Transformative Connectivity: Trends in satellite innovation

Study period 2022-2025

Question 1/1

Strategies and policies for the deployment of broadband in developing countries

Question 3/1

The use of telecommunications/ICTs for disaster risk reduction and management

Question 5/1

Telecommunications/ ICTs for rural and remote areas

Interim deliverable 2024

Introduction: State of the industry

The satellite industry is going through a phase of unprecedented growth and innovation. It is expected to generate an estimated USD 250 billion in social and economic benefits across the world and the number of satellite broadband users is set to double to at least 500 million people by 2030.[1] Satellite technology is a powerful tool that contributes to the achievement of multiple Sustainable Development Goals (SDGs)[2] by expanding access to education, health, and financial inclusion, as well as helping address environmental challenges including climate change. Satellite services are an important tool to help bridge digital, education, health, social, gender and economic divides across diverse geographies, across mature and developing economies alike. Today, fast and direct-to-consumer satellite broadband is making a huge difference in some parts of the world as are business-to-business (B2B) solutions enabled by partnerships with mobile network operators (MNOs) and Internet service providers (ISPs) to enable, for example, cellular backhaul, community Wi-Fi solutions[3] or satellite direct-to-device services.

In a world characterized by increasing data, mobility, vulnerability to threats and inequality, the reach and resilience of satellite systems are essential in expanding connectivity in every part of the globe. As the world is becoming increasingly digital, it needs ever more performing, ubiquitous, reliable, resilient and inclusive connectivity.

The World Bank[4] and the Asian Development[5] Bank highlight the importance of satellites in addressing access gaps, especially in regions with dispersed populations and challenging terrain.[6] As this report will detail, the successful deployment of satellite services depends on an enabling policy and regulatory environment at the national, regional and global levels fostering growth, innovation and continuous investment from industry.

1 SG1RGQ/108 from GSOA
2 1/251 from GSOA
3 Presentation from GSOA at the Transformative Connectivity Satellite Workshop
4 https://documents1.worldbank.org/curated/en/674601544534500678/pdf/Main-Report.pdf -
5 https://www.adb.org/sites/default/files/publication/696521/sdwp-076-digital-connectivity-low-earth-orbit-satellite.pdf
6 SG1RGQ/224 from Saudi Arabia

Chapter 1: Expanding connectivity in developing countries and in rural and remote areas

The growth in Internet connectivity around the world has been uneven, with developing countries lagging furthest behind. Despite an estimated sevenfold increase in developing countries since 2005,[1] Internet use remains far below that of higher-income countries (93%), reaching only 27 per cent in low-income countries.[2] Affordability continues to be a main barrier to Internet use. Median fixed broadband prices in low-income countries accounted for one-third of monthly gross national income per capita in 2022,[3] leaving even basic access to the Internet out of the reach to too many.

The statistics surrounding the challenge of broadband access in developing countries obscure an even greater challenge: connecting the rural communities within developing countries that are the least connected regions on the Earth. Around the world, the share of Internet users is estimated to be 1.62 times as high in urban areas as in rural areas in 2023. In Africa, for example, Internet use in urban areas is almost 2.5 times as high as use in rural areas.[4]

Compared to their urban counterparts, rural areas usually have lower income levels, lower levels of education and lower levels of ICT skills, all of which are negatively correlated with demand for Internet services. Moreover, terrestrial broadband access technologies such as fibre-optic cables, digital subscriber lines, or copper-based cable Internet require extensive infrastructure to become operational. In regions where terrain can be rugged and sparsely populated, deploying such infrastructure can be prohibitively expensive, particularly in developing countries. As a result, investment models for terrestrial broadband connectivity in rural, developing regions are often not commercially viable due to the high cost of deployment and low demand.

Access to health, education and financial inclusion are enabled by satellite connectivity for people living in rural regions where good quality care is often unobtainable. Companies such as Hispasat enable telemedicine projects with software, hardware, and human capacity building in areas that lack terrestrial connectivity.[5] Other examples of how satellites are bringing meaningful connectivity and bridging the gender, economic and digital divides are projects like *Mi Pueblo Connectado* (Hispasat),[6] *Conectando Sueños* in Colombia, Chile and Ecuador (Echostar Group), Connecting Maternity Clinics (Avanti) or bringing connectivity to remote isolated communities and islands (INTELSAT).[7]

A new generation of satellite technologies and related business models offers hope for better connectivity in rural, developing communities. Satellite networks can help connect these areas by providing a fast, affordable service in places where broadband provided via legacy networks is otherwise unreliable or too expensive, or where it does not exist at all. The benefit of satellite broadband is particularly pronounced in areas that are difficult or expensive to reach with terrestrial infrastructure. Satellites can provide coverage to even the most remote areas, and the minimal ground-infrastructure makes it a compelling solution for bridging the digital divide.

Commercial satellite services have existed for many decades. However, due to technological and economic constraints, they have filled more of a niche market in various parts of the world, as opposed to significantly addressing the digital divide. In the last several years, however, the satellite industry has born witness to tremendous technological developments that hold great promise for expanding connectivity in developing and least developed countries and in remote and rural regions around the world.

A variety of technological developments in the satellite industry can provide improved connectivity in rural communities. For instance, some satellite operators have launched multi-orbit networks, which use a combination of satellites at various orbits to best exploit the unique characteristics in terms of coverage, throughput, latency, speed or operational ease, while satellite platforms using geostationary Earth orbit (GEO) very high-throughput satellite (VHTS)and medium Earth orbit (MEO) systems can deliver improved connectivity rates and speeds, and flexible and consumer-focused options. Virtual and software-defined satellites and software defined networking (SDN) introduce flexibility and programmability into traditional satellite networks, simplifying their integration into the telecommunication ecosystem.[8]

One key development is the emergence of low Earth orbit (LEO) satellite systems[9]. Because they orbit closer to the Earth (at altitudes between 160 and 2 000 km) than geostationary satellites (GSOs), LEO satellites can provide high-speed connectivity. At these speeds, LEO satellites can provide sufficient speeds for many critical modern services such as real-time videoconferencing, industrial applications, live streaming, and financial trading. In recent years, systems including OneWeb, SpaceX's Starlink, Amazon's Kuiper,[10] and Telesat's Lightspeed[11] have deployed, or have planned deployment, to deliver high-speed connectivity around the world.

In addition, customer terminals which feature single aperture phased array antennas that overlay send and receive antennas, result in a form factor that is smaller and lighter than legacy antenna designs. Other developments include steerable spot beams that send strong signals to customer terminals and control how bandwidth is

1 ITU Global Connectivity Report 2022: https://www.itu.int/itu-d/reports/statistics/global-connectivity-report-2022/index/
2 Facts and Figures 2023 https://www.itu.int/hub/publication/d-ind-ict_mdd-2023-1/
3 World Bank "Digital Progress and Trends Report 2023 https://openknowledge.worldbank.org/server/api/core/bitstreams/95fe55e9-f110-4ba8-933f-e65572e05395/content
4 Facts and Figures 2023 https://www.itu.int/hub/publication/d-ind-ict_mdd-2023-1/
5 1/346 Remarks from Hispasat at the Transformative Connectivity Satellite Workshop
6 1/179 from Argentine Republic
7 1/151: GSOA Contribution Satellite for SDGs - Transforming lives
8 Report of joint workshop on Transformative Connectivity Satellite Workshop https://www.itu.int/md/D22-SG01-C-0346
9 SG1RGQ/95. Amazon. "Bridging the digital divide through advances in satellite technology"
10 Presentation from Amazon Kuiper at the Transformative Connectivity Satellite Workshop
11 Presentation from Telesat at the Transformative Connectivity Satellite Workshop

allocated across a region; and inter-satellite links (ISLs) that relay data between satellites in order to create a continuous user connection as satellites pass by a terminal's field of vision.

These developments in technology naturally lend themselves to new use cases and business models, and ultimately new ways to address the digital divide.

The new generation of satellites provides a new outlook for direct-to-consumer satellite connectivity. For the first time, people living in remote areas can have access to fibre-like speed and latency for their broadband connections. The technological advancements noted above have made the price of satellite connectivity much cheaper than in the past.

The advancements in satellite technology have also lent themselves to new business models in partnership with MNOs. Satellite networks can enable backhaul connectivity for cellular networks, allowing mobile operators to extend coverage at lower costs than deploying more expensive terrestrial infrastructure. Further partnerships between satellite and mobile network operators have the potential to improve the state of connectivity by providing seamless and reliable connectivity to historically underserved areas. Prominent examples include Amazon Kuiper partnering with Vodacom Africa, Telesat and Telefónica Global Solutions partnership in Brazil, and OneWeb and Orange partnering in Africa and Latin America.

Satellites have also helped to empower community networks. Community networks are local networks built and managed by a community using them, initiatives that typically start with shared objectives such as community development, education, or health care. Satellites can provide backhaul to and from a community network, which is then distributed throughout the community over a mobile or LAN network that community members can access. The Internet Society (ISOC) has successfully used LEO satellites to empower community networks in developing and indigenous communities around the world.[12]

Global perspectives on satellite regulation

Across different regions, satellite technology continues to play a vital role in extending digital connectivity and driving innovation. The landscape of satellite communication regulation is rapidly evolving, with various countries, like the United States of America, Brazil and South Sudan, each facing unique challenges and opportunities in leveraging space technology for communications.

The Federal Communications Commission (FCC) of the **United States of America** has long played a critical role in the United States satellite ecosystem. It is responsible for licensing satellite systems and managing the spectrum essential for satellite operations from launch to communication. In 2022, FCC launched the Space Innovation Agenda focused on transparency, efficiency and fostering investment in space-based communications. The agenda also created a dedicated Space Bureau within FCC. The agenda came at a time of rapid growth, with a surge in satellite applications, particularly for non-geostationary satellite orbit (non-GSO) and low Earth orbit (LEO) satellite systems and new technologies like in-space servicing and direct-to-cell communications. By 2023, FCC had processed over 2 800 satellite applications, with 21 per cent of them relating to non-GSO/LEO proposals and 14 per cent to GSO satellites. As the complexity of these systems increases, the Space Bureau is central to managing spectrum access and supporting the growth of innovative space technologies.[13] Additionally, FCC is deeply involved in space sustainability. All satellite licenses must include orbital debris mitigation plans - a crucial factor as satellite constellations grow in number and complexity. This regulatory foresight is important for preventing collisions and ensuring the long-term viability of orbital operations, especially with the increasing demand for satellite constellations.

Brazil's space journey began in the 1960s and saw its first satellite launch in 1995, marking the country's emerging presence in the global satellite ecosystem. Over time, Brazil's national telecommunication agency (ANATEL) has overseen the expansion of satellite capabilities, authorizing over 100 satellite systems. Today, Brazil operates 13 domestic satellites and 46 foreign GSO satellites, with a growing footprint in non-GSO systems. Recent regulatory reforms have simplified satellite landing rights and reduced fees, fostering competition and innovation in satellite broadband services, particularly Ka-band satellites.[14] This expansion has significantly boosted broadband access in both commercial and scientific applications, with developments in CubeSats and Internet of Things (IoT) services becoming central to Brazil's digital ecosystem. These advances contribute to the country's goal of expanding connectivity to remote and underserved regions, bridging the digital divide and facilitating economic growth through enhanced Internet access and broadband services.

In **South Sudan,** [15] a country facing immense developmental challenges, satellite technology is seen as a transformative tool for achieving nationwide broadband connectivity by 2030. With 79 per cent of the population living in rural areas, the terrain and geographical issues make terrestrial networks difficult to implement. Satellite broadband holds the potential to bridge this gap, providing connectivity to remote and isolated areas. However, affordability remains a key barrier, making it challenging for many citizens to fully benefit from these technologies. South Sudan has taken significant steps towards improving connectivity, including by launching its first international fibre link in 2020, but continues to rely heavily on satellite communications. As South Sudan works to integrate terrestrial technologies and expand 4G and 5G mobile networks, there is a strong emphasis on capacity-building and regulatory reforms to support the country's socioeconomic development through better Internet access.

12 1/346 Remarks from ISOC at the Transformative Connectivity Satellite Workshop

13 1/346 Remarks from FCC at the Transformative Connectivity Satellite Workshop

14 1/346 Remarks from ANATEL at the Transformative Connectivity Satellite Workshop

15 1/346 Remarks from South Sudan at the Transformative Connectivity Satellite Workshop

Dominican Republic: The Biennial Project Plan of the Telecommunications Development Fund of INDOTEL-RD for 2021-2022, "Connecting the Unconnected", has executed an Access and Infrastructure component to bring connectivity to small and isolated rural communities and mountainous and unserved regions, through the installation of nine Internet satellite kits for eight communities located in three of the poorest, least developed provinces of the country.[16]

Chapter 2: Terrestrial and non-terrestrial network integration for connectivity everywhere

The optimum solution for future connectivity does not lie with one technology alone but through a combination of multiple technologies - pooling their different strengths to deliver greater availability and exceptional resilience for more people while improving cost efficiency.

The growing demand for satellite connectivity presents significant opportunities for deploying non-terrestrial networks (NTNs) in more rural regions and markets. Emerging markets in remote and rural areas, where traditional terrestrial infrastructure is lacking, represent a substantial opportunity for non-terrestrial network connectivity. This includes unserved and underserved areas in regions in Africa, South and South-East Asia and the Americas in particular. Additionally, sectors such as automotive, transportation, agriculture and IoT applications are poised for growth as NTNs provide solutions for connectivity challenges in these industries.

A non-terrestrial network (NTN) refers to a 3GPP-defined concept involving the integration of satellite and terrestrial networks for the support of seamless service continuity in diverse environments. NTNs encompass satellite-based networks operating in frequency bands allocated to mobile satellite services (MSS) or fixed satellite services (FSS). They leverage the 3GPP-defined mobile system, technology and waveforms. Thanks to this technology commonality, economies of scale can be achieved for IoT, broadband, voice and emergency services, for example, at the terminal level.[17]

Satellite technologies are well-suited to large-scale, global IoT deployments, providing coverage across wide geographies. Standards bodies, like 3GPP and the LoRa Alliance, have embraced satellite technology, allowing cost-effective deployments and operations worldwide. Satellite IoT opens the door to transformative applications in a range of sectors, such as smart cities, precision agriculture and environmental monitoring, by overcoming existing connectivity challenges. Satellite narrowband IoT (NB-IoT) solutions employ small, low-power and low-cost IoT modules designed for efficient operations with satellite networks, making applications more affordable and sustainable.

The integration of NTNs and terrestrial networks can provide seamless connectivity and roaming capabilities for IoT devices transitioning between ground-based and satellite coverage areas. As IoT and satellite technologies converge, they promise to reshape how people connect, communicate, and interact with the world, ushering in a new era of global connectivity and possibilities.

The Connecta IoT system from Plan-S, for example, provides scalable, low-cost connectivity that powers applications, including precision agriculture, infrastructure monitoring and disaster relief. Sateliot is planning a system to expand access by collaborating with multiple communication ecosystem stakeholders, ensuring the best service to the final user by leveraging the expertise and strengths of its partners.

Another sub-category of NTNs is direct-to-device (D2D) connectivity, which involves connecting satellites directly to smartphones. One approach utilizes existing allocations and standardized protocols and frameworks, capitalizing on 3GPP NTN specifications for seamless terrestrial and satellite connectivity networks across various applications, with no additional changes to the ITU Radio Regulations. This variant necessitates increased collaboration with mobile chipset vendors to support relevant MSS frequencies in their user equipment.

An alternative approach is for D2D to operate in the same frequency bands as those used by MNOs, providing a solution to complement mobile coverage, addressing gaps in connectivity where traditional networks fall short, potentially using off-the-shelf mobile handsets. However, the technical and regulatory challenges of this variant are under study.[18]

As stakeholders navigate these challenges and opportunities, collaboration between satellite operators, mobile network operators and regulatory bodies is essential to realize the full potential of satellite D2D connectivity to usher in a new era of ubiquitous and seamless communication. This opportunity is driving parallel developments in other industry bodies, such as the GSM Association (GSMA), which is updating its frameworks to support network convergence and ensure global interoperability for devices and services across terrestrial and non-terrestrial networks.[19]

Collaboration between terrestrial mobile and satellite service providers is crucial for the success of NTNs. These sectors have not operated in silos, in fact, many MNOs are already using satellites for backhauling base station traffic in remote areas, but closer cooperation can lead to improved service offerings and customer experiences. By fostering a cooperative environment, the industry can leverage joint expertise and resources, creating comprehensive solutions that meet diverse connectivity needs. The GSOA and GSMA cooperation agreement signed in February 2024 is an important step in strengthening collaboration to accelerate the successful integration of non-terrestrial and terrestrial networks.

Some of the greatest benefits for citizens in most recent years are down to collaboration between terrestrial and non-terrestrial networks. This continued collaboration will enable populated and urban areas to have high-speed connectivity and enhance the development of new services, while also connecting rural and remote areas and helping bridge the digital divide.

16 SG1RGQ/167 from Dominican Republic
17 1/238 from Ericsson Ltd
18 WP4C at ITU-R
19 Report of joint workshop on Transformative Connectivity Satellite Workshop https://www.itu.int/md/D22-SG01-C-0346

Chapter 3: Satellites for disaster mitigation, response and recovery

Effective disaster response relies on coordination and communication. Satellites bring essential connectivity to disaster responders when other communication options are incapacitated.[20] This is particularly critical in the first 48 hours, the most crucial time-frame after a disaster for managing relief efforts and ensuring the safety of affected populations. When terrestrial networks are affected, satellite communications provide essential connectivity for public officials, responders and communities to share information and coordinate efforts. This connectivity ensures that even those without access to other communication channels can stay informed and connected with their loved ones and authorities.

Beyond the immediate aftermath, satellite communications are instrumental in continuing recovery efforts, maintaining open communication lines throughout the rebuilding process. They enhance all phases of disaster management: mitigation, preparedness, response and recovery. Satellite data that is conveyed in real time helps identify high-risk areas and monitor environmental changes, while satellite connectivity facilitates quick and accurate communication among emergency services, ensuring efficient relief efforts and real-time updates.

The number of recorded natural disasters has more than doubled between 1980-1984 and 2015-2019 - a trend likely to continue in the next decade.[21] Over the past 60 years, satellite communications have contributed to disaster response efforts, providing critical connectivity when terrestrial networks fail. However, these contributions were provided by overcoming many technological and administrative barriers, such as importation of the satellite terminal equipment to the disaster-hit area, training of personnel, interoperability of different devices and networks or limited spectrum resources. Today, changing satellite communication technologies promise to open a new chapter in disaster communications where more robust and well-integrated systems may provide safer and faster connectivity for disaster responders. Such a shift in connectivity during response and recovery periods after a disaster can exponentially increase the number of saved lives.[22]

Recent advancements in satellite communications have focused on the significant potential of new space-based connectivity technologies to transform disaster response and recovery. MEO and LEO constellations that offer enhanced speeds and reduced latency allow for more efficient and reliable communication during emergencies and ensure that first responders and coordination centres can exchange real-time information seamlessly. This brings opportunities to provide better connectivity for responders, enabling communications for everyone through unified networks, to predict disasters beforehand and warn people and take measures and assess the infrastructure in time.

Satellites that provide real-time data and imagery of the Earth that can be used to predict and monitor disasters[23] could help us to save lives and goods to a very significant scale. In 2022, the United Nations launched an ambitious international initiative called Early Warnings for All[24] with the goal of achieving comprehensive global early warning system coverage by 2027. This initiative underscores the importance of a people-centred approach to disaster management, ensuring that communities are at the heart of all efforts. The initiative is structured around four key pillars:

1. Disaster Risk Knowledge: This involves understanding the various risks that different regions face, including natural disasters like earthquakes, floods, and hurricanes. By gathering and analysing data, communities can better prepare for potential threats.
2. Observation and Monitoring: Continuous monitoring of environmental conditions is crucial. This includes using advanced technologies such as satellite imagery and remote sensing to track weather patterns and other indicators of impending disasters.
3. Warning Dissemination and Communication: Effective communication channels are vital for disseminating warnings to the public. This pillar focuses on ensuring that alerts reach people in a timely manner, utilizing various platforms such as mobile networks, social media and traditional media outlets.
4. Preparedness and Response Capabilities: Building the capacity of communities to respond to disasters is essential. This includes training, drills, and the development of emergency response plans to ensure that people know what to do when a disaster strikes.

A connectivity revolution in disaster management could significantly reduce losses globally by up to USD 148 billion from 2025-2029.[25]

As discussed in the previous section, D2D satellite communications eliminate the need for bulky satellite terminals, which offers a more efficient and accessible solution for disaster response and recovery. D2D simplifies logistics, reduces costs and speeds up the deployment of communication networks in disaster-stricken areas.

Hybrid constellations have also significantly enhanced disaster communications. By integrating different satellite orbits, hybrid constellations enable real-time data exchange and continuous monitoring, which are crucial for effective disaster response and recovery. This technology ensures that first responders and coordination centres can communicate efficiently, even in remote or underserved areas.

The Internet of Things can power a resilient network of sensors to provide real-time data and situational awareness after a disaster. Sensors can be deployed on main transportation roads, bridges and critical infrastructure to gather immediate information about

[20] SG1RGQ/110 from GSOA
[21] SG1RGQ/103-E from Access Partnership
[22] Presentation from Viasat at the Transformative Connectivity Satellite Workshop
[23] SG1RGQ/110: GSOA Contribution - The use of telecommunications/ICTs for disaster risk reduction and management
[24] Presentation from BDT, ITU at the Transformative Connectivity Satellite Workshop
[25] SG1RGQ/103 from Contribution Access Partnership

the extent of damage during a disaster. These sensors monitor structural integrity, traffic flow and environmental conditions, transmitting data directly to crisis centres via satellite.

This capability allows crisis centres to obtain a comprehensive picture of the damage within minutes, enabling quicker and more informed decision-making. Instead of relying on manual assessments, which can be time-consuming and dangerous, satellite-enabled IoT provides accurate, real-time insights. This technology enhances the efficiency of emergency response and ensures that resources are allocated effectively, ultimately saving lives and reducing the impact of disasters.

Regulators and policy-makers should ensure meeting the spectrum requirements in a harmonized way so that seamless communication can be provided without interference. The February 2023 earthquake disaster in Türkiye highlighted the importance of such harmonization. Turksat's swift response in re-establishing communication networks was made possible through the central coordination and support of regulators and policymakers.[26]

Examples of restoring communication networks reconnecting after service disruptions

- **Tonga's** connectivity restoration in 2022 and 2019: The urgency for connectivity reached a peak in January 2022 when the catastrophic eruption of the Hunga Tonga-Ha'apai volcano was followed by a tsunami. The damage was profound, severing the Tonga Cable System and cutting off international calls. However, SES stepped in, utilizing their GEO satellite technology to restore the first international calls, bringing a vital lifeline to the isolated nation amidst chaos. This was not the first time that Tonga had faced such challenges. In January 2019, connectivity issues arose when the Tonga Cable System was cut in two places. SES had previously demonstrated its commitment to restoring communications in times of crisis, and once more, they rose to the occasion, ensuring that the people of Tonga could connect with the outside world.
- **Papua New Guinea's** earthquakes and cable cut: In May 2019, a powerful 7.2 magnitude earthquake struck, causing significant damage to essential terrestrial and subsea infrastructure. This left many areas without connectivity, but SES quickly responded by deploying their O3b MEO beam. This strategic move provided an additional 1.5 Gbps of low-latency IP transit service, alleviating network congestion and allowing vital communication to resume. As if nature had not already tested its resilience, a further earthquake shook Papua New Guinea in September 2022. Understanding the urgency, SES and its partners rapidly increased the O3b MEO capacity to support disaster recovery efforts, reinforcing their commitment to ensuring that even in the face of adversity, connectivity would not be lost. Through these efforts, SES not only restored communications, but also helped communities to stay connected during their most challenging moments.[27]
- Earthquake in **Noto Peninsula, Japan**[28]: At 4.10 p.m. on 1 January 2024, a powerful earthquake struck the Noto Peninsula in Ishikawa Prefecture, Japan, registering a maximum intensity of 7 on the Japanese seismic scale. The quake and subsequent tsunami caused significant destruction, resulting in 241 confirmed deaths, 12 persons missing, and nearly 1 300 injured across eight prefectures, making it Japan's deadliest earthquake since 2016. In response, KDDI partnered with local governments and agencies, including the Self-Defence Forces, to prioritize evacuation centre support and restore communication networks. They installed mobile base stations and satellite antennas, providing free Wi-Fi at evacuation centres and facilitating online classes in schools serving as shelters.

Chapter 4: Creating supportive frameworks

Governments play a pivotal role in promoting satellite connectivity by creating supportive policy and regulatory frameworks that are forward-looking and enhance a policy environment that is agile enough to respond to the rapid evolution of the digital market. Such frameworks empower the satellite industry to drive growth, innovation and investment, for the benefit of end users. With this objective in mind, administrations may wish to consider:

Effective Policy Frameworks:

Employ transparent and streamlined regulatory frameworks with clear rules to provide regulatory certainty. This includes the timely publication and updates of domestic/regional authorization frameworks.

- Allocate relevant frequencies for use by satellite systems on a domestic basis consistent with the ITU Radio Regulations, and with minimal spectrum fees.
- Adopt a technologically neutral approach to meeting connectivity targets that provide consumers and providers with the flexibility to choose the technology that best fits local needs.
- Employ simplified and streamlined licensing procedures that enable the provision of satellite broadband services and earth station licensing, including blanket licensing of ubiquitously deployed customer terminals.
- Fast-track temporary licenses for satellite services in time for emergency and protection from interference to ensure effective disaster communications.
- Transparent and time-bound application processes to allow operators to ensure timely connectivity for consumers.
- Allow for satellite provision of international satellite capacity without a specific requirement for local ground stations.

[26] Presentation from Turksat at the Transformative Connectivity Satellite Workshop

[27] Presentation from SES at the Transformative Connectivity Satellite Workshop

[28] SG1RGQ/192 from Japan

- Permit terminals installed on foreign vessels/aircraft to operate while in temporary transit on a non-interference basis.
- Reduce or remove import tariffs, quotas or local manufacturing requirements for satellite user terminals.
- Enforce clear rules for sharing spectrum with terrestrial and space services in bands where they co-exist, either through power limits or coordination.
- Boost competition by eliminating barriers to entry and giving consumers greater choice, while providing incentives for existing operators to improve their services.
- Expand accessibility by encouraging investment and stimulating competition, thereby helping to bridge the digital divide.[29]
- Encourage the ratification of the Tampere Convention[30] on the provision of telecommunication resources for disaster mitigation and relief operation, if not done yet.

Effective Partnerships:

- Cooperation between the public authorities and private sector, especially satellite operators, is crucial for leveraging various technologies and administrative mechanisms in times of crisis. Traditionally, satellite operators cooperate with terrestrial operators after a disaster to provide backhaul connectivity until the terrestrial systems start running again.
- Collaboration and partnership agreements between different private organizations are crucial for expanding connectivity, technological innovation and business models and solutions. For example, GSOA's partnerships with GSMA and the European Space Agency (ESA) are valuable models.
- Business models and creative partnerships between satellite operators and technology providers. For instance, SES collaborates with the Amazon Web Services Disaster Response Program to provide data-driven, cloud-based solutions that enhance response efforts.
- Fostering Public Private Partnerships for humanitarian response. Satellite connectivity can be put into use only when there is a coordination mechanism that illustrates where and how the connectivity gaps of responders and communities are addressed. The emergency.lu platform of the Government of Luxembourg is a good example of public-private partnership that enables operators such as SES to provide connectivity to humanitarian organizations and first responders without charge.[31]
- Funding frameworks for preparedness: Proactive measures should be taken to develop cooperation and funding frameworks well in advance of any potential disasters, ensuring readiness and rapid deployment when necessary. By fostering these partnerships early, we can significantly enhance our disaster response capabilities and mitigate the impacts of future emergencies.

Investment Incentives:

- Encourage investment by creating an attractive investment climate for the development, upgrade and expansion of telecommunication infrastructures in the long term. This can help spur the rapid deployment of communication networks.
- Encouraging investment in resilient telecommunication infrastructure requires creating a favourable regulatory environment and offering investment incentives.
- Governments can provide tax breaks, subsidies or other financial incentives to telecom operators and infrastructure providers willing to invest in disaster-resilient networks.[32]
- Removing regulatory barriers and offering investment incentives in times of disasters can attract private sector investment in disaster-resilient telecommunication infrastructure.[33]

Conclusion

Satellite technology represents a transformative solution to global connectivity challenges, particularly in developing countries and in rural and remote regions. By expanding connectivity in these historically underserved areas, satellite networks are bridging the digital divide and driving sustainable development through improved access to health care, education, employment and financial inclusion.

The continued success and growth of satellite services hinges on supportive policy and regulatory frameworks and enhanced collaboration between governments, industry and regulators. Clear regulatory environments, investment incentives and strengthened partnerships between satellite operators and terrestrial service providers will be crucial in maximizing the transformative benefits of satellite technology and in fostering affordable, resilient and meaningful universal connectivity for all.

[29] SG2RGQ/110 from Madagascar
[30] https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/TampereConvention.aspx
[31] emergency.lu – Luxembourg's emergency response
[32] SG1RGQ/249 from South Africa
[33] SG1RGQ/217 from Samoa

For further information, consult:

Joint Question 1/1, Question 3/1 and Question 5/1 workshop on the topic of "Transformative connectivity: Satellite Workshop", https://www.itu.int/en/ITU-D/Study-Groups/2022-2025/Pages/meetings/workshop-satellite_april24.aspx

Q1/1 Final Report for the 2018-2021 study period: "Strategies and policies for the deployment of broadband in developing countries": https://www.itu.int/en/myitu/Publications/2021/07/22/12/33/Consumer-information

Q5/2 Final Report for the 2018-2021 study period: "Utilizing telecommunications/ICTs for disaster risk reduction and management": https://www.itu.int/hub/publication/d-stg-sg02-05-2-2021/

Q5/1 Final Report for the 2018-2021 study period: "Telecommunications/ICTs for rural and remote area": https://www.itu.int/hub/publication/d-stg-sg01-05-1-2021/

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