New Space Law Created to Enable Space Innovation While Preserving the RF Environment in Space

Notable Outcomes of the ITU's 2019 World Radio Conference

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Abstract

Suddenly, Low Earth Orbit is becoming increasingly crowded at an accelerating pace. As the first "megaconstellations" of hundreds and thousands of small communications satellites are being launched into new constellations, there are also a growing number of smaller satellites being launched by newly space-faring nations as well as non-profit institutions. In both cases, there is an urgent need for appropriate global and national legal/regulatory frameworks to support and govern these innovations within the bounds of the Outer Space Treaty. One venerable regulatory institution is addressing these challenges: the International Telecommunication Union (ITU). The ITU's ongoing activities to incrementally prepare a basis in international law to both encourage and regulate these new space innovations quietly establishes a proven model for the world to follow. In 2019, the ITU and its members gathered for its quadrennial treaty conference, the World Radiocommunication Conference (WRC-19), to address, among other items, how to handle the filings for new very large non-geostationary satellite constellations and the growing number of cubesats, which are often launched without adherence to the ITU's Radio Regulations, a treaty instrument on access to radiofrequency spectrum and the orbits. This paper examines how the ITU develops a legal framework to balance the encouragement of innovative space services whilst ensuring that existing international legal norms are observed. In particular, it will provide insights the innovative results achieved by WRC-19. The ITU's longstanding history of successfully facilitating new space technologies is remarkable and offers an often overlooked model for other institutions for adopting space law.

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1. Introduction

We are fortunate to be living in the midst of a new 21st century space race, where innovations long dreamed of are becoming real. One aspect of this new space race is the resurgence of interest in constellations of non-geostationary (NGSO) satellites to provide connectivity to all corners of the world, such as those proposed by OneWeb, SpaceX, and Amazon, who propose systems consisting of hundreds or thousands of satellites. This so-called "megaconstellation" boom is propelled in large measure by the rise of telecommunications technologies and services that have enabled a world where social and economic development and advancement are increasingly dependent on constant connectivity and access to growing amounts of data. Telecommunications is globally recognized as a "key enabler to accelerate social, economic and environmentally sustainable growth and development, while the spread of ICT [Information and Communication Technology] and global interconnectedness has [sic] great potential to accelerate human progress, to bridge the digital divide, and to develop knowledge societies".[1] As massive populations have sheltered at home from COVID-19 in much of 2020 and extending into 2021, the significance of our everyday reliance on broadband connectivity for work, education, healthcare, entertainment, and social connection has been sharply clarified. And, at the same time, the lack of universal availability of broadband – our inability to close the digital divide – continues to be a top priority worldwide.[2]

On *terra firma*, new Fifth Generation (5G) advanced wireless systems promise to go far to address the world's increasing demands for high-speed, low latency mobile broadband connectivity, but such terrestrial-bound services are unlikely to ever be able to meet and keep pace with all such needs, especially in rural and remote areas, including the poles, the seas, and the air. Moreover, new applications of broadband connectivity abound, such as connecting autonomous vehicles on the roads and in the air. At the same time, demand is growing for narrowband, low latency services, such as paging, texting, and monitoring, stimulated by the rise of machine-to-machine communications and Internet-of-Things.

In light of these trends, and the growth in the availability and affordability of launch services, every week we hear news of the advancement of these

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1 Federal Communications Commission, Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, 16th Broadband Deployment Report Notice of Inquiry, FCC 20-112, 2020, https://docs.fcc.gov/public/attachments/FCC-20-112A1.pdf (accessed 13.09.20).

2 International Telecommunication Union, Connect 2030 Agenda for Global Telecommunication/Information and Communication Technology, Including Broadband, for Sustainable Development, Resolution 200 (Rev.Dubai, 2018) ITU, 2019, https://www.itu.int/en/council/Documents/basic-texts/RES-200-E.pdf (accessed 13.09.20).

emerging megaconstellations which promise to deliver broadband services to all regardless of location – the ultimate solution to the digital divide.[3] Batches of multiple satellites are being launched at single a time into Low Earth Orbit (LEO) to populate these constellations. Meanwhile, interest in launching very small satellites, either singly or in small systems, is also growing as space becomes more accessible for experimentation and the success of new commercial industries providing remote sensing and mapping services; more governments able to perform important scientific services, such as climate and resource monitoring; as well as research and educational institutions. The 2020 State of the Satellite Industry Report observed that there are 2,046 operational satellites in orbit from 75 nations, reflecting a 77% increase over the past five years due, in large part, to the launch of small satellites (less than 1,200 kg).[4] At the International Telecommunication Union (ITU), the United Nations (UN) agency that manages the overall coordination of satellites and terrestrial telecommunication systems, the size and complexity of filings for satellite systems has grown to the point of requiring new approaches to the administration of such filings.

The 2020 International Astronautical Congress addressed the challenges of this 21st century space race, including development of legal and regulatory approaches that encourage and promote these nascent space endeavors while ensuring adherence to the fundamental principles of the Outer Space Treaty and related instruments and ensuring a safe and sustainable space environment for all. Although there are a paucity of new space law treaties to address these burgeoning challenges, "soft law" mechanisms, including formulation of standards and voluntary guidelines, in addition to regional and national measures, are being concurrently pursued as alternative approaches.[5] Notably, the ITU provides a model of ongoing space law creation that timely addresses innovations in space technology and services as they develop within the legal norms of its basic instruments. The ITU's recently concluded 2019 World Radiocommunication Conference ("WRC-19"), demonstrated this capability as it adopted Final Acts containing a regulatory approach for managing megaconstellation filings; new regulations to encourage innovation and more efficient use of spectrum and orbital resources by next generation satellite networks and systems; and streamlining

3 A.L. Allison, B.C. Chesley, Accommodating New Commercial Space Applications in the Global Legal/Regulatory Framework: An Evolutionary Approach to Launching the New Space Revolution, IAC-17-F1.2.8, 68th International Astronautical Congress, Adelaide, Australia, 2017, 25-29 September.

4 Satellite Industry Association, 2020 State of the Satellite Industry Report, 2020, Satellite Industry Association, https://sia.org/wp-content/uploads/2020/07/2020-SSIR-2-Pager-20200701.pdf (accessed 13.09.20).

5 J.M. Beard, Soft Law's Failure on the Horizon: The International Code of Conduct for Outer Space Activities, 38 U. Pa. J. Int'l L. 335 (2017), https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1936&context=jil (accessed 27.09.20).

regulations for the benefit of small satellites with short duration missions. Moreover, the Conference proposed agendas for the next two WRCs to address further space innovations, including enabling satellite services between satellites in different orbits and consideration of the regulatory approach to facilitate operation of sub-orbital vehicles; among many additional items. This paper will briefly describe these developments and the process by which new space law is regularly being achieved by the ITU and its broad-based membership.

Fig. 1. The headquarters of the ITU on Place des Nations, in Geneva, Switzerland (ITU photo)

2. The Role of the ITU in Space Law

As an initial matter, all space systems require assured, reliable access to radiofrequency spectrum from their location in space to control their operations, to deliver their payload, and to perform their missions. Due to the sizeable investments and the long lifetime of space systems, there must be a high level of confidence that these operations will be able to successfully operate throughout their lifetimes, including freedom from harmful radio interference. The ITU is the UN agency charged managing these responsibilities. Through application of the provisions of the Radio Regulations, the ITU treaty on use of radiofrequency spectrum and orbital resources, space system operators, acting through Member States, attain international recognition of their radiofrequency assignments in their orbital locations and protection from harmful interference from others for the lifetime of their systems.

The ITU, originally established as the International Telegraph Union in 1865, is the world's oldest intergovernmental institution, pre-dating the invention of radio and space systems. A separate International Radiotelegraph Union was founded in 1906 to develop harmonized approaches to managing the implementation of radio technology, initially for maritime operations, and Unions merged in 1932. With the creation of the UN in 1947 in the aftermath of the Second World, the ITU became a UN specialized agency. The ITU is headquartered in Geneva, Switzerland, just across the plaza from the UN's European Headquarters (shown in Fig. 1).[6]

Some ascribe the ITU's longevity and success to its technological, rather than political, orientation. A major contributor that drives its ongoing technological relevancy and pace is the membership and active participation of the private sector, including satellite operators and manufacturers, in its activities, particularly at the working levels such as the ITU Radiocommunication Sector's ("ITU-R") technical Study Groups and Working Parties. The private sector may join each of the ITU's three Sectors (Radiocommunication, Telecommunication Standardization, and Telecommunication Development) as "Sector Members," and submit contributions directly into all non-treaty meetings, and participate in decision-making. There are more than 700 Sector Members, in addition to others under other categories of participation (associates, academia, and small and medium enterprises). As the ITU's work statement is contribution driven, these private Sector Members are able to play a significant role in defining and focusing the ITU's work, particularly in the ITU-R.

The ITU's mission is to extend the benefits of new telecommunications technologies to all the world's inhabitants.[7] In fulfillment of this role, it facilitates and manages access to radio spectrum and orbital resources and maintains the Master Register of International Frequency Assignments which records the use of spectrum and orbital resources that have successfully completed the processes of the Radio Regulations and are thus entitled to receive international recognition and protection from harmful interference.[8]

6 A.L. Allison, The ITU and Managing Satellite Orbital and Spectrum Resources in the 21st Century, Springer, Cham, 2014.

7 International Telecommunication Union, Collection of the Basic Texts of the International Telecommunication Union Adopted by the Plenipotentiary Conference, ITU, Geneva, 2019, https://www.itu.int/pub/S-CONF-PLEN-2019 (accessed 13.09.20).

8 International Telecommunication Union, ITU Radio Regulatory Framework for Space Services, ITU, 2015, https://www.itu.int/en/ITU-R/space/snl/Documents/ITU-Space_reg.pdf (accessed 27.09.20).

Fig. 2. Excerpts from the ITU Constitution.

ITU Constitution Article 45

Harmful Interference

- **No. 197** All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of the Radio Regulations.
- **No. 198** Each Member State undertakes to require the operating agencies which it recognizes and the other operating agencies duly authorized for this purpose to observe the provisions of No. 197 above.
- **No. 199** Further, the Member States recognize the necessity of taking all practicable steps to prevent the operation of electrical apparatus and installations of all kinds from causing harmful interference to the radio services or communications mentioned in No. 197 above.

ITU Constitution Article 44

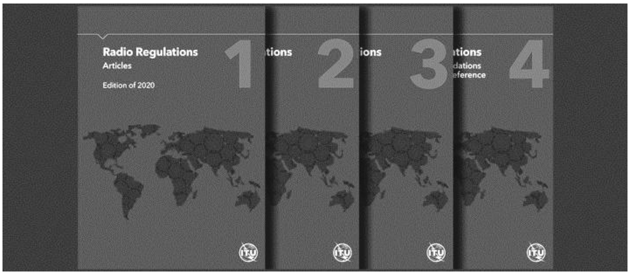
Use of the Radio-Frequency Spectrum and of the Geostationary-Satellite and Other Satellite Orbits

- **No. 195** Member States shall endeavour to limit the number of frequencies and the spectrum used to the minimum essential to provide in a satisfactory manner the necessary services. To that end, they shall endeavour to apply the latest technical advances as soon as possible.
- **No. 196** In using frequency bands for radio services, Member States shall bear in mind that radio frequencies and any associated orbits, including the geostationary-satellite orbit, are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies, taking into account the special needs of the developing countries and the geographical situation of particular countries.

The ITU is a periodic intergovernmental organization whose authority is retained by the 193 Member States who govern the Union at treaty conferences. The governing body of the ITU is its Plenipotentiary Conference which occurs every four years and has authority to adopt and amend the ITU's Constitution and Convention; elect the Union's officials, and determine its general policies for fulfilling its purposes based on the proposals of its

Member States. The ITU's Constitution provides the fundamental legal tenets that are the basis of its oversight of radio and space systems (see Fig. 2). These foundational principles – mutual protection and preservation of shared natural resources so that they can be utilized to support the highest number of services and provide equitable access to all nations, now and into the future – comprise the ITU's version of sustainability. Thus, in order to keep pace with the rapid and accelerating pace of development of technology and services, and the world's desire for the successful implementation of these technologies and services, the ITU has to act continuously to update its standards and treaties in order to continue to fulfill its very mission.[9]

Fig. 3. The ITU's Radio Regulations, 2020 edition.



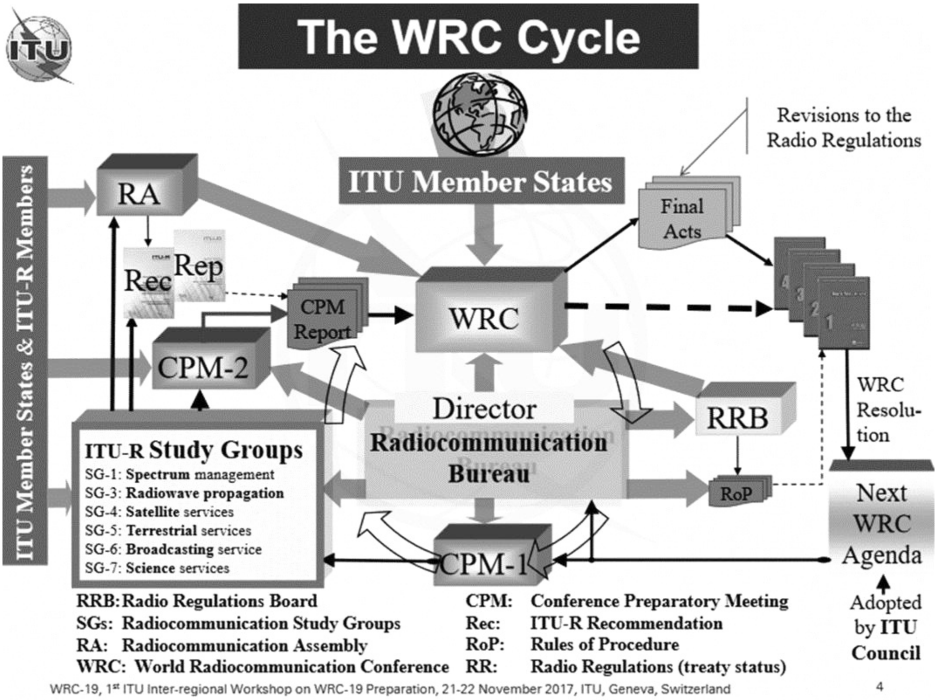
The Radio Regulations (see Fig. 3),[10] are another ITU treaty instrument that implements the Constitution's principles by providing detailed underpinnings for the global framework for spectrum and orbit use, including protecting services from harmful interference and ensuring efficient use of these resources to ensure maximum services and equitable access. The Radio Regulations are adopted and modified at another treaty conference, the World Radiocommunication Conference (WRC). A new edition of the Radio Regulations is published following every WRC to incorporate the new and amended provisions. The most recent edition of the Radio Regulations was published in September 2020 to incorporate the revisions adopted by WRC-19. These changes to the Radio Regulations entered into force on 1 January 2021 – the 37th time the Radio Regulations have been updated in their 114-year history.[11]

9 A.L. Allison, Meeting the Challenges of Change: The Reform of the International Telecommunication Union, 46 Fed. Comm. Law J. 491, 496 (1992).

10 International Telecommunication Union. Radio Regulations, ITU, Geneva, 2020, https://www.itu.int/pub/R-REG-RR/en (accessed 27.09.20).

11 International Telecommunication Union, Members Communiqué, ITU Updates Global Treaty which Enables Better Access to Affordable Broadband Technologies, ITU, 15 September 2020, https://www.itu.int/en/mediacentre/Pages/cm05-2020-ITU-Radio-Regulations-update.aspx (accessed 21-09-20).

Fig 4. ITU WRC Cycle.



WRCs are convened every four years to keep pace with rapid technological change. They address items on an agenda recommended by the previous WRC and approved by ITU Council. Having a set agenda affords members a multi-year preparatory period to conduct technical studies and to develop solutions for each agenda item; to develop proposals; and to build consensus on particular solutions (see Fig. 4).[12] Because of the large number and increasing complexity of WRC agenda items; the increasing level of competition among different radio services for limited resources; and the rapid rise of new technologies and services; a full four years are needed to complete the preparatory process.

The modern tradition in the ITU is that are made by consensus, rather than by voting. Achieving consensus increases the level of difficulty resolving the agenda items, but results in more durable international agreements. The duration of WRCs is four weeks and typically includes evening, weekend,

12 International Telecommunication Union, ITU Preparations for CPM 19-2, RA-19 and WRC-19, WRC-19-1WRSP Doc. 17/27, ITU, 2017, https://www.itu.int/dms_pub/itu-r/md/15/wrc19prepwork/c/R15-WRC19PREPWORK-C-0027!!PDF-E.pdf (accessed 24.09.20).

and inevitably, all- night sessions in order to achieve consensus – literally "consensus by exhaustion." One of the most challenging items of recent WRCs has been on agreeing on the draft agendas for the next Conferences. At their conclusion, WRCs adopt Final Acts which contain amendments to the Radio Regulations.

3. WRC-19: Space Law Created to Enable New Space Applications

Fig. 5. ITU's 2019 World Radiocommunication Conference in Sharm el-Sheikh, Egypt (ITU photo).

The ITU convened its most recent World Radio Conference in Sharm el-Sheikh, Egypt, from 28 October to 22 November (pictured in Fig. 6). With attendance by 3,420 delegates and 163 Member States, it was the largest WRC in history, attesting to the growing importance of telecommunications services to most countries, and access to space resources. WRC-19's agenda included 35 items covering a wide range of telecommunication and space-based services, in addition to proposing agendas for the next WRC, expected in 2023, and following WRC in 2027. Although the marquee topic was 5G spectrum, satellite and space agenda items proved to be major topics of this conference, including issues related to the rapid growth of satellite filings and proposed new space-based services.[13]

At WRC-19's conclusion, the Heads of Delegation signed Final Acts comprising 550 pages, including amendments to the Radio Regulations and proposed agendas for future conferences. They include measures to address emerging satellite services, such as a new regulatory approaches for managing megaconstellation filings; encouraging efficient use of spectrum and orbital resources by next generation satellite systems; and streamlining regulations

13 ITU Secretary General, Agenda of the Conference, WRC19/1, ITU, 2019 https://www.itu.int/dms_pub/itu-r/md/16/wrc19/c/R16-WRC19-C-0001!!MSW-E.docx (accessed 30.09.20).

for small satellites for short duration missions (such as cubesats).[14] These actions may be routine ITU accomplishments, but they are nevertheless notable as they are new space law responsive to new space developments – almost in real time. Moreover, with its adoption of a recommended agenda for WRC-23 to address additional space issues that are arising, such as enabling services between satellites in different orbits and consideration of a regulatory approach to facilitate introduction of sub-orbital vehicles; one can see how the way to new space law is being paved for adoption in the near future.[15]

The following sections discuss some of these highlights of WRC-19.

Fig.6. A rendering of the proposed OneWeb constellation. (OneWeb image).

3.1. A Regulatory Mechanism for Managing Large NGSO Satellite System Filings

Like others in the space community, the ITU is coping with adapting to the new reality being visited upon it by the rise of megaconstellations (such as the one portrayed in Fig. 7). How can it continue to ensure that spectrum and orbital resources are not being reserved without being put into use, thus potentially depriving others of access to these resources? How can it continue to operate within the Radio Regulations' tight timeframe for management of coordination process, including the publication of notices to inform Members States of filings that potentially impact their systems and the performance of required technical and regulatory examinations? How can it ensure that the Master Register continues to reflect real systems and actual use of recorded

14 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

15 ITU Council, Resolution 1399, Agenda of the World Radiocommunication Conference (WRC-23), Doc. C20/69, ITU, 2020, https://www.itu.int/md/S20-CL-C-0069/en (accessed 29.09.20).

frequency assignments and orbital locations? The Radio Regulations, and the resources of the ITU's Radiocommunication Bureau, were not designed to address systems of this immense size and complexity. Indeed, the Radio Regulations lacked any definition of the regulatory time period for NGSO satellite systems.

In 2015, the previous WRC contemplated the emerging challenge looming over the ITU's historic regulatory regime for managing orbital and spectrum resources from these proposed megaconstellations. The ITU Radiocommunication Bureau Director raised the issue in his Report to WRC-15 and compared it to the earlier crisis when the ITU was overwhelmed by a large influx of "paper" filings for GSO networks, many of which were submitted for speculative or anticompetitive reasons, making it impossible for the Bureau to timely process them and for the parties to complete coordination.[16] The ITU eventually tackled the issue through adoption of a range of regulatory, financial, and administrative measures which shortened the regulatory period for bringing satellite networks into use from nine to seven years; started charging cost recovery fees for processing satellite filings based on their size and complexity; and required submission of due diligence information about the networks in order to provide the Bureau and other parties data to assess the authenticity of the claims to the spectrum/orbital resources, which could be challenged by the Radiocommunication Bureau or by other Member States.[17]

The United Kingdom and the United States, the notifying administrations for the proposed OneWeb and Starlink systems, respectively, submitted proposals to WRC-15 proposing the adoption of new regulatory requirements for coordinating and managing these emerging large NGSO satellite systems. However, these proposals had been developed at the very end of the four-year preparatory cycle and thus had not had the opportunity to garner support from other nations or regional groups. Moreover, delegates were concerned that the complex endeavor of crafting wholesale new regulatory solutions could not be accomplished within the timeframe of WRC-15 itself. Thus, they agreed to postpone needed action until the next WRC in 2019. They would devote the intervening four years to working within the ITU-R's technical working groups to develop a regulatory solution that would be ready for approval by WRC-19 and that would address both

16 A.L. Allison, The ITU and Managing Satellite Orbital and Spectrum Resources in the 21st Century, Springer, Cham, 2014.

17 Director, Radiocommunication Bureau, Report of the Director on the Activities of the Radiocommunication Sector, Part 2, Doc. CMR15/4(Add.2)(Rev.1), ITU, 2015, https://www.itu.int/dms_pub/itu-r/md/15/wrc15/c/R15-WRC15-C-0004!A2-R1!MSW-E.docx (accessed 27.09.20).

the need for a definition of bringing into use of NGSO systems and the introduction of a milestone-based approach to the Radio Regulations.[18]

Bringing into Use. Under Article 11 of the Radio Regulations, in order to obtain international recognition of a frequency assignment to a space station of a satellite network, it must be "brought into use" by the expiry of the regulatory period of seven years. The Radio Regulations have long provided a definition of what this concept of "bringing into use" means, at least for GSO networks in No. 11.44B:

> A frequency assignment to a space station in the geostationary-satellite orbit shall be considered as having been brought into use when a space station in the geostationary-satellite orbit with the capability of transmitting or receiving that frequency assignment has been deployed and maintained at the notified orbital position for a continuous period of 90 days.[19]

The Radio Regulations lacked any definition for bringing into use the frequency assignments for the space stations comprising a NGSO system. In the absence of a regulatory provision, the Radiocommunication Bureau applied a provisional definition (a Rule of Procedure) based on the No. 11.44B to require the launch of a single satellite of an NGSO systems within seven years as the baseline requirement for bringing into use the frequency assignments to the NGSO system. However, the launch of a single satellite set too low a threshold to establish real progress on the implementation to merit regulatory protection for the whole system as described in its ITU filings. For example, the United Kingdom had proposed to WRC-15 that the required number of satellites for bringing into use an NGSO system should be based on a percentage of the total number of satellites comprising the system. This would more clearly indicate actual progress of the notified system and a fairer determination of actual use of the resources that had been reserved with the filing of the system with the ITU.[20]

During the preparations for WRC-19, the view emerged that:

> [I]t would be unrealistic to expect to have all the satellites of a system, in some cases consisting of hundreds or thousands of satellites, to be deployed within this seven-year regulatory period. Therefore, the BIU [bringing into use] of frequency assignments of non-GSO systems cannot always be considered as a confirmation of the full deployment of these systems, but

18 International Telecommunication Union, Minutes of the Seventh Plenary Meeting, CMR15/504, ITU, 2015, https://www.itu.int/md/R15-WRC15-C-0504/en (accessed 27.09.20).

19 International Telecommunication Union. Radio Regulations, ITU, Geneva, 2020, https://www.itu.int/pub/R-REG-RR/en (accessed 27.09.20).

20 United Kingdom of Great Britain, Northern Ireland, Proposals for the Work of the Conference (Agenda Item 9), CMR15/132(Add.23), ITU, 2015, https://www.itu.int/dms_pub/itu-r/md/15/wrc15/c/R15-WRC15-C-0132!A23!MSW-E.docx (accessed 29.09.20).

> instead may in some cases be just an indication of the commencement of deployment of satellites capable of using the frequency assignments.[21]

Instead of extending the bringing into use period for NGSO systems, an alternative approach was developed to gauge the implementation of these large systems beyond the seven-year regulatory period. Ultimately, WRC-19 decided to retain the bringing into use construct and to establish a clear definition in the Radio Regulations for its application to NGSO systems – new provision No. 11.44C – based on the launch of a single satellite operating within the orbital and frequency parameters of the system as described in the filing:

> A frequency assignment to a space station in a non-geostationary-satellite orbit network or system in the fixed-satellite service, the mobile-satellite service or the broadcasting-satellite service shall be considered as having been brought into use when a space station with the capability of transmitting or receiving that frequency assignment has been deployed and maintained on one of the notified orbital plane(s) [footnote omitted] of the non-geostationary satellite network or system for a continuous period of 90 days, irrespective of the notified number of orbital planes and satellites per orbital plane in the network or system. The notifying administration shall so inform the Bureau within 30 days from the end of the 90-day period [footnotes omitted] On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC subsequently.[22]

Of note is the new element in the provision on publication of the information on the ITU's website and regulatory publications to provide transparency and to ensure that others are able to monitor the implementation of the system.

Milestone-Based Process. In application of the Outer Space Treaty, the Radio Regulations require that satellite operators, even though they will provide services from outer space (beyond any country's jurisdiction) to the territories of multiple countries, must obtain a license from a single country to authorize operation of its space station or stations, in the case of a NGSO system. The licensing state will typically also serve as the operator's representative, or "notifying administration," to the ITU. The notifying administration represents the satellite operator in the ITU's processes, including submission of satellite filings such as coordination requests and notifications to the

21 International Telecommunication Union, Report of the Conference Preparatory Meeting to the World Radiocommunication Conference 2019, Doc. CMR-19/3, ITU, 2019, https://www.itu.int/dms_pub/itu-r/md/16/wrc19/c/R16-WRC19-C-0003!!MSW-E.docx] (accessed 28.09.20).

22 International Telecommunication Union. Radio Regulations, ITU, Geneva, 2020, https://www.itu.int/pub/R-REG-RR/en (accessed 27.09.20).

Radiocommunication Bureau culminating in the recording of the frequency assignment in the IITU's Master International Frequency Register.

Some national administrations that license commercial satellite operators have instituted various approaches into their domestic regulations to ensure that planned systems are actually implemented so that their promised services are provided to the nation and to prevent warehousing of spectrum and orbital resources. These approaches have included a milestone-based approach. For example, in the United States, the Federal Communications Commission (FCC) revised its milestone requirements for NGSO systems to extend the six-year period for launch and operation of a satellite network following the grant of the license. The FCC adopted a two-step milestone for NGSO systems requiring 50% of the constellation to be operational six years after grant of the license, and the remaining 50% completed by the end of the following three years.[23]

At WRC-19, following four years of preparatory studies, the Delegations agreed to a milestone-based approach that would allow NGSO systems to be fully implemented a number of years beyond the seven-year regulatory period with performance milestones comprising objective standards, including percentage of completion at set timeframes. Such process would serve to incentivize the notifying administrations to timely deploy their systems and services and "provide a balance between [*sic*] the prevention of spectrum warehousing, the proper functioning of the coordination mechanisms, and the operational requirements related to the deployment of the non-GSO system".[24] Moreover, this new approach would "help ensure that the Master Register reasonably reflects the actual deployment of such non-GSO satellite systems . . . and improve the efficient use of the orbital/spectrum resources".[25] In other words, this new milestone-based approach will promote more sustainable consumption of the spectrum/orbit resource.

23 Federal Communications Commission, Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters, 32 FCC Rcd 7809, FCC, 2017, https://ecfsapi.fcc.gov/file/0927000146342/FCC-17-122A1_Rcd.pdf] (accessed 28.09.20).

24 Secretary-General, Report on the Radiocommunication Assembly 2019 (RA-19) and the World Radiocommunication Conference 2019 (WRC-19), Doc. C20/27, ITU, 2020, https://www.itu.int/md/S20-CL-C-0027/en (accessed 28.09.20).

25 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

Table 1. Frequency allocations subject to the milestone based approach for non-geostationary satellite systems pursuant to WRC-19Resolution 35.[26]

	Space radiocommunication services		
Bands (GHz)	Region 1	Region 2	Region 3
10.70-11.70	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (space-to-Earth)	
11.70-12.50	FIXED-SATELLITE (space-to-Earth)		
12.50-12.70	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (space-to-Earth)	BROADCASTING-SATELLITE FIXED-SATELLITE (space-to-Earth)
12.70-12.75	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-Space)	FIXED-SATELLITE (Earth-to-space)	BROADCASTING-SATELLITE FIXED-SATELLITE (space-to-Earth)
12.75-13.25	FIXED-SATELLITE (Earth-to-space)		
13.75-14.50	FIXED-SATELLITE (Earth-to-space)		
17.30-17.70	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	None	FIXED-SATELLITE (Earth-to-space)
17.70-17.80	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (space-to-Earth)	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)
17.80-18.10	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)		

26 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

18.10-19.30	FIXED-SATELLITE (space-to-Earth)		
19.30-19.60	FIXED-SATELLITE (space-to-Earth) FIXED-SATELLITE (Earth-to-space)		
19.60-19.70	FIXED-SATELLITE (space-to-Earth) (Earth-to-space)		
19.70-20.10	FIXED-SATELLITE (space-to-Earth)	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)	FIXED-SATELLITE (space-to-Earth)
20.10-20.20	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)		
27.00-27.50		FIXED-SATELLITE (Earth-to-space)	
27.50-29.50	FIXED-SATELLITE (Earth-to-space)		
29.50-29.90	FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space)	FIXED-SATELLITE (Earth-to-space)
29.90-30.00	FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space)		
37.50-38.00	FIXED-SATELLITE (space-to-Earth)		
38.00-39.50	FIXED-SATELLITE (space-to-Earth)		

Although the overall concept of a milestone-based approach was readily agreed by WRC-19, achieving consensus on the myriad details proved to be tremendously difficult, including the percentages and timeline of the milestones; which satellite services and frequency bands they would be applied to; and transitional measures – their retroactive application to pending systems. However, all agreed that a solution could not be postponed until the next WRC in light of the continuing volume of large filings being received by the ITU. The agreement that was finally achieved is contained in new Resolution 35, "A milestone-based approach for the implementation of frequency assignments to space stations in a non-geostationary-orbit satellite system in specific bands and services" (Sharm El-Sheikh, 2019) and a new Radio Regulations provision (No. 11.51) that incorporates by reference the milestone resolution into the treaty. The new approach applies only to NGSO systems in the communications satellite services–FSS, Mobile-Satellite, and Broadcasting-Satellite Services in the most congested commercially used frequency bands: Ku, Ka, and V-Bands shown in Table 1.

Table 2. Deployment information required for the milestone process under WRC-19 Resolution 35.[27]

A. Satellite system information

1) Name of the satellite system
2) Name of the notifying administration
3) Country symbol
4) Reference to the advance publication information or the request for coordination, or the notification information, if available
5) Total number of space stations deployed into each notified orbital plane of the satellite system with the capability of transmitting or receiving the frequency assignments
6) Orbital plane number indicated in the latest notification information published in Part I-S of the BR IFIC for the frequency assignments into which each space station is deployed

B. Launch information to be provided for each deployed space station

1) Name of the launch vehicle provider
2) Name of the launch vehicle
3) Name and location of the launch facility
4) Launch date

C. Space station characteristics for each space station deployed

1) Frequency bands from the notification information that the space station can transmit or receive
2) Orbital characteristics of the space station (altitude of the apogee and perigee, inclination, and argument of the perigee
3) Name of the space station

The first step of the new milestone-based procedure occurs at the expiration of the seven-year bringing into use period. Notifying administrations of NGSO systems subject to the Resolution must submit deployment information to the ITU Radiocommunication Bureau, described in Table 2, within thirty days, including satellite system information, launch information,

27 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

and space station characteristics for each space station deployed. This information will be made available on the ITU's website and in the Bureau's regular regulatory publications.

Table 3: NGSO System Milestones.[28]

1st Milestone	7 + 2 years	10%
2nd Milestone	7 + 5 years	50%
3rd Milestone	7 + 7 years	100%

Assuming that the NGSO system is not 100% deployed, the following steps of the milestone process is shown above in Table 3. The first milestone applies two years after the seven-year regulatory period. The notifying administration submits information indicating that at least 10% of total number of satellites of the system have been deployed. Then the same process applies for the next two milestones: three years later, when the system should be at 50% deployment, and finally two years after that, when the system should be 100% complete. At each stage, the Radiocommunication Bureau will examine the information for milestone compliance and make an entry into the Master Register. Should an NGSO system fail to meet any of the milestones, the Bureau will apply a "deployment factor" to reduce the size of the constellation in the Master Register based on the milestone and the number of satellites deployed to date. For example, if the administration fails to meet the first milestone (10%), the constellation will be scaled to a number not greater than ten times the number of satellites then deployed, and further expansions of the system will not be considered as part of this assignment. At the second milestone (50%), the system would be scaled to two times the number of satellites deployed. And for the final milestone, the constellation will be recorded at the current number of satellites deployed.

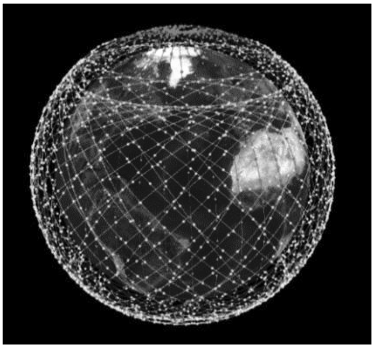
All of these provisions comprising the milestone approach, as well as special provisions for certain transitional cases, will be reviewed by the next WRC in 2023 based on the experiences gained over the intervening four years. Several open questions remain to be resolved, including the oversight of these constellations following the conclusion of the procedure; how the deployment information will be assessed; and how these systems will be coordinated among each other.

Finally, the ITU-R membership will need to conduct technical studies during the WRC-23 preparatory period on "the tolerances for certain orbital

28 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

characteristics of the [satellites covered by the milestone-based process] to account for potential differences between the notified and deployed orbital characteristics for the inclination of the orbital plane, the altitude of the apogee of the space station, the altitude of the perigee of the space station and the argument of the perigee of the orbital plane".[29] Besides evaluating the bringing into use and milestone compliance, this information has implications for space safety and the sustainability of the low Earth orbit.
These issues will likely make for a very intensive WRC-23 and preparatory period which is already under way. WRC-23 provides an opportunity to assess the new milestone-based procedure and to take further measures to achieve its goals.

Fig. 7. An illustration of one of the proposed V-Band NGSO systems in 2016. (Boeing image).



3.2. Next Generation Satellite Systems

Another example of the ITU's responsive action to create new space law to enable space development is WRC-19's actions to enable the next generation of satellite systems to operate in the 50/40 GHz bands, also referred to as the Q/V-band. These millimeter wave frequency ranges are the next global communications satellite allocation available to support the growth of communication satellites after saturation of the Ka-Band for GSO networks and the Ku/Ka-Band allocation that is prioritized for NGSO systems. Specifically, at issue are the FSS allocations in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz. The Radio Regulations lacked provisions for the implementation of satellite systems in this frequency range. Again, the development of technology and the interest by satellite operators to provide services from these higher frequency bands

29 International Telecommunication Union, Minutes of the Tenth Plenary Meeting, Doc. CMR15/571, ITU, 2019, https://www.itu.int/md/R16-WRC19-C-0571/en (accessed 28.09.20).

drove the ITU to develop space law to provide the framework to facilitate the development of these innovative space services. The ITU received satellite filings for many systems in this frequency range, such as the one depicted in Fig. 8.

In the Radio Regulations, FSS allocations generally permit either GSO or NGSO operations, absent a specification otherwise. However, Article 22 assigns regulatory priority to GSO networks in these cases. No. 22.2 mandates that NGSO systems shall not claim protection from GSO networks in the FSS and enumerates technical sharing provisions on how NGSO operations are to control their interference into GSO networks. However, Article 22's detailed technical provisions only address satellite operations below 30 GHz. These provisions were adopted by WRCs in 1997 and 2000 based on the proposed systems and technology of that era, including Teledesic.[30] That approach set a strict emission limit, an equivalent power flux density (EPFD), to limit the operation of NGSO systems to ensure protection of co-frequency GSO networks. As a result of a late-conference compromise, the limit was calculated based on the expected emissions of 3.5 homogeneous 20th century NGSO systems. The Conferences also took action to exempt a portion of FSS spectrum in the Ku and Ka-Bands from application of No. 22.2 and to prioritize it for development of NGSO-FSS systems. Although, none of those proposed systems materialized, today's emerging megaconstellations, including OneWeb, Starlink, and the proposed Amazon Kuiper system, directly benefit from these regulations made at the end of the last century.

As technology has continued to advance, such as phased array antennas, beam forming techniques, and digital processing capabilities, it is becoming technically and commercially feasible to utilize this higher band, millimeter wave spectrum to deliver satellite services. The physical properties of this spectrum range, though challenging, allow for delivery of high-speed, high capacity broadband services. Also appealing is the fact that this large spectral region was largely undeveloped, a veritable spectrum green field, although for these very same reasons, it is also targeted for development by terrestrial 5G services. The physical challenges of higher band spectrum, including greater attenuation from the atmosphere such as rain fade, also have the beneficial impact of lessening the interference impact on other systems. Thus, a strict application of the 1990s-era regulations to satellite operations in this higher frequency range would result in inefficient use of the spectrum and would unnecessarily constrain the design and number of systems and services that could be offered to all the world's inhabitants. WRC-19 included an agenda item dedicated to exploring new sharing approaches that would encourage

30 Inter-American Telecommunication Commission, Proposals for the Work of the Conference, Agenda Item 1.6, CMR19/11(Add.6), ITU, 2019, https://www.itu.int/dms_pub/itu-r/md/16/wrc19/c/R16-WRC19-C-0011!A6!MSW-E.docx (accessed 28.09.20).

innovative GSO and NGSO satellites to be implemented utilizing the V-Band and a needed update to the Radio Regulations.[31]
Although it turned out to be one of the most complex and contentious items of the Conference, WRC-19 was successful in adopting an entirely new sharing approach for satellite sharing in V-Band to allow for flexibility in system design for modern NGSO systems and more efficient use of the spectral and orbital resources. Instead of setting a fixed limit on the number of NGSO systems based on an outdated model, the new metrics will protect GSO networks based on the aggregate emissions of deployed NGSO systems based on their system characteristics. WRC-19 adopted new provisions for Article 22 based on a single-entry and aggregate short term and long term protection metric. These metrics will be based on actual systems and will be periodically reviewed by a consultation group that will track the aggregate contribution of operational NGSO systems. These new regulatory provisions are supplemented by new Resolutions, including Resolution 769, "Protection of geostationary fixed-satellite service, broadcasting-satellite service, and mobile-satellite service networks from the aggregate interference produced by multiple non-GSO FSS systems in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz" (Sharm el-Sheikh, 2019).[32]
Additional details on this new approach, including on the coordination of NGSO systems will need to be further developed by WRC-23. It is also expected that future conferences may wish to extend this sharing approach to the Ku and Ka-Bands in order to achieve further efficiencies and services.

Fig. 8. A small satellite with short duration Mission (Millennium Space Systems).

31 A.L. Allison, B.C. Chesley, Accommodating New Commercial Space Applications in the Global Legal/Regulatory Framework: An Evolutionary Approach to Launching the New Space Revolution, IAC-17-F1.2.8, 68th International Astronautical Congress, Adelaide, Australia, 2017, 25-29 September.

32 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

3.3. Small Satellites with Short Duration Missions

WRC-19 also acted to improve the ability of small satellites operators, including nanosats and picosats, to work within the ITUs processes to obtain assured access to LEO, another decision leading to the improved sustainability of the orbit. The ITU does not define satellites categories by size or mass, as these features are not part of the regulatory data that is provided to the Radiocommunication Bureau by notifying administrations. The data element that does distinguish them is the length of their missions, so small satellites are denoted as satellites having short-duration missions, which is defined as not exceeding three years. These small satellite operators include commercial entities, governments of newly space-faring nations; and educational and research institutions. Their purposes extend to a diversity of services, including remote sensing, space weather research, upper atmosphere research, astronomy, communications, technology demonstration, and education. An example is shown in Fig.9.

The ITU's procedures for managing the spectrum and orbital resources pertain to all satellites, be they large or small. But these procedures, with their seven-year timeframe, do not lend themselves well to short duration mission satellites which, by their very nature, have missions – and operational lifetimes -- far shorter than the ITU's procedural timeline. Thus, these satellites are often deployed outside the ITU's processes creating risk of harmful interference to other satellites.

In 2015, a group of nations from the Southern Africa Development Community (SADC), led by South Africa, proposed that the next WRC agenda include modifications to the existing regulatory procedures for notifying satellite networks to facilitate the deployment and operation of nanosatellites and picosatellites, taking into account their short development time, short mission time, and unique orbital characteristics.[33] Although this sensible proposal was not accepted as an item for the WRC-19 agenda, the Conference promised to consider the issue at WRC-19 under Agenda Item 7, its standing agenda item on improvement of the satellite procedures. Indeed, the Southern Africans, ultimately achieved progress on their goal at WRC-19 as they continued to drive the study of this topic during the four years of preparations within the ITU-R and obtained the support, or at least sympathetic understanding, from other nations.

As is often the case at the ITU, where the steady cadence of treaty conferences, supplemented by ongoing deliberations in regular technical preparatory meetings, enables serial consideration of emerging complex issues, often results in adoption of incremental measures that can be tried and tested and then improved at future conferences. Thus, the ITU's progress is

33 Angola, Botswana, Common Proposals for the Work of the Conference (Agenda Item 7), Doc. CMR15/130(Add.25)(Add.4), ITU, 2015, https://www.itu.int/dms_pub/itu-r/md/15/wrc15/c/R15-WRC15-C-0130!A25-A4!MSW-E.docx (accessed 29.09.20).

often evolutionary, rather than revolutionary, but nonetheless serves to enable the implementation of innovations in technologies and services, true to the Union's very purpose. In the case of small satellites with short-duration missions, WRC-19 adopted a Resolution providing limited relief in addition to tweaks to the Radio Regulations to tighten the procedural timeline applicable to everyone, and to modify the required data elements to accommodate small satellite operations.

Resolution 32, Regulatory procedures for frequency assignments to non-geostationary-satellite networks or systems identified as short-duration mission not subject to the application of Section II of Article 9 (Sharm el-Sheikh, 2019), applies to small satellite networks, or systems not exceeding ten satellites, whose mission do not exceed three years and do not operate in the services or allocations of the major commercial communications satellites.[34] The Resolution takes several small, but important steps to tailor the application and timing of the regulations for the benefit of these satellite operators. It establishes date of the launch of the first satellite as the date of being brought into use. It provides instructions to the Radiocommunication Bureau to take measures to expedite the processing of short-duration mission satellites; to post information as received on the ITU's website, and compressing certain procedural steps, and waiving others. Administrations are also encouraged to make every effort to accelerate their analysis of small satellite filings and to quickly resolve interference concerns. As is the case for all satellites, the Resolution reiterates that small satellites with short-duration missions must have the capability of ceasing transmissions immediately to eliminate harmful interference. WRC-19 also modified the Radio Regulations to shorten initial steps in the coordination process from nine months to six. Member States were not willing to shorten their response time, although a footnote was added to the provision to encourage them to respond as soon as possible. Additionally, the required data elements for satellite filings were modified to accommodate short-duration satellites.

Finally, the Resolution instructed the Director of the Radiocommunication Bureau to report to WRC-23 on the implementation of the Resolution. Although the Southern Africans received some initial improvements to the ITU's procedures for the benefit of small satellites with short duration missions, they may seek further improvements at future WRCs, either in response to the Director's Report to WRC-23, or under standing Agenda Item 7.

34 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

4. Look Ahead to the Next World Radio Conferences

In August 2020, the ITU approved the robust agenda that was proposed by WRC-19 for the next WRC in 2023 which comprises some 32 items, including several devoted to innovations in space services, including:

- Use of the frequency bands 17.7-18.6 GHz and 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) by NGSO FSS earth stations in motion;
- Inter-satellite service allocations in the frequency bands 11.7-12.7 GHz, 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz, including study of whether space-to-Earth direction transmissions from space stations in higher orbital altitudes (such as geostationary orbit) can be successfully received by lower orbital altitude NGSO satellites, without impacting other allocated services;
- Regulatory provisions to facilitate radiocommunications for sub-orbital vehicles;
- Accommodating use of GSO FSS networks by control and non-payload communications of unmanned aircraft systems.

WRC-19 also adopted a robust preliminary agenda for the following WRC in 2027 which included several items that were unable to be accommodated on the 2023 agenda, such as: developing the V-Band for aeronautical and maritime earth stations to communicate with GSO FSS space stations; development of the 71-76 GHz and 81-86 GHz frequency bands for satellite services; inter-satellite links for mobile-satellite services, and an additional allocation for worldwide narrowband mobile-satellite systems.[35] These preliminary agenda items will be considered by WRC-23 for the WRC-27 draft agenda.

Immediately following WRC-19, the ITU convened the initial Conference Preparatory Meeting (CPM) for WRC-23 to organize the ITU-R's preparations for the next two World Radio Conferences based on the proposed agendas.[36] The meeting allocated responsibility to the ITU-R Study Groups and Working Parties to lead or contribute to technical studies and regulatory solutions for each agenda item. These efforts will culminate in the preparation of the CPM Report to WRC-23 which will collect the results of the studies for each agenda item and recommended solutions, including examples of regulatory text. Ideally, this process distills the results of the

35 International Telecommunication Union, Final Acts of the World Radiocommunication Conference 2019, ITU, Geneva, 2019, https://www.itu.int/pub/R-ACT-WRC.14-2019/en (accessed 25.09.20).

36 ITU Radiocommunication Bureau, Results of the First Session of the Conference Preparatory Meeting for WRC-23 [CPM23-1], CA/251, ITU 2019, https://www.itu.int/dms_pub/itu-r/md/00/ca/cir/R00-CA-CIR-0251!!MSW-E.docx (accessed 29.09.20).

preparatory efforts and the regulatory solutions for each item into a single agreed approach, or a small number of alternative approaches. A second CPM is convened about six months before the WRC to review and approve the CPM Report, which then serves as a very useful resource to all participants, including the Member States who may not have fully participated in the preparatory activities for all of the agenda items.

In 2021, ITU-R preparations for WRC-23 are well underway, with meetings of the Study Groups and Working Parties being conducted virtually. Similarly, national and regional preparations are also taking place. The ITU's WRC activities to develop and evolve new provisions of space law in order to meet the demands of the march of technology and the need for services seem to be perpetual.

5. Conclusion

The ITU, through its quadrennial World Radiocommunication Conferences, is a reliable and effective inter-governmental institution that, in partnership with private sector experts, is facilitating innovation and the introduction of new space systems and space-based services to serve the planet, while making extensive efforts to balance the implementation of the these new systems with the need for sustainability of the limited spectrum and orbital resources that it manages for the benefit of mankind. The ITU creates relevant space law multiple times each decade as technology advances and provides a proven model for future efforts to forge global consensus to promote and manage space activities for the benefit of all.