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MAGAZINE

Celebrating the Radio Regulations

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ITU Radio Regulations – Now more important than ever

Houlin Zhao, ITU Secretary-General

"In an increasingly "wireless" world, the Radio Regulations enable all radio services to share the spectrum."

During this month of December we are celebrating the 110 years of existence of the ITU Radio Regulations – the essential international treaty governing the use of the radio-frequency spectrum and satellite orbits for ubiquitous wireless communications.

The ITU Radio Regulations ensure interference-free operations of radiocommunication systems and provide all countries with equitable access to the radio spectrum – a scarce natural resource that does not distinguish national borders and needs to be harmonized globally.

In an increasingly "wireless" world, the Radio Regulations enable all radio services to share the spectrum while satisfying their evolving requirements, protecting incumbents, and providing high-quality services to an increasingly growing number of users and applications.

Since the early 1900s, the management of the radio-frequency spectrum and the regulation of its use have been major functions of ITU. In their role as global spectrum coordinators, ITU Member States have developed, and are constantly updating, the Radio Regulations.

The first set of international regulations, drawn up in 1906, mainly concerned maritime radiotelegraphy. The 1906 Radiotelegraph Convention gathered 30 maritime States on 3 November 1906 in Berlin for the first International Radiotelegraph Conference, and adopted the "International Radiotelegraph Convention" establishing the principle of compulsory intercommunication between vessels at sea and in-land stations. The Annex to that Convention contained the first regulations governing wireless telegraphy.

RÉGLEMENT DE SERVICE,

ANNEXÉ A LA

CONVENTION RADIOTÉLÉGRAPHIQUE INTERNATIONALE.

Table des Matières.

The 1906 Radiotelegraph Convention gathered 30 maritime States

Germany, the United States of America, Argentina (Republic of), Austria, Hungary, Belgium, the United States of Brazil, Bulgaria, Chile, Denmark, Egypt, Spain, France, Great Britain, Greece, Italy, Japan, Mexico, Monaco, Montenegro, Norway, the Netherlands, Persia, Portugal, Romania, Russia, Siam, Sweden, Turkey, and Uruguay.

Today's Radio Regulations apply to some 40 different radiocommunication services around the world, and cover frequencies ranging from 9 kHz to 3000 GHz. They now include over 2000 pages specifying the governing principles, as well as the rights and obligations of ITU's 193 Member States in using spectrum and satellite orbit resources efficiently, and in a coordinated manner, so as not to cause harmful interference to each other.

Since 1906, 38 World Radiocommunication Conferences have revised the ITU Radio Regulations to respond to technological and social development. The 2016 version, which was adopted by the World Radiocommunication Conference 2015 (WRC-15), is now available **online**.

Over the last 110 years, the Radio Regulations have proven to be a perfectly suited instrument to govern the use of the frequency spectrum and satellite orbits, based on international cooperation and mutual understanding. With the growing complexity of our interconnected world and ubiquity of wireless systems, it is now more important than ever to maintain the pace and efficiency of radiocommunication conferences, to ensure the timely and responsive evolution of this precious instrument.

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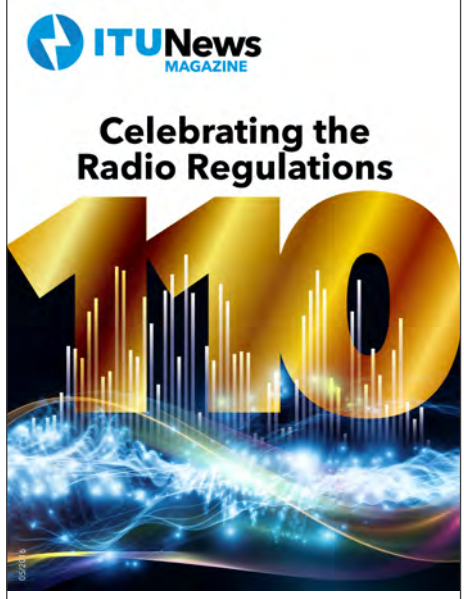
Celebrating the Radio Regulations



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(Development and application)

110 years of ITU radiocommunications

1906 First international radio conference

The 1906 **International Radiotelegraph Conference** is held in Berlin, establishing the first regulations governing radio (today called the Radio Regulations) – what becomes a cornerstone of ITU's mission to facilitate communication worldwide.

1912 Titanic tragedy prompts common wavelength for radio distress signals

In response to the Titanic tragedy, the **1912 International Radiotelegraph Conference** agrees on a common wavelength for ships' radio distress signals, and establishes **SOS Morse Code**.

1932 New name for ITU

A merge of the International Telegraph Convention and the International Radiotelegraph Convention into a single **International Telecommunication Convention** reflects ITU's mission to include all communication technologies.

1933 Radio signals from space

The detection of radio waves from space in 1933, heralds the field of radio astronomy, which later becomes part of ITU's responsibilities in supervising the use of radio spectrum. See the ITU Space Services Department (**SSD**).

1947 ITU joins the United Nations' family

Joining the **UN**, and the creation of the International Frequency Registration Board (**IFRB**) by the International Radio Conference in Atlanta City, marks the beginning of ITU's vital role in the overall management of the radio-frequency spectrum.

1957 Dawn of the space age

A small satellite called Sputnik is launched in 1957. Six years later, in 1963, ITU holds an extraordinary administrative conference for space communications. In 2016 ITU hosts the Global Conference on Space and the Information Society (**GLIS**).

1979 The need for upper frequency bands

Due to congestion in the lower radio frequency bands the World Administrative Radio Conference of 1979 (**WARC-79**), a diplomatic marathon lasting over three months, stimulates the development of the upper frequency bands, especially above 20 GHz.

1992 The ITU Radiocommunication Sector is born

The Consultative Committee on International Radio (CCIR), established in 1927, is renamed as ITU's Radiocommunication Sector (**ITU-R**). ITU-R ensures rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services.

1993 ITU responds to a wireless world

ITU first agrees radio-frequency spectrum allocations for 2G mobile telephony at the World Radiocommunication Conference held in 1993 (**WRC-93**).

1994 ITU approves first standard for digital audio broadcasting

Research into Digital Audio Broadcasting (DAB) for radio began in 1981 – and the first **standard** for the technology is approved by ITU in 1994. See the ITU's **Broadcasting Services Division**.

2006 From analogue to digital television

ITU sets a deadline of June 2015 for the switchover from analogue to digital terrestrial television in Africa, the Middle East and Europe as well as the Islamic Republic of Iran. **See video**.

2012 Towards IMT-Advanced mobile (5G)

ITU agrees specifications for **IMT-Advanced** – a global platform on which to build the next generation of interactive mobile services (commonly known as 5G). See ITU's **Focus Group on IMT-2020**.

2015 Radio spectrum allocated for global flight tracking

Following missing Malaysia airlines flight MH370, the World Radiocommunication Conference 2015 allocates the **frequency band 1087.7–1092.3 MHz** in the Earth-to-space direction to enable transmissions from aircraft to satellites, to increase future air safety.

In 2016, ITU celebrates 110 years of the Radio Regulations

See the entire **digital collection** of the Radio Regulations since 1906, and read more about the ITU Radiocommunication Sector (**ITU-R**).

ITU Radio Regulations – 110 years of success

François Rancy

Director, ITU Radiocommunication Bureau

Digital transformation has become the engine of world economic and social development, and radiocommunications are the vector by which most of this transformation is taking place. They contribute directly, or as enablers, to each and every one of the Sustainable Development goals adopted by the **United Nations** in 2015 as part of its **2030 Agenda for sustainable development**.

> ***"The Radio Regulations are the basis for a sustainable ecosystem which has flourished over the last 110 years and made radiocommunications a fundamental part of today's world."***
>
> François Rancy

Mobile and broadcasting networks, satellites, radio relays, radars, drones, short range devices such as Wi-Fi or Bluetooth are constantly providing us with a wealth of information, as well as applications, that we are using seamlessly without realizing that they all rely on one common and intangible resource: spectrum.

It took only a few years after the decisive experiments on wireless telegraphy by Alexander Popov (1895) and Guglielmo Marconi (1901) to agree on the need to globally manage this essential resource in a rational way and sign the first international treaty regulating its use, the International Radio Telegraph Convention (**1906**). The annex to this Convention contained the first regulations governing wireless telegraphy. These regulations have since been expanded and revised by numerous World Radio Conferences (**WRCs**), and are now known as the Radio Regulations.

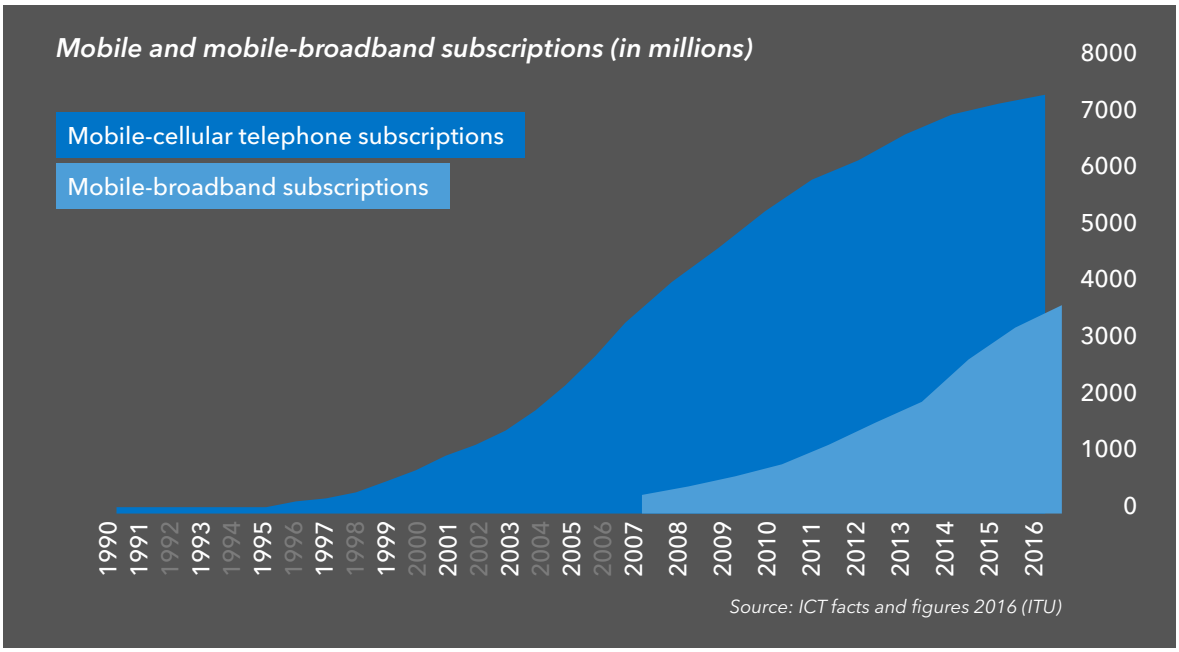
Source: Cardiff Council Flat Holm Project via Wikimedia Commons

British Post Office engineers inspect Marconi's wireless telegraphy equipment, during a demonstration on Flat Holm Island

Spectacular growth in the use of wireless communications

A hundred and ten years later, we keep witnessing spectacular growth in the use of wireless communications. Innovative technological solutions using radio transmission are laying the foundations for a truly wireless world. Radio has become pervasive in our lives, from personal devices such as mobile phones and radio-controlled watches, radio headsets, to equipment for home and office networking, radio positioning systems for navigation, intelligent transport systems, intelligent cities, broadcasting through radio and television, Earth imagery and meteorological satellites, and emergency communications and disaster warning systems.

One striking example in the wireless revolution is the astounding growth of mobile communications since the service was initially deployed. In 1990, there were only about 11 million mobile subscribers worldwide. This number increased to over 300 million by the end of 1998, and it has boomed to more than 7 billion today. We are now witnessing the full deployment of the third and fourth generation (3G and 4G) mobile broadband systems, based on ITU standards known as International Mobile Telecommunications **(IMT)-2000** and **IMT-Advanced** (see Figure).



Nearly 4 billion users are currently enjoying the benefits of IMT services, and the number is expected to rise to 6 billion by 2020, when large-scale development of the fifth generation (5G) will commence and accelerate the digital transformation by integrating the Internet of Things (IoT), and vertical activities like health, transportation and retail.

The ITU Radio Regulations and enabling mass-market applications

The framework for the development of 3G was established in 1992 at ITU's World Administrative Radio Conference (**WARC-92**), where, among other regulatory provisions, the radio-frequency spectrum bands were identified on a global basis for use by countries when deploying IMT systems.

WRC-2000 and **WRC-07** provided the framework for 4G by opening up the 1.8 GHz and 2.6 GHz bands and the "first digital dividend" bands respectively.

For 5G, WRC-15 opened up the "second digital dividend" bands and **WRC-19** is expected to open more spectrum in the bands above 24 GHz.

The Radio Regulations have also enabled the successful development of a number of mass-market applications, like short wave and FM sound radio, analogue and digital television broadcasting, Wi-Fi and Bluetooth, satellite positioning (e.g. GPS, Glonass, Galileo or Compass) and satellite television reception. Today, more than one billion people watch TV through digital terrestrial television broadcasting and a similar number through satellite dishes, in frequency bands which have been harmonized globally by the ITU Radio Regulations for many decades, since the corresponding technologies became available.

Less visible, but equally important, the Radio Regulations are the enabler of satellite imagery and Earth resource monitoring, space science and missions, meteorology, maritime and aeronautical transport and safety, civil protection and defence systems.

A few significant landmarks in the history of the ITU Radio Regulations

Below is an overview of the most significant decisions taken by ITU World Radiocommunication Conferences since 1903, and how the modifications they introduced to the Radio Regulations have enabled the sustained development of radiocommunications over the last 110 years.

Participants at the Preliminary Conference on Wireless Telegraphy (Berlin, 1903)

- **1903, Berlin**
  Preliminary Radio Conference in Berlin in 1903 with the aim of establishing international regulations for radiotelegraph communications.
- **1906, Berlin**
  The first International Radiotelegraph Conference was attended by representatives of 30 nations. It produced the International Radiotelegraph Convention with an annex containing the first regulations in this field and decided that the Bureau of ITU would act as the conference's central administrator, and the Radiotelegraph Section of the Bureau began operation on 1 May 1907.
- **1912, London**
  The second International Radiotelegraph Conference agreed on a common wavelength for ships' radio distress signals. Also, every ship was instructed to maintain radio silence at regular intervals, when operators should listen for distress calls.
- **1927, Washington**
  The conference allocated frequency bands from 10 kHz to 60 MHz to the various radio services (fixed, maritime and aeronautical mobile, broadcasting, amateur, and experimental) and established the International Radio Consultative Committee (CCIR). It also introduced a mandatory notification for stations capable of causing international interference.

- **1932, Madrid**
  The ITU Plenipotentiary Conference decided that a new name would be adopted to reflect the full range of ITU's responsibilities: **International Telecommunication Union**. The new name came into effect on 1 January 1934. The term "Radiotelegraph" was replaced by "Radiocommunications".
- **1947, Atlantic City**
  The ITU Plenipotentiary Conference voted for the ITU to become part of the UN family. The International Radio Conference, preceding this Plenipotentiary Conference created the ***International Frequency Registration Board (IFRB)*** to act as an administrative body to administer the Radio Regulations. The Conference also gave birth to the Master International Frequency Register and the relevant notification and registration procedures.
- **1959, Geneva**
  The Administrative Radio Conference further developed the Frequency Allocation Table, extending it to 40 GHz and introducing allocations to space research and radioastronomy services. It enhanced operational procedures for communications of stations in the maritime mobile and aeronautical services, particularly for distress and rescue operations.
- **1963, Geneva**
  The Extraordinary Administrative Radiocommunication Conference allocated frequency bands for space radiocommunication purposes.
- **1964, and 1966, Geneva**
  The Extraordinary Administrative Radiocommunication Conference held in two sessions in 1964 and 1966 adopted an allotment plan for the aeronautical mobile (R) service.
- **1967, Geneva**
  The World Administrative Radio Conference on the Maritime Mobile Service reviewed the parts of the Radio Regulations concerning maritime issues (about 3/4 of the Radio Regulations). It revised MF/HF/VHF channelling arrangements and introduced new types of communications such as selective calling; direct-printing telegraphy and data services to the Radio Regulations.
- **1971, Geneva**
  The World Administrative Radio Conference for Space Telecommunications, allocated most of the frequency bands which have since been used extensively by the broadcasting, fixed, mobile, meteorological and Earth-exploration satellite services in the L, C, X, Ku and Ka bands.
- **1979, Geneva**
  The World Administrative Radio Conference, Geneva, 1979 was one of the most significant conferences in ITU history. It revised the entire Radio Regulations and made many new allocations, including the 900 MHz band for the mobile (except aeronautical) service, 1.2 GHz band for the radionavigation-satellite service, the 2.4 GHz band for industrial, scientific and medical (ISM) purposes, paving the way for the development, many years later, of 2G mobile, GPS and WiFi. It also opened the higher frequency bands up to 400 GHz and consolidated the procedures and associated criteria.

- **1985, and 1988, Geneva**
  The two sessions of the World Administrative Radio Conference on the use of the geostationary-satellite orbit and the planning of space services established the plans for the fixed-satellite and the broadcasting-satellite services and associated feeder links (Appendices 30, 30A and 30B), consolidating the decisions taken by the Regional Administrative conferences for Regions 1 and 3 (1977, Geneva) and Region 2 (1983, Geneva).
- **1987, Geneva**
  The World Administrative Radio Conference for the mobile services allocated many frequency bands to the mobile service, paving the way for the development of this service in the 1800 MHz, 2 GHz and 2.6 GHz bands.
- **1992, Malaga Torremolinos**
  The World Administrative Radio Conference made a number of new allocations to the mobile-satellite service (for non-GSO satellites at 1.6, 2 and 2.6 GHz), the fixed-satellite service (13.75–14 GHz), the broadcasting-satellite service (sound and HDTV), the broadcasting service (sound) and the mobile service, identifying the 1.9/2.1 GHz band for IMT on a globally harmonized basis, paving the way for the successful development of 3G.
- **1992, Geneva**
  The Additional Plenipotentiary Conference restructured the ITU into three Sectors, with the ITU Radiocommunication Sector (ITU-R) resulting from the merging of CCIR and IFRB, and including the Radio Regulations Board (RRB) and the Radiocommunication Bureau (BR). It also established a regular cycle of conferences to rapidly respond to technological advances.
- **1995, and 1997, Geneva**
  WRC-95 and WRC-97 established the global framework for non-geostationary satellite networks on a shared basis with geostationary satellite networks. These decisions were further refined by WRC-2000 and WRC-03, and now represent a basic enabler for the development of new projects using more advanced space and launch technologies. WRC-97 also opened up the 47 GHz and 48 GHz bands for use by High Altitude Platforms Systems (HAPS) and introduced due diligence obligations in the use of orbit/spectrum resources.
- **2000, Istanbul**
  WRC-2000 finalized the work of simplification of the Radio Regulations by unifying the various procedures and incorporating by reference the ITU-R Recommendations of mandatory application. WRC-2000 also identified the 900 MHz, 1.8 GHz and 2.6 GHz bands for IMT and adopted regulatory conditions for the use of the 1.9/2.1 GHz bands by HAPS. It entirely reshuffled Appendices 30 and 30A for Region 1 to take into account the technological changes which had occurred since 1988. It also allocated the 1164–1300 MHz band to the radionavigation-satellite service, thereby enabling the development of competing commercial and government systems for global positioning worldwide.
- **2003, Geneva**
  WRC-03 opened up 545 MHz of spectrum in the 5 GHz band for RLANs, enabling the sustained development of Wi-Fi. It also relaxed the sharing conditions adopted in 1992 for the use of the 13.75–14 GHz band by the fixed-satellite service to take into account technological progress.

- **2007, Geneva**
  WRC-07 opened up to the mobile service the "first digital dividend" bands (700 MHz in Regions 2 and 3 and 800 MHz in Region 1) and identified them for IMT, as well as the 450–470 MHz and 2.3–2.4 GHz bands worldwide and the 3.4–3.6 GHz band in a number of Region 1 and 3 countries. It allocated an additional 400 MHz of bandwidth to the existing primary allocations for the Earth exploration satellite service, thus facilitating research and exploration of Earth resources and environmental elements. WRC-07 also revised the technical and regulatory provisions applicable to the fixed-satellite service for 1.6 GHz of spectrum in the C and Ku-bands subject to Appendix 30B, to take into account the technological changes which had occurred since 1988. Morse telegraphy, which was at the origin of radiocommunications, has been removed from the Radio Regulations.
- **2012, Geneva**
  WRC-12 allocated additional spectrum to the meteorological-satellite service and updated conditions for the development of passive sensors for ice cloud and precipitation measurements and for storm monitoring and climate studies. New frequencies were also allocated for the terrestrial component of Unmanned Aircraft Systems, HAPS gateways and space object detection. WRC-12 also adopted provisions to facilitate the operation of oceanographic radars and strengthened the regulations for due diligence in the use of orbit/spectrum resources.
- **2015, Geneva**
  WRC-15 opened up the "second digital dividend" band (700 MHz) to the mobile service (IMT) in Region 1, and in the 3.4–3.6 GHz band worldwide. It also made several allocations to the fixed-satellite service in the 13.4–13.65 GHz and 14.5–14.8 GHz bands to balance the uplink and downlink bands in the three Regions. In response to an urgent requirement from international civil aviation, WRC-15 also opened up the 1087.7–1092.3 MHz band for reception of ADS-B signals from aircraft by space stations, thereby enabling global flight tracking. WRC-15 also allocated the 78 GHz frequency band to radiolocation, thus providing a globally harmonized basis for automotive radar to prevent collisions. The band 4200–4400 MHz was allocated for Wireless Avionics Intra-Communications systems (WAIC) for future replacement of cables in aircraft.

The World Radiocommunication Conference process

From the beginning, the WRC process has been one of constant improvement over the years to adjust the international regulatory framework to new technologies as they develop and enable new uses, as these new uses modify spectrum requirements.

In order to function properly, all radiocommunication systems make use of specific radio frequencies, taking advantage of their different propagation characteristics. However, these are ruled by the laws of physics, not by national borders. Consequently, as radio technology developed, the international community established a global regulatory framework, the Radio Regulations, in order to ensure harmonized use of spectrum and prevent radio interference[1]. Complying with this framework is an essential task for ITU Member State administrations to ensure their services obtain international recognition and are compatible with the services of other ITU Member State administrations.

Article 5 and the Table of Frequency Allocations

The main part of the Radio Regulations lies in its Article 5, the Table of Frequency Allocations, which specifies which radiocommunication services may be used in which part of the spectrum.

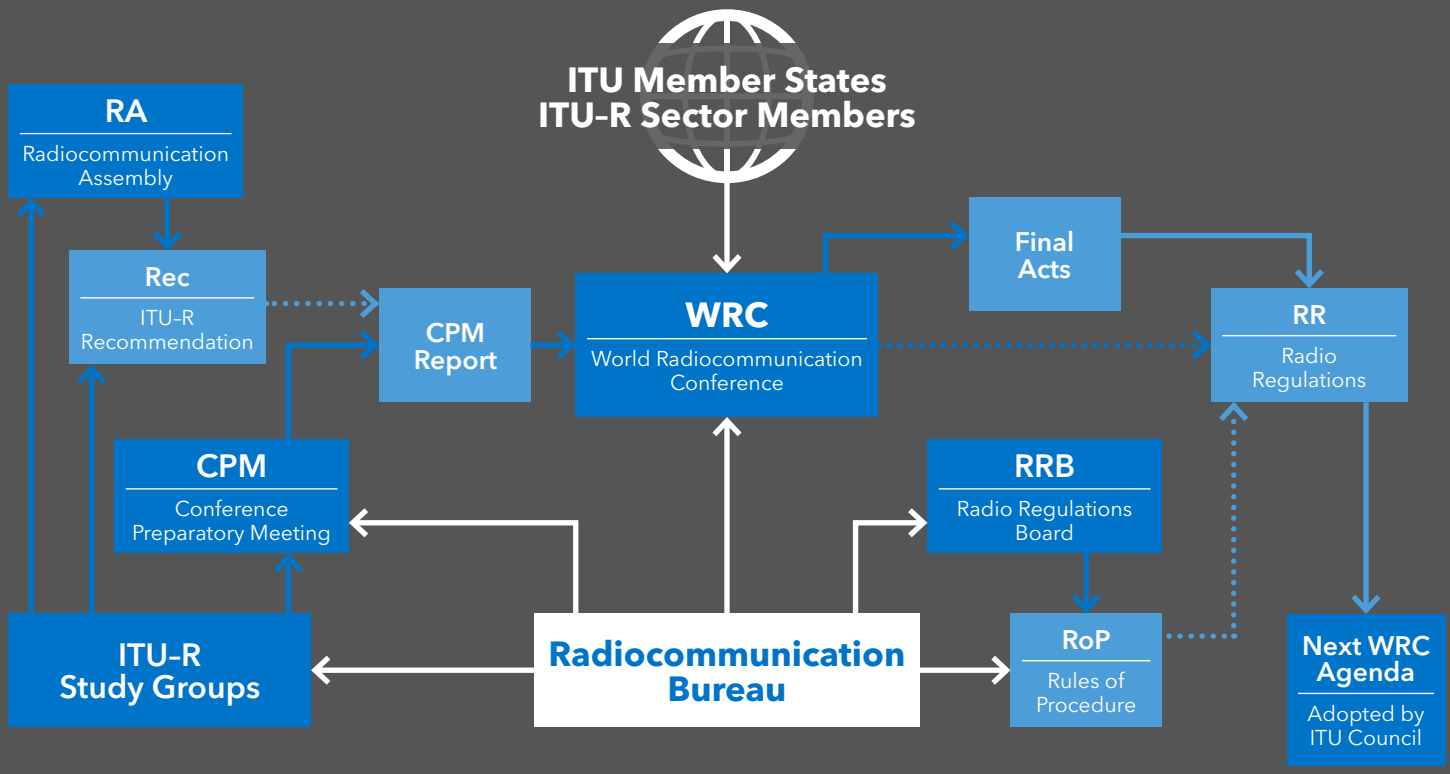
These allocations are made in order to ensure that the services allocated in any particular frequency band can be used by various countries in an equitable manner without harmful interference through regulatory procedures and associated technical criteria. These are described in other Articles of the RR, in its Appendices, in the Resolutions and Recommendations adopted by WRCs and in the ITU-R Recommendations of mandatory application. The **Radio Regulations** are publicly available free of charge.

Article 5 frequency allocations provide a high degree of spectrum harmonization within and between Regions. This is complemented by spectrum identifications, which are not mandatory in nature, but are rapidly adopted by most countries in order to benefit from the economies of scale provided by the worldwide market. This is the case in particular, for identifications for IMT, which enabled the harmonized development of 3G and 4G broadband mobile networks and are expected to play the same role for 5G.

Since 1979, in view of the enormous demand for spectrum, the Radio Regulations have been revised and updated regularly, in order to keep pace with the rapid expansion of existing systems and new, spectrum-hungry advanced wireless technologies. The ITU World Radiocommunication Conferences are at the heart of this updating process (see Figure).

1 Pursuant to its Constitution, the ITU is responsible for the allocation of spectrum and registration of frequency assignments, and of orbital positions and other parameters of satellites in order to avoid harmful interference between radio stations of different countries.

The World Radiocommunication Conference process



ITU-R: ITU Radiocommunication Sector

The modifications of the RR adopted by a WRC are contained in its Final Acts, which also include a draft Agenda for the following WRC, which is formally adopted by the ITU Council. The WRC process is therefore a permanent process, which is fed by:

- The studies carried out by ITU-R Study Groups, opened to all stakeholders, which address the technical, economic, regulatory and operational aspects of the issues included in the WRC Agenda. The results of these studies are included in ITU-R Recommendations and Reports, which are summarized in the Report of the Conference Preparatory Meeting (CPM) and are not binding in nature.
- The CPM Report, which is adopted six months before the conference, and forms the basis of the proposals to be made by Member States to the WRC.
- The Radio Regulations Board (RRB), composed of twelve elected members from all regions, which adopts the Rules of Procedure, the complement of the RR in its application, and acts as a referee in conflicts arising from the application of the RR.
- The Radiocommunication Bureau (BR), which administers the application of the RR and provides support to the whole process.

The importance of consensus building

Throughout this process, consensus is the constant practice, in order to ensure that decisions, whether binding or not, will be implemented worldwide, thus reinforcing harmonization. It also ensures that decisions will not lead to disruption to already deployed networks and services. The Radio Regulations are an international treaty, and the WRCs, which modify them, are treaty-making conferences.

Decision by consensus is the guarantee that this treaty as it evolves, will continue to be reflected in national legislation, and enforced by national governments, as they sign the Final Acts of WRCs. At WRC-15, 150 Member States present signed the Final Acts at the end of the Conference.

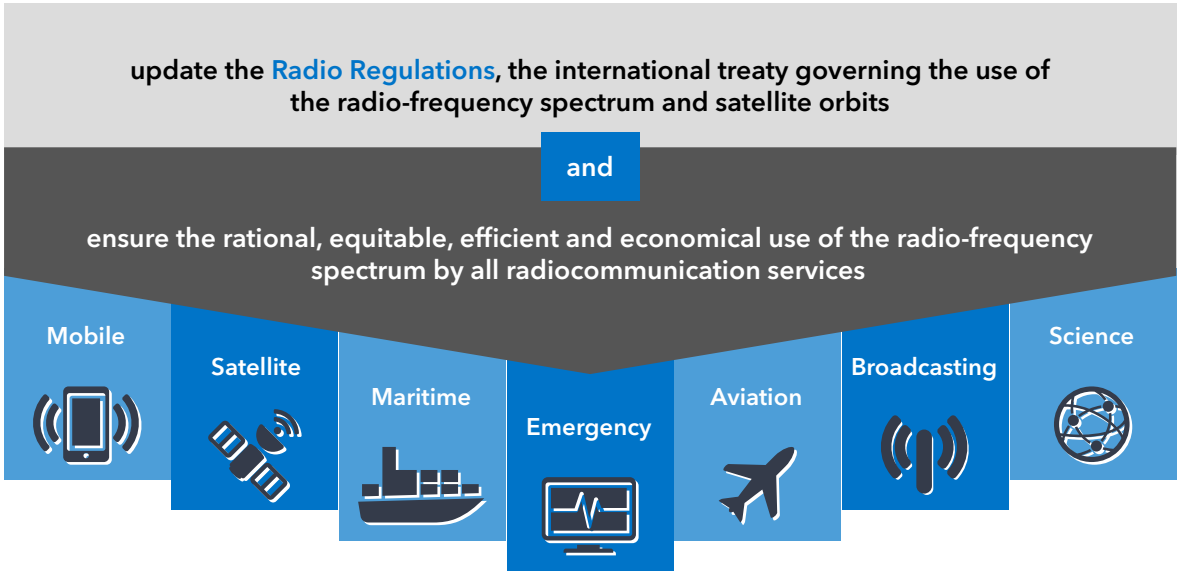
Building this consensus is a key requirement of the four-year preparation cycle of WRCs. This is achieved through the leadership of six regional groups which regularly convene regional preparatory meetings and develop common proposals to the conference, and by informal inter-regional coordination meetings, in addition to and in support of the preparatory process carried out in the ITU-R Study Groups and CPM.

On this foundation, careful technical, operational and regulatory studies ensure that the modifications to the Radio Regulations, introduced by WRCs, respond to rapid technological and social evolution, keep harmful interference within manageable limits under all circumstances, and maintain the right balance between the protection of incumbents and the satisfaction of emerging needs.

Thanks to this process, which has been constantly improved over the years and has now become permanent, the preparation of the next WRC starting as soon as the previous one has ended, the Radio Regulations deliver a stable and predictable global framework which ensures long-term protection of the investments of a multi-trillion dollar industry, through the universal commitment of governments and all other stakeholders. The Radio Regulations are the basis for a sustainable ecosystem which has flourished over the last 110 years and have made radiocommunications a fundamental part of today's world.

Participants at the World Radiocommunication Conference 2015 in Geneva (WRC-15)

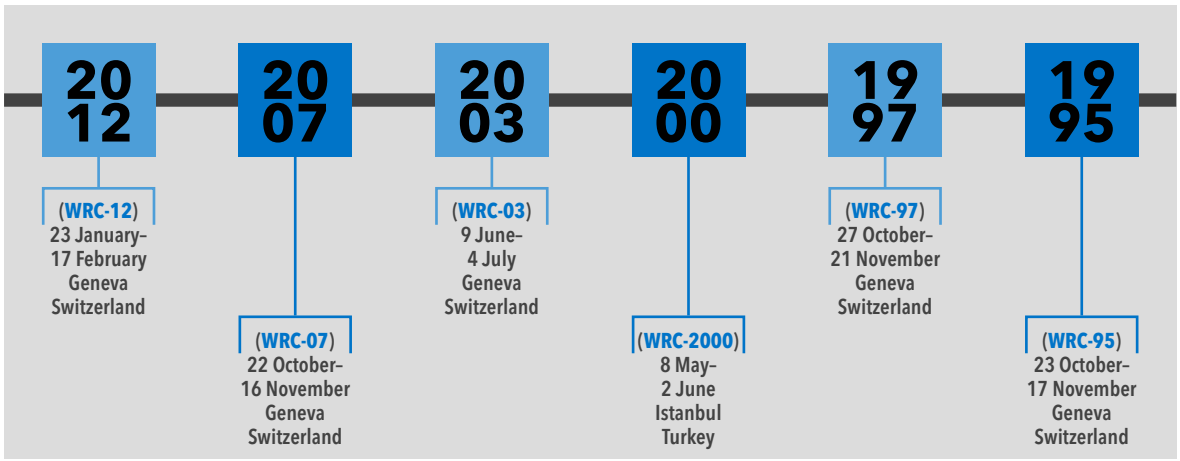
ITU World Radiocommunication Conferences (WRCs)



Past ITU World Radiocommunication Conferences

2015
(WRC-15)
2–27 November
Geneva, Switzerland

Over **3250 participants** attended WRC-15
from **163 ITU Member States** and
131 Observer organizations



Source: ITU Radiocommunication Sector

The next ITU World Radiocommunication Conference will be held in 2019 (WRC-19)

Radio Regulations: The foundation of the mobile world

Mats Granryd

Director General, **GSMA**

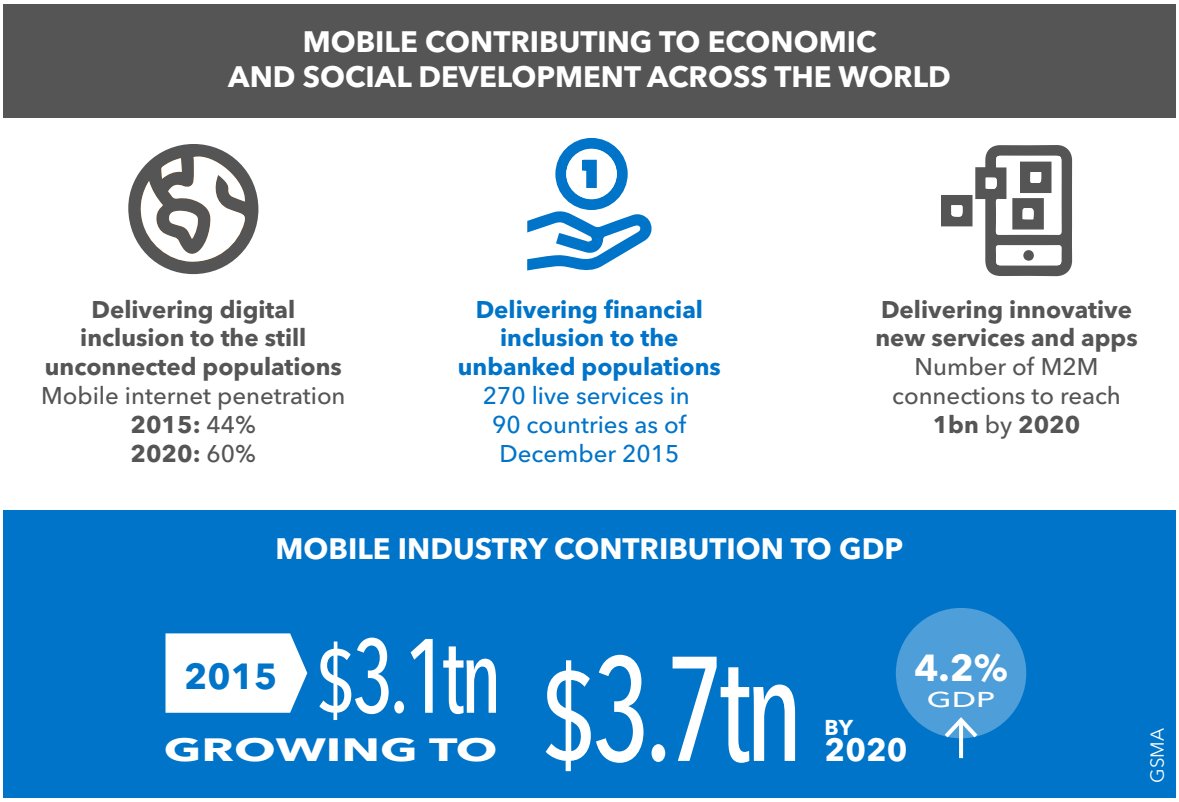

GSMA

Mobile networks have become an intrinsic part of our everyday lives. They help us keep in touch with friends and family, stay on top of work, monitor our health, manage our homes and businesses, conduct financial transactions, and so much more. It is nearly impossible to envision our lives without mobile.

> ***"The delegates sitting in Berlin in 1906 to negotiate the first Radio Regulations governing wireless telegraphy surely had no idea what they were starting."***
>
> Mats Granryd

The ITU **Radio Regulations** form the core of the international framework for management of the radio frequency spectrum, affording protection for existing radio services while enabling the introduction of new and enhanced services. The delegates sitting in Berlin in 1906 to negotiate the first Radio Regulations governing wireless telegraphy surely had no idea what they were starting. Then, it would have seemed far-fetched to think that 4.8 billion people would today be connected to each other through globally interoperable mobile networks.

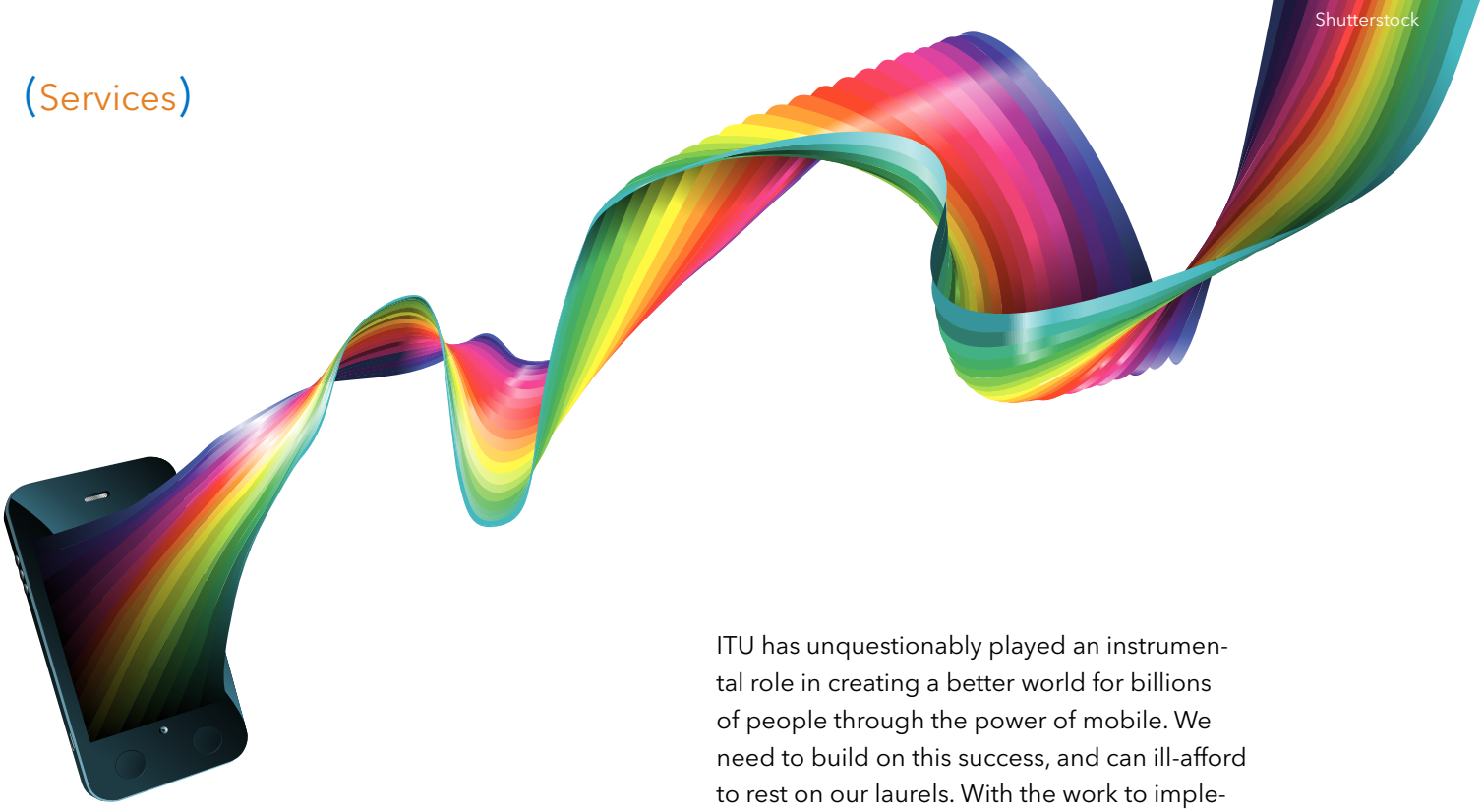
Mobile networks are increasingly critical to national prosperity. In 2015, the mobile industry generated USD 3.1 trillion, or 4.2 per cent of global GDP, and contributed USD 430 billion to public funding. This growth would never have been possible without the harmonization of mobile spectrum through ITU.



The importance of spectrum harmonization

Spectrum harmonization has created economies of scale, which in turn have made mobile services and handsets more affordable. Starting with the 900 MHz band in 1979, the Radio Regulations have laid the foundation for the high-speed mobile broadband networks we rely on every day. This was followed by the 1.8 GHz band in 1987, the 2 GHz band in 1992, the 2.6 GHz band in 2003 and the 700/800 MHz bands in 2007 and 2012, which permitted the development of 3G and 4G networks in a globally harmonized way.

Mobile has already had a truly transformative impact on the lives of people around the world, and mobile operators and governments need to continue working together to ensure mobile's full potential is realized. This will be critical to meeting the targets of the United Nations Sustainable Development Goals (**SDGs**), as mobile networks have the power to accelerate the achievement of the SDGs in a way no other technology can.



Shutterstock

It's not just about connectivity – it's what this connectivity enables. For example, mobile operators are already delivering financial services to more than 400 million unbanked people in over 90 countries around the world, and with the right environment, will extend this even further. Mobile is also helping to reduce the **mobile gender gap**, connecting women in developing markets to life-enhancing services, particularly mobile Internet and mobile money.

The need for improved mobile network coverage

A key enabler for success will be the timely release by governments of more of the harmonized spectrum identified through the ITU process. In particular, the digital dividend spectrum and, in the future, more frequencies below 700 MHz need to be made affordably available to support improved mobile network coverage. Governments should resist the growing trend to artificially inflate the prices for spectrum access as we work together to reach the many people who still don't have access to the Internet.

ITU has unquestionably played an instrumental role in creating a better world for billions of people through the power of mobile. We need to build on this success, and can ill-afford to rest on our laurels. With the work to implement the **results of WRC-15** ongoing, and the **work toward WRC-19** ramping up, we need to remember that the ability of hundreds of millions of people to get connected for the first time depends on what happens next.

Updating the Radio Regulations to reflect the changing demand for use of the spectrum is vital. Mobile operators need timely access to the right amount and type of spectrum under the right conditions in every market. Speed, coverage and quality will be heavily dependent on this. As we move to next generation networks, we cannot lose of sight of the value of harmonization as we work toward a common, harmonized set of spectrum bands to support **5G**.

Mobile operators, governments and the ITU need to work hand-in-hand to connect everyone and everything to a better future. And let's do it with the same spirit of inventiveness and collaboration that got us started **110 years ago**.

The Radio Regulations and satellite telecommunications

Aarti Holla

Secretary General, EMEA Satellite Operators Association (**ESOA**)


ESOA

The ITU Radio Regulations, with their unique structure and role, have been instrumental in the success of the satellite telecommunication industry since its inception.

> ***"Global respect for the Radio Regulations ensures regulatory stability, vital to attract high up-front investment which the satellite industry requires."***
>
> Aarti Holla

Satellites are international by nature, and while each State remains sovereign in using radio spectrum, radio waves do not themselves respect borders.

Global respect for the **Radio Regulations** ensures regulatory stability, vital to attract high up-front investment which the satellite industry requires, the return on which is seen only over the long operational lifetime of a satellite venture.

But the administration-driven, consensus-based approach of the ITU goes further, providing ever-increasing relevance for the Radio Regulations in today's rapidly changing telecommunication environment: the Radio Regulations effectively become the arbitrator for the use of spectrum for the overall good of global society, avoiding decisions based solely on the economic considerations of any one industry or the needs of any one world region.

The radiotelecommunication industry as a whole sees incredible change, what would have been pure science fiction 15 years ago is now taken for granted, with further advances always being just over the horizon.

Consensus in frequency use

While these advances seem to provide unlimited opportunity for connecting the world in faster and more effective ways, policymaking needs to take account of all world regions, since important economic, social or geographic differences require different technological solutions to address the needs of the population.

Within the satellite industry, we have recently seen the effectiveness of the Radio Regulations in the context of the debate on the use of the **C-band spectrum**.

With their resistance to rain fade under even the most challenging climatic conditions, satellite services in the C-band are recognized for their ability to provide a wide range of critical and irreplaceable telecommunication services in many parts of the world. But the C-band was also being targeted by the mobile terrestrial industry to help to fill their increasing capacity needs.

Thanks to thorough and open debate at the ITU Member State level, consensus was found on how to best use these frequencies to address the planet's telecommunication needs as a whole. While a portion of the C-band was made available for International Mobile Telecommunications (IMT) services, the revised Radio Regulations following **WRC-15** found consensus for a regulatory environment which ensures current and future investment in C-band satellite infrastructure in the regions of the planet where it is of critical importance.

Looking forward, we now see a similar debate in the international community for higher (Ka, Q and V) frequency bands. The satellite industry has made substantial current and planned investment into the Ka-band, for the development of next-generation high-throughput satellites – key to providing more capacity to connect the planet in today's information society. In this respect, the ITU process at WRC-15 found consensus to not study the satellite Ka-band for future identification for IMT, so preserving the balance of telecommunication connectivity solutions.

The ITU mechanisms and the Radio Regulations have served the wireless communication industries well in balancing the world's connectivity needs and bridging digital divides.

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> ***ITU must be praised for its ability to find consensus on the way forward against the backdrop of the fastest-changing technology in history.***
>
> Aarti Holla

Considering all countries and industries

The ITU has a unique, carefully balanced democratic process, which respects the interests of all countries and industries worldwide, not just the desires of a few. While some individual desires might not be fully satisfied – the world is better served overall. ITU must be praised for its ability to find consensus on the way forward against the backdrop of the fastest-changing technology in history.

In today's rapidly evolving telecommunications world, with the increasing pressures on spectrum and sharing, it is only by maintaining, not diminishing, the relevance of the ITU and its Radio Regulations that that we can assure a global use of spectrum which benefits all tele-communications industries and regions of the world.

The Radio Regulations and maritime communications

Kitack Lim

Secretary-General, International Maritime Organization (**IMO**)


IMO

The first recorded rescue at sea arising from a distress message sent by radio took place in 1899, when the Goodwin Sands lightship in the Dover Strait, United Kingdom, was able to alert coastal authorities to launch a lifeboat to rescue the crew of the German ship Elbe, which had run aground.

> ***"The first Radio Regulations, adopted in 1906, established "SOS" as the ubiquitous "mayday" international maritime distress call."***
>
> Kitack Lim

Since then, shipping has benefitted from the developments in terrestrial radiocommunications and, later, satellite communications, for maritime distress and safety communications and the wider development of ship-to-ship and ship-to-shore general communications.

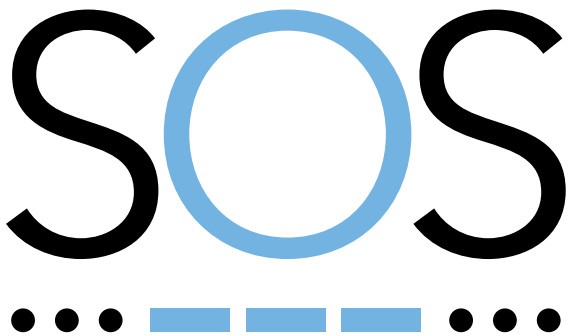
On numerous occasions, maritime radiocommunications have helped rescue people at sea, through distress alerting, locating and search and rescue. The use of discrete frequencies and strict operational procedures, as stipulated in the Radio Regulations, have saved many lives. Radiocommunications further provide for social communication between crews and passengers at sea and their friends and families ashore.

The remarkable development in radiocommunications has gone hand-in-hand with the need for international regulation to ensure interference-free use of frequencies for different services, access for all, and protection of specific frequencies available for distress and safety.

Early days dedicated to maritime mobile

The first Radio Regulations, adopted in 1906, established "SOS" as the ubiquitous "mayday" international maritime distress call. But the Titanic disaster in April 1912 illustrated the need for improvement and a few months later, the **1912 International Radiotelegraph Conference**, held in London, agreed on a common frequency for ships' radio distress signals. Also, every ship was instructed to maintain radio silence at regular intervals, when operators should listen for distress calls.

In this context, it is worth noting that the first three ITU Radio Conferences in **1903**, **1906** and **1912** were dedicated to the maritime mobile service.



The basis for safety of life at sea

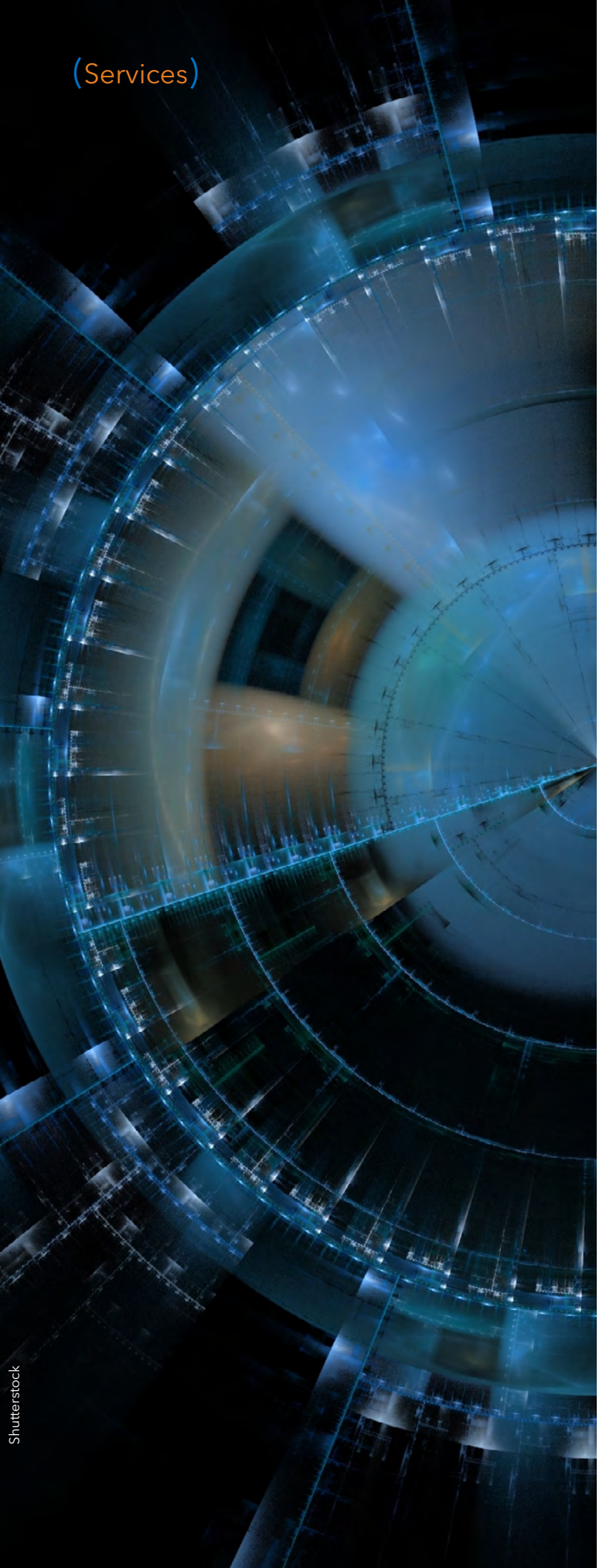
Two years later, in 1914, a maritime conference in London adopted the first International Convention for the Safety of Life at Sea (**SOLAS**), which included chapters on radiotelegraphy, life saving and fire protection, navigation and construction. This formed the basis for the current, much expanded SOLAS Convention in force today.

By the time the International Maritime Organization (**IMO**) was established as the United Nations (**UN**) specialized agency for shipping matters, by means of a convention adopted in 1948, and the ITU had been recognized as the UN specialized agency for telecommunications in 1947, the cooperation between the two had been cemented.

The development of maritime radiocommunications clearly needs to take into account the operational needs, as defined by IMO, and the regulatory needs, as defined by ITU.

Satellite communications for maritime

In the 1960s, IMO began to study the operational requirements for a satellite communications system devoted to maritime purposes. **INMARSAT** was thus established under the auspices of IMO in 1979 to provide maritime satellite communications, and further work led eventually to the establishment and adoption of the comprehensive Global Maritime Distress and Safety System (**GMDSS**). At each step, cooperation with ITU was crucial.



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ITU established the appropriate regulatory framework for the implementation of the GMDSS through the **1983** and **1987** World Administrative Radio Conferences for the Mobile Services (WARC-MOB-83 and -87) which adopted amendments to the Radio Regulations prescribing frequencies, operational procedures and radio personnel for the GMDSS. The GMDSS became fully operational in 1999.

Modernizing the Global Maritime Distress and Safety System

Today, IMO is working on the modernization of the GMDSS and the implementation of e-navigation, with important liaison work with ITU through the Joint IMO/ITU Experts Group on Maritime Radiocommunication Matters.

Against a background of continuous growth in demand for spectrum from almost all radiocommunication sectors, and new challenges such as cybersecurity for shipping, IMO has a clear interest in safeguarding the use of spectrum allocated for use by maritime services and in continuing its close collaboration with ITU.

I congratulate ITU as it celebrates 110 years of the Radio Regulations and look forward to further work together as the world of communications moves inexorably with both the opportunities and challenges this will present.

Aviation and ITU: Celebrating 110 years of dynamic partnership

Dr Fang Liu

Secretary General, International Civil Aviation Organization (**ICAO**)


ICAO

In 1906, when the first regulations governing wireless telegraphy were established, aviation, like radiocommunications, was still in its infancy.

Around the world, inventors, pioneers and dreamers were busy developing flying machines of all shapes and configurations, progressing from balloons and gliders to eventually achieve powered, heavier-than-air manned flight.

Air transport's role in fostering peace and prosperity

Today, air transport plays a major role in fostering peace and prosperity worldwide by providing uniquely, safe, secure and rapid global connectivity for both citizens and businesses alike. And its role in supporting wide-ranging objectives for social and economic development globally is becoming more and more appreciated, with 13 of the **17 Sustainable Development Goals** under the United Nations' **2030 Agenda** being directly supported by international civil aviation.

> ***"The Radio Regulations, thanks to the efforts of the ITU and of the radio regulatory community, have consistently accommodated the needs of aviation."***
>
> Dr Fang Liu

ICAO

Air travel set to double by 2030

Over 100 000 aircraft now take off and land in aviation's global network, each and every day, carrying many tonnes of freight and more than 10 million passengers to their worldwide destinations.

By 2030, current forecasts indicate these numbers will double as aviation continues to provide its invaluable benefits to societies and economies wherever aircraft fly.

This amazing growth has been predicated on ever increasing levels of aviation safety and efficiency, two of our sector's most enduring legacies.

The role of the Radio Regulations in air transport achievements

The ITU **Radio Regulations** and the associated international regulatory framework have played a very significant role in these achievements, with the safety of air operations being strongly dependent on the availability of sufficient and suitably protected radio spectrum.

This is nothing short of essential to support the high integrity and availability requirements of aeronautical radio systems utilized for communications, navigation and surveillance (CNS).

By recognizing the critical safety aspects of CNS radiocommunications, the Radio Regulations effectively accord them a special level of treatment and protection at the international level.

They also complement and support the International Civil Aviation Authority (ICAO) regulatory provisions embodied in our Standards and Recommended Practices (SARPs) for CNS systems, as contained in Annex 10 to the *Convention on International Civil Aviation*.

The Radio Regulations have also evolved very dynamically within the general telecommunications environment, with its many and diverse frequency spectrum users. In contrast, ICAO's SARPs respond to the operational safety aspects of air navigation, and are developed and agreed by the aviation community through ICAO. Jointly, these two sets of regulatory provisions constitute an effective and proven framework in which modern aviation CNS technology can be evolved and refined.

As innovative aviation applications are introduced, the Radio Regulations, thanks to the efforts of the ITU and of the radio regulatory community, have consistently accommodated the needs of aviation. This clearly demonstrates that, even at 110 years of age, the Radio Regulations remain a very flexible set of instruments uniquely suited to the development and optimization of modern radiocommunications for a diverse range of users.

WRC-15 allocates spectrum for aircraft flight tracking and remotely piloted aircraft

Two recent and prominent examples of the ITU community's responsiveness to aviation's needs occurred at last year's World Radiocommunication Conference (**WRC-15**). The first was the agreement on a new frequency allocation for space based reception of Automatic Dependent Surveillance – Broadcast (ADS-B) transmissions from aircraft, which enables the tracking of aircraft globally. This achievement was the culmination of an intensively cooperative process between the ITU and ICAO, and delivered a comprehensive and effective response, achieved in record time.

The second example involved Remotely Piloted Aircraft Systems (RPAS), another technology with great potential for innovative civil aviation applications. Here WRC-15 agreed regulatory spectrum provisions related to the use of fixed satellite service (FSS) spectrum for command and control links for remotely piloted aircraft.

WRC-19 to address spectrum needs for Global Aeronautical Distress and Safety System

Looking ahead, **WRC-19** will address spectrum needs and regulatory provisions for the introduction and use of the new ICAO Global Aeronautical Distress and Safety System (GADSS). It will also address stations on-board sub-orbital vehicles, a technology that has been discussed at a conceptual level for some time and which is now close to becoming a reality.

Relying on a long-standing partnership

In facing these future technology challenges, as we have for the last **110 years**, the aviation community will be able to rely on its long-standing partnership with the ITU to ensure that the Radio Regulations maintain their global role in guiding and supporting aviation and other communications innovations for the benefit of us all.

Radio Regulations – the lifeblood of broadcasters

Simon Fell

Director of Technology and Innovation, European Broadcasting Union (**EBU**)


EBU

ITU and the EBU can genuinely be called "brothers in spectrum planning". In the early 1920s the ITU was ably managing spectrum use for radio telegraphy. But radio broadcasting in the medium wave band was beginning to explode in Europe and elsewhere.

For radio listeners the situation was chaotic. The use of spectrum by different nations was a "free for all". After sunset, medium waves can be carried for great distances. A listener in France might be listening contentedly to a serious music concert from a French broadcaster, only to be interrupted at the crescendo by a voice cutting in from the BBC's Uncle Arthur and his "Hello Children" show. Quelle horreur!

Removing chaos with an MF frequency plan for Europe

The **BBC** in the UK had been established in 1922, led by an engineer called John Reith, and he was well aware of the situation. He drove forward the idea that broadcasters should get together and create a body to draw up an MF frequency plan for Europe that would remove the chaos.

> ***"Without ITU doing the job of creating agreement between nations, and cataloguing the results in the Radio Regulations, there would be no broadcasting."***
>
> Simon Fell

EBU

This was done, and in April 1925, the International Broadcasting Union (IBU/UIR) was established in Geneva. This was the predecessor of what is now the European Broadcasting Union. The IBU established the first frequency plan for broadcasting in the MF band. John Reith also agreed that his Director of Programmes, Arthur Burrows (yes, it was the same "Uncle Arthur" who had broadcast to children), could move to Geneva and become the Secretary General of the IBU.

Frequency planning for broadcasting was rightly later taken on board by ITU, but it has always been a critically important issue for broadcasters.

'Cold war' tensions lead to IBU's division in two

In the years of the late 1940s, "cold war" tensions were such that the west European members and east European members of the IBU separated into two unions in 1951, the EBU/UER and the OIRT. Happily, they came back together as one union in 1993, which kept the newer name of **EBU/UER**.

EBU and OIRT joined by seven 'sister unions'

In 1956, the 60s and 70s, the EBU and OIRT were joined by seven "sister unions". Their members serve the listener and viewers of the world.

They are the Asia-Pacific Broadcasting Union (**ABU**), the Arab States Broadcasting Union (**ASBU**), the African Union of Broadcasting (**AUB**), the Caribbean Broadcasting Union (**CBU**), the International Association of Broadcasting (**IAB/AIR**), the North American Broadcasters Association (**NABA**) and the *Organizacion de Telecomunicaciones de Iberoamerica* (**OTI**). The unions work together in the World Broadcasting Union (**WBU**) Technical Committee. We coordinate our activities in many areas, and one of the most important is spectrum management – the very heart of the ITU Radio Regulations.

Relying heavily on the ITU Radio Regulations

The WBU members rely heavily on the ITU Radio Regulations. In a specific country, nations are sovereign about what and where they broadcast, but there must be controls where broadcasts have the potential to spill over into other countries – there must be regulation about international interference. Without ITU doing the job of creating agreement between nations, and cataloguing the results in the Radio Regulations, there would be no broadcasting.

The WBU has continuously endeavoured to help the process of international frequency planning. There have been a series of planning conferences for terrestrial and satellite broadcasting, and we have taken major parts in them, and often prepared computer programmes for frequency planning that have been used at conferences.

Crediting EBU's computer programmers for frequency planning

One such person was Prof. Henri Mertens, one of our EBU staff in Brussels, whose computer programmes helped make the WARC-77 successful. This conference was the launch pad for satellite broadcasting. Others include Ken Hunt and Terry O'Leary, from EBU Geneva, who are credited with the creation of much of the software for WRC-95, which laid the foundation for digital terrestrial broadcasting. Last year was the 20th anniversary of that epoch-defining conference, justifiably celebrated by the ITU.

WRC-15 agreed to keep remaining UHF frequency spectrum for TV broadcasting

The latest WRC, in 2015 (**WRC-15**), was a critical and nail biting event for the broadcasters of the WBU. We were, and are, convinced that keeping the remaining parts of the UHF frequency spectrum for television broadcasting is very much in the public interest. Happily the conference agreed. Mobile technology is advancing, but is not yet at the point where it can substitute for broadcasting. It goes without saying that broadcasters follow closely the evolution of technologies such as 5G, against the time it may match broadcasting in efficiency, costs and capacity.

We have survived the first 90 years of cooperation between ITU and the broadcasting unions. ITU's work has profoundly influenced the services that broadcaster's offer, which in turn has a major impact on the quality of life across the world. ITU is rightly proud of its achievements.

Assuring critical communications – standards and spectrum

Phil Kidner

Chief Executive Officer, TCCA


TCCA

With less than ten million users worldwide, the mission-critical communications market is tiny compared to the billions of consumer and commercial users of mobile networks. Yet those few million users are the people that protect and secure people and property. They are the people that you and I rely on in times of crisis. They work for Public Protection and Disaster Relief (PPDR) organizations. These include the police, medical services, fire and rescue services, security forces, and national border guards and the military.

> ***"The need for international cooperation among public protection and disaster relief agencies has never been more apparent."***
>
> Phil Kidner

Critical communications are also used widely in potentially hazardous sectors such as air, sea and ground transport, the utilities, mining, oil and gas.

Essential communications for emergency services

To date, the mission-critical communications market has been served by specific purpose-designed technologies that meet the unique needs of these users. A police officer calling for back-up needs to connect immediately, and needs an immediate response. Coordination of emergency services across a major incident relies on guaranteed communications. If a plane is making an emergency landing at an airport, many people need to be alerted instantly. There is no room for poor signals, or dropped calls.

Through the **Radio Regulations**, the ITU allocated harmonized spectrum across the world for those technologies many years ago, and the result is a highly successful sector that benefits from innovation, competition and economies of scale. These latter two benefits are particularly important to the critical communications market, as with few exceptions, governments around the globe do not have endless budgets to allocate to emergency communications services.

A growing need for broadband

But there is change afoot on the airwaves. Current critical communications technologies fully support voice and some data requirements, but not broadband. And as we have seen from the consumer and business world, the use of mobile data now dictates the way many of us live and work, as broadband connectivity becomes ubiquitous.

Using LTE (Long Term Evolution) for critical broadband brings the potential of enhancing the work of PPDR users by enabling data-centric operations. This means support from applications such as real-time video streamed back from an incident to central control centres.

In order to build a critical broadband communications service, however, our industry needs to replicate the properties of the narrowband technologies in use today, in particular that of **TETRA** (Terrestrial Trunked Radio), which is the most widely-used mission-critical communications technology in the world. LTE is not purpose-designed for mission-critical use. Much work is ongoing to incorporate support for critical user applications in the standards so that critical broadband can complement today's technologies in the future.

Equally important is the need for harmonized spectrum for critical broadband. This will enable cross-border collaboration, and catalyze a competitive and cost-effective market for manufacturers and users alike.

How ITU is making it happen

ITU is playing a crucial role in making this happen. At the 2015 World Radiocommunication Conference (**WRC-15**), ITU Member States considered the increasing need for harmonized frequency ranges for PPDR communications, and agreed to a highly significant resolution supported by the 163 participating nations. **Resolution 646 (Rev. WRC-15)** encourages administrations to use specific frequency ranges for PPDR to the maximum extent possible, highlighting broadband in particular.

This underlines that although existing technologies such as TETRA will continue to support PPDR requirements, the growing need for broadband applications must be addressed. This resolution also considers that many administrations wish to promote interoperability and interworking between communications systems used for PPDR, both nationally and for cross-border operations in emergency situations and for disaster relief.

This is a great step forward, but continued effort on both regional and national levels is needed to reach the objective of harmonized spectrum across the world. Today, the need for international cooperation among PPDR agencies has never been more apparent.

The Radio Regulations and science services

John Zuzek

Chairman, Study Group 7,
ITU Radiocommunication Sector

The ITU Radiocommunication Sector (ITU-R) **Study Group 7** deals with the science services. These comprise systems for space operation, space research, Earth exploration and meteorology, systems for remote sensing, including passive and active sensing systems, radio astronomy and radar astronomy, and systems for the dissemination, reception and coordination of standard-frequency and time-signal services.

> ***"Special provisions have been added to the Radio Regulations to recognize the importance of protecting Earth-observation systems for all humankind."***
>
> John Zuzek

These radio services enable us to distribute standard time and frequency information, obtain important data about the Earth and its atmosphere, study other planets and extraterrestrial bodies, explore our solar system, and even to peer into the history of the cosmos itself. The systems used for these purposes have far reaching effects for everyone on the planet, from studying and monitoring climate change to assisting meteorologists in the prediction of the weather, from assisting in the prediction and monitoring of natural disasters to the human and robotic exploration of space. They contribute directly to many of the **Sustainable Development Goals** adopted by the United Nations in 2015 as part of its **2030 Agenda**, as they support the understanding and protection of key natural resources and the protection of populations against natural disasters.

Systems for scientific purposes and the sensitivity of receivers

The majority of the systems operated for scientific purposes use very sensitive receivers that require protection from interference. For example, radio astronomy receivers are particularly susceptible to interference from airborne or satellite transmitters, as are the sensitive receivers used to receive data from space-exploration missions operating in deep space (i.e. beyond 2 000 000 kilometers from the Earth). Active and passive remote sensing instruments operating on Earth-observation satellites are looking down at the Earth's surface and atmosphere and are susceptible to interference from transmitters operating on or near the surface of the Earth. These sensitive receivers can only operate successfully due to the allocation of certain frequency bands to their respective radio services and due to the regulatory protections afforded to them by many special provisions of the Radio Regulations.

NASA

By their very nature, passive sensors and radio astronomy receivers are attempting to receive and process at very weak, naturally occurring radio signals at specific frequencies determined by the laws of physics. Therefore, if such signals are corrupted by interference, it is not possible to simply use another frequency to obtain the information. The information is simply not available.

Protecting data transmission links from loss or corruption

Once scientific data is obtained by Earth-observation-systems or by spacecraft sent to explore other extraterrestrial bodies, the data must be transmitted down to the Earth for scientists to make use of that data. These data transmission links must also be protected or the scientific data may be corrupted or lost.

While there are many examples of how the Radio Regulations have assisted and impacted the development of these systems and supporting scientific endeavours, a couple of major changes to the Radio Regulations in the last ten years are particularly notable.

Protecting frequency bands and Earth-observation systems

While there are certain frequency bands where no emissions are permitted in order to enable Earth observation, weather prediction, and radio astronomy observations, additional provisions to protect some of these frequency bands from out-of-band interference have been placed in the Radio Regulations.

Furthermore, special provisions have been added to the Radio Regulations to recognize the importance of protecting Earth-observation systems for all humankind. This is especially important as we continue to study and try to understand how the Earth's climate is changing and to evaluate its impact on extreme weather events throughout the world.

Protecting the scientific use of the radio frequency spectrum

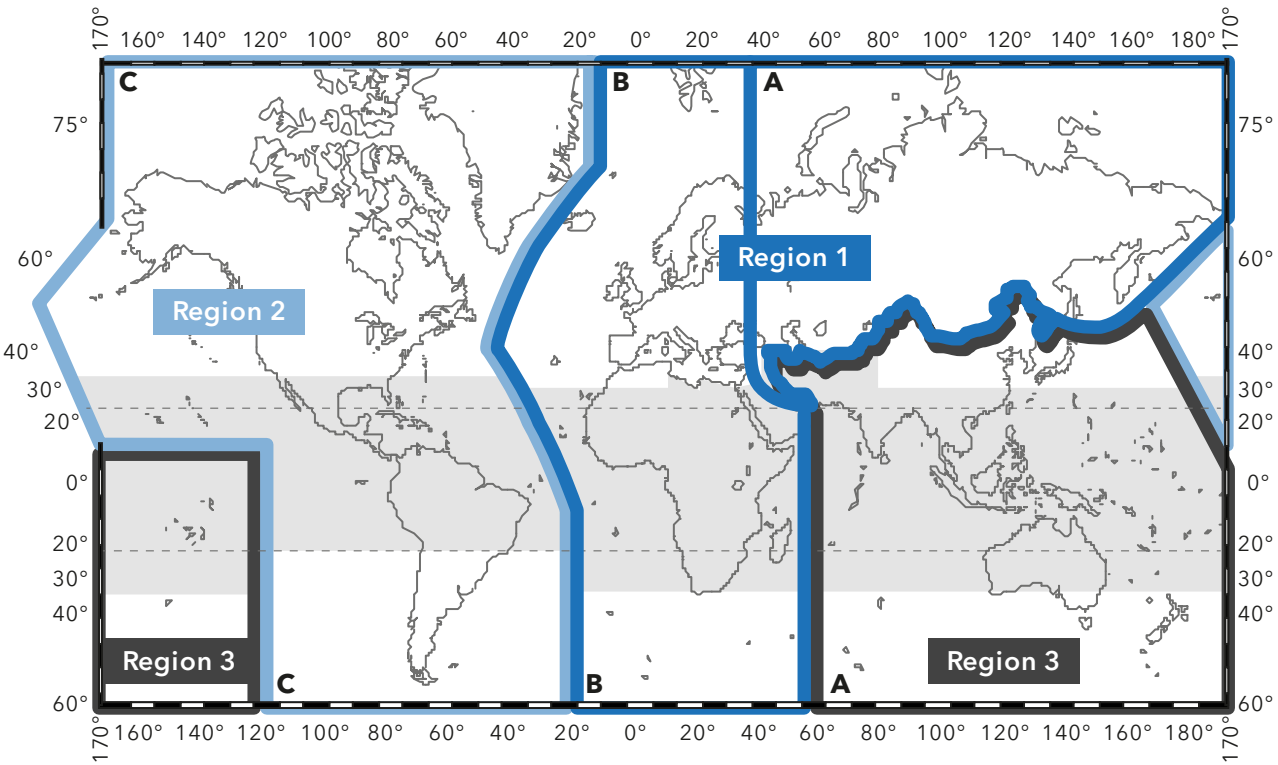
Systems operating in the science services have been enabled and continue to be protected by the allocations of frequency bands to these services and the associated provisions enacted in the Radio Regulations to protect the scientific use of these frequency bands. Looking at the Earth from space, there are no countries, no boundaries, and no nationalities. But international cooperation as evidenced in the Radio Regulations is required to enable and protect the scientific use of the radio frequency spectrum for everyone.

Relying on enforcement by national administrations

In our increasingly connected world, where billions of mobile devices are expected to operate in or near the frequency bands allocated to science services, the future of these services will also increasingly rely on the efforts of national administrations to enforce the power limitations specified for these devices by the Radio Regulations.

For the allocation of radio spectrum frequencies the world is divided into three regions

Region 1	Region 2	Region 3
Arab States	Americas	Asia-Pacific
Africa		
Europe		
Commonwealth of Independent States		



Building spectrum harmonization

Abdoulkarim Soumaila

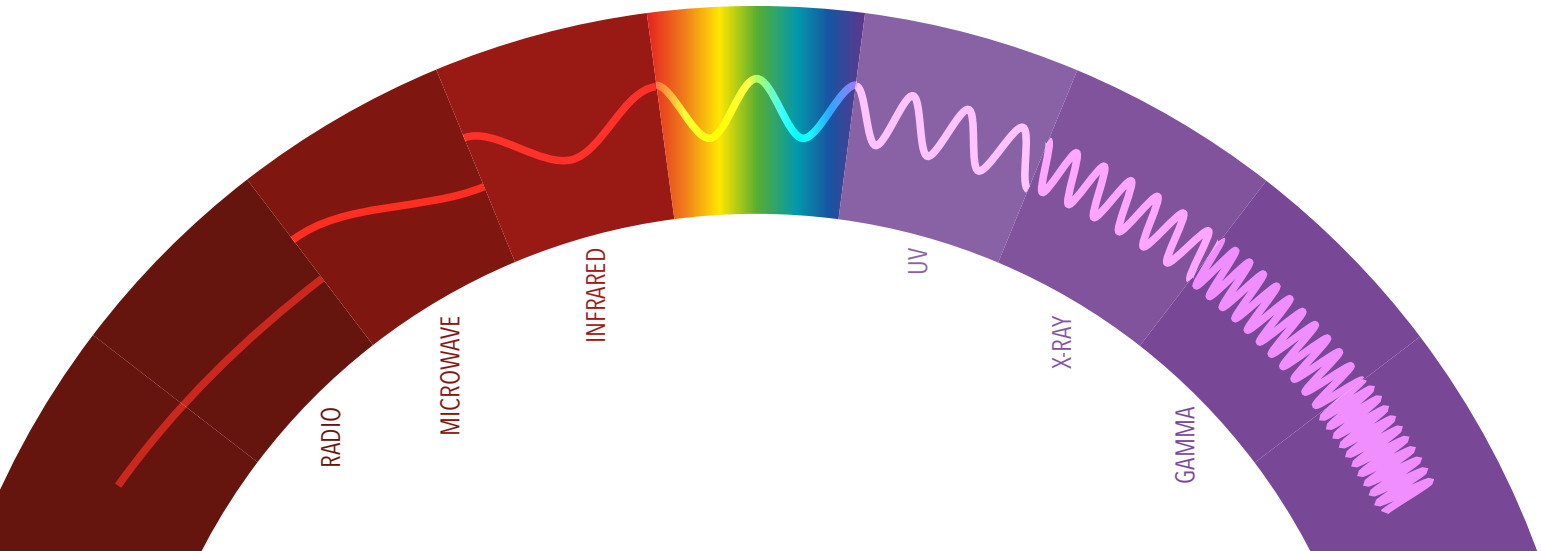
Secretary General, African Telecommunication Union (**ATU**)


ATU

The electromagnetic spectrum can be divided into frequency bands whose characteristics are more suited for use by one communication type and not for another. This is a familiar phenomenon with other natural resources, such as land.

"The Radio Regulations are the ultimate spectrum harmonization fostering tool worldwide."

Abdoulkarim Soumaila



Why is spectrum harmonization important?

Harmonization is crucial to deriving the maximum benefits from natural resources, especially if harmonization is achieved by best match of attributes to usage type, and is widespread as far as possible. Spectrum harmonization maximizes the benefits that may be obtained from it, including:

- **Economies-of-scale:** the cost advantage that arises with increased output of a product. Economies of scale emerge because of the inverse relationship between the quantity produced and per-unit fixed costs. The widespread purchase of mobile phones by many people across the world, for instance, has been made possible by lower phone prices as a result of phone manufacturers targeting the worldwide market.
- **Investment** is greatly enhanced by harmonization. The latter creates large single markets whose investment economics are much more favourable than small fragmented markets. Harmonization gives what is called the "right signal" because it effectively entails relevant governments' endorsement which is crucial to any high-capital investment.
- **Interference risk minimization across borders:** spectrum waves are "no respecter" of international boundaries. Complete confinement of a spectrum wave within a given country's boundaries is essentially infeasible, which entails real risk of harmful interference across borders. Harmonization reduces this risk because the use of systems with similar characteristics facilitates their compatibility in border areas.
- **Research and Development (R&D)** is greatly enhanced by harmonization. R&D funding and activities are increased and focused on harmonized bands, as manufacturers endeavour to win the equipment/device introduction race in the band. Enhanced R&D benefits all stakeholders, as evidenced in LTE/4G-enabled smartphones, for example.
- **Increased competition**, which usually brings user advantages that arise when more suppliers hustle to provide products at lower prices and/or better quality. For example, it is common knowledge that the cost of smartphones has gone down as competition has increased.
- **Future harmonization:** Harmonization today fosters the harmonization of tomorrow, which ensures that the world continues to maximize the benefits of spectrum for all mankind.

The role of the Radio Regulations in fostering harmonization

The **Radio Regulations** are the ultimate spectrum harmonization fostering tool worldwide. Harmonization is achieved by the allocation of different bands for use by different radiocommunication services (e.g. the band 470–608 MHz is allocated to the broadcasting service on a primary basis worldwide). There are over 40 radio communication services in the Radio Regulations. Allocations and their respective status are established by world radiocommunication conferences (**WRCs**) in such a way that the services allocated in each band can be made compatible through appropriate coordination procedures.

For reasons of harmonization, it is sometimes essential to designate a band, or portion thereof, for use by a specific system or application under specific technical conditions. This is termed "identification" (e.g. 694–790 MHz was identified for International Mobile Telecommunications (IMT) by **WRC-15**).

To cater for historical differences in the use of the spectrum, and to foster progressive harmonization, the world is divided into three Regions (Region 1: Africa, Europe, the Middle East and CIS (Commonwealth of Independent States) countries; Region 2: the Americas, and Region 3: Asia and the Pacific). Sometimes harmonization is only possible at regional or sub-regional level. When harmonization is not possible at these levels, countries or groups of countries, may elect to allocate/identify bands differently via footnotes in the Radio Regulations.

The 'give-and-take' at world radiocommunication conferences

Spectrum allocation and identification is done via the review of the Radio Regulations by World Radiocommunication Conferences (WRCs), which are held every four years. Therefore, what builds spectrum harmonization is the almost four-year rigorous preparations at national, sub-regional, regional and global levels. At all these levels, and aided by the global preparatory mechanisms of the ITU, lots of "give-and-take" happens among stakeholders, which results in harmonization at WRCs.

Since 1992, WRCs have allocated to the mobile service and identified for International Mobile Telecommunications (IMT) on a worldwide basis several frequency bands: 1.9/2.1 GHz in **1992**, 1.8 GHz and 2.6 GHz in **2000**, 450 MHz, 700, 800 MHz, 900 MHz, 2.3 GHz and 3.5 GHz in **2007** and **2015**. These spectrum harmonization decisions established the basis for the development of 3G, 4G and 5G.

Additional spectrum for IMT 2020 (5G) at WRC-19

WRC-19 is expected to take similar ground-breaking decisions for the harmonization of additional spectrum for **IMT-2020** (5G) in the bands above 24.25 GHz. Although these identification decisions for IMT are not binding on ITU Member States, the fact that they are taken by consensus means that they constitute a long-term commitment by governments and regulators worldwide. Hence, they provide a clear signal to manufacturers and operators that they can safely develop terminals, equipment and networks with the assurance of regulatory stability and worldwide market interoperability in the foreseeable future.

The role of the Radio Regulations Board

Lilian Jeanty

Chairman of the **Radio Regulations Board** in 2016

The tasks of the Radio Regulations Board (**RRB**, the Board) are defined in the ITU Constitution, the Convention and the **Radio Regulations**, and include approval of Rules of Procedure and the consideration of appeals against decisions made by the Radiocommunication Bureau (BR) regarding frequency assignments. The work of the Board has a clear impact on the development and implementation of the Radio Regulations (RR).

> ***"The work of the Radio Regulations Board has a clear impact on the development and implementation of the Radio Regulations."***
>
> Lilian Jeanty

The Radio Regulations are the basic material for the Board when carrying out its tasks. The Board works within the limits of the Radio Regulations and cannot take decisions that go beyond it, unless a World Radiocommunication Conference (**WRC**) has given the Board specific tasks or competencies to take decisions on a case-by-case basis on certain issues.

The Radio Regulations also clarify the relations between the Board and the BR, both regarding the development of Rules of Procedure and other issues.

Rules of Procedure

Rules of Procedure (RoP) are developed when there are difficulties in the application of the Radio Regulations, or when there is a need to inform members about BR practices. The Board may also be tasked by a conference to develop rules of procedure on specific issues.

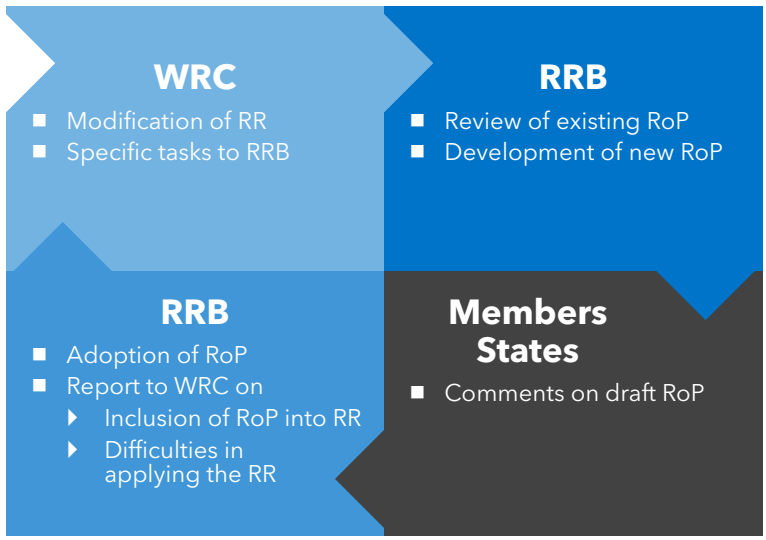
The aim of the rules of procedure is to ensure the impartial, accurate and consistent processing of frequency assignment notices, and to assist in the application of the Radio Regulations. They are developed in an open and transparent manner, allowing **ITU Member States** to comment on the draft rules before they are adopted.

After each WRC, the Board considers the impact of the decisions of the conference. Existing rules of procedure may be modified or supressed, as appropriate, to reflect the decisions by the conference and newly-developed rules of procedure.

Before each WRC, the Board makes suggestions on the possible inclusion of existing rules of procedure in the Radio Regulations. These proposals are considered by the conference when it is reviewing the Radio Regulations.

In this way the Board contributes both to the implementation of the Radio Regulations and to their improvement.

The cycle of production of the Rules of Procedure



RR = Radio Regulations
RRB = Radio Regulations Board (the Board)
RoP = Rules of Procedure
WRC = World Radiocommunication Conference

In response to Resolution 80

At each WRC, in response to **Resolution 80**, the Board provides a report on the application of the principles contained in Article 44 of the ITU Constitution, and No. 0.3 of the Preamble to the Radio Regulations. These principles relate to the need for rational, efficient, economic and equitable use of orbit-spectrum resources and the due diligence in applying these principles is reflected in several key provisions of the Radio Regulations – in particular Nos. 13.6 and 11.44B – relating to the effective use of frequency assignments.

WRCs take this report in consideration when amending the Radio Regulations. It is an important element of the contribution of the Board to the improvement of the Radio Regulations.

Appeals to the Radio Regulations Board

The Board is regularly requested to resolve disputes between **ITU Member States** on access to spectrum, in particular in cases of harmful interference. These cases may relate to terrestrial or satellite services and are generally resolved by the Board's affirmation of the principles embedded in the Radio Regulations, and the acceptance of the conclusions of the Board by the Member States involved.

The Board also regularly considers appeals against decisions made by the Bureau, mostly for satellite networks. Due to technical or financial problems, the development of satellite projects may be delayed, resulting in exceeding the regulatory time limits for bringing into use the corresponding frequency assignments. This applies in particular in case of launch failure or delays due to co-passenger issues.

The Bureau is not entitled to extend the regulatory time-limits in the Radio Regulations, but **WRC-12** and **WRC-15** gave authority to the Board for limited and qualified extensions of these limits.

The role of the procedures of the Radio Regulations and associated technical criteria

Kyu-Jin Wee

Chairman, **Asia Pacific Telecommunity Conference Preparatory Group for WRC-19**


APT

Have you ever wondered how is it that satellites, TV, radio, smartphones and even airplanes all work seamlessly, without destructive interference?

> ***"Have you ever wondered how is it that satellites, TV, radio, smartphones and even airplanes all work seamlessly, without destructive interference?"***
>
> Kyu-Jin Wee

Avoiding harmful interference is a central objective of the **ITU Radio Regulations**, as reflected in their Preamble. Since the early development of radiocommunication regulations at the beginning of the twentieth century, interference management constituted the foundation of these regulations. The wide variety of communication systems requiring access to radio frequencies (including safety-of-life communications), made it imperative to establish an orderly and reliable way to organize this access in order to prevent harmful interference between them.

Key to minimizing harmful interference

Radiocommunication systems will always be limited in their ability to cope with interference due to increasing levels of aggregate noise, excess demand for specific radio spectrum bands or simply due to operational incompatibilities.

Therefore, interference minimization does not solely rely on technical tools to "broker" spectrum access, but more fundamentally on how radio spectrum as a resource is planned. The Radio Regulations are the result of a permanent planning process which has been at work for the **last 110 years** in order to organize and maintain multilateral agreement among the governments of all countries, while taking into account the interests of all the industries involved.

Ensuring equitable access and rational use of spectrum and satellite orbits

Another key objective of the Radio Regulations is to ensure equitable access to, and rational use of, the radio-frequency spectrum and satellite orbits. Radio frequencies propagate seamlessly across territories and do not automatically stop at country borders. Hence, ensuring coordinated use of radio spectrum amongst countries is a critical outcome of the Radio Regulations. This allows countries to confidently invest in high capital expenditure ("capex") terrestrial networks and satellite systems, which have become essential to support economic growth and competitiveness.

These fundamental objectives – "avoidance of harmful interference", "equitable access and rational use" – have been guiding the ITU in its continuous review and update of the Radio Regulations.

Allocations of spectrum to different services are made in the Radio Regulations only subject to the condition that harmful interference can be avoided and equitable access preserved through the application of appropriate procedures and criteria, to be followed and enforced by the authorities of the countries involved, if necessary with the assistance of the ITU Radiocommunication Bureau (BR).

The Radio Regulations contain a number of such procedures and criteria, which have been developed and refined throughout the years in order to ensure that:

- Equitable access to spectrum/orbit resources between radiocommunication services and between countries is preserved.
- The characteristics used by radiocommunication stations in their ability to produce or receive interference are known to the potentially affected parties, which implies their notification to, and publication by, BR. This ensures that the potential sources and victims of interference are known and the authorities under the jurisdiction of which these stations are placed (the national governments and regulators) are clearly identified.
- Characteristics that could result in causing harmful interference to radiocommunication stations of other countries are either not permitted (by the imposition of "hard limits" on the power radiated in certain or all directions and/or for certain percentages of time) or trigger a coordination procedure with other countries in order to ensure compatible use through an appropriate procedure.
- Symmetrically, any receiving characteristics that could result in suffering harmful interference triggers a coordination procedure with the relevant countries to ensure the protection of the corresponding station.
- On completion of the procedure, the rights to transmit and receive without harmful interference are established.

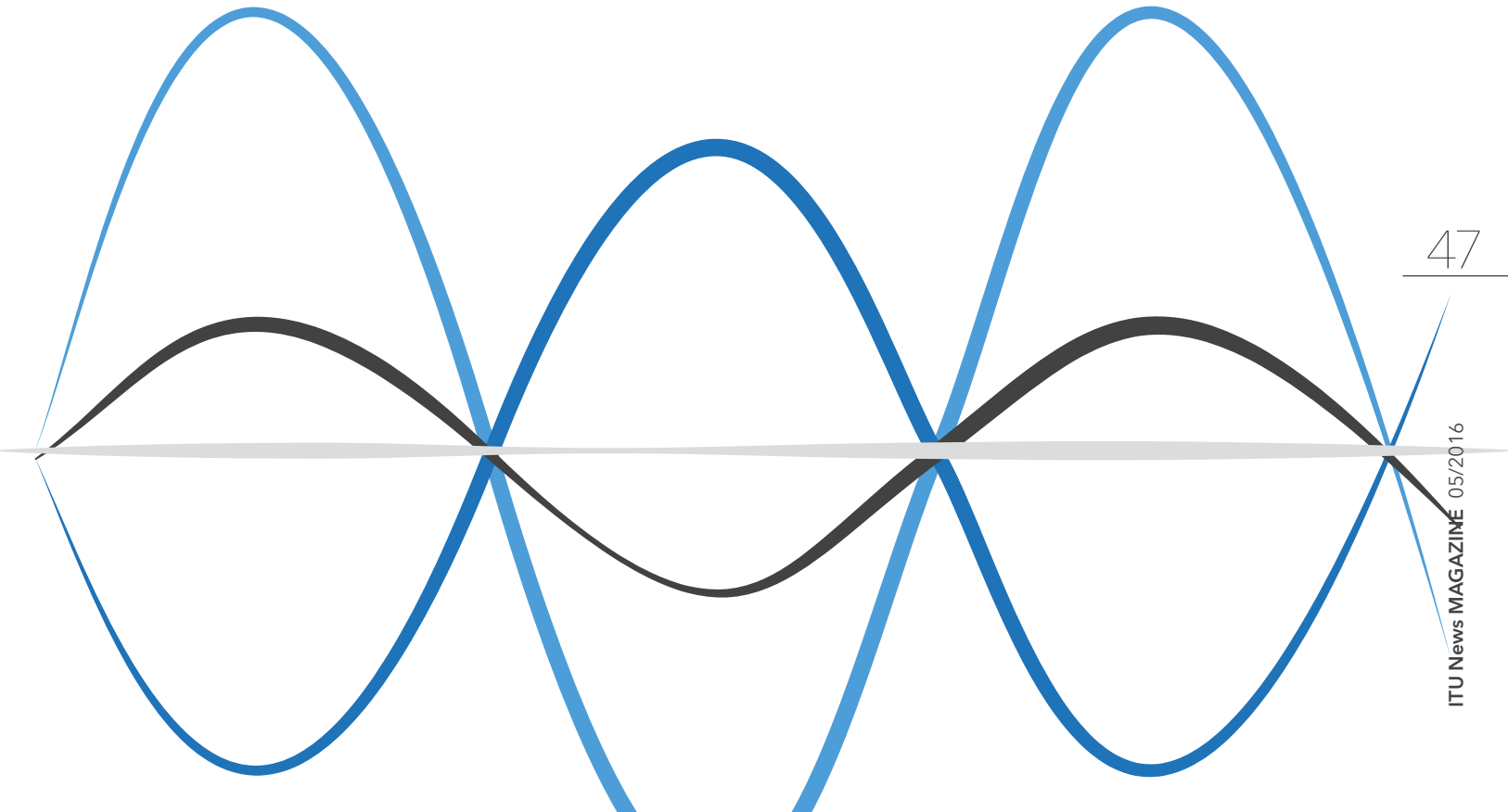
Reasons for long-term success

There are several fundamental underlying conditions which explain why these procedures and associated provisions have been working successfully for 110 years without any enforcing mechanism, with less than a fraction of a per cent of assignments in operation suffering from harmful interference:

- Administrations are responsible for regulating and authorizing the use of spectrum in their jurisdictions and for enforcing laws and regulations on that use.
- In signing the final acts of World Radiocommunication Conferences, **ITU Member State administrations** commit to applying the updated Radio Regulations as part of their national legislation.
- Any transmit station has to have a licence.
- Utmost goodwill is exercised in applying the provisions of the Radio Regulations.
- If in spite of the application of the relevant procedure (nothing is perfect), harmful interference occurs, the case can be resolved by dialogue, and if necessary, through the intervention of BR or the Radio Regulations Board (**RRB**).

Counting on goodwill

The procedures of the Radio Regulations and the associated technical criteria remain a fundamental vehicle to ensure rational, equitable and economical use of radio spectrum among ITU Member States, while preventing harmful interference. Future reviews of the Radio Regulations will continue requiring our utmost goodwill to make it all work for the benefit of everyone.



The importance of regional and inter-regional cooperation in the WRC process

Carmelo Rivera

Chairman, Inter-American Telecommunication Commission (**CITEL**) Working group on WRC-19

The World Radiocommunication Conference (**WRC**) process requires that consensus be built within and between countries. Since 1993, the increase in the pace of WRCs has required improved cooperation within and between regions in the preparation of, and during conferences, so that consensus can be reached and solutions found in a relatively limited time period.

Regional preparatory groups have emerged in six regions (Africa, the Americas, the Arab States, Asia and the Pacific, the Commonwealth of Independent States and Europe) to ensure this cooperation.

"Due to the diversity both within and between countries in each region, a primary challenge for regional cooperation, is to encourage forward moving technology, while reducing the digital divide."

Carmelo Rivera

Shutterstock

Advancing technology while reducing the digital divide

Due to the diversity both within and between countries in each region, a primary challenge for this cooperation is to encourage forward-moving technology while reducing the digital divide.

The importance of information sharing

There are several ways to respond to this challenge, but none are as important as the sharing of information. Ideas of how this challenge can be overcome originate from a myriad of sources – economical, societal, developmental and educational – all key to maintaining a level playing field. Information must be shared not only throughout the region but also throughout the world. No one region is alone in this difficult task. All regional groups attend one another's meetings and regularly provide updates on their preparatory work progress, and report back on any pertinent issues observed during their attendance at other regional meetings. This exchange of information is essential in attempting to minimize divisions that no one wants, and no one benefits from.

Inter-regional workshops – getting ahead of the game

ITU has helped tremendously in the past by sponsoring inter-regional workshops where each of the six regional groups can send representatives to report to others on their progress in preparing for the **next World Radiocommunication Conference** (WRC), and to exchange ideas on methods and thoughts on how to solve the complicated issues brought forward on the agenda. Because these workshops are informal meetings, they enable an unprecedented exchange of information. During the WRC-15 preparation cycle, the inter-regional workshops resulted in several less contentious agenda items being resolved within the first two weeks of the conference, thereby allowing participants to focus on the more complicated issues. While it is true that a couple of those items were not resolved until the very last possible hour, imagine how much more difficult it would have been, had the easier issues not been dealt with at the beginning.

Contentious agenda items – being prepared

There are 24 items on the agenda of the next WRC, to be held in 2019. One of those agenda items has nine issues that will all require solutions. Those who have attended WRCs in the past are aware of Agenda Item 7, which is like a mini-conference of its own. Without the ITU inter-regional workshops it would be difficult to prioritize and find solutions that the majority of attendees can be satisfied with at the end of the four-week period assigned to the conference. Once again the workshops will give us an idea of which agenda items are the most difficult for Member States to reach a consensus, and which will be resolved shortly after the start of the conference. Surprises are not normally welcome at a world radiocommunication conference.

The Inter-American Telecommunication Commission (CITEL) congratulates ITU on the **110th anniversary of the ITU Radio Regulations**. Our region has already begun its preparation for the next WRC, and we look forward to seeing where deliberations have led other organizations in attempting to resolve the numerous **WRC-19** agenda items placed in front of us. We look forward to participating in the ITU inter-regional workshops, where we will also have the opportunity to share our ideas and prospective solutions.

The role of ITU-R studies in support of the Radio Regulations

Tariq Al Awadhi

Chairman, Arab Spectrum Management Group (**ASMG**)

ASMG

The ITU Radiocommunication Sector (**ITU-R**) studies are conducted by six Study Groups (**SGs**) and their Working Parties (WPs), in accordance with the mandate defined in Articles 11 and 20 of the ITU Convention. The studies are mainly focused on the agenda items of a World Radiocommunication Conference (**WRC**) or a Question or Resolution addressed to the Secretary-General by any conference or the Radiocommunication Assembly (**RA**), the Council or the Radio Regulations Board (**RRB**).

> *"ITU Radiocommunication Sector studies greatly facilitate the decisions to be made at conferences to update the Radio Regulations."*
>
> Tariq Al Awadhi

The ITU-R study group cycle

Study Groups, however, are not limited to only these studies. Any topic relating to the mandate of a SG may be studied based on an input contribution document to the meeting. Each Study Group prepares a four-year plan, generally referred to as a study cycle, that is aligned with the WRC cycle. The plan may be reviewed at each meeting of the Study Group.

Who can participate at ITU-R study group meetings?

All **ITU Member States**, **Radiocommunication Sector Members** and **Associates** can participate at the meetings of SGs and their associated WPs and any other groups (e.g. Task Groups, Joint Groups, Rapporteur Groups, etc.).

Academia (Universities, colleges and research establishments, etc.) can also participate in the work of the WPs. However, the rights for adoption and approval of texts such as Resolutions, Recommendations, Reports, Handbooks, Opinions and Questions, do vary based on the status of the entity at the meeting.

Study groups and the output draft Report of the Conference Preparatory Meeting

An important output from the SG activities is the draft Report of the Conference Preparatory Meeting (**CPM**), on the basis of which the CPM prepares a consolidated Report on the ITU-R preparatory studies for each agenda item of the WRC. The CPM report includes technical and regulatory solutions to the agenda items, and is the basis on which ITU Member States develop their formal proposals to the WRC. The WRC reviews and if necessary, revises the **Radio Regulations**. The WRC decisions (Final Acts) include new and revised provisions of the Radio Regulations including its Appendices, the WRC Resolutions and Recommendations and the ITU-R Recommendations incorporated by reference.

Shaping national spectrum regulations in every country

The Radio Regulations constitute a multilateral treaty among ITU Member States. As such, it is incorporated by Member States within their national regulations on spectrum use. As an example, the United Arab Emirates (UAE) spectrum regulatory framework includes a Table of National Frequency Allocation, which has three columns: the first showing the ITU-R Region 1 allocations, the second showing the UAE allocations, and the third showing the references to the international agreements and other notes.

ITU-R study group activities therefore directly support the WRC decision-making process. In turn, WRC decisions shape national spectrum regulations in every country.

The importance of active participation in ITU-R study groups for all countries

For these reasons, an active participation in ITU-R study groups is an important element of any country's strategy to ensure that its national interests are taken into account in the development of international regulations.

United Arab Emirates – main interest in space and terrestrial services

Like most countries, the UAE has a National Committee for the preparations of the WRC and a vibrant Industry Group. The agenda items of the WRC are discussed at its meetings with a view to formalizing the UAE input contributions to the ITU-R study groups. The UAE is active especially in ITU-R study groups 4 and 5, due to space services and terrestrial services being the main interest areas.

The importance of regional group discussions for building consensus

To build consensus, it is desirable that proposals to ITU–R Study groups, like proposals to WRCs, be discussed in regional groups before being submitted. For the UAE, the relevant regional group is the Arab Spectrum Management Group (ASMG), which started developing contributions to the different WPs, SGs and WRCs in 1995. Some of the subjects of prime interest have been:

- Mobile-satellite service (MSS) allocations.
- Broadcasting-satellite service (BSS) allocations.
- Appendices 30 and 30A of the Radio Regulations.
- Allocations in the 13.75–14 GHz band at WRC-03.
- Earth stations on board vessels (ESV).
- Mobile service allocations and IMT identifications, in particular in the 700 MHz band.
- Equitable access to, and efficient and effective use of, spectrum/orbit resources.
- Amateur allocations.
- Broadband Public Protection and Disaster Relief (PPDR) band identification.
- Internet of Things (IoT).

Collaboration between regional groups

Another important step in building consensus is the collaboration between regional groups. As an example, at **WRC-12**, realizing the importance of harmonization, the high demand for broadband services and the value of lower frequencies to provide coverage, ASMG worked extensively with other regional groups to allocate the frequency band 694–790 MHz to the mobile service and identify it for International Mobile Telecommunications (IMT). The conference was able to reach agreement, subject to review by **WRC-15**, which confirmed this decision.

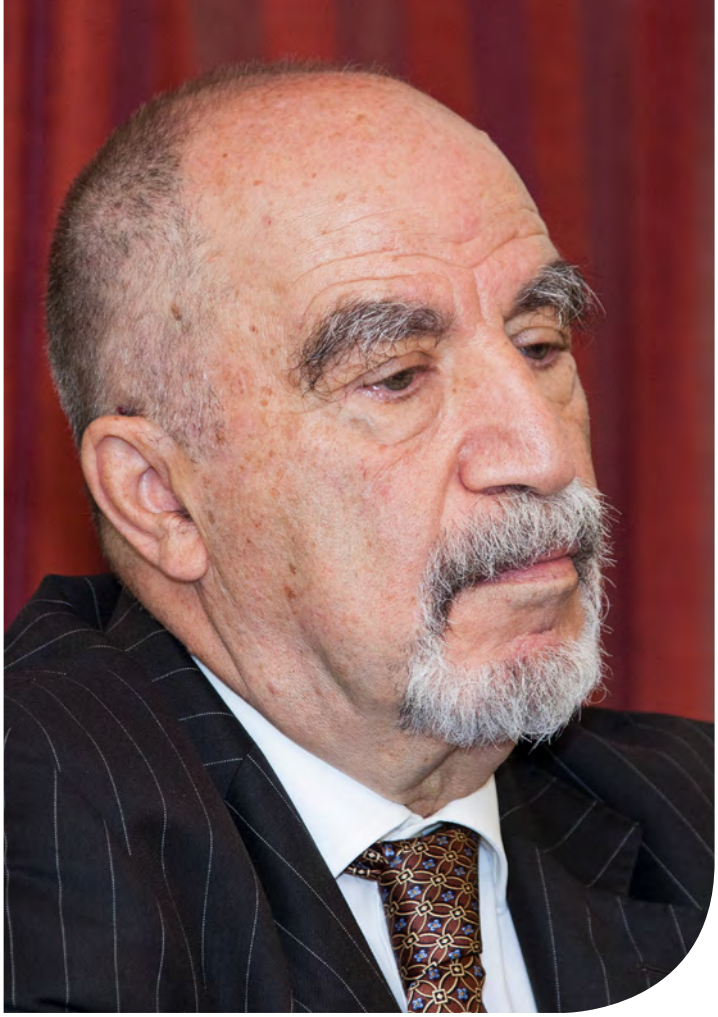
ITU Radiocommunication Sector studies – vital for resolving topics on conference agendas

The ITU–R studies play a vital role in identifying technical, operational and regulatory approaches to resolving topics included in the agendas of world radiocommunication conferences. Coupled with the related activities at both the national and regional levels, these studies greatly facilitate the decisions to be made at those conferences to update the Radio Regulations.

The role of ITU standards in developing the Radio Regulations

Albert Nalbandian

Chairman, Regional Commonwealth in the field of Communications (**RCC**) Working Group on WRC–19/RA–19



The success of any radiocommunication system depends on the availability of spectrum and of relevant harmonized standards. Standards play a fundamental role in developing and complementing the Radio Regulations (**RR**).

> ***"Standards play a fundamental role in developing and complementing the Radio Regulations."***
>
> Albert Nalbandian

The Service Regulations (the forerunner of today's RR), which entered into force on 1 July 1908, constituted *de jure* a binding standard and contained a series of technical provisions to be observed in order to ensure the interference-free operation of all radiocommunication systems.

Of the 42 provisions in the Service Regulations, 16 addressed technical aspects of the transmission of radiotelegrams, including the standard distress signal **SOS in Morse code** (··· −−− ···). The SOS distress signal standard was retained in the RR up to **WRC–07**, when the provision on Morse radiotelegraphy was suppressed.

Sharp rise in interest in radiocommunications follows 1906 conference

After the **1906 conference**, interest in the use of radiocommunications both at sea and on land rose sharply. Radiocommunications made a huge leap forward with the transition, after the invention of the triode in 1906, to radio apparatus using vacuum tubes. This significantly improved the sensitivity and selectivity of radio systems, as well as reducing the size of apparatus while enhancing their operating characteristics.

The need emerges for technical standards

As new radio devices were invented and applied in radiocommunication systems, a need emerged for technical standards, which played a significant role in the evolution of the Radio Regulations. In 1927, with a view to developing Recommendations on the technical bases for effective use of the spectrum and on the characteristics of radio systems, the International Radio Consultative Committee (CCIR) was set up within ITU (becoming, as from 1993, the **ITU-R study groups**).

As radiocommunications evolved, new radio services were included in the Radio Regulations, such as the fixed, broadcasting and amateur services and, in addition to the maritime-mobile service, the land-mobile and aeronautical-mobile services. As early as 1929, more than 20 CCIR texts were adopted in relation to spectrum allocation, frequency measurements and transmitter stability, limiting transmitter power, and methods of reducing interference and unwanted emissions.

ITU-R Recommendations are universally recognized and used as standards by all stakeholders in the radiocommunication community. Compliance with these standards may be either mandatory *(de jure)*, in the case of incorporation in the Radio Regulations by reference, or non-binding *(de facto)*, in the majority of cases.

Launch of first satellite prompts space radiocommunication studies

The launch of the first artificial satellite in 1957 prompted CCIR to embark on studies on space radiocommunications. In 1959 already, Recommendation 259 "Selection of frequencies used in telecommunication with and between artificial earth satellites and other spacecraft" was adopted. Standards were developed and adopted for space services. This process was based on the sharing criteria developed within CCIR for the shared use of frequency bands, primarily in the 1–10 GHz range, by the fixed and fixed-satellite services.

The worldwide migration from analogue to digital radio and television broadcasting also relies on the widespread implementation of ITU-R Recommendations for standard television, high-definition (HDTV), ultra-HD (UHDTV) and high frame rate television. These standardization activities are now continuing with high-dynamic range (HDR), future virtual reality, 360° and other audio and visual immersive technologies.

ITU-R Recommendations – key role in development of cellular communications

ITU-R Recommendations also played a key role in the development of cellular communications. The template for modern cellular communication networks was shaped in ITU-R in 1990, with the adoption of **Recommendation ITU-R M.687** laying down the principles for the establishment of International Mobile Telecommunications (IMT) networks. Globally harmonized frequency bands for operation of IMT systems were first identified in the Radio Regulations at the **World Administrative Radiocommunication Conference in 1992**. Today, all 3G and 4G mobile broadband systems are based on the ITU's IMT standards, and work on **IMT for 2020** and beyond is well underway, in close collaboration with the mobile broadband industry and the wide range of stakeholders in the 5G community.

It is of course impossible in this article even just to list all the ITU-R Recommendations relating to the Radio Regulations which have been adopted by **ITU Member States**. Suffice it to note, therefore, that there are now over 1000 ITU-R Recommendations in force in 16 different series elaborated by the six **ITU-R study groups**.

ITU-R Recommendations in the SM and P Series address spectrum management and various aspects of radiowave propagation, and are thus "common" to all radio services.

Recommendations in the other 14 series relate to one or more radio services, including sharing criteria for shared use of the spectrum by specific services, ranging from TV and sound broadcasting to radionavigation and from space applications to personal mobile communications.

ITU-R Recommendations and the Radio Regulations

Recognizing the importance of a direct linkage between Recommendations and the provisions of the Radio Regulations, **WRC-95** decided to incorporate ITU-R Recommendations in the Radio Regulations by reference. The term "incorporated by reference" applies only to recommendations which are of mandatory application.

The current **Radio Regulations (2016 edition)** comprise four volumes. Volume 4 contains the texts of 39 ITU-R Recommendations incorporated by reference.

Looking back in judgement on the outcomes of the **International Radiotelegraph Conference of 1906**, we may state that the Service Regulations adopted by that conference responded effectively to the needs of radiocommunciation development at that time, and laid the foundations for today's Radio Regulations. The Radio Regulations, coupled with the ITU-R Recommendations, form the core of the international framework for the effective and efficient management of the radio frequency spectrum.

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