability to accelerate and extend 5G networks. SES, notably, was a founding member of the 5G-IA (Infrastructure Association)[4] and a pioneer in defining the role of satellite in 5G through active participation in research, development, and standardisation activities. Since then, specific standardisation work has been undertaken in dedicated bodies such as for instance the 5G-PPP, 3GPP (in the System Aspects SA and Radio Access Network RAN groups), ETSI, ATIS (NTN group) and the ITU.

Participations in 5G initiatives | SES
5G Readiness Guide | SES

[4] https://5g-ppp.eu/5g-infrastructure-association-5g-ia-a-step-forward-with-new-governance/

https://www.sat5g-project.eu/
https://satis5.eurescom.eu/
https://www.5g-vinni.eu/
https://www.ses.com/insights/delivering-5g-everywhere-satellite

Thanks to this work, satellite systems are already an integral and essential part of the 5G ecosystem, able to actively contribute to the deployment of 5G services to end-users in the most remote geographical areas. They are enabling communications on the move, direct to premises connectivity in rural and urban areas, direct connectivity to end user devices or video content / big data delivery worldwide. Satellites are also reinforcing 5G service reliability by providing service continuity to users, reducing power consumption and by scaling 5G networks through the provision of efficient multicast/broadcast resources for data delivery towards the network.

SES recently completed multiple field tests and technical demonstrations with a major mobile operator and cloud provider in the U.S. The tests – which lasted a week – validated SES's ability to deliver fiber-like performance for mobile operators and came back with some unprecedented results:

- 10,000 simultaneous calls were maintained over a 10-hour period over a single MEO satellite link;
- Fiber-quality video latency and an impressive mean opinion score – a common industry measurement of voice quality – of 4.23 out of 5; and
- MEO test configuration delivered 900 Mbps aggregate throughput.

Reimagine_5G_Networks-Technology_Showcase.pdf (ses.com)
SES Leads Satellite-enabled 5G Tests | SES

As countries around the world have long worked to identify additional spectrum bands for terrestrial IMT, SES and other satellite operators are experiencing continuous pressure to limit satellite access to essential spectrum. (see Powering Satellite Connectivity Services with Spectrum | SES). An often overlooked issue is whether satellite services have access to sufficient spectrum resources to support the deployment of 5G networks where terrestrial infrastructure cannot provide cost-effective reach, and to ensure communications networks have built-in resiliency. The same question exists in relation to the role of satellite in the emergence of 6G systems. Therefore, we support Ofcom's continued focus on the role satellite plays in the UK's communications ecosystem and how that role can only be fulfilled with adequate spectrum.

Satellite Makes the Cloud Available Everywhere

Another important evolution is how satellites and cloud services help each other to expand access and options for citizens. With the increasing rollout of digital transformation initiatives, cloud service providers such as Microsoft need to be able to process an increased amount of data at the edge of their network. According to Gartner, edge computing is on the rise, as 75% of enterprise-generated data will be created and processed outside of a centralised data centre by 2025.[5] This can apply to government use cases such as humanitarian aid and disaster response but also civil industrial applications like smart mining and agriculture and telehealth.

As a perfect illustration, the cloud brings many benefits to the oil and gas industry, as equipment monitoring can now provide insights into every aspect of an operation through IoT solutions, feeding critical data into onshore IT systems that previously operated in isolation. Cloud computing platforms allow companies to process and analyse the data they collect more effectively and cost-efficiently by reducing legacy on-premises systems and introducing more flexible consumption options, opening the door to new business models and new revenue streams. Connectivity is essential to take full advantage of these benefits and when it comes to activities in the high seas like offshore rigs and platforms, mining in landlock countries and hard to reach areas, or agriculture in remote and rural area, terrestrial network may not be a financially viable option. Satellite connectivity can bridge this gap in a cost-efficient way.

https://www.ses.com/blog/transforming-mining-sector-high-performance-connectivity
https://energydigital.com/oil-and-gas/driving-offshore-growth-satellite-communications

Therefore, big players such as IBM, Microsoft Azure or Amazon have started to partner with satellite operators such as SES to extend their reach. SES solutions provide secure connectivity between the cloud provider data centers to their end users' remote sites, allowing their users to connect and have greater performance, taking advantage of the productivity, scalability, and operational agility that cloud computing enables, even in remote and hard-to-reach areas.

Satellite communications platforms are also benefiting from much enhanced network agility and security coming out of the cloud functionalities.

https://www.ses.com/insights/future-satellite-and-cloud/ses-and-microsoft
Microsoft, SES and Nokia demonstrate satellite and 5G integration for Australian Defence remote access to Azure cloud services | SES

[5] What Edge Computing Means For Infrastructure And Operations Leaders (gartner.com)

	SES Expands Multi-Cloud Offerings with Oracle Cloud Infrastructure FastConnect | SES SES's O3b mPOWER Tapped by Microsoft for Azure Network Cloud Services | SES https://www.ses.com/press-release/ses-expands-cloud-leadership-amazon-web-services-direct-connect-partner **ESIMs Rely on Satellite** Ofcom is correct to explore expanding spectrum access for Earth Stations in Motion (ESIMs), also referred to as Earth Stations on Mobile Platforms (ESOMPs). Consumers and businesses today demand high-speed broadband at home, the office and on the move. More and more, consumers and business travellers expect high speed broadband while traveling where terrestrial-only wireless and wired broadband networks cannot realistically deliver connectivity. ESIMs mounted on ships, aircraft, trains, and vehicles fill in this critical gap in terrestrial-only broadband networks. SES has led the way by delivering ESIM connectivity in the United Kingdom and around the world through its geostationary orbit satellite fleet using the C-, Ku-, and Ka-bands, as well as its O3b constellation using the Ka-band. Since 2014, in fact, the O3b constellation has delivered maritime ESIM connectivity to cruise ships transiting the ports and waters of the United Kingdom. ESIMs have been using the Ku-band and C-band Earth Stations on Vessels (ESVs) since the early 2000's. In addition, ESIMs already use millimetre wave frequencies such as the Ka-band (27.5-30 GHz and 17.7-20.2 GHz) to deliver higher broadband speeds to flights and will further use the Q/V-band for even greater throughput in the future. While SES and ESIMs services have successfully demonstrated satellite's ability to expand the true ubiquity of broadband connectivity, limits to FSS spectrum allocations can hamper the ability of ESIMs to deliver the highest level of broadband service possible or in some instances threatens the ability of satellite operators to deliver continuous ESIM coverage. For example, the United Kingdom currently prohibits satellite operators from providing ESIM service using the C-band, only permits ESIMs to operate in 250 megahertz out of the available 500 megahertz in the 14-14.5 GHz Ku-band uplink and restricts Ka-band ESIMs to 27.5-27.8285 GHz, 28.4445-28.8365 GHz, and 29.5-30 GHz. Overall, less than half of the FSS frequencies in the C-, Ku-, and Ka-bands are available for ESIMs transiting the UK waters and airspaces, resulting in less capacity and slower speeds to UK consumers, businesses, and visitors relying on ESIM connectivity to fill in the gaps in broadband networks. Other CEPT countries make more spectrum available for the usage by ESIMs or ESOMPs, in line with the ECC decisions.

	Criticality of the International Framework SES commends Ofcom for its extensive recognition of the importance of the ITU Radio Regulations and its willingness to engage with industry stakeholders to support Ofcom international representation activities in these forums. SES very much appreciates that Ofcom raises the importance of managing ITU-R filings for satellite orbital positions and radio frequencies at a national level "in a thorough, transparent and predictable way, consistent with international rules" and its "inten[t] to initiate a review of the procedures for the management of satellite filings and make changes, ensuring requirements remain transparent and, where appropriate, to reflect the latest international rules." Harmonisation work achieved by the CEPT and by ETSI on spectrum usage and standards are also essential to take into account. This harmonisation effort in Europe has been instrumental in setting up similar conditions on spectrum use, licensing regimes and equipment usage across many different countries, thereby facilitating the deployment of services spanning territories covered by the footprint of our satellites. It is therefore important that the UK continues to participate to the telecommunications standardisation efforts conducted in ETSI, CEN and CENELEC, considering the trade flows between the UK and the rest of Europe.
Question 2: Do you agree with the broad areas we have prioritised for our work?	**Emergency and Disaster relief – Critical services** A new report by Access Partnership has revealed that the annual number of natural disasters is expected to increase by 37% (from 442 to 541 occurrences) by 2025 worldwide.[6] It is not surprising, as organisations such as the Intergovernmental Panel on Climate Change, the International Monetary Fund (IMF), the World Bank, and the World Meteorological Organization (WMO) all agree that weather-related disasters are likely to increase and range farther in the coming years due to climate change. Terrestrial networks are particularly vulnerable to a wide range of disasters such as hurricanes, floods, and earthquakes that can disrupt their services. Thanks to their ubiquitous coverage and resilience against catastrophic events, satellite communications are available for rapid deployment when other communications systems have been destroyed or become overloaded, enabling immediate vital communications for relief efforts. For example, when an earthquake and tsunami devastated Tonga,[7] SES and other

[6] https://accesspartnership.com/the-citizen-natural-disasters-set-to-increase-by-37-globally-by-2025-report/?hss_channel=lcp-472410&utm_campaign=Access%20Alerts&utm_medium=email&_hsmi=210545090&_hsenc=p2ANqtz-9Nyz2q3Z193Mx309mlvRfur35BMaMX5pQOEI6cF2NazWplrJeWDk2YkRAcilckymLyORUyNuzHZIW1ll4avTmyJeVUMQ&utm_content=210545090&utm_source=hs_email

[7] https://www.ses.com/press-release/ses-enables-digicel-restore-first-international-calls-tonga

satellite operators were able to help restore connectivity within days using existing satellite infrastructure on the island.

https://www.ses.com/press-release/ses-enables-digicel-restore-first-international-calls-tonga
https://www.ses.com/blog/restoring-communications-disaster-stricken-mozambique-satellite
https://www.ses.com/press-release/sess-and-gilat-telecoms-resilient-network-restores-connectivity-africa

Today, as demonstrated by the Covid pandemic, access to the Internet has become so integral to daily life, education, healthcare, and commerce, that even a short-term disruption of the communication networks can have a high economic and human cost. Ensuring that satellite communications is integrated into the communications network provides the peace of mind that, in any situation, connectivity will always be available to those that need it most.

Safe Access to Space

Today, space sustainability is challenged by the rapidly rising numbers of space objects and debris which could impact the provision of existing space-based services (e.g., navigation, earth observation, weather monitoring, and broadband). SES therefore welcomes Ofcom's recognition of the importance of safe use/ access to space and its intention to discuss this question with their counterparts in the CAA and the UK Space Agency. SES also encourages Ofcom to further engage with private stakeholders on these questions.

SES and other satellite operators and space industry associations are committed to work with governments around the world to develop and implement appropriate policies to enable continued safe, reliable, and equitable access to space for all nations.

SES, for example, has been operating in space for over 35 years and is a leader in responsible space use. Our ESG strategy[8] focuses on sustainable space and demonstrates our desire to further collaborate and innovate to address the challenges of this unique operational environment. We have been working in collective action platforms on the formulation of policy documents to highlight the importance of space sustainability together with association such as the Satellite Industry Association (SIA)[9] and Global Satellite Operators Association (GSOA)[10].

[8] https://www.ses.com/press-release/ses-unveils-bold-new-esg-strategy-and-targets-2021-annual-report-publication
[9] https://sia.org/space_safety/
[10] https://gsoasatellite.com/reports_and_studies/space-sustainability-the-time-to-act-is-now/

	SES is a signatory of the World Economic Forum Space Industry Debris Statement[11] and endorses the Space Safety Coalition. SES pledges to reduce and prevent space debris and emissions caused by space activities through these endorsements. SES works with governments, civil society, commercial partners, and competitors to substantially reduce its footprint and encourage innovative spacecraft and other means of technologies for this aim. To encourage collective action and endorsement of best practices in space, SES also intends to undergo the Space Sustainability Rating (SSR) process being developed by the World Economic Forum. The SSR is an ongoing process intended to increase transparency in participating organizations' space debris mitigation policies. Upon establishment, SSR will provide a sustainability score for companies on their debris mitigation strategies and their alignment with international guidelines.
Question 3: Are there other issues and actions that are likely to be important over the next 2 – 4 years?	As explained in response to Q2 above, terrestrial communication networks are vulnerable to disruption from a wide range of disasters. Nowadays, consumers and businesses can no longer afford to wait for network restoration in case of a disruption or damage caused by natural disaster or cyber-attacks. Time and time again, satellites have come to the rescue to restore terrestrial networks in the wake of storms, earthquakes, tsunamis, terrorist attacks, fibre cuts or simply technical issues. It is therefore important to ensure that satellite systems have sufficient access to harmonised spectrum resources such as the C-, Ku-, Ka-, and Q/V-bands. All of these frequency bands have unique characteristics that make them invaluable for satellite network resiliency. Typically, C-band provides for a more robust connection that is resistant to weather disruptions and delivers important emergency broadcast video content. Ka- and Q/V-bands enable higher broadband speeds, whist Ku-band provides a balance of capacity and robustness.
Question 4: Do you have any evidence on whether specific actions should be a high priority?	SES welcomes Ofcom's initiative to further secure satellite access to spectrum. This will help to incentivize investments from our industry and provide new opportunities to deploy satellite services in the UK. SES thus welcomes that Ofcom will "consider additional spectrum access that could provide greater bandwidth for user terminals (14.25 – 14.5 GHz), gateways (Q and V bands), and Earth Stations in Motion (for aircraft and ship connectivity)." In particular, SES notes Ofcom's intention to "consider use by ship and aircraft earth stations as part of [their] consultation on future use of th[e] band [14.25 – 14.50 GHz]." Additional Ku-band spectrum needs to be made available in the UK to meet the increasing demand for ubiquitously deployed very small aperture satellite terminals (VSATs), aircraft-mounted earth stations (AES) or earth stations on board vessels (ESVs). At the moment, this usage is

[11] https://www3.weforum.org/docs/WEF_Space_Industry_Debris_Statement_2021.pdf

	incompatible with Ofcom's requirement for individual licensing of FSS Earth stations using the upper half of the 14.0-14.25 GHz band. SES therefore supports Ofcom's plans to look at "options for the future use of the 14.25 – 14.50 GHz band" and expects to contribute to Ofcom's consultation on their concrete plans and proposals as soon as released in 2022. SES also welcomes Ofcom's intention to "develop [its] approach to licensing gateway earth stations in Q / V bands and higher frequencies." The Q/V bands are well suited for feeder links for the next generation of high throughput satellite systems due to their sizeable contiguous spectrum and the opportunity to further augment wide bandwidth in case of Ka-band shortage. FSS access to the full 27.5–30 GHz frequency band is extremely important and Ofcom should indeed "consider updating the earth station network license to allow use of wider bands, including conditions to protect users of the Spectrum Access licenses" for any fixed or mobile satellite earth station. The whole FSS Ka-band made up of 2.5 GHz for uplinks in 27.5-30.0 GHz and 2.5 GHz for downlinks in 17.7-20.2 GHz is vital for Very High Throughput systems such as O3b mPOWER which SES will be operating as of 2023. Although the Ka-band market for ESIM is already established, the World Radiocommunication Conference 2019 (WRC-19) adopted an agenda item (1.16) that calls for the ITU to study and develop technical, operational and regulatory measures, as appropriate, to facilitate the use of the frequency bands 17.7 - 18.6 GHz, 18.8 - 19.3 GHz, 19.7 - 20.2 GHz (space-to-Earth), 27.5 - 29.1 GHz and 29.5 - 30 GHz by NGSO FSS earth stations in motion, while ensuring due protection of existing services in those frequency bands for the next WRC conference in 2023. SES would therefore encourages Ofcom to also engage on WRC-23 work on NGSO ESIM in 27.5 - 29.1 GHz and 29.5 - 30 GHz.
Question 5: Do you have any other issues you wish to comment on?	N/A
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?	SES welcomes Ofcom's initiative to introduce a new NGSO licensing process and pursue improvements to international NGSO rules. SES has commented on Ofcom's consultation on the licensing of NGSO systems in 2021, and we took careful note of the outcome statement and documents released by the UK regulator (Statement: Non-geostationary satellite systems – licensing updates - Ofcom). The Strategy refers to NGSO as synonymous to mega-constellations (para 6.6), but it is imperative that Ofcom recognises that not all NGSO systems are mega-constellations. SES's O3b constellation,

	has been in operation since 2014 and is a MEO constellation of a dozen of satellites. The next generation constellation, O3b mPOWER, will start launching in 2022. (O3b mPOWER | SES) It initially comprises 11 satellites, and while mPOWER is planned to scale up, it will remain far below thousands or even hundreds of satellites. The Strategy also lists the "commercial NGSO system currently being deployed or planned" (Table 5), but some systems are missing from Ofcom's list that is provided such as, O3b (O3b MEO | SES) which have filings and is licensed in the UK. On the other hand, SES fully subscribes to Ofcom's intention to foster competition in the satellite sector and "enable as many NGSO systems as possible, to provide services and increase choice for people and businesses in the UK." To this end, Ofcom's support in facilitating a transparent dialog amongst satellite operators is most welcome, but it is fundamental that ITU coordination principles are fully respected.
Question 7: Do you have any evidence on whether specific actions relating to NGSO communication systems should be a high priority?	N/A
Question 8: Do you have any other comments relating to NGSO systems?	N/A