
Internet Society
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DECOLONIZING THE INTERNET
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Global Governance of
LEO Satellite Broadband
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Decolonizing the Internet

Global Governance of LEO Satellite Broadband

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Contents

Overview:

Broadband internet services provided by low Earth orbit (LEO) satellite constellations have emerged as the solution to meet the increasing global demand for high-speed, low-latency connectivity. Their promise renewed the significance of satellite communications for global internet infrastructure, which had reached unprecedented capacity with the growing use of fiber optic cable networks and new-generation mobile technologies. Substantial segments of contemporary social, economic, and governmental functions require broadband connectivity as a key enabler. Recently, Covid-19 has highlighted this link.[1] Indeed, the opportunities available to societies with access to meaningful connectivity and those without access are vast. This, shortly referred to as the digital divide, when sustained, expands the development gap, which highlights the importance of time when considering solutions. The LEO satellite constellations offer the quickest solution for making broadband connectivity available anywhere, including in underserved areas of the globe, where it is most needed. So, if used effectively, they can contribute to mitigating the adverse effects of the digital divide. However, competing interests are associated with using this technology, ranging from global problems, such as space sustainability and global development, to domestic concerns with an international dimension, such as cybersecurity, cybersovereignty, and trade. These issues need to be addressed with input from key stakeholders if the promise of LEO satellite constellations is to be realized. This report analyzes the bearing of these issues on developing nations' interests in the context of international law. It reveals the shortcomings of the international law instruments in addressing the potential tension points and proposes that developing nations adopt a holistic approach that integrates their interests in telecommunications, sustainable development, sustainable use of space, and world trade.

In the last decade, the advancements in space communication technologies and satellite launch and manufacturing technologies led to a striking increase in the number of satellites deployed in LEO. Compared to those deployed in geostationary orbit, these are typically smaller satellites and easier to deploy. They are used for many purposes, including earth exploration, space research, monitoring climate change and global warming, national defense, and communication. The LEO satellite broadband technology relies on multi-satellite fleets referred to as constellations which enables them to provide seamless global coverage. The first section of the report introduces the technical aspects of the LEO satellite constellations proving broadband services to the extent that they are relevant to international law issues discussed in this report. The environmental concerns arising from the exponential increase in the number of space objects and the resulting space traffic are also indicated in this section. It constitutes one of the most significant issues concerning these constellations and needs to be addressed through global governance mechanisms. Its direct impact on connectivity-related issues is limited and beyond this report's scope.

Section II establishes the link between the digital divide, sustainable development, and meaningful connectivity. The Broadband Commission, co-established by the International Telecommunications Union (ITU) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), advocates for the recognition of broadband as a basic public utility. The ITU also defines meaningful connectivity as broadband connectivity that is '*available, accessible, relevant, and affordable, but also that is safe, trusted, user-empowering and leads to positive impact.*'[2] Meaningful connectivity plays an enabling role in achieving the United Nations' (UN) sustainable development goals (SDGs). Its function

[1] 'The State of Broadband: Accelerating broadband for new realities' (The Broadband Commission for Sustainable Development, 2022).

[2] 'The State of Broadband : Broadband as a Foundation for Sustainable Development' (The Broadband Commission for Sustainable Development, 2019).
'Global internet growth stalls and focus shifts to 'meaningful universal connectivity' to drive global development' ITU Press Release 22 September 2019.

is so significant to the realization of the SDGs that it has been referred to as SDG Zero.[3] The LEO satellite constellation systems are deployed to provide global broadband coverage, and making their services available in a new jurisdiction requires minimal or no infrastructure. The potential speed and ease of providing universal broadband connectivity highlight the role that they can play in achieving the SDGs.

The developments in communication technologies, such as 5th generation mobile technology (5G) and LEO satellite broadband, are perceived in the context of their potential role with respect to the existing global power structures.[4] The public and private companies from the countries that lead these new technologies compete to extend their presence and influence. The resulting ownership and control structures expand the gap with others, especially emerging economies that already rely on others' ICT goods and services. Their deepening dependencies are becoming more challenging to counterbalance, as well as their power to protect their national interests. In the context of global communications infrastructure, these concerns are generally expressed with reference to the consolidation of power in data-based international economic activities and their link to cybersecurity.[5] In the last decade, the domestic policies and resultant measures aimed to mitigate such dependencies, or their perceived adverse effects have been associated with the state sovereignty principle, leading to the increasing use of the term cybersovereignty. In the words of the European Union (EU) authorities, the policies and measures adopted in this context aim to establish their "*right to control the social, economic and security impact of the Information Communication Technologies (ICTs) and other reliant technologies as an extension of their political and territorial sovereignty*."[6] Section III of the report analyses the LEO satellite constellations as part of the global broadband infrastructure and in the context of cybersecurity, cybersovereignty, and data security considerations.

The telecommunications sector is regulated at national, regional, and international levels. The ITU is the international organization responsible for coordinating the shared global use of the frequency spectrum and the orbit positions of satellites, improving communications infrastructure for global development, and standard setting for interoperability of global communications systems. These three functions place the ITU in a central role in the international coordination and regulation of telecommunication satellites, which include the LEO satellite constellations. The IV section of the report analyses the ITU regulations and the initiatives at the ITU from a non-spacefaring developing country perspective. There is an emphasis on capacity building through alliances and expertise. This section includes a World Trade Organization (WTO) Law analysis concerning satellite services-related commitments of states and the link between supply chain security and cybersecurity. Whether space-faring or non-spacefaring, the countries are beneficiaries of satellite services, and the supply chain's security concerns all beneficiaries. Therefore, analysis of relevant commitments of their trading partners and themselves in the context of broadband services provided by LEO satellite constellations is essential to domestic policies.

[3] United Nations Development Programme, 'The catalytic role of digital connectivity' (*Singapore Global Centre Blog,* 8 November 2020) <https://www.undp.org/sgtechcentre/blog/catalytic-role-digital-connectivity> accessed on 19 May 2022.
Jimena Leiva Roesch, 'SDG Zero? A People-Centered Approach to Universal Connectivity' (International Peace Institute, 2021).

[4] Berna Akcali Gur, 'Cybersecurity, European digital sovereignty and the 5G rollout crisis' (2022) 46 Computer Law & Security Review 105736.

[5] Laura de Nardis, *The Internet in Everything* (Yale University Press 2020) 212.

[6] Tambiama Madiega, 'Digital sovereignty for Europe' (European Parliamentary Research Service Ideas Paper, PE 651.992, July 2020).

The global governance of outer space is based on its recognition as global commons, a resource not owned by any one nation but crucial to the future of all humankind.[7] Its exploration and use "shall be carried out for the benefit and in the interests of all countries and shall be the province of all mankind."[8] All space-related activities, including the domestic regimes regulating the launch and operation of commercial communication satellites, are expected to comply with international law, specifically international space law treaties.[9] The international law framework had been designed to safeguard the peaceful exploration and use of space. The commercial use of outer space by the LEO satellite industry is taking place against the backdrop and the general regulatory framework established in the Outer Space Law and general principles of public international law. The satellite constellations in LEO are all space objects subject to the jurisdiction and control of their registering states. All nations are potential space-faring nations, and the sustainable use of space concerns all countries, not just those with space capabilities in this period. In adopting a comprehensive approach, space law related implications of space-based technologies should also be considered by developing nations. They should represent their interests in relevant international platforms, preferably through alliances with others with similar concerns. The report concludes with recommendations for developing countries.

Methodology

This report relies on a mixed methodology that compiles 1) desk research of legal and policy documents, 2) expert interviews with leading scholars and practitioners in the field, 3) a global survey among internet users addressed through ISOC chapters, who shared their views on priorities for the further development and implementation of LEO based connectivity. These observations have been assessed against legal documents relating to sustainable development goals, international human rights law, outer space, and telecommunication regulations within and beyond the ITU as well as reports and news regarding the emerging LEO satellite broadband sector. Based on this mix of research methods and resources, a recommendation for a comprehensive and sustainable development-focused approach for any future regulatory or normative approach to LEO-based internet access has been made.

[7] Benjamin Silverstein and Ankit Panda, 'Space Is a Great Commons. It's Time to Treat It as Such' (Carnagie Endowment for International Peace, March 2021).

[8] The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies, (entered into force 27 January 1967) 610 U.N.T.S. 205 (OST).

[9] Christopher Daniel Johnson, 'The Outer Space Treaty', *Oxford Research Encyclopedia of Planetary Science* (2018) <https://doi.org/10.1093/acrefore/9780190647926.013.43> accessed on 7 July 2022.

LEO Satellite Constellations – An Introduction

A general understanding of LEO satellite constellations' architecture is essential to understanding and informing policy decisions and regulatory frameworks. Identifying these tension points in international relations and policymaking is also crucial. Therefore, this section briefly explains their components and how they work.

The implications of LEO use

The LEO constellations are typically deployed between 300 and 2000 km from Earth. Their proximity to earth means that the amount of time required for a signal to be sent and received is much shorter compared to systems in GEO. Due to their similar characteristics the satellites in LEO and MEO are often referred together as non-geostationary (NGSO) satellites. That is why they are able to provide high-speed, low-latency services that are compatible with terrestrial networks, primarily consisting of fiber optic cables and wireless mobile networks. The low latency is particularly important for applications that require real-time data transmissions, such as voice-over-internet protocol, video conferencing, surveillance and imaging, and remote-controlled machines.

Figure 1.1. Earth's orbits by altitude. (NASA illustration by Robert Simmon)[10]

However, low altitude also means that satellites in LEO have a much smaller coverage area on earth and travel at higher speeds. That is why much larger numbers of satellites are required to provide global coverage, whereas three satellites in GEO are sufficient to provide almost global coverage.

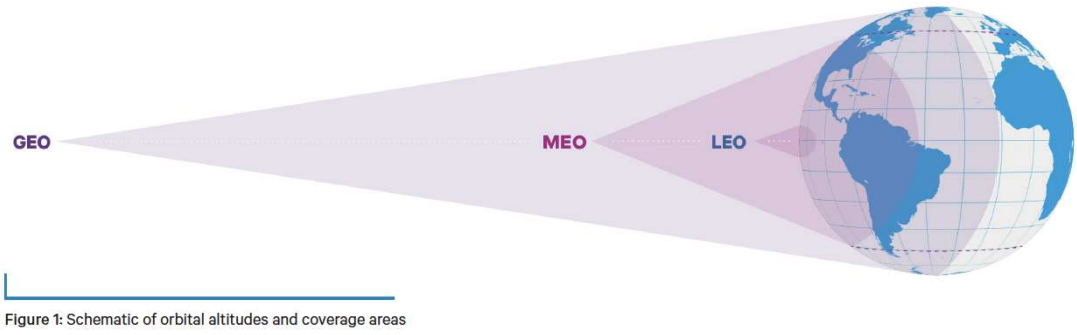

Figure 1.2 Orbital Altitudes and coverage areas[11]

[10] Holli Riebeek, 'Catalog of Earth Satellite Orbits' *(NASA Earth Observatory* 4 September 2009) <https://earthobservatory.nasa.gov/features/OrbitsCatalog> accessed on 12 September 2022.

[11] SES, 'GEO, MEO, AND LEO How orbital altitude impacts network performance in satellite data services', (*Satelliteyoday.com* May 2020) <https://www.satellitetoday.com/wp-content/uploads/2021/02/Guide-GEO-MEO-LEO-1.pdf> accessed on 23 February 2023.

The satellite constellation systems consist of "*a number of similar satellites, of a similar type and function, designed to be in similar, complementary orbits for a shared purpose, under shared control*."[12] Prompted by the emergence of one megaconstellation project after another, the ITU updated its regulations in 2019. It defined LEO satellite constellations as "*non-GSO satellite systems having more than one orbital plane where the mutual relative position of each orbital plane and each satellite in its orbital plane is important*." The vast number of satellites in a constellation move in a controlled and pre-designed manner in their designated route, where the location of each one satellite is important for the functioning of the system. Coordination is facilitated through inter-satellite links as well as from the ground.

The satellites in constellations are typically smaller. They are quicker to produce and easier to launch, making them more affordable than bigger satellites launched to higher orbits. They are standardized in design which makes the satellite fleet's expansion, update, renewal less burdensome and decreases operational costs. There has been a surge in megaconstellations and small satellite use for various functions due to these advantages.

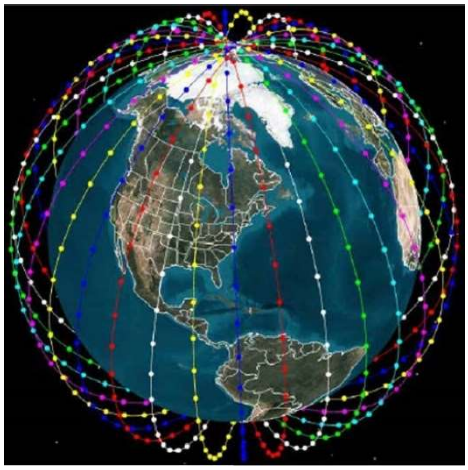

Figure 1.3. Illustration of a satellite constellation[13]

The substantial increase in the number of space objects in LEO requires sophisticated space traffic management to ensure the safe and sustainable use of orbital space and continued service. It is a task that concerns space-faring nations that have in-orbit assets as well as others who benefit from and rely on services provided by satellites. The terms of shared use of orbital space are governed by space law, a branch of international law. The relevant norms are explored in section V.

The components of a satellite broadband system

To use the broadband services provided by the LEO satellite constellations, the users will have to obtain user terminals to connect their internet-enabled devices. The LEO satellite system will also need to connect to the internet through a gateway earth (ground) station. The user terminals will link to the satellite in closest proximity, which may be a different satellite in the constellation at a given time.

[12] Lloyd Wood, 'Satellite Constellation Networks' in Yongguang Zhang (ed) *Internetworking and Computing Over Satellite Networks* (2003) Springer 13-34.

[13], 'A satellite mega-constellation' (The European Space Agency July 2018) <https://www.esa.int/ESA_Multimedia/Images/2018/07/A_satellite_mega-constellation> accessed on 3 January 2023.

That satellite will be connected to other satellites, one of which will have a connection to the ground station, so there will always be seamless connectivity.

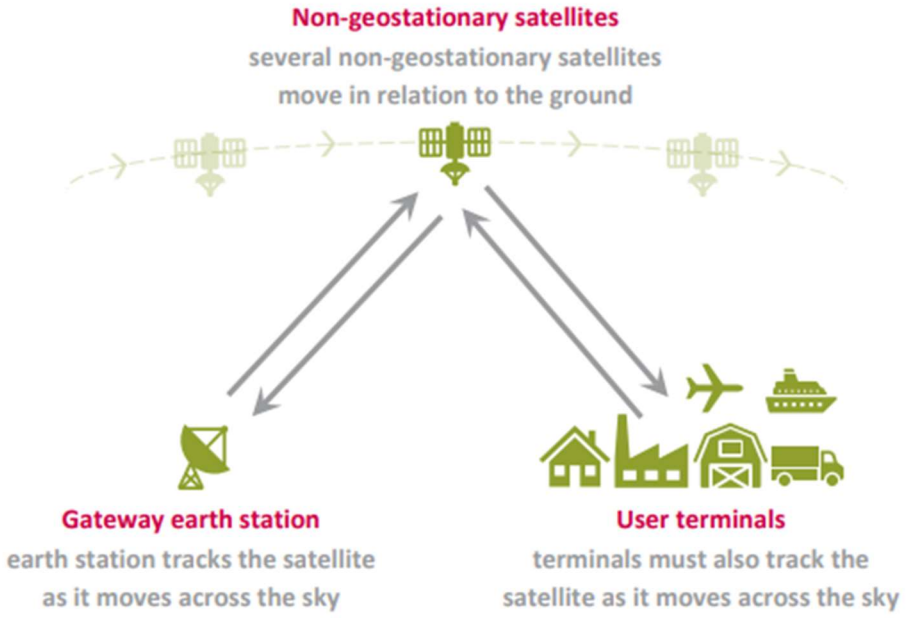

Figure 1.4. Key elements of a NGSO satellite system[14]

At the time of this report, the distance between the gateway and the user terminal is required to be at most approximately one thousand kilometers. In addition, if more than one non-geostationary systems are operating in the same area, they are likely to require separation distances from their competitors to avoid signal interference and service degradation. This requirement may limit the number of operators that can coexist in a certain jurisdiction and should be taken into consideration by national regulators when licensing or authorising new operators.[15] These licensing, and authorization requirements for ground stations and for user terminals usually differ from country to country. The technological advancements in inter-satellite links are expected to reduce the dependence on ground stations. These advancements also support multi-orbital solutions, whereby satellites in higher orbits support and augment the constellations in LEO.

Finally, the satellites require the use of frequency spectrum for their uplink and downlink connection with the user terminals and ground stations. The frequency spectrum is a limited natural resource, the global coordination of which is regulated by the ITU. In accordance with these regulations, the frequency spectrum assignment in a particular country is subject to their jurisdiction, often exercised through licensing and authorization procedures of domestic regulatory agencies. The uninterrupted use of the frequency spectrum is essential for the uninterrupted provision of all wireless services, including that of satellites. For satellite broadband, the coexistence of operators in proximity may

[14] 'Consultation: Non-geostationary satellite systems – Licensing updates' (OFCOM 2021) <https://www.ofcom.org.uk/__data/assets/pdf_file/0015/222450/ngso-licensing-consultation.pdf> accessed on 5 January 2023.

[15] 'A Risk Assessment Framework for NGSO-NGSO Interference', (FCC Satellite Communication Plan Working Group, Technological Advisory Council 2017) <https://transition.fcc.gov/oet/tac/tacdocs/meeting12617/TAC-NGSO-risk-assessment-framework-v100-2017-12-06.pdf> accessed on 10 December 2022.
'Starlink Internet Services Limited: Decision on applications for six non-geostationary earth station gateway licenses Decision' (OFCOM 2022) <https://www.ofcom.org.uk/__data/assets/pdf_file/0029/247178/statement-starlink-ngso-application.pdf> accessed on 10 January 2023.

require technical cooperation between them. A licensing requirement for licensees to cooperate is a good solution to resolve this problem.[16] The issue is explored in section IV.

Environmental Concerns

The global attention surrounding the new LEO satellite constellation ventures is mainly due to the vast number of satellites for their operation. That is why they are often referred to as megaconstellations. At the time of this report, 42,000 satellites are planned by the US venture Starlink, 13,000 satellites are planned by the Chinese venture GW, and 648 by the UK and India venture OneWeb.[17] The EU had announced its plans to launch their own.[18] The expansive orbital presence required by these systems is one of the primary reasons for the new space race and for the need to update domestic and international policies and regulations that existed for communication satellites providing internet services in higher orbits and smaller satellite constellations in LEO s.[19] To put into perspective, the early constellations, such as Orbcom, Iridium, and Globalstar, existed as early as the 1990. They received minimal attention from the public beyond a few stakeholders and did not prompt new policies or regulations.

The new space race was to be expected. From a strategic perspective, the monopoly of control over orbital resources by a few states and their companies is undesirable for most others. Indeed, with a single decision, the US Federal Communications Commission (FCC) authorized one company to operate more satellites in 15 years than have been launched before. Similar decisions by all states with the private and public capacity to launch satellite constellations in LEO may result in chaos and an environmental catastrophe. So far, these decisions do not involve environmental impact assessments. If perceived as undepletable and remains unregulated, the new space race can have a grave impact on LEO resources. If regulated, LEO satellite constellations' specific qualities should be considered. They are designed to function for a few years and burn in the atmosphere. When the numbers increase, the pollution caused by this design could be dramatic, even affecting climate change. Space debris and an exponential increase in potential collisions could render the LEO unusable.[20] Collisions will likely disrupt space-based connectivity, other space-based services, and other potential benefits that could be accessed in space beyond the orbits. It is in the interest of all space-faring nations and all future space-faring nations to protect the orbital resources for its present and future uses. Recognizing the importance of these environmental concerns and sustainable use of space generally, projects as elaborate as megaconstellations should be considered based on global need and capacity rather than purely international strategic competition. The impulse to compete in a space that is already congested

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[16] 'Consultation: Non-geostationary satellite systems – Licensing updates' (OFCOM 2021) <https://www.ofcom.org.uk/__data/assets/pdf_file/0015/222450/ngso-licensing-consultation.pdf> accessed on 5 January 2023.

[17] Andrew Jones, 'China is developing plans for a 13,000-satellite megaconstellation' (*Space News* 2021) <https://spacenews.com/china-is-developing-plans-for-a-13000-satellite-communications-megaconstellation/> accessed on 10 October 2022.

[18] European Commission, 'Welcome to IRIS2' Statement 17 November 2022

[19] Tom Butash, Peter Garland and Barry Evans, 'Non-geostationary satellite orbit communications satellite constellations history' (2021) 39 International Journal of Satellite Communication Network 1.

[20] 'A call for space safety for all' (*Viasat.com* 26 August 2022) <https://news.viasat.com/blog/corporate/a-call-for-space-safety-for-all?utm_campaign=NEPA&utm_source=LinkedIn&utm_medium=social11> accessed on 1 January 2023.

Aaron C. Boley and Michael Byers, 'Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth' (2021) 11 Scientific Reports 10642.

could be mitigated if countries are provided with the opportunity to benefit from space resources and the space technologies that rely on these resources on a fair and equitable basis.[21]

LEO Satellite Constellations and Sustainable Development

The internet has been developed by industrialized societies and still largely relies on infrastructure and applications built, operated, and owned by them. As the social, economic, and government functions are becoming increasingly dependent on broadband internet connectivity and the data transfers it enables; the imbalanced ownership and control structure empowers the already powerful while sustaining the gap between them and the others. The expression 'colonization of the internet' has been used to highlight the global inequity in sharing the benefits of internet technologies and infrastructure. In the same context, dependence on and use of non-domestic infrastructure and applications and access to and use of data by public or private entities from beyond national borders have come to be assessed with respect to their risks to national security and economic security. Despite these concerns, countries continue their best efforts to invest in and acquire the technology and infrastructure that will facilitate their digital transformation, which is essential to meet developmental steps. The availability of broadband internet is essential to benefit from its use for a wide range of functions. In that context, the ITU has defined SDG 9 (Industry, Innovation, and Infrastructure), SDG 17 (Partnership for the Goals), SDG 4 (Quality Education), and SDG 5 (Gender Equality) as most relevant goals for its activities and also added SDG 11 (Sustainable Cities and Communities), SDG 10 (Reduced Inequalities), SDG 8 (Decent Work and Economic Growth), SDG 1 (No Poverty), SDG 3 (Good-Health and Well-Being) as goals where Information Communication Technologies (ICTs) will have the most significant impact.[22]

A more equitable internet use that reduces global inequalities rather than exacerbates them is achievable. LEO Satellite broadband can play a significant role in that endeavor by speeding up the process by which broadband internet is made available. 5G technology is expected to give rise to a new phase in production, consumption, transportation, and delivery systems, referred to as the Fourth Industrial Revolution.[23] However, upgrading national mobile infrastructure to 5G is capital intensive, and it is a challenge to many developing countries, some of which are yet to complete their shift to 4G. Fiber optic cables are also capital intensive, which does not justify investment in places with sparse populations or unsuitable terrain. Complementing the terrestrial networks with LEO satellite broadband is a promising solution to these problems. They require minimal terrestrial infrastructure to become available in a particular region, so the time and capital requirements are expected to be significantly lower. Their compatibility with new-generation mobile infrastructure is particularly important because the population in low- and middle-income countries connect to the internet primarily through their phones.[24]

Universal connectivity, meaning availability for all, in and of itself, is insufficient. The Broadband Commission defines meaningful connectivity as *"the possibility for everyone to enjoy a safe, satisfying,*

[21] Berna Akcali Gur and Joanna Kulesza, 'What we owe each other: equitable access to secure, affordable, and reliable LEO broadband satellite services' (Giganet Annual Symposium, Ethiopia, 2022)

[22] ITU submission to UN Department of Economic and Social Affairs, Sustainable Development (*Un.org* 2020) <https://sdgs.un.org/un-system-sdg-implementation/international-telecommunication-union-itu-24522> accessed on 23 February 2023.

[23] Klaus Schwab, 'The Fourth Industrial Revolution: What It Means and How to Respond' (*Foreign Affairs* 12 December 2015) <https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution> accessed on 6 July 2022.

[24] Jessica Clement, 'Mobile internet traffic as percentage of total web traffic 2021' (*Statista* 2021) https://www.statista.com/aboutus/our-research-commitment/408/j-clement accessed on 10 October 2022.

enriching, productive, and affordable online experience."[25] According to a recent document by the UN, Office of Secretary General's Envoy on Technology, and the ITU, the use and quality of connectivity are complementary, and they depend on several factors, including affordability of connection, access to and affordability of mobile and/or fixed devices, presence of digital skills, connection security, navigation safety, and infrastructure.[26] When connectivity becomes universal and meaningful, the applications it enables can be utilized to create social and economic impact, leading to economic development and innovation.[27] The legal and policy frameworks should support this process. A more level global playing field will be achieved when an increased number of countries achieve these benchmarks and internet colonization will be less of a concern. The developing countries will benefit from shaping their policies concerning their use of LEO satellite broadband in consideration of these benchmarks.

At the intersection of connectivity and sustainable development, affordability emerges as a central concern.[28] If LEO satellite broadband is to contribute to development, the connection, services, and devices required for access should be affordable and available. If LEO systems provide backhaul services to incumbent telecom operators, their integration into the system should not adversely affect affordability. Also, connection security and navigation safety should be ensured by all parties owning or controlling the communication infrastructure involved in their respective roles. Considering the prevalent cybersecurity and data privacy concerns arising from cross-border data transfers, they are also at the forefront of policy discussions regarding LEO satellites, especially in the context of connection security and navigation safety. In that respect, host countries should seek transparency about data traffic facilitated by these systems and ensure broadband services are provided in a manner consistent with their laws and regulations. This subject is further explored in the next section of this report.

The benchmarks for sustainable development should inform the policies and norms at domestic and international levels, if the LEO satellite broadband is to fulfill its promise to bridge the digital divide. Otherwise, they will primarily serve the interests of the powerful states that already own and control much of the remaining internet infrastructures. Indeed, the leading LEO satellite broadband companies are from the US, Canada, the UK, and China, followed by a planned EU venture. A competitive market is generally deemed beneficial. However, the deployment of a satellite constellation by each country is not feasible, most countries will rely on services provided by others. It is also not desirable in an already congested space where debris and traffic management are already concerns. It is in the interest of all to agree on the terms of this service that will serve diverse interests of all, consistent with the UN SDG agenda, negotiated ideally via a multistakeholder platform.

[25] 'Manifesto: Global Goal of Universal Connectivity' (The Broadband Commission for Sustainable Development 2020) <https://www.broadbandcommission.org/> accessed on 23 February 2023.

[26] 'Achieving universal and meaningful digital connectivity: Setting a baseline and targets for 2030' (ITU and UN Office of the Secretary General's Envoy on Technology 2022) <https://www.itu.int/itu-d/meetings/statistics/wpcontent/uploads/sites/8/2022/04/UniversalMeaningfulDigitalConnectivityTargets2030_BackgroundPaper.pdf> accessed on 9 October 2022

[27] Barbara van Schewick, *Internet Architecture and Innovation* (The MIT Press 2012)

[28] John Garrity and Arndt Husar, 'Digital Connectivity and Low Earth Orbit Satellite Constellations: Opportunities for Asia and the Pacific' (ADB Sustainable Development Working Paper Series, No 76, April 2021) < https://www.adb.org/sites/default/files/publication/696521/sdwp-076-digital-connectivity-low-earth-orbit-satellite.pdf> accessed on 3 March 2022.

Internet access as a fundamental right

In its early days, internet access has been championed as the platform of freedoms where traditional state controls have ceased to exist, as an enabler of global citizenry. In time that perception has evolved immensely, as well as the reach of internet connectivity around the globe. The broadband internet became increasingly available and essential for social, governmental, and economic activities. Not only internet access became a basic need for people to access these activities, but effective public and private oversight became necessary to ensure network and information security and reliability as well as the associated rights and freedoms. Domestic political preferences have become determining factors in the scope of regulatory oversight and its effect on fundamental rights. Despite diverging views on whether internet access should be considered a fundamental right because of its association with development, its facilitation remains a shared global goal. One of the regulators' significant challenges is ensuring the continued implementation of existing oversight mechanisms when new technologies bring new challenges. So, regulators will want to achieve universal broadband access using the fastest and most cost-effective technological alternative but would not want that choice to undermine their established control mechanisms. Both objectives have an impact on fundamental rights and how they are exercised.

The first generation of human rights includes civil and political rights as contained in the International Covenant on Civil and Political Rights (ICCPR). They are called negative obligations- requiring a state to allow certain individual liberties rather than provide additional resources or services. Their provision does not necessitate additional expenditure on behalf of the state; hence they are described as cost-free. They may be provided without any other prerequisites. They have been defined within the ICCPR and accompanying document with sufficient detail and may be characterized as precise. The international accord on such rights as the right to life or privacy was relatively easy to achieve on the international level as their existence is non-ideological (non-political).

The international community agreed on a second group/generation of human rights for economic, social, and cultural rights covered in the International Covenant on Economic Social and Cultural Rights (ICESCR). These cover positive rights that are considered resource-intensive, requiring additional activities from states. They are progressive, so their scope changes with time as necessitated by social and economic conditions. However, they are also subject to political interpretation, making them ideologically divisive. So, they have been referred to as aspirations or goals than "real" legal requirements. The notion of the generations of human rights rests on the idea that while the first category covers rights that are substantial to human dignity, the second generation is conditioned by the provision of the first generation.

The third generation of human rights covers collective rights that refer to groups of individuals rather than to individuals. This category includes environmental rights, such as the right to a healthy or adequate environment; sexual rights, such as lesbian, gay, bisexual, and transgender (LGBT) rights; and the right to water, perceived as conditional to the right to life. Therefore, they may be derived from other human rights, such as the right to life, health, or private and family life. The right to communication is considered a third-generation human right, originating from the well-established right to freedom of expression.

Internet access is considered among the fourth generation of human rights, a shorthand reference to rights discussed in the doctrine yet needs to be recognized by jurisprudence. These are rights derivative of one or more rights from the groups already developed cover:

- The right to Internet access as a derivative of the right to access information

- The right to be forgotten as a derivative of the right to privacy
- The right to virtual personality as a derivative of intellectual property rights
- Right to Internet access as a fourth-generation human right

The UN has also recognized internet access as “an indispensable tool for realizing a range of human rights, combating inequality, and accelerating development and human progress” and encouraged states to ensure universal access.[29] Since then, this much-debated right to Internet access has been interpreted to require positive obligations of states to facilitate access by investing in technology infrastructure and ensuring the availability of internet-enabled devices. Given the global discrepancy in states' economic and technical capabilities, it is not universally recognized as an obligation as such. Nevertheless, it is a desirable goal for various reasons discussed in this report, including but not limited to sustainable development.

Data security and privacy considerations

Data security aims to ensure confidentiality, integrity, and availability against threats such as unauthorized access, use, disclosure, disruption, modification, or destruction.[30] Data privacy is "about retaining the ability to disclose data consensually, and with expectations about the context and scope of sharing."[31] From a fundamental rights perspective, both are related to privacy, personal data protection, and intellectual property rights. They are also related to internet access as a right because it is only possible to have meaningful access with connection security and navigation safety. In response to the increasing risks and threats, the domestic regulatory measures that have been adopted around the globe subject digital data flows, data collection, storage, and processing to national laws and regulations, some of which also require localization. It is well established that global companies who have control over and access to data are to comply with these measures. The companies providing satellite broadband services will not be exempt from the domestic regulatory requirements where they provide their services in. The scope of their compliance requirements will be determined in accordance with the range of services they offer and the business model they operate in. These measures varying from jurisdiction to jurisdiction, are an impediment for LEO satellite broadband companies from a business perspective but a necessity for most states that would like to ensure that their data security standards are not compromised.

Regions and countries adopt a variety of interpretations, at times contradictory interpretations of human rights.[32] Whether privacy or freedom of expression, the practice in Europe, the Americas, and Asia differs tremendously. It is every state’s prerogative to determine the level of protection they deem appropriate. However, for emerging economies establishing institutional, political, and technological structures to enforce their specific measures presents a challenge. Despite the need for a more holistic approach due to the convergence of ICTs, networks, and services, regulatory fragmentation remains

[29] UNGA Human Rights Council, ‘Report of the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression, Frank La Rue” 16 May 2011, A/HRC/17/27.
[30] NIST Information Technology Laboratory Computer Security Resource Centre, ‘INFOSEC’ (2023) Glossary <https://csrc.nist.gov/glossary/term/infosec> accessed on 21 February 2023.
[31] Internet Society, ‘What is Privacy?’ (*Internetsociety.org*) <https://www.internetsociety.org/issues/past-categories/privacy> at accessed on 13 September 2021.
[32] Eva Brems, Human Rights: Universality and Diversity, Martinus Nijhoff Publishers 2001, p. 285 ff.
Perry Keller, 'Sovereignty and Liberty in the Internet Era', in Richard Rawlings, Peter Leyland, and Alison Young (eds), Sovereignty and the Law: Domestic, European and International Perspectives (Oxford, 2013).

in most domestic legal systems.[33] So, technological advancements at any layer of the internet present an additional challenge to their struggle. These fragmented processes also slow down their internet penetration, thus sustaining the development gap with states already on the other side of the digital divide. Aligning regulatory approaches through regional or treaty-based initiatives with like-minded states is likely to strengthen the effectiveness of these regulatory measures and decrease the burden on LEO satellite companies to comply with a reduced variety of regulations when providing their services. As the technology matures, these types of alliances will also help share the burden of following up on data security-related concerns specific to LEO broadband constellations. The regulatory developments in technologically more advanced jurisdictions, such as the EU, can act as a guide to identify potential risks and assess alternative regulatory responses.

Global Data Economy

Data economy refers to generation, collection, storage, processing, distribution, analysis, elaboration, delivery, and exploitation of data enabled by digital technologies and facilitates economic growth, job creation and societal progress.[34] The internet's growth led to and was, to a great extent, driven by the data economy. The convergence of communication networks, terminals, a wide range of services, and markets boosted the size of the 'data economy' and the global competition to claim a more significant share of the data value chain. As a result of their reach to data across the globe, digital platforms, cloud services, data analysis, and processing technology companies have amassed tremendous wealth and power. The consolidation of these companies in a few states and the resulting global imbalance in benefiting from data resources has led to concerns about the exploitation of the countries that merely provide data and depend on others for digital technology and services and has been defined as digital colonialism.[35] Digital colonialism is understood to expand the already existing digital divide, which was examined briefly in the previous section.[36]

The significance of data as resource has become so high that many claim it will be a determining factor of the new world order.[37] That is why establishing control over national data and its cross-border flows, ensuring data security and integrity, and receiving a fair share from the global data economy have become common objectives for countries. The provision of LEO satellite broadband services will also be considered with respect to their role in the global data value chain, technological dependence, and whether they indeed have the potential to exacerbate concerns that had been defined as digital colonialism. A thorough understanding of changes in data flow patterns due to the use of this technology is essential, which requires domestic expertise and transparency of the industry. If access

[33] Silvia Elaluf-Calderwood and Jonathan Liebeanu, 'Idea to Retire: Internet without policy metrics' (*Brookings.edu* 2016) <https://www.brookings.edu/blog/techtank/2016/03/02/idea-to-retire-internet-without-policy-metrics/> accessed on 23 February 2023.
Ann Buckingham, Camilla Bustani et. al, 'Telecommunications Reform in Emerging Markets', in Ian Walden (ed), Telecommunications Law and Regulation, 5th ed. (Oxford University Press 2018).
[34] European Commission, 'Building a European Data Economy' COM(2017) 9 final.
European commission, 'European Data Market study: SMART' IDC (2016).
[35] Danielle Coleman, 'Digital Colonialism: The 21st Century Scramble for Africa through the Extraction and Control of User Data and the Limitations of Data Protection Laws' (2019) 24 Michigan Journal of Race & Law 417.
[36] United Nations Conference on Trade and Development, 'Digital Economy 2021 Report' (UN 2021).
[37] Bhaskar Chakravorti, Ajay Bhalla, and Ravi Shankar Chaturvedi, 'Which Countries Are Leading the Data Economy?' (2019) Harvard Business Review <https://hbr.org/2019/01/which-countries-are-leading-the-data-economy> accessed on 19 February 2021.

to and use of this technology is to lead to sustainable development, the concerns of potential users must be addressed and discussed transparently, preferably in a multistakeholder platform.[38]

Integration of LEO Satellite Broadband to global internet infrastructure

Satellites have long been used as communication infrastructures. The first successful deployment of a communications satellite resulted from the SCORE project by Advanced Research Projects Agency (ARPA and later DARPA) in the US in 1958.[39] This same government agency is credited with the technical foundation of the modern Internet in the 1960s to design computer networks that would continue to function in emergencies, especially in a nuclear attack.[40] In time, both the internet and communication satellites became commercialized. The internet transformed into an essential utility primarily provided to the masses through terrestrial communication infrastructure. Satellites remained significant as the most viable last-mile solution in remote and sparsely populated areas, for mobile communications at sea, land, and air, at times of emergency and disaster where terrestrial networks are unfeasible or unavailable. Satellites were not considered a viable alternative to terrestrial infrastructure. Especially not after fiber-based networks, which enable interference-free, reliable data transmission at light speed, became ubiquitous.

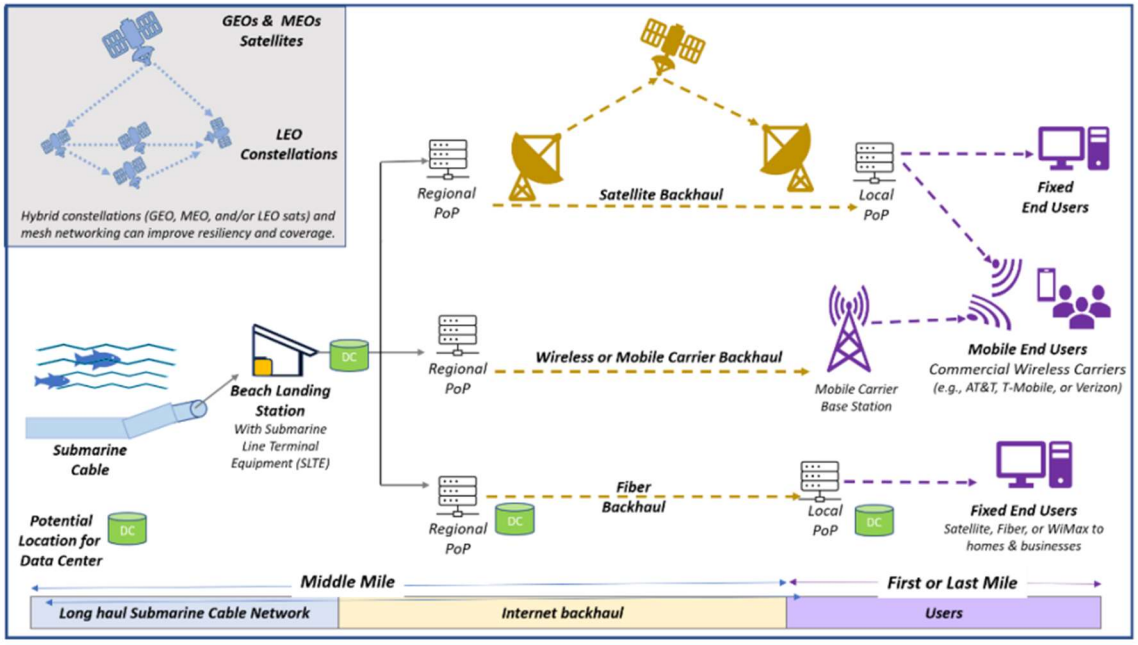

Figure 3.1 Global Internet Infrastructure and the role of satellites[41]

[38] Claudia Marquina, 'How low-earth orbit satellite technology can connect the unconnected' (World Economic Forum February 2022) <https://www.weforum.org/agenda/2022/02/explainer-how-low-earth-orbit-satellite-technology-can-connect-the-unconnected/> accessed on 2 January 2023.

[39] 'SCORE' (NASA Space Science Coordinated Archive 2022) <https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=1958-006A> accessed on 10 November 2023.

[40] Mitch Waldrop, 'DARPA and the Internet Revolution' (*Darpa.mil* 2015) available at <https://www.darpa.mil/about-us/timeline/modern-internet> accessed on 10 January 2023.

[41] Lori W Gordon and Karen L Jones, 'Global Communications Infrastructure: Undersea and Beyond' (The Aerospace Corporation Centre for Space Policy and Strategy 2022) <https://csps.aerospace.org/papers/global-communications-infrastructure-undersea-and-beyond> accessed on 30 January 2023.

The advancements in wireless mobile technologies have further advanced internet-enabled social, industrial, or governmental functions. The role satellites would play in global internet infrastructure was deemed limited until the emergence of the megaconstellations deployed in LEO. The exact scope of their role and viable business models is taking shape as the industry matures.[42] Some companies are complementing their existing satellite networks in MEO and GEO with smaller constellations in LEO.[43] These ventures can compete with, but they can also complement the wireless networks (i.e., 5th Generation Mobile Network) and terrestrial ones.[44] They can compete and collaborate with incumbent telecom operators. The early entrants to the market pursue different business models. One Web and Hughes are among those that have prioritized the business-to-business model and prefer to provide backhaul services for wireless communications and network redundancy to back up to fiber-optic networks. Eutelsat announced that it would focus on one specific LEO application: connectivity for the Internet of Things (IoT) devices through a multi-orbit system. The variety of business models indicate that LEO satellite technology will become a complementary piece of the global communications network in various forms rather than replace existing cable and wireless infrastructures. So, all policy decisions should consider LEO satellite constellation specific goals as part of or in connection with the policies concerning global internet infrastructure and connectivity in general.

Cybersecurity Considerations

Cybersecurity refers to the "security of cyberspace, where cyberspace itself refers to the set of links and relationships between objects that are accessible through a generalized telecommunications network, and to the set of objects themselves where they present interfaces allowing their remote control, remote access to data, or their participation in control actions within that cyberspace"[45] The increasing use of satellite technology for broadband access and its integration with the existing internet infrastructure exposes it to the current global cybersecurity crisis and the indeterminacy of international norms in that area. Also, increased reliance on LEO satellite constellations for broadband services will likely expand the cyberthreat landscape as these systems have cyber vulnerabilities specific to their technologies and how they function.[46] The European Union Agency Space Program, confirmed that data transmitted via space technologies are vulnerable to cyberattacks. The increased use of novel technologies such as software-defined satellites, reliance on in-orbit reconfigurations, and

[42] Daniel Voelsen, 'Internet from Space' (Stiftung Wissenschaft und Politik Research Paper 6, April 2021) < https://www.swp-berlin.org/en/publication/satellite-internet> accessed on 24 February 2022.
'Perspectives on LEO Satellites' (Internet Society November 2022) < https://www.internetsociety.org/resources/doc/2022/perspectives-on-leo-satellites/> accessed on 1 December 2023.

[43] Shaun Waterman, 'Beyond GEO: Major Operators Have A Multi-Orbit Focus' (*Via Satellite* 12 March 2020) <https://interactive.satellitetoday.com/beyond-geo-major-operators-have-a-multi-orbit-focus/> accessed on 30 June 2022.

[44] 'Satellite Connections Are Critical Elements of the New 5G Networks' (Hughes, 2022) <https://www.hughes.com/resources/insights/5g/satellite-connections-are-critical-elements-new-5g-networks> accessed on 30 May 2022.

[45] 'Definition of Cybersecurity – Gaps and overlaps in standardisation' (ENISA December 2015) <https://www.enisa.europa.eu/publications/definition-of-cybersecurity > accessed on 23 February 2023.

[46] David Livingstone and Patricia Lewis, *'Space, the Final Frontier for Cybersecurity?'* (2016) Chatham House Research Paper, International Security Department.
Pingyue Yue et al., "On the security of LEO satellite communication systems: Vulnerabilities countermeasures and future trends" (*ArXiv>EESS* 2022) < https://arxiv.org/abs/2201.03063 > accessed on 20 February 2023.

use of lasers for data transfers exacerbates the risks.[47] The researchers have been revealing further security flaws since the system became operational.[48]

The LEO satellite constellations require a large number of ground control and service support infrastructures, and they are connected to cloud infrastructures.[49] The location of their ground stations is coordinated with cloud entry points to facilitate faster links and better network management.[50] This is a mutually beneficial arrangement because cloud service providers benefit from the connectivity services provided by satellite systems. The expected interconnectivity of LEO satellite constellations with 5G mobile networks raises further security concerns. 5G is expected to enable industrial transformation and advanced mobile applications and services by delivering higher speed and capacity to support massive machine-to-machine communications and providing low-latency, high-reliability service for time-critical applications.[51] 5G-enabled applications will exponentially expand the number of connected people, devices, governments, and critical infrastructures, wherein cloud services will also play a key role. Given the inherently international nature of satellite communications and their link to these terrestrial infrastructures and services, the implications of cybersecurity risks will not be confined to national borders.[52] The protective measures adopted to address cybersecurity concerns associated with the internet and telecommunication networks should be reevaluated and reconfigured to tackle the new problems. The persistence of cybersecurity concerns will hinder the effective use of this technology and the benefits for development. Time is of the essence to resolve issues, considering the extended role that they target in global connectivity and their fast-expanding presence.[53]

Cybersecurity remains one of the most contentious topics in international platforms, causing a stalemate. However incremental these proceedings may be, the developing countries should continue to participate and promote their interests, preferably in coordination with others with similar concerns. They should also follow the other national and regional regulatory initiatives addressing cyber vulnerabilities concerning space technologies. The public authorities and private sector of space-faring nations have a more informed insight into this sector. Their policies and regulatory responses are also likely to influence regional and multilateral negotiations.

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[47] 'EUSPA: the gatekeeper to a secure EU Space Programme' (*European Union Agency for the Space Programme (EUSPA) News* 21 April 2022) < https://www.euspa.europa.eu/newsroom/news/euspa-gatekeeper-secure-eu-space-programme > accessed on 30 April 2022.

[48] Matt Burgess, 'The Hacking of Starlink Terminals Has Begun' (*Wired.com* 10 August 2022) <https://www.wired.com/story/starlink-internet-dish-hack/> accessed on 10 September 2022.

[49] Jordan Novet, 'Google wins cloud deal from Elon Musk's SpaceX for Starlink internet connectivity' (*CNBC.com* 13 May 2021) <https://www.cnbc.com/2021/05/13/google-cloud-wins-spacex-deal-for-starlink-internet-connectivity.html> accessed on 10 July 2022.

[50] Adam Smith, 'Elon Musk's Starlink space internet attached to Microsoft system in breakthrough that could power computers all over the world' (*The Independent* 21 October 2020) <https://www.independent.co.uk/space/elon-musk-spacex-starlink-microsoft-azure-b1206439.html> accessed on 20 October 2021

'Technology Futures Spotlight on the technologies shaping communications for the future' (OFCOM, 2021) https://www.ofcom.org.uk/__data/assets/pdf_file/0011/211115/report-emerging-technologies.pdf

[51] '5G - Fifth generation of mobile technologies' (ITU December 2019) <https://www.itu.int/en/mediacentre/backgrounders/Pages/5G-fifth-generation-of-mobile-technologies.aspx> accessed on 18 September 2021.

[52] Madelyn R Creedon, 'Space and Cyber: Shared Challenges, Shared Opportunities' (2012) 6 Strategic Studies Quarterly 3.

[53] Jan Kallberg, 'Designer Satellite Collisions from Covert Cyber War' (2012) 6 Strategic Studies Quarterly 123.

One example is the US Space Policy Directive-5 of 2017. It relates to the cybersecurity of space systems and establishes best practices based on the understanding that space systems are not immune to cybersecurity risks that exist for terrestrial systems. It implements a comprehensive standards-based approach and emphasizes supply chain security, encryption, and physical security of components. They also discuss whether space systems should be regulated as the 17th critical sector by the Cybersecurity and Infrastructure Security Agency (CISA).[54] Communication and information technology sectors are already defined as critical infrastructure. The CISA classifies infrastructure critical if '*their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof*'. So far, space systems are not considered critical infrastructure, but in May 2021, it started a working group.[55] In April 2022, the Satellite Cybersecurity Act was introduced in Congress.[56] According to this act, reliance on national and foreign commercial satellites constitute a national security matter. So, ensuring these satellites' cybersecurity and network security should be one of CISA's tasks.[57] Another example is the UK's Space Industry Regulations of 2021, which has a dedicated cybersecurity section.[58] Also, the Telecommunications (Security) Act of 2021 is expected to be complemented with strict security requirements on public telecommunications providers, which will also apply to satellite communications providers.

The global regulatory power EU recently passed Network and Information Systems Directive (NIS2). There is a proposal to further regulate the security-related aspects of space-based services through the CER Directive.[59] The EU instruments should be of particular interest to developing countries for three main reasons. First, the EU has been late to the new space race, and so the initial policies will regulate non-domestic services, intending to address concerns akin to developing countries that also rely on non-domestic technologies. Second, as a region that has space presence, it has insight and expertise into space technologies. Third, it has had a successful track record in influencing regulatory developments worldwide, especially in digital sectors. There are strong indications that it will continue that role in the near future.

These legal instruments attest to the recognition of the scale of cyberthreats associated with space communications technologies. The approach adopted in the US, UK and the EU suggests that commercial enterprises providing broadband services will be subject to scrutiny in relation to their cyber vulnerability and the risks they pose as part of national infrastructure. In the past year, the cyberattack by Russia targeting Ukraine military internet access via ViaSat affected thousands of internet users and internet-connected wind farms in central Europe. It is unclear whether the spillover was unintentional.[60] The spillover effects are not uncommon in cyber-attacks and this incident is an

[54] Edward Swallow and Samuel Visner, 'It's time to declare space systems as critical infrastructure' Politico 2 April 2021

[55] 'CISA Launches a Space Systems Critical Infrastructure Working Group' (CISA 13 May 2021) <https://www.cisa.gov/news/2021/05/13/cisa-launches-space-systems-critical-infrastructure-working-group> accessed on 20 January 2023 .

[56] S.3511 – US Satellite Cybersecurity Act 117th Congress (2021-2022)

[57] Jennifer Gregory, 'Congress Wants to Study the Cybersecurity of Satellites' (*Securityintelligence.com* 7 September 2022) <https://securityintelligence.com/news/satellite-cybersecurity-act-bill-congress/> accessed on 23 February 2023.

[58] United Kingdom, The Space Industry Regulations 2021 No 792, Chapter 3.

[59] European Commission, 'Proposal for a Directive of the European Parliament and of the Council on the resilience of critical entities' COM(2020) 829 final

[60] Patrick Howell O'Neill, 'Russia hacked an American satellite company one hour before the Ukraine invasion' (*Technologyreview.com* 10 May 2022) <https://www.technologyreview.com/2022/05/10/1051973/russia-hack-viasat-satellite-ukraine-invasion/> accessed on 15 February 2023.
Sophie Mellor, 'Germany is trying to transition away from Russian fuel and hackers are now hitting German wind energy companies' (*Fortune.com* 25 April 2022) <https://fortune.com/2022/04/25/germany-trying-to-

example for one where satellite connectivity was the target. The national and regional data protection regimes as well as agreements on cybersecurity measures regimes impact how communications networks are set up and protected. The multilateral and multistakeholder platforms have not been able to resolve differences among the major powers. As global reliance on satellite broadband increases and the use of broadband for a wider range of functions becomes necessary, the assessment of the existing cybersecurity arrangements for critical infrastructure became even more urgent.[61] Developing countries should align their policies to tackle issues through regional efforts, align their security interests, and formalize their stance with reference to the already existing national and regional regulatory developments.

Cybersovereignty Considerations

The jurisdictional uncertainties surrounding other layers of the internet had less impact on telecommunications which functions as the physical layer of cyberspace. Also, telecommunications services have never ceased to be tightly regulated as there is a universal recognition of sovereign control over the telecommunications infrastructure, most of which is located on national territories.[62] Therefore, the implementation of national security measures over them has been less controversial. In 2013, the UN also recognized the application of state sovereignty and international norms and principles that flow from sovereignty in the context of cyberspace.[63] The two substantive Group of Governmental Experts (GGE) consensus reports in 2013 and 2015 acknowledge not only the application of International Law but also the territoriality principle in relation to cyberinfrastructure.[64] In these documents, the states are encouraged to take appropriate domestic measures to protect their cyberinfrastructure against cyber threats in order to achieve an open, secure, stable, accessible and peaceful global cyberspace. Russia and China led the Open-Ended Working Group (OEWG) Process also led to a consensus report at the UN in March 2021.[65] In addition to endorsing the 2015 GGE Report, the report drew attention to the increasing reliance of critical national infrastructures on ICTs and the resultant increase in the threat landscape. Once again, the states are encouraged to take appropriate measures to protect their critical infrastructure while endorsing global connectivity, capacity building and states responsibility to ensure general availability and integrity of the Internet. According to these non-binding UN resolutions, it is a state's sovereign right and responsibility to take appropriate measures to protect its critical infrastructure, including its critical information infrastructure, telecommunications. This in turn is expected to strengthen global connectivity. These documents indicate a general acceptance of security based domestic cybersovereignty policies as long as they do not disrupt global connectivity.

Satellite broadband presents a unique challenge for cybersovereignty policies because there is minimal and in some cases no need for terrestrial infrastructure for its use. So, the questions arise as to how domestic measures, which apply to territorial infrastructure and domestic internet service providers,

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transition-away-from-russian-fuel-and-hackers-are-now-hitting-german-wind-energy-companies/> accessed on 12 February 2023.

[61] Roy Balleste, 'The Law of Space Cyber Operations: Gripping Mysteries, Entangled Frontiers, and Security Challenges' (2022) 13 Journal of Law, Technology, & the Internet 146.

[62] Nanette S. Levinson and Derrick L. Cogburn, 'The Next Turn in Internet Infrastructure Governance' in Laura DeNardis and others (eds), *The Turn to Infrastructure in Internet Governance* (Palgrave Macmillan 2016)

[63] UNGA 'Report of the UN Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security' Sixty-eighth session, 24 June 2013 (A/68/98).

[64] UNGA 'Resolution adopted by the General Assembly on 21 December 2009 Creation of a global culture of cybersecurity and taking stock of national efforts to protect critical information infrastructures' Sixty-fourth session, 17 March 2010 (A/RES/64/211)

[65] UNGA 'Open-ended working group on developments in the field of information and telecommunications in the context of international security Final Substantive Report' (10 March 2021) A/AC.290/2021/CRP.2.

are to apply to its use. The international regulatory framework does not support the provision of satellite services in a particular country without proper authorization and licensing procedures, however implementation of cybersecurity measures is a separate matter. As in most ICT related advancements, including the 5G roll out crisis, countries once again found themselves ill-equipped to define and implement policies that would protect their interests. The absence of a comprehensive global legal framework for cybersecurity and the stalemate at the multilateral platforms, primarily due to the growing economic and ideological rivalry between the US and China, increases the significance of domestic solutions. Indeed, geopolitical tensions play a major role in how cyber policies are shaped.[66] The large satellite constellation projects in LEO are not immune to these tensions and have aggravated them. In line with its cybersovereignty policies and digital fortress approach to global connectivity, China has declined services of Starlink to be provided within its borders.[67] At the time of this report, China has also started the process of deploying its own mega constellation.[68] Russia, even before its conflict with Ukraine, had stated that they perceive Starlink constellation as a US military project and would not allow it to provide services within its borders.[69] They referenced the extensive contractual relationship between the US Defense Department and Space X, Starlink's mother company as justification for their caution. Soon after, Starlink's avid support and availability for Ukraine during the conflict revealed geopolitical implications of ownership of this technology and internet access during times of emergency.[70] Russia also ceased satellite launches it undertook for OneWeb.[71] The EU member states have not ruled out using the services of foreign satellite broadband companies. Some member states have already licensed and authorized operational ones. However, to avoid reliance on non-domestic companies for satellite broadband and to establish their influence in outer space matters, the EU has also decided to fund its own satellite constellation in LEO.[72] The varying regulatory responses of these major powers demonstrate their unique interpretations of cybersovereignty and how it influences their decisions regarding LEO satellite broadband.[73]

[66] Milton Mueller, *Will the Internet Fragment?: Sovereignty, Globalization and Cyberspace* (Polity Press 2017) Francesca Musiani, 'Infrastructuring digital sovereignty: a research agenda for an infrastructure-based sociology of digital self-determination practices' 25 Information, Communication & Society 785.

[67]Evelyn Cheng, 'Musk says Beijing doesn't want him to sell Starlink in China' (*Cnbc.com* 10 October 2022) <https://www.cnbc.com/2022/10/10/musk-says-beijing-doesnt-want-him-to-sell-starlink-in-china-ft-report.html> accessed on 11 November 2023.

[68] Larry Press, 'A New Chinese Broadband Satellite Constellation" (*CircleID.com*, 2 October 2020) <http://www.circleid.com/posts/20201002-a-new-Chinese-broadband-satellite-constellation/> accessed on 8 December 2020.

Andrew Jones, 'China is developing plans for a 13,000-satellite mega constellation' (*SpaceNews.com* 21 April 2021) <https://spacenews.com/china-is-developing-plans-for-a-13000-satellite-communications-megaconstellation/> accessed on 10 October 2022.

[69] Eric Berger, 'Russia may fine citizens who use SpaceX's Starlink Internet service' (*Arstechnica.com* 12 January 2021) <https://arstechnica.com/science/2021/01/russia-may-fine-citizens-who-use-spacexs-starlink-internet-service/> accessed on 2 February 2023.

[70] Berna Akcali Gur, and Joanna Kulezsa, 'Satellite Internet Access in Times of Cyberconflict' (*Directionsblog.eu* 28 April 2022) <https://directionsblog.eu/satellite-internet-access-in-times-of-cyber-conflict/> accessed on 30 April 2022.

[71] Akash Sriram, 'OneWeb to launch satellites with rival SpaceX after suspending ties with Russian agency' (*Reuters* 21 March 2022) <https://www.reuters.com/business/aerospace-defense/oneweb-launch-satellites-with-rival-spacex-after-suspending-ties-with-russian-2022-03-21/> accessed on 30 April 2022.

[72] , 'The new IRISS Constellation will be beneficial to EU citizens in several ways, find out 5 of them!' (*EUSPA News* 29 November 2022) <https://www.euspa.europa.eu/newsroom/news/new-iriss-constellation-will-be-beneficial-eu-citizens-several-ways-find-out-5-them> 7 February 2023.

International Telecommunications Regulation and Trade

Telecommunications Regulation

ITU, the UN's specialized organization for telecommunications, plays an active role in global development and addressing emerging policy issues arising from the changing telecommunication environment. Before, it was given a mandate in global development, its primary role was facilitating interoperability of global communications through standardization, spectrum management and coordination. In 1991, the ITU's mandate to provide technical assistance to developing countries was placed on the same level as its other roles. The ITU Constitution (CS), a binding international treaty, includes an obligation for its activities to be conducted in observance of the concerns of developing countries.[74] In 2002, bridging the digital divide was also confirmed as a priority for ITU.[75] The LEO satellite constellations are on the ITU's agenda for their role in global development, for their requirements of spectrum and orbital space and relevant standardization requirements. It is a valuable forum to negotiate these matters. It has almost global membership and since it has embraced a multistakeholder membership model, ITU has also started providing an opportunity for state members to engage in consultations with private sector members and civil society members under the same roof.

Registration of Satellite Constellations

The ITU coordinates and manages an international recognition system for orbital positions and the radio frequencies required by satellites. The governing rules and regulations, as well as the ITU Member States' associated rights and obligations, are stipulated in the CS, ITU Convention (CV), the Radio Regulations (RR), and the Rules of Procedures (RoP). Radio Regulations (RR) are a part of the administrative regulations and also has international treaty status.[76] RR provides the basic framework for the global coordination and management of the radio-frequency spectrum. Every three to four years ITU Member States meet at the World Radio Conference to review, and, if necessary, revise the RR provisions governing the use of the radio-frequency spectrum and the geostationary-satellite and non-geostationary-satellite orbits. The satellite operators act through a Member States representative, in most cases a national administrative body, to file their requests in the Master International Frequency Register (MIFR), which is a record of frequency assignments and orbital positions used or planned to be used. The member states to ensure that their rules and regulations comply with these principles, although there may be differences among national regulations. Their filing requests are coordinated with the previously determined frequency allocations, which had been determined through prior planning and coordination processes involving regular negotiations between national administrations to the ITU. Its role entails facilitating equitable access to these resources The ITU recognizes frequency spectrum and satellite orbits as limited natural resources which must be used rationally, efficiently, and economically.[77]

The World Radiocommunication Conference (WRC) convenes every four years to review and update the RR. The WRC agenda includes a review of current practices in light of technological developments, such as increased use of the LEO satellites for broadband. Preparation for the WRC is a multistakeholder process that involves the participation of governments, regulatory authorities,

[74] Constitution of the ITU, Article 12 and Article 17.
[75] 'Final Report World Telecommunication Development Conference Istanbul' (ITU, Turkey, 18-27 March 2002)
[76] Constitution of the ITU, Article 37.
[77] Constitution of the ITU, Article 44.

network operators, equipment suppliers, and spectrum users at national, regional, and global levels. It is an important opportunity for any stakeholder to achieve their policies and goals. In WRC-19, the increase in LEO satellite projects led to Resolution 35 by which the ITU Members have agreed on a definition of satellite constellations constellation.[78] At the same conference the members have also agreed on a regulatory requirement for the filed constellation projects to have ten percent of their constellation in orbit within the first two years after the start of deployment, fifty percent in five years and one hundred percent in seven years.[79] This time phased approach intends to prevent unrealized or failed projects from occupying limited and valuable frequency spectrums for extended periods of time, having benefited from the first come first served principle. The proper functioning of coordination, notification and registration mechanisms is essential to safeguard the operational requirements related to the deployment of LEO satellite constellations which are classified as non-GSO systems by the ITU. It is expected that significant new issues will be resolved at WRC-23 concerning the use of LEO satellites for broadband use, such as those in relation to inter-satellite links and earth stations in motion.[80]

Developing countries, as well as other members of the ITU, have formed regional organizations and became members of specialized international organizations to promote their collective interests. The regional organization members mainly comprise national administrations. Some examples of these are the European Conference of Postal and Telecommunications Administrations (CEPT), the Inter-American Telecommunication Commission (CITEL), the Asia-Pacific Telecommunity (APT), the African Telecommunications Union, and the Arab Council of Ministers for Telecommunication and Information. These organizations help define a common response to agenda items of the ITU conferences. They also serve as a venue for regional administrations to coordinate the radio frequencies, which are usually managed through multilateral agreements, such as the HCM Agreement[81] for some European countries. There are also bilateral agreements in place that encourage the coordination of frequencies among individual licensees within the border coordination zone, such as those between Canada and the US.[82] These bilateral and multilateral frequency spectrum arrangements are conducted in accordance with the Table of Frequency Allocations which authorizes several radiocommunication services in each band to provide flexibility for each state to coordinate according to their sovereign needs.[83] A greater level of harmonization of the frequency spectrum and a global 'open Skies' policy have been advocated for worldwide services and those intended for the general public.[84] The idea behind this policy is two-fold. One is to minimize technical interference and incompatibilities across borders to increase efficiency for global connectivity. The other is to maximize market efficiency by removing market access barriers, most notably licensing and authorization requirements, once they have completed registry requirements at the ITU through any ITU Member

[78] World Radio Conference 2019 (WRC-19), Mandatory data item A.4.b.1.a, Appendix 4.

[79] WRC-19, Resolution 35.

[80] ITU 'Managing radio frequency spectrum amid a new space race' (*News* 12 November 2021) <https://www.itu.int/hub/2021/11/managing-radio-frequency-spectrum-amid-a-new-space-race/> accessed on 20 February 2023.

[81] Agreement between the Administrations of Austria, Belgium, the Czech Republic, Germany, France, Hungary, the Netherlands, Croatia, Italy, Liechtenstein, Lithuania, Luxembourg, Poland, Romania, the Slovak Republic, Slovenia and Switzerland on the Coordination of frequencies between 29.7 MHz and 39.5 GHz for fixed service and land mobile service, Vilnius, 2005.

[82] 'Satellite Agreements With Canada' (*FCC.gov* 6 November 2002) <https://www.fcc.gov/satellite-agreements-canada> accessed on 12 February 2023.

[83] RR, Article 5.

[84] ITU-R, 'Guidance on the regulatory framework for national spectrum management' June 2015 Rep. ITU-R SM.2093-2 https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2093-2-2015-PDF-E.pdf

State.[85] Increased market efficiency, and competition will arguably provide consumers with more choices and better access in a shorter period. However, as mentioned in earlier sections, there are legitimate reasons for states' insistence in preserving their sovereign right to authorize and license the satellite services provided within their jurisdiction.[86]

There are also physical limitations to the co-existence of multiple satellite systems. As mentioned in the first section of this report, the risk of signal interference and service degradation is much higher for non-geostationary satellite systems. Coordination at international level may have to be complemented at national level. This is essentially a problem that needs to be resolved among the operators, whereas the national regulators will want to ensure that the services of the operators that are already licensed will not be adversely affected by the new ones. A licensing requirement involving a commitment to resolve these differences, with deference to their existing obligations to coordinate under ITU coordination procedures. [87]

The enduring compliance of states with the ITU coordination process shows their recognition and the RR's necessity for effective functioning of satellites. The utilization of the radio-frequency spectrum is a matter of state sovereignty, but international coordination is necessary, particularly to avoid harmful interference and other technical problems. Another important objective of the RRs is to facilitate the rational, efficient, and economical use of the radio frequencies and the associated orbits which are limited natural resources to ensure equitable access by developing countries and others whose geographical situation constitutes an impediment.[88] These technical goals and policy objectives are characteristic of the non-trade values ITU represents, most notably connectivity and development. They also constitute a framework for present and future policies relating to the use of LEO satellite services for broadband.

Satellite Services in WTO Law

Businesses operating LEO satellite constellations aim for global coverage. Their business model is inherently international and relies on provision of their services to customers across the globe, whether they be individuals, businesses, or governments. The WTO remains the prominent organization operating a system of trade rules negotiated and signed by a majority of the world's nations. Its role had been central to the liberalization of the telecommunications services trade and the introduction of privatization and competition to a sector that had been traditionally operated by government monopolies.[89] The definition of telecoms services in WTO instruments includes satellite communications. The relevant provisions are stipulated primarily in the 1994 General Agreement on Trade in Services (GATS), GATS Annex on Telecommunication (Annex), Reference Paper on Regulatory Principles on Basic Telecommunications (Reference Paper), and the Technical Barriers to Trade Agreement (TBT). These instruments recognize the sovereign right of member states to regulate the provision of telecommunication services, national regulation of frequency spectrum, and the

[85] 'Regulation of global broadband satellite communications' (*ITU.int* April 2012) <https://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_RegulationBroadbandSatellite.pdf> accessed on 17 February 2023.

[86] 'Guidance on the regulatory framework for national spectrum management' ITU-R SM.2093-2 (*ITU.int* June 2015) <https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2093-2-2015-PDF-E.pdf> accessed on 23 February 2023.

RR, Article 5.

[87] 'Consultation: Non-geostationary satellite systems – Licensing updates' (OFCOM 2021) <https://www.ofcom.org.uk/__data/assets/pdf_file/0015/222450/ngso-licensing-consultation.pdf> accessed on 5 January 2023.

[88] Constitution of the ITU Article 44 Paragraph 2 (CS 196), reiterated in RR No. 0.3.

[89] Marco C. E. J. Bronckers and Pierre Larouche, 'A Review of the WTO Regime for Telecommunications Services', in K. Alexander and M. Andenas (eds.), *The World Trade Organization and Trade in* Services (Brill 2008) 319–79.

associated licensing procedures within their territories to meet national policy objectives. They also constitute a commitment among WTO members that they will not exercise their jurisdiction in a manner that will result in barriers to trade in services. The increasingly prevalent regional and bilateral trade agreements mostly draw on the WTO regulatory framework, while some of the newer ones also elaborate on issues relating to the use of new telecommunications technologies.[90] The WTO instruments as well as regional and bilateral trade agreements between the concerned jurisdictions, constitute reference points in judging the extent of market access commitments a country has made with respect to foreign LEO satellite companies to provide broadband services within their jurisdiction.

ITU, the UN special agency for information and communication technologies and the WTO has a cooperation system in place with the WTO since 2000.[91] ITU has been the primary international regulatory body for the telecommunications sector. For a period starting from the 1980s until recent years, the liberalization of the services trade and the inclusion of telecommunications services in the WTO agreements shifted the institutional focus to the WTO. The leading economies, looking to liberalize telecommunications services across the globe, considered WTO a better platform to negotiate cross-sectoral deals as it operated in an atmosphere more conducive to introducing privatization and competition to a sector that had been traditionally operated by government monopolies. During the following decades telecommunications markets have become significantly more competitive, also leading to the privatization of satellite treaties. The emergence of the Internet in the 1990s, intensified the transformation of global trade and the telecommunications industry. The increased interconnectedness led to a higher recognition of the telecommunications industry both as a tradeable service and as a trade facilitator.[92] However, in recent years, the increasing skepticism towards further trade liberalization, growing awareness of privacy risks and national security implications of connectivity, and the present disparity between global market distribution have left the WTO's role in jeopardy. In the meantime, the ITU's regulatory role, which includes international coordination and regulation of (telecommunication) satellites, remained useful and effective.

Market Access

At the time of this report, 123 of the WTO members agreed to a range of market access and national treatment commitments on trade in telecommunications services, and 105 of them agreed to the regulatory principles in the Reference Paper. Therefore, whether a certain WTO Member has made a commitment to grant market access and national treatment in a certain sector, to allow the cross-border provision of telecommunications services, or to the establishment of companies to provide telecommunications services or foreign direct investment in existing companies will be determined with reference to these instruments. Even when such a commitment exists, the countries may rely on exceptions clauses in these treaties to derogate from their obligations. Some states have already asserted their concerns over the staggering rise in the number of satellites in LEO and their implications on national security.[93] Once a dormant clause, reliance on national security exceptions to justify

[90] José-Antonio Monteiro, 'Hold The Line: The Evolution of Telecommunications Provisions in Regional Trade Agreements' (WTO Staff Working Paper, ERSD-2021-7, 24 February 2021) <https://www.wto.org/english/res_e/reser_e/ersd202107_e.pdf> accessed on 23 February 2023.

[91] RR No. 8.3.

[92] Ian Walden, 'Telecommunications Law and Regulation: An Introduction', in Ian Walden (ed), *Telecommunications Law and Regulation*, 5th ed. (Oxford University Press 2018) 3-26.

[93] Maria Kolomychenko, "Exclusive: Russia Opposes U.S. OneWeb Satellite Service, Cites Security Concerns" (*Reuters.com* 24 October 2018) <https://www.reuters.com/article/us-oneweb-russia-security-exclusive-idUSKCN1MY1P8> accessed on 15 February 2023.
Mariel John Borowitz, Lawrence Rubin and Brian Stewart, 'National Security Implications of Emerging Satellite Technologies' 64 Orbis 515.

national trade restrictions has become more commonplace in recent years.[94] Satellites have long been perceived as dual-use technologies, significant for military purposes as well as commercial use. Increasing reliance on this technology for broadband when offered by only a few companies established in jurisdictions that are already dominating the digital realm will likely exacerbate the existing cybersecurity and national security related concerns especially among major powers that are not considered traditional allies. Despite the concerns, there is demand, as connectivity is not only a tradeable service but a facilitator of trade and development. Section 6 (a) of the GATS Annex on Telecommunications recognizes that an efficient, advanced telecommunications infrastructure in countries, particularly developing countries, is essential to the expansion of their trade in services. In consideration of how things stand, the efficient use of LEO broadband technology will require consideration of the interests of the countries that will authorize their use within their jurisdiction and respecting their national security and cybersecurity concerns, as well as taking their cross-border trade commitments into consideration.

The WTO Members have also agreed to a set of regulatory principles. In the sectors where they have made specific commitments, their regulatory practices are expected to be transparent, reasonable, objective, and impartial.[95] So, licensing, procedural demands, technical standards and the requirements and procedures should not be utilized to set unnecessary barriers to trade. These commitments are significant for LEO satellite broadband services as they will need to obtain licenses and authorizations from each jurisdiction in which they will be seeking to provide their services in. Setting up earth stations, frequency spectrums and providing broadband services are all licensable activities. There are also specific regulatory commitments. Most significant for satellite broadband relates to the allocation of scarce resources such as frequency spectrum. According to Article 6 of the Telecommunications Services Reference Paper of 1996, the procedure followed for the assignment of frequency spectrum should be objective, timely, transparent, and non-discriminatory.

The treaty obligations under the General Agreement on Tariffs and Trade (GATT) and the Information Technology Agreement (ITA) are also relevant. The LEO satellite broadband companies will need to export equipment to facilitate the use of their services, most significantly the user terminals. These terminals need to be installed at the user's premises and have been subject to standards and conformity assessment procedures for licensing by national regulatory agencies and customs regulations. ITA signatories have committed to removing tariffs on information technology products, including telecommunications equipment. In 2015, the members extended the ITA coverage and made specific reference to telecommunications satellites. The commitments are made on a most-favored nation (MFN) basis. This means that the signatories have agreed to extend their commitments to all WTO Members, irrespective of whether they've signed the ITA. The national licensing procedures for the equipment and the customs duties applicable to the user terminals will be an important issue, especially for LEO broadband companies that are planning to provide their services directly to customers.

Cassandra Steer, 'Why Outer Space Matters for National and International Security' (Center for Ethics and the Rule of Law January 2020) <https://www.law.upenn.edu/live/files/10053-why-outer-space-matters-for-national-and> accessed on 5 July 2022.

[94] Berna Akcali Gur, 'Restrictions on Trade in Telecommunications: WTO's Cybersecurity Conundrum' (2021) 55 Journal of World Trade 477.

[95] Rolf. H. Weber, 'Regulatory Autonomy and Privacy Standards under the GATS' (2012) 7 Asian Journal of WTO & International Health Law & Policy 25.

Supply Chain

Supply chain refers to the ecosystem of processes, people, organizations, and distributors involved in the creation and delivery of a final solution or product.[96] In the cybersecurity context, supply chain attack occurs when a network system is compromised by a threat actor through a third-party partner to gain access to that system and data. It is a globally prevalent threat, whereas 62 percent of organizations are under impact.[97] The hardware and software used in the system, the personnel employed by the supplier as well as the data storage system could present risks and could be used to gain access. The increasing range and number of cyberattacks have led to an intensified focus on global supply chains and applicable security controls. The latest example was the 5G Rollout crisis, where the trustworthiness of suppliers became the central issue to the security of the network.

In the past satellite technologies were developed by a handful of spacefaring nations under strict control and supervision of state authorities, mostly the military. Also, space and terrestrial systems were largely isolated from each other, each serving a different set of users and requirements.[98] That has started to change with the privatization of satellite companies, then increasing global interconnectivity, and the involvement of an increasing number of commercial enterprises in satellite connectivity. The increasing reliance on commercial enterprises and the growing global cyber threat landscape raises cybersecurity concerns in general but even more so for the governmental services, especially defense.

The technologies in LEO satellites are also sourced from a broad international supply base. It's hardware components and the (third-party) software used for the end products and solutions require security upgrades on a regular basis. Most of these upgrades will be conducted through remote connections, which could render these systems more vulnerable to cyberattacks.[99] Indeed intentional or unintentional disruption of radio signal transmissions due to weaknesses in the supply chain could cause grave cybersecurity risks. In the US, a zero-trust security model was proposed for the software and systems on satellite networks.[100] This system is designed to tackle security risks arising from the supply chain by "*treating all system components as untrusted, a software-design method that can prevent commercial service providers from monitoring government communications*."[101] The national regulatory processes will have limited success, especially in securing the satellite networks, as there is minimal terrestrial presence. However, international stakeholders within the space supply chain have invested interests in agreement on standards and processes to ensure ongoing commercial

[96] European Union Agency for Cybersecurity, ' Threat Landscape for Supply Chain Attacks' (ENISA 2021) <https://www.enisa.europa.eu/publications/threat-landscape-for-supply-chain-attacks> accessed on 15 January 2023.

[97] 'Securing the software supply chain is a top priority'(*Anchore.com* 2022) <https://anchore.com/blog/2022-security-trends-software-supply-chain-survey/> accessed on 20 February 2023.

[98] Algirde Pipikaite, Aarti Holla-Maini, Bryan Ware and Mark Dickinson, 'Will the battle for space happen on the ground?' (*Weforum.org* 25 May 2022) <https://www.weforum.org/agenda/2022/05/increased-cybersecurity-for-space-based-services/> accessed on 20 February 2023.

[99] David Livingstone and Patricia Lewis, 'Space, the Final Frontier for Cybersecurity?'(2016) Chatham House Policy paper, International Security Department.

[100] Joel Machen, ''Zero trust' can secure satellite communications against cyberattack' (*c4isrnet.com* 25 April 2022) <https://www.c4isrnet.com/opinion/2022/04/25/zero-trust-can-secure-satellite-communications-against-cyberattack/> accessed on 20 February 2023.

[101] Scott Rose, Oliver Borchert, Stu Mitchell, Sean Connelly, 'Zero trust Architecture' National Institute of Standards and Technology Special Publication, 800-207, August 2020) <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-207.pdf> accessed on 21 August 2021.

relationships. So, once again, a multistakeholder process emerges as the most viable solution to address the concerns.

WTO and Sustainable Development

Trade, just as communication, is an important component of achieving the UN SDGs. Long before the UN adopted the SDGs, WTO's establishment mandate recognized development as the goal of trade and economic relations among its members. The first paragraph of the Marrakesh Agreement establishing the WTO not only recognizes raising living standards and ensuring full employment as goals of trade but also emphasizes optimal use of global resources and protection and preservation of the environment as mutually supportive goals.[102] Therefore, the WTO had been given an active role in the achievement of the UN SDGs. It prepares annual reports to the UN's High-level Political Forum and collaborates with the UN's Department for Economic and Social Affairs, although it is not one of the specialized agencies of the UN. Therefore, the trade related commitments of the WTO Members, including satellite services, should be read in conjunction with their role in the achievement of the SDGs and their commitment to consider use of global resources and the environment.

LEO Satellite Constellations and Space Law

The use of the Earth's orbits by is governed by space law, a branch of public international law, designed to safeguard the peaceful exploration and use of outer space. Space Law is based on the recognition of space as global commons, a resource not owned by any nation but crucial to the future of all humankind. The space-faring nations deploying satellite constellations are utilizing the LEO, which is a limited natural resource. Since the deployment of the first artificial satellite Sputnik 1 in 1957, technological advancements have enabled more and more activities to be conducted by use of space technologies, such as GPS and navigation, broadcasting, and remote sensing. A wide range of these are services provided and consumed on a commercial basis by private and public actors, the beneficiaries of which span the globe.[103] Just as connectivity, access to these services is considered essential for global development. So, it is in the interest of all to ensure that space is used in a safe and sustainable manner and that the present and future benefits are available to all nations. The developing countries, as beneficiaries of a range of space-based services, not only broadband services, should ensure that their developmental interests are protected.[104] A thorough understanding of space law will enable states to develop a comprehensive approach to maximize their benefits from their services. They should assess and sign these treaties, if they deem them appropriate, and advocate policies for sustainable use of space resources and for access to its benefits from resources to be accessed on a fair and equitable basis.

The first treaty governing rules for the exploration and use of space is the Outer Space Treaty (OST), signed in 1967 under the auspices of the UN. The superseding four treaties and resolutions are built on the principles agreed upon in the OST, and these instruments are considered the main body of space law. Domestic laws and regulations governing space-related activities are expected to comply with this body of law which contains provisions with respect to the freedoms and responsibilities of states. The launch and operation of commercial communication satellites are expected to comply with

[102] The Marrakesh Agreement Establishing the WTO, Preamble, Para 1.

[103] 'Introduction: Satellites & Services' (Satellite Industry Association 2022) <https://sia.org/satellites-services/introduction-satellites-services/> accessed on 15 December 2022.

[104] Cristian Van Eijk, 'Unstealing the Sky: Third World Equity in the Orbital Commons' 47 Air and Space Law 25. Mark Danberg, 'We must regulate the exploitation of limited resources in space' (*Financial Times* 8 August 2022) <https://www.ft.com/content/9d090532-1a74-445f-9e12-8127f83436cc> accessed on 13 February 2023.

the internationally agreed set of norms and principles.[105] The states rely on the right of freedom of exploration and use of outer space enshrined in Article I(2) of the OST when authorizing and licensing the elaborate LEO satellite constellation projects. This freedom applies to all countries without discrimination of any kind and on the basis of equality, not only to the signatories of the OST.[106] This principle is an acknowledgment that all states are potential space-faring nations.

Space law addresses a variety of other matters as well. For example, the preservation of the space and Earth environment, liability for damages caused by space objects, the settlement of disputes, the rescue of astronauts, the sharing of information about potential dangers in outer space, the use of space-related technologies, and international cooperation. Several fundamental principles guide the conduct of space activities, including the notion of space as the province of all humankind, the freedom of exploration and use of outer space by all states without discrimination, and the principle of non-appropriation of outer space. The application of these principles has been further developed by other treaties, conventions, and UN General Assembly resolutions. The security regime developed on the basis of the UN Charter is also applicable to military activities in space, particularly those that could be classified as the use of force and the law of armed conflict. In response to increased military use of space and increased tensions, there have been efforts to modernize this body of law and to create a clear legal regime with respect to the changing threat landscape. Just as other multilateral efforts, these are also at an impasse despite the urgency with respect to security concerns.[107] The major barrier to progress is the current wave of global political and military tensions, commercial rivalry, and polarization.[108] More and more States are becoming parties to these treaties, negotiating cooperative agreements based on their provisions and promulgating national space law. For interested parties, UN Outer Space Affairs (UNOSA) office provides information and advice, upon request, to governments, non-governmental organizations, and the general public on space law , in order to promote understanding, acceptance, and implementation of international treaties.

In 2022 COPUOS prepared a background paper regarding the registration of large constellations in accordance with the Convention on Registration of Objects Launched into Outer Space and the non-binding General Assembly Resolution 1721 B (XVI). According to this document, there are inconsistencies in state practice among the 72 signatories to the Registration Convention, and there is no specific mechanism for large constellations. Therefore, some satellites remain unregistered, and the registries do not require information as to which satellites are deployed as part of a constellation.[109] This is another reason for the significance of the registration system at the ITU. The

[105] Christopher Daniel Johnson, 'The Outer Space Treaty' *(Oxford Research Encyclopedia of Planetary Science* 24 January 2018) <https://doi.org/10.1093/acrefore/9780190647926.013.43> accessed on 7 July 2021.

[106] Stephen Gorove, 'Freedom of Exploration and Use in the Outer Space Treaty: A Textual Analysis and Interpretation' (1971) 1 Denver Journal of International Law and Policy 93.

[107] Clementine G. Starling, Mark J. Massa, Christopher P. Mulder, and Julia T. Siegel 'The Future of Security in Space: A Thirty-Year US Strategy' (Atlantic Council April 2021) <https://www.atlanticcouncil.org/wp-content/uploads/2021/04/TheFutureofSecurityinSpace.pdf page 22> accessed on 5 September 2022.

James Landale, 'Can space diplomacy bring order to the final frontier?' (*BBC News* 26 September 2020) <https://www.bbc.co.uk/news/uk-54296015> accessed on 30 September 2021.

Cassandra Steer, 'Why Outer Space Matters for National and International Security' (Center for Ethics and the Rule of Law January 2020) <https://www.law.upenn.edu/live/files/10053-why-outer-space-matters-for-national-and> accessed on 5 July 2022.

[108] Theresa Hitchens, 'At UN meeting, space cooperation picks up momentum, but Moscow and Beijing play spoilers' (*Breakingdefence.com* 3 February 2023) <https://breakingdefense.com/2023/02/at-un-meeting-space-cooperation-picks-up-momentum-but-moscow-and-beijing-play-spoilers/> 25 March 2022.

Deborah Housen-Couriel, 'Cybersecurity threats to satellite communications: Towards a typology of state actor responses' (2016) 128 Acta Astronautica 409.

[109] UNGA, 'Registration of large constellations and megaconstellations' LSC 61st session, 2 February 2022 (A/AC.105/C.2/L.322).

issue of UN registration of megaconstellations was raised the issue at the UNOOSA Legal Subcommittee in 2022. It will be further discussed at a working group.[110] It will be in the interest of all states to consider becoming a party to the UN treaties on outer space, benefit from UN resources to build expertise to develop national or regional space policy, strategy, and regulatory frameworks, and to participate in UN processes, such as working groups where policies are developed in relation to space-based technologies, including megaconsteallations.[111]

Satellite Constellations and Space Sustainability

The number of satellites in LEO skyrocketed to form constellations with global coverage. The filings at the ITU indicate that the number will increase even higher in the next decade. These LEO satellites, smaller in size than those in higher earth orbits, also move faster. These two dramatic changes in the LEO are compounded by the space debris, some of which could not be tracked, that increases by the year. There are also natural elements of outer space, mainly meteoroids, that are tracked in space traffic management. Congestion increases the already existing risk of collision. Scientists point out the heightened risks and propose the assessment of the collision probability as a priority.[112] There are examples proving their point. Two incidents involving Starlink had already been reported. In 2019 the European Space Agency (ESA) moved its earth observation satellite and in 2021 China had to maneuver its space station away to avoid it colliding with a Starlink satellite.[113] Collisions could cause loss of critical functions of a constellation which may impact functioning of any critical national infrastructure that it is connected with on Earth. If collision is with another satellite, whether part of a constellation or not, it could cause the same effect on the earth assets connected to that constellation or single satellite, jeopardizing functions of a wide range of space-dependent systems.[114] The damage can be long-term when collisions lead to *space debris past a certain critical mass.* According to Kessler theory, once that threshold is passed, the amount of space debris will keep on increasing. The collisions will continue to give rise to more debris which would then lead to more collisions.[115] There is an urgent need to address space debris and traffic management via a multistakeholder process.[116] Transparency, communication, and agreement on rules of conduct for emergency situations will be key to starting this process.

Sustainable use of space is necessary for sustainable development. One interpretation of the due regard obligation of states to the interests of other states, in Article IX of the OST, includes

[110] UNGA, 'Report of the Legal Subcommittee on its sixty-first session, held in Vienna from 28 March to 8 April 2022' LSC 61st session, 19 April 2022 (A/AC.105/1260).

[111] UNGA, 'Bringing the benefits of space to all countries: a guidance document on the legal framework for space activities' LSC 61st session, 26 January 2022 (A/AC.105/C.2/117).

[112] Alexis Petit, Alessandro Rossi, Elisa Maria Alessi, 'Assessment of the close approach frequency and collision probability for satellites in different configurations of large constellations' (2021) 67 Advances in Space Research 12.

[113] Loren Grush, 'China complains to UN after maneuvering its space station away from SpaceX Starlink satellites' (theverge.com 28 December 2021) <https://www.theverge.com/2021/12/28/22857035/china-spacex-starlink-tianhe-space-station-satellites-collisions> accessed on 15 January 2023.

[114] Beyza Unal, 'Collision risks in space due to mega-constellations' (*Observer Research Foundation* 18 October 2021) <https://www.orfonline.org/expert-speak/collision-risks-in-outer-space-due-to-mega-constellations/> accessed on 1 July 2022.

[115] 'Kessler Effect' (European Space Agency 2022) <https://www.esa.int/Enabling_Support/Space_Engineering_Technology/The_Kessler_Effect_and_how_to_stop_it)> accessed on 1 Fberuary 2023.

[116] Theresa Hitchens, 'As danger grows for commercial firms in space, so does call for norms: Aerospace' (Breakingdefense.com 23 August 2022) <https://breakingdefense.com/2022/08/as-danger-grows-for-commercial-firms-in-space-so-does-call-for-norms-aerospace/> accessed on 10 October 2022.

transparency and sharing information regarding their space activities with the international community.[117] The best practice guidelines to ensure the safety and sustainability of future space usage produced by the UN Committee on the Peaceful Uses of Outer Space (COPUOS) in 2019 include terms to this effect. There are mutual benefits for all states benefiting from space-based services to keep it safe and sustainable. In its role to govern the exploration and use of space for the benefit of all humanity and to pursue international cooperation in the peaceful uses of outer space, COPUOS also set up a Working Group on the Long-Term Sustainability of Outer Space Activities. It is in the best interest of all member states to have active representation in these UN processes.

The states retain control over their satellites and other space objects that they launch into space, and they bear international responsibility for all activities in space conducted by their public or private entities. Article VII of the OST establishes that international liability for all damage caused by these objects or their components to another State or to its public or private persons on Earth, in air or in outer space. Therefore, there is a very high incentive for states to not lose control of space objects that they are responsible and liable for.[118] The average time for space objects and debris located in LEO to re-enter Earth's atmosphere is approximately five to ten years. It is longer for objects at higher altitudes. So, states are responsible and liable to manage all space objects to minimize collision risks throughout this period.[119] Just as ICTs satellites are also considered dual-use technologies.[120] In 2013, the UN's First Committee on Disarmament and International Security discussed the security matters at the intersection of cyber and space technologies for international transmission and connection and warned that outer space was becoming more "congested, contested and competitive" and called for a binding document to prevent its militarization.[121] Almost a decade later, thousands of satellites have been launched, most in the form of large constellations and thousands more are planned to be launched. Yet, the prospect of a binding document remains far. The security concerns arising from potential military applications remain, and they are not likely to be resolved easily. A possible solution will require an agreement among major space-faring nations and may address the acceptable uses of these technologies and increase trust also on the part of third countries that will rely on these services.

Given the convergence of civilian, military, commercial, and security interests in the space domain, emerging economies should familiarize themselves with space law, and invest in human capital and expertise, even if developing their own space technologies seem like a far prospect.[122] As the space economy is picking up pace, there are more opportunities to do so. The Regional Centers for Space Science and Technology Education established by the UN is one example. Pooling resources through regional alliances is also important. The newly established regional space agencies prove increased interest and awareness towards the significance of space-based technologies and expertise from a

[117] UNOOSA and UK Space Agency, 'Awareness-raising and capacity-building related to the implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities' (UNOOSA May 2022) <https://spacesustainability.unoosa.org/sites/spacesustainability.unoosa.org/files/files/documents/2022/May/lts_guidelines_stakeholder_study_report_may_2022.pdf> accessed on 15 February 2023.

[118] Chris Johnson, 'Legal and Regulatory Considerations' in Small Satellite Program Guide, Chapter 5

[119] Francis Lyall & Paul Larsen*, Space Law: A Treatise* (2nd edn, Routledge Press 2018) 389.
Scott Atkins, 'Governance in Outer Space: The Case for a New Global Order' (Norton Rose Fulbright November 2022) <https://www.nortonrosefulbright.com/en/knowledge/publications/e8862684/governance-in-outer-space-the-case-for-a-new-global-order> accessed on 23 February 2023.

[120] UNGA 'Report of the UN Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security' Sixty-eighth session, 24 June 2013 (A/68/98).

[121] UNGA, 'First Committee, 'Outer Space Increasingly 'Congested, Contested and Competitive', First Committee Told, as Speakers Urge Legally Binding Document to Prevent Its Militarization' Sixty-eighth session, 25 October 2013 (GA/DIS/3487).

[122] Chen, David Kuan-Wei. "Space Law Education and Capacity-Building" (*Oxford Research Encyclopedia of Planetary Science* 29 September 2021)

region that had little influence in outer space policymaking platforms. In 2021 the Latin American and Caribbean Space Agency (LACA) and in 2023, the African Space Agency was inaugurated.[123] Their budgets and ambitions may be more modest when compared to the space superpowers, yet it is a very important step for alignment and promotion of regional interests, as well as building expertise. One example of this took place at the 2022 the UN Open-Ended Working Group (OEWG) on Reducing Space Threats where the states from the global south put forward their preference toward binding treaties, rather than voluntary norms and raised their concerns about the inclusivity of the process.[124]

Recommendations

Broadband connectivity, whether enabled by terrestrial or space-based technologies is essential for development. The recent developments in space-based technologies, especially the mega constellations in LEO, have raised hopes as a quick solution to providing high-speed low latency broadband services anywhere around the globe, including in hospitable terrain and remote areas. It is in the interest of most countries to benefit from this technology and to complement their existing communications infrastructure. In doing so, each country or region must determine the right policies according to their unique circumstances and needs with respect to their existing international commitments. They will also need to participate in and promote their interests at relevant international organizations, especially the ITU, WTO and COPUOS, where pre-existing commitments are being interpreted and new norms are being adopted to respond to the new developments. The domestic initiatives with respect to connectivity, trade, and space technologies will produce the best results if they are not decided in isolation from each other but in a holistic manner, primarily in consideration of their SDGs, their cybersecurity, the environment, and space sustainability.

In this report, we introduced the policy issues and associated international norms that have been at the forefront of LEO satellite constellation-related debates. An initial list of our recommended actions for developing counties is as follows:

1. They should reassess and revise domestic rules and regulations that apply to licensing and authorizing broadband services via satellites. The regulatory interventions of space-faring nations that have a comprehensive understanding of technology could guide this process. Different business models need to be considered. Whether the companies will seek to be authorized as direct-to-end user service providers or in partnership with incumbent telecom service providers will depend on the market and regulations of each jurisdiction. An important decision is to be made regarding gateways. Technically there is no need to establish a gateway in each jurisdiction. The decision will have to be made with its potential impact on cybersecurity and cybersovereignty concerns of each jurisdiction. Regional alliances will increase market efficiency.

[123] Christian Santana, 'The Latin American Space Agency gets off the ground' (*Global Affairs* 17 January 2022) <https://en.unav.edu/web/global-affairs/el-despegue-de-la-agencia-latinoamericana-del-espacio> accessed on 23 February 2023.
Mustapha Iderawumi, 'AUC inaugurates the African Space Agency' (*Satnews.com* 30 January 2023) <https://news.satnews.com/2023/01/30/auc-inaugurates-the-african-space-agency/> accessed on 23 February 2023.
Joshua Faleti, 'The AfSA Act; a Step in the Right Direction' (*Space in Africa* 18 April 2021) <https://africanews.space/the-afsa-act-a-step-in-the-right-direction/> accessed on 22 February 2023.
[124] Rajeswari Piilai Rajagopalan, 'Space and Cyber Global Governance: A View from the Global South' (CIGI Cybersecurity and Outerspace Essay Series 29 January 2023)

2. Frequency spectrum and orbital resources are limited natural resources, which are managed by the ITU. The ITU is committed to connecting all the world's people, wherever they live and whatever their means. They also play an active role in promoting development through the ICTs and standard setting for interoperability. The ITU has an almost global membership. The members should actively participate in decision-making processes at the ITU, particularly the world radio conferences held every three to four years to review and revise the RR. Regional groups that already exist would be particularly useful for pooling resources and enhancing expertise for achieving effective representation of shared interests.

3. The commitments under the WTO treaties and their preferential trade agreements are also relevant as to whether the countries have agreed to allow market access to satellite communications services from their trading partners. Countries should reassess their commitments under these treaties and reconsider their interests and priorities associated with satellite broadband technology.

4. COPUOS is tasked with the facilitation of cooperation in peaceful uses of outer space, encouragement of space research programs, and studying legal problems arising from the exploration of outer space. Developing countries should participate in this committee and also take advantage of the capacity-building and expertise-enhancing educational opportunities that the UN Office for Outer Space Affairs has to offer. Increased awareness of international space law is necessary. Joining space law treaties may provide the nations with additional rights and should be considered by all non-space-faring nations. In strengthening their space law policies, pooling resources via regional space agencies is recommended.

5. The transparency of national regulators and operators of LEO satellite constellations will build confidence in potential markets and clear the way for the harmonization of domestic and regional policies, which in turn will facilitate the integration of the emerging LEO satellite technology into the global communication infrastructure recently enhanced by 5G.

6. The national policies regarding all aspects of satellite broadband shall be produced and determined in a holistic manner. The national regulatory agencies should align their policies with each other and with the relevant international organizations.

Annex I: International laws and regulations on LEO satellite broadband

INTERNATIONAL LAW

Treaties - General

- UN 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies[Outer Space Treaty]
- UN 1972 Convention on International Liability for Damage Caused by Space Objects [Liability Convention]
- UN 1976 Convention on Registration of Objects Launched into Outer Space [Registration Convention]

Treaties - ITU

- ITU 1992 Constitution of the International Telecommunication Union
- ITU 2002 Telecommunications Convention
- ITU 2019 World Radiocommunication Conference (WRC-19) Final Acts
- ITU 2020 Radio Regulations
- ITU 2021 GSR-21 Best Practice Guidelines
- ITU 2023 World Radiocommunication Conference, Radio Regulations review

Secondary Sources of international law

- UN General Assembly 1963 Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space [Declaration of Legal Principles]
- UN General Assembly 1996 The Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries [Benefits Declaration]
- IADC 2007 Space Debris Mitigation Guidelines, Revised
- UN General Assembly 2007 Recommendations on enhancing the practice of states and international intergovernmental organizations in registering space objects.
- UNIDROIT 2012 Protocol to the Convention on International Interests in Mobile Equipment on Matters specific to Space Assets [Space Protocol]
- UN General Assembly 2013 Recommendations on national legislation relevant to the peaceful exploration and use of outer space.
- UNOOSA / ITU 2015 Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites
- UN Committee on the Peaceful Uses of Outer Space 2018 Guidelines for the Long-term Sustainability of Outer Space Activities.
- UN 2020 Committee on the Peaceful Uses of Outer Space Scientific and Technical Subcommittee, Revised Draft "Space2030" agenda and implementation plan

REGIONAL and INTERNATIONAL ORGANISATIONS

WTO

- WTO 1994 General Agreement on Trade in Services (GATS)
- WTO 1994 GATS Annex on Telecommunications
- WTO 1996 Fourth Protocol to the General Agreement on Trade and Services
- WTO 1996 Reference Paper: Negotiating group on basic telecommunications

EU

- EU 2018 DIRECTIVE 2018/1972 establishing the European Electronic Communications Code
- EU 2021 Starlink EU/UK/EEA Privacy Policy
- 2001 Amended Convention of the European Telecommunications Satellite Organization (Amended Convention)
- EU Regulation 2021/696 of the European Parliament and of the Council of 28 April 2021 establishing the Union Space Programme and the European Union Agency for the Space Programme
- EU 2022 Proposal for a Regulation of the European Parliament and of the Council establishing the Union Secure Connectivity Programme for the period 2023-2027, COM(2022) 57 final
- Decision (CFSP) 2021/698 on the security of systems and services deployed, operated and used under the Union Space Programme which may affect the security of the EU
- Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union [NIS 2 Directive]

ESA

- ESA 1980 Convention of the European Space Agency and Rules of Procedure of the ESA Council
- ESA 2014 Space Debris Mitigation Policy for Agency Projects
- ESA 2014 Space Debris Mitigation and Re-entry Safety Regulatory Framework

ISO

- ISO 2019 ISO 24113: Space debris mitigation requirements

To access full database of relevant international law documents, treaties, regulations as well as soft law sources, private law contracts and other policy documents, visit the project website at : www.cyber.uni.lodz.pl/LEOs

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Annex II National LEO brodband policy options with recommendations.

OPTION	APPROACH	KEYWORD	DESCRIPTION	PROS	CONS	RECOMMENDATION
OPTION 1	EFFICIENT	"QUICK LEOs"	PROMPTLY ALLOWS NATIONAL LEO SATELLITE-BASED INTERNET ACCESS	INSTANT INCREASE IN INTERNET PENETRATION POPULAR APPROACH AMONG NON-SPACE-FARING NATIONS FACILITATES GROWTH AND INNOVATION	POTENTIAL DATA SECURITY AND LIABILITY RISKS FOR STATE AND INDIVIDUAL USERS UNPOPULAR APPROACH AMONG SPACE-FARING NATIONS	NOT RECOMMENDED
OPTION 2	CAUTIOUS	"SLOW LEOs"	DEVELOP GUIDING POLICY QUESTIONS TO CONSIDER BEFORE DECIDING ON LEO SATELLITE-BASED SERVICE IN YOUR JURISDICTION	ALLOWS FOR INFORMED DECISION MAKING GOOD GOVERNANCE PRACTICE	TIME-CONSUMING DELAYS PENETRATION INCREASE	RECOMMENDED
OPTION 3	PASSIVE	"NO LEOs"	REFRAIN FROM ALLOWING LEO SATELITE-BASED SERVICE WITHIN YOUR JURISDICTION, CAUTIOUSLY OBSERVE FURTHER DEVELOPMENT, AND WAIT FOR THE TECHNOLOGY TO MATURE	UPHELD STATUS QUO: NO RISK OR NEW LIABILITIES	PERMANENTLY STIFLES INNOVATION AND GROWTH	NOT RECOMMENDED
OPTION 4	COST-INTENSIVE	"MY LEOs"	DEVELOP NATIONAL/REGIONAL LEO SATELLITE BASED BROADBAND SERVICE	FULL TECHNOLOGICAL AUTONOMY / INDEPENDENCE SECURITY ECONOMIC POTENTIAL	EXTREMELY COST-INTENSIVE DELAYED RESULTS: NO IMMEDIATE INTERNET PENETRATION GROWTH STIFFLES INTERNATIONAL COOPERATION	NOT RECOMMENDED
OPTION 5	COOPERATIVE	"OUR LEOs"	JOIN FORCES WITH LIKE-MINDED ACTORS TO DEVELOP A COMPREHENSIVE, RULES-BASED ORDER FOR LEO ACCESS, FACILITATING SUSTAINABLE DEVELOPMENT AND CONNECTIVITY FOR ALL	EFFECTIVE IMPACT ON FURTHER DEVELOPMENT OF LEO RELEVANT POLICIES	RESOURCE-INTENSIVE: HUMAN RESOURCES, CAPACITY BUILDING, ACTIVE ENGAGEMENT	RECOMMENDED
OPTION 6	ENGAGED	"UNIVERSAL LEOs"	ACTIVELY ENGAGE WITHIN EXISTING INTERNATIONAL AND REGIONAL FORUMS TO ENSURE RELEVANT POLICIES CURRENTLY DEVELOPED FACILITATE GLOBAL ACCESS AND CONNECTIVITY FOR ALL THROUGH SUSTAINABLE DEVELOPMENT GOALS	EFFECTIVE IMPACT ON FURTHER DEVELOPMENT OF LEO-RELATED POLICIES	NONE	STRONGLY RECOMMENDED