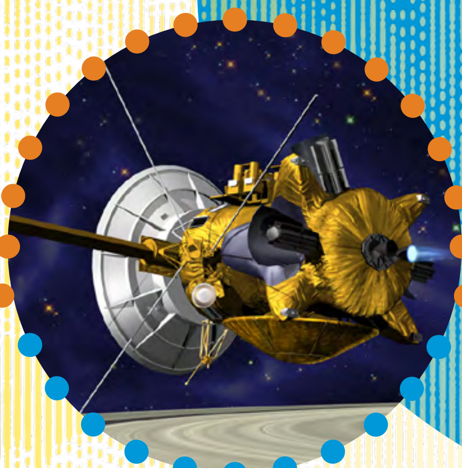
ITUNews MAGAZINE

90 years of global collaboration



Celebrating CCIR/ITU–R Study Groups

Issue No. 4/2017

LS telcom
Smart Spectrum Solutions

SpectrumMap™ – Cloud Based Solution to Visualize Spectrum Usage

Global Spectrum Experience

Smart Spectrum Solutions

Systems Solutions and Expertise in
Spectrum Management, Spectrum Monitoring
and Radio Network Planning & Engineering.

Testimony to the sustainable development of the wireless ecosystem

Houlin Zhao, ITU Secretary-General

> *These events highlight the eminent role of ITU–R Study Groups in enabling and shaping the overall wireless ecosystem and ensuring its sustainable development.*

Please join me in congratulating the CCIR*/ITU Radiocommunication Sector (ITU–R) Study Groups on their 90th Anniversary – a truly inspiring global collaboration that has gone a long way to develop universally applied regulations, standards and best practices, to enable the sustainable development of the wireless ecosystem.

Today, more than 5000 specialists participate in the work of the **ITU–R Study Groups** on topics such as efficient use and management of spectrum and satellite orbit resources, radiowave propagation, definition of future radiocommunication systems characteristics and performance, including fixed communications, aeronautical, maritime and land mobile communications, public protection and disaster relief, sound and television broadcasting, radiolocation, satellite communications and radionavigation, Earth exploration, meteorology, space science and radio astronomy.

As part of the 90-year celebrations, a series of events have been taking place including a high-level session on 12 June at the **WSIS Forum**, which showcased ITU–R Study Group achievements and a dedicated session on 21 September at **ITU Telecom World 2017** in Busan, Republic of Korea, which discussed the industry's perception of the importance of the work of the ITU–R Study Groups. A special celebration ceremony will be held on 21 November at ITU which will gather the main players working on the **preparatory process** leading to the World Radiocommunication Conference 2019.

These events highlight the eminent role of the ITU–R Study Groups in enabling and shaping the overall wireless ecosystem and ensuring its sustainable development. See inside this edition of ITU News to learn more about this rich 90-year history of ITU collaboration.

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*CCIR – International Radio Consultative Committee.

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90 years of global collaboration

Celebrating CCIR/ITU-R Study Groups

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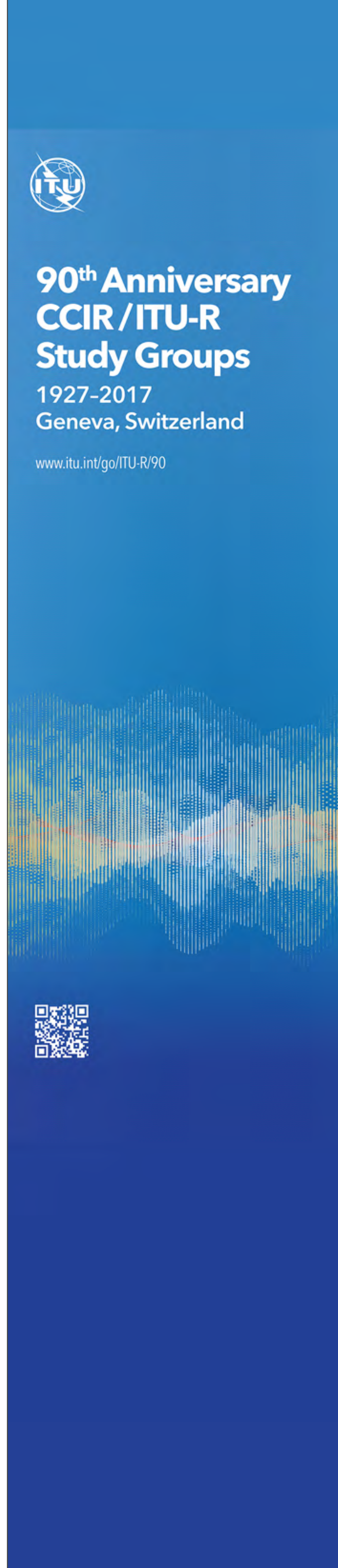

90th Anniversary
CCIR / ITU-R
Study Groups
1927-2017
Geneva, Switzerland
www.itu.int/go/ITU-R/90

Since 1927, CCIR/ITU-R Study Groups have been at the centre of the activities of the ITU to fulfill its purpose of ensuring the rational, equitable, efficient and economic use of the radio-frequency spectrum by all radiocommunication services.

François Rancy

The CCIR/ITU-R Study Groups — 90 years of support to the sustainable development of the wireless ecosystem

François Rancy

Director, ITU Radiocommunication Bureau

Digital transformation has become the engine of world economic and social development. 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 their **2030 Agenda for Sustainable Development**.

Mobile and broadcasting networks, satellites, radio relays, radars, drones, short range wireless technologies are constantly providing us with a wealth of information or applications that we use seamlessly without realizing that they all rely on one common and intangible resource: spectrum.

The ingredients for the ITU to enable the sustainable development of the global wireless ecosystem were in place. Since then, the CCIR/**ITU-R Study Groups** have been at the centre of the activities of the ITU to fulfill its purpose of ensuring the rational, equitable, efficient and economic use of the radio-frequency spectrum by all radiocommunication services.

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, which have since been expanded and revised by numerous World Radio Conferences (**WRCs**), and are known as the **Radio Regulations**.

Only two years after the first television experiments, the **International Radiotelegraph Conference** (Washington, 1927) adopted the first table of frequency allocations, including broadcasting, and created the International Radio Consultative Committee (CCIR) in order to conduct technical and related studies on radiocommunications.

The global wireless ecosystem and its development

2017 marks the **90th anniversary of the "CCIR/ ITU-R Study Groups"**, a testimony of global collaboration to produce universally applied regulations, standards and best practices which enable the sustainable development of the wireless ecosystem for all, as illustrated by the continuous growth in the use of wireless communications in the last thirty years. Innovative technological solutions using radio transmission are laying the foundations for a truly wireless world. Radiocommunications have 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.

The WRC process, constantly supported by the CCIR/ITU–R Study Groups, delivers, through regular updates of the Radio Regulations, a stable and predictable global framework which ensures the long-term protection of the investments of a multi trillion-dollar industry, through the universal commitment of governments and all other stakeholders.

In parallel with the WRC process, the work of **ITU–R Study Groups** also enabled, through the adoption of **globally harmonized standards**, 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–R for many decades, since the corresponding technologies became available.

Less visible, but equally important, the ITU–R process is the enabler of satellite imagery and Earth resources monitoring, space science and missions, meteorology, maritime and aeronautical transport and safety, civil protection and defence systems.


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Work for ITU World Radiocommunication Conferences

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. Complying with this framework is an essential task for administrations to ensure their services obtain international recognition and are compatible with the services of other administrations.

Since 1979, the **Radio Regulations** have been revised and updated every three or four years, in order to keep pace with the rapid expansion of existing systems and new, spectrum-hungry advanced wireless technologies. The ITU **WRCs** are at the heart of this updating process and the **ITU–R Study Groups** at the heart of their preparation, which culminates six months before every WRC, with the adoption of the **Conference Preparatory Report**, a nearly 1000-page document summarizing several years of studies by **ITU–R Study Groups** on the technical, operational and regulatory/procedural issues relating to the WRC agenda.

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

Work for globally harmonized standards and best practices in radiocommunications

Equally important for the sustainable development of the wireless eco-system is the activity of the CCIR/**ITU–R Study Groups** to produce **Recommendations**, **Reports** and **Handbooks** which are universally recognized and applied instruments in all countries for authorizing, regulating, managing and monitoring spectrum use, manufacturing equipment and devices, deploying and operating terrestrial and satellite networks.

As a result of regular reviews by **ITU Radiocommunication Assemblies** to ensure the efficiency of their work, the ITU–R Study groups cover six areas, for which the most remarkable achievements are described below.

Spectrum management

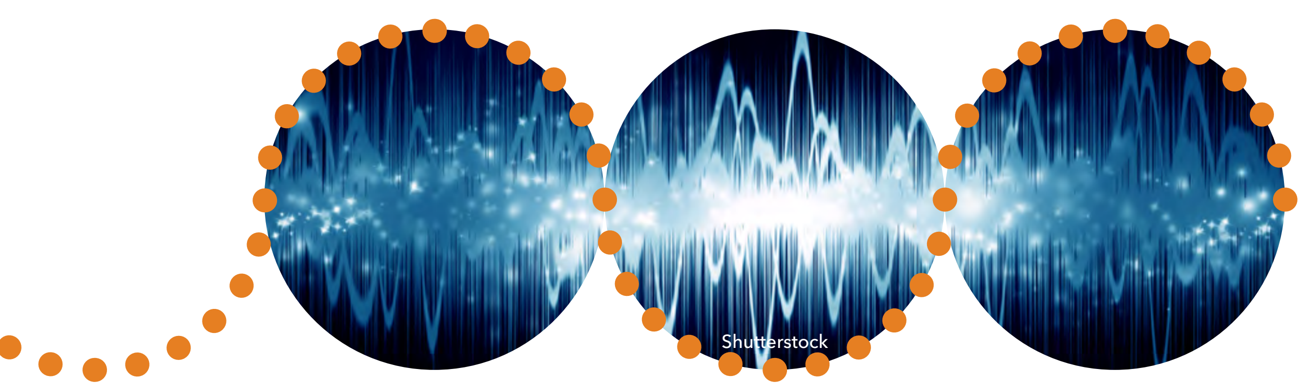
Spectrum management is carried out by national regulatory authorities (NRAs) within the international regulatory framework provided by the **Radio Regulations**. This activity is an essential enabler to the development of the radiocommunication ecosystem globally.

For more than 70 years, CCIR/**ITU–R Study Group 1** has embraced the development of standards, best practices and guidance for NRAs to manage spectrum in a rational, efficient and economical way, with particular attention to the needs of developing countries.

This production covers in particular spectrum monitoring, the eyes and ears of the spectrum management process, with the bestseller **ITU–R Handbook on this subject**, as well as the detection of weak signals, short range devices, cognitive radio systems or other emerging technologies and approaches, and **economic aspects of national spectrum management**.

Radiowave propagation

CCIR/**ITU–R Study Group 3** has developed a comprehensive suite of step-by-step procedures in the **ITU–R P-series recommendations** for predicting radiowave propagation for all types of terrestrial and satellite systems over frequencies up to 100 GHz, thereby enabling system planning and inter-service interference analysis. This suite is complemented by a **series of handbooks** to facilitate the use of this material worldwide.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Satellite services

CCIR/**ITU–R Study Group 4** activities have provided the basis for important WRC decisions, the most recent being:

- Following the disappearance of Malaysia airlines flight MH370, the allocation by **WRC-15** of the **frequency band 1087.7–1092.3 MHz** in the Earth-to-space direction enables satellite reception of tracking signals compliant with **ICAO** (International Civil Aviation Organisation) standards, to improve aircraft tracking in particular for polar, oceanic and remote areas.
- Given the growing demand for broadband satellite communications to mobile platforms, the adoption by WRC-15 of conditions for operation of earth stations in motion using the 20/30 GHz bands in all Regions enables satellite systems to provide global broadband connectivity on mobile platforms such as ships, aircraft, and land vehicles.
- The improvement of the satellite regulatory procedures in order to facilitate rational, efficient, and economical use of radio frequencies and any associated orbits.

In addition, development of Recommendations and/or Reports on:

- Satellite transmission for UHDTV satellite broadcasting.
- Use of satellite and terrestrial broadcast infrastructures for public warning, disaster mitigation and relief.
- System characteristics in the radionavigation-satellite service.
- Specifications of the satellite radio interfaces for International Mobile Telecommunications-Advanced (IMT-Advanced).
- Global broadband Internet access by fixed-satellite service systems.

Terrestrial services

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 has boomed to more than 7 billion today. We are now witnessing the full deployment of the third and fourth generations (3G and 4G) mobile broadband systems, based on ITU standards known as **IMT-2000** and **IMT-Advanced** (IMT stands for International Mobile Telecommunications). 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 and vertical activities like health, transportation and retail.


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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 the 1.8 GHz and 2.6 GHz bands and the "first digital dividend" bands respectively. For 5G, WRC-15 opened the "second digital dividend" spectrum at 700 MHz, as well as spectrum at 1.5 and 3.5 GHz. WRC-19 is expected to open more spectrum for 5G in the bands above 24 GHz.

Defining and specifying the third generation (3G) took over ten years of hard work. The ITU Radiocommunication Sector (ITU–R), in close collaboration with national and regional standards development organizations, finalized the technical standards for the radio interfaces of third generation systems under the brand IMT-2000. ITU's IMT-2000 global standard for 3G was unanimously approved at the ITU Radiocommunication Assembly 2000 (**RA-2000**), which opened the way to enabling innovative applications and services (e.g. multimedia entertainment, infotainment and location-based services, among others).

The fourth generation (4G) specifications for fourth generation mobile technologies, named IMT-Advanced, were agreed in January 2012 at the ITU Radiocommunication Assembly (**RA-12**) in Geneva. IMT-Advanced systems include the new capabilities that go beyond IMT-2000, providing access to a wide range of telecommunication services supported by mobile and fixed networks, which are increasingly packet-based.

The work on the fifth generation (5G) started in early 2012. In September 2015, ITU–R finalized its "Vision" of **IMT for 2020** 5G mobile broadband connected society, including the overall requirements for IMT-2020 and the methodology for assessing the technologies that will fulfill these requirements. The technical standards for IMT-2020 will be finalized by ITU–R in 2020. While enhancing mobile broadband communications, 5G will also extend the application of this technology to use cases involving ultra-reliable and low latency communications, and massive machine-type communications. In addition, the ITU World Radiocommunication Conference 2019 (**WRC-19**) will address the need to identify additional spectrum to support the future growth of IMT.

Studies have also been conducted on Fixed Wireless Access (FWA) systems for potentially large deployment coverage. Performance and availability objectives are established with the aim of integrating these systems in the public networks, standardizing the RF arrangements in the various frequency bands allocated by the Radio Regulations. These arrangements allow homogeneous patterns to be used, which are desirable for interconnecting systems on international circuits and to minimize mutual interference and achieve the economies of scale required for reduced costs.

ITU–R studies on **terrestrial services** also relate to the maritime mobile service, including the Global Maritime Distress and Safety System (GMDSS), the aeronautical mobile service and the radiodetermination service, including both radiolocation and radionavigation services.

In close cooperation with the International Maritime Organization (**IMO**), ITU–R also contributes to the development of operational procedures for urgency, distress and safety communications and operation of systems belonging to the maritime mobile service, including the management of Maritime Mobile Service Identities (MMSI).

Air traffic control and other communications related to safety and regularity of flight depend on the availability of spectrum for the aeronautical mobile service, which is the subject of constant studies in ITU–R.

Systems belonging to the radiodetermination service are being employed not only by the aeronautical, maritime and meteorological industries but to an ever increasing degree by other industries as well as the general public.

A series of Recommendations and Reports were developed by ITU–R Study groups, including radars used to effectively manage aeronautical and maritime traffic and meteorological radar employed for weather, water and climate monitoring and prediction. These radars play a critical role in immediate meteorological and hydrological alert processes and represent the last line of detection of weather that can cause loss of life and properties in flash flood or severe storm events.

Another field of action is Intelligent Transport Systems (ITS), utilizing the combination of computers, communications, positioning, and auto-motion technologies to improve the safety, management, and efficiency of terrestrial transportation. Work on ITS within the ITU–R was initiated in 1995. An important application of ITS is the use of sensor technologies for the monitoring and identification of objects near vehicles. This application is now largely used.

Radiocommunication services have become extremely important to Public Protection and Disaster Relief (**PPDR**). Experience from recent major disaster events has shown that at times, PPDR agencies are solely dependent on radiocommunication services as the only form of communications available. In order to provide effective communications, PPDR agencies and organizations have set objectives and requirements that include interoperability between agencies and staff in the field, reliability, functionality, security in operations and fast call set-up for rapid access to wider communication networks. Future advanced solutions used in PPDR applications will require higher data rates than narrow-band solutions predominantly in use today, along with video and multimedia capabilities. Due to the variety of applications, the studies on PPDR are spread over all ITU–R Study Groups.

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Broadcasting service

From 1927, CCIR started work on standardization of television and sound **broadcasting**, ranging from studio production to distribution and delivery of associated signals, with constant attention to improving quality and spectrum efficiency and reducing power consumption and costs for the industry and the end users, contributing to the global success of this ecosystem.

In 1949, the ITU's first technical standards for television were released. ITU standards now cover all kinds of sound and vision broadcasting, including today's HDTV and UHDTV, multimedia and data transmissions to a plethora of devices.

In 1982, the adoption of Recommendation **ITU–R BT.601** on "Studio encoding parameters for digital television for standard 4:3 and widescreen 16:9 aspect ratios", paved the way for the development of digital television.

In 1990, the adoption of Recommendation **ITU–R BT.709**: HDTV standards for production and international programme exchange enabled the development of high-definition television broadcasting globally.

In 1995, ITU–R adopted the first standard for digital audio broadcasting (**DAB**), after 15 years of studies, enabling the advent of digital sound broadcasting.

From 2000 to 2006, ITU–R Study Groups conducted the studies in support of the Regional Radiocommunication Conference (**RRC-06**), which established the regulatory framework for the transition from analogue to digital television for 119 ITU countries of Africa, Europe, Central Asia and Middle East. **See video**.

In 2012, the adoption of Recommendation **ITU–R BT.2020-0**: Parameter values for ultra-high definition television systems for production and international programme exchange, paved the way for the development of UHDTV globally.

CCIR and ITU–R Study Group's important role in setting the foundations for international broadcasting was recognized by the US National Academy of Television Arts & Sciences, which gave Emmy Awards to the Union in 1983 and **2012**.

Science services

The ITU/**WMO** (World Meteorological Organization) Handbook "**Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction**" (2017), emphasizes the remarkable achievement of CCIR/ITU–R in delivering globally harmonized spectrum and standards for the terrestrial and space segments of WMO's global observing system, including active and passive sensing systems, data collection platforms, meteorological and oceanographic radars, lightning control system, radiosondes to protect human life, health and property and monitor and manage Earth resources.


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ITU–R **Study Group 7** outputs, such as the ITU–R Handbook "**Space research communications**" (2002), provide technical guidance on spectrum use and operational system characteristics to implement men or robotic space programs, such as International Space Station, Solar systems planetary missions and deep space universe exploration discoveries, contributing to the progress of overall human knowledge of the space environment and origin of the universe.

The ITU–R **Handbook on radioastronomy** (2013) summarizes the results of ITU–R studies on the characteristics of radioastronomy, preferred frequency bands for observation, special applications to facilitate development of the service worldwide and the study of fundamental sciences such as physics, cosmology, astrophysics etc.

ITU–R studies also allow the modern world to be synchronized. This essential condition is met by globally harmonized spectrum and standards for distribution reference frequency and time signal as described in the ITU–R Handbook "**Satellite Time and Frequency Transfer and Dissemination**" (2010).

Conclusion

Through the constant and careful investigation of radiocommunication systems, the activity of **ITU–R Study Groups** in conducting technical, operational and regulatory studies ensures that the global regulations, standards and practices, respond to the rapid technological and social evolution, while keeping harmful interference within manageable limits.

These studies support the ITU WRC process, which has been constantly improved over the years and delivers a stable and predictable global regulatory framework which ensures the long-term protection of the investments of a multi trillion-dollar industry, through the universal commitment of governments and all other stakeholders.

By their collaborative studies on the definition, harmonization and compatibility of all radiocommunication services, ITU–R Study Groups also produce universally applied standards and best practices which ensure that the development of all these services integrates technological advances in a non-disruptive way (by protecting and encouraging investments), is affordable to all (through the economies of scale resulting from global harmonisation and interoperability) and is sustainable in the long term (by ensuring efficient use of spectrum without harmful interference).

In summary, the work of ITU–R Study Groups and before it, that of CCIR, harnesses technological progress to the benefit of all and enables the long-term sustainability of the radiocommunication ecosystem, which has flourished over a century and become a fundamental part of today's world.

Directors of the International Radio Consultative Committee (CCIR) (1927–1993)

The first Director of the International Radio Consultative Committee (CCIR) was appointed in 1948 and took up his duties in 1949. The Director of the CCIR was subsequently elected by the CCIR Plenary Assembly initially for a six-year term and thereafter for three-year terms. From 1989, the Director was elected by the ITU plenipotentiary conference.

Balthazar VAN DER POL
Netherlands
1949–1956
1 January 1949 – 31 December 1956

Ernst METZLER
Switzerland
1957–1963
1 January 1957 – 20 June 1963

Leslie William HAYES
United Kingdom
1963–1966
Acting: 1 July 1963 – April 1964
Ad interim: 17 April 1964 – 31 August 1966

Jack W. HERBSTREIT
United States
1966–1974
1 September 1966 – 31 August 1974

Richard C. KIRBY
United States
1974–1993
1 September 1974 – 28 February 1993

Directors of the ITU Radiocommunication Bureau (BR) (1993-present)

Since 1994, the Director of the ITU Radiocommunication Bureau (BR) is elected by the ITU Plenipotentiary Conference for a four-year term and may be re-elected for one further term.

1993
1994

Richard C. KIRBY
United States
1 March 1993 – 31 December 1994

1995
2002

Robert W. JONES
Canada
1 January 1995 – 31 December 2002

2003
2010

Valery TIMOFEEV
Russian Federation
1 January 2003 – 31 December 2010

2011

François RANCY
France
1 January 2011 – present

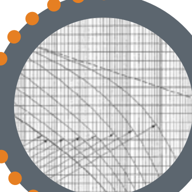
90th Anniversary CCIR/ITU-R Study Groups (1927–2017)

1927 Creation of the International Radio Consultative Committee (CCIR)

The International Radiotelegraph Conference, held in Washington in 1927, established the International Radio Consultative Committee (CCIR), and adopted the first Table of frequency allocations to the various radio services.

1929 First Plenary Assembly of the International Radio Consultative Committee (CCIR)

The International Radio Consultative Committee (CCIR) met for the first time in The Hague, Netherlands and adopted its first 24 technical Recommendations concerning frequency measurement and stability, frequency allocation, power limits on broadcasting transmitters and elimination of spark transmitters.



1937 Adoption of sophisticated radio wave propagation curves

The fourth International Radio Consultative Committee meeting adopted the famous "Cairo curves" for wave propagation at medium frequencies (MF) that were later used for the LF/MF Broadcasting Conference held in Geneva, 1975. Within two years World War II had erupted, and there were to be no more CCIR meetings for a decade.

1947 Establishment of specialized secretariats

The 1947 International Radio Conference (Atlantic City) decided that each of the International Consultative Committees for telephone, telegraph and radio (CCIF, CCIT, and CCIR) would have a specialized secretariat.

1949 Release of ITU's first technical standards for TV

ITU's first technical standards for television were released. ITU standards now cover all kinds of sound and vision broadcasting, including today's HDTV and UHDTV, multimedia and data transmissions to a plethora of devices.

1977 Planning of the broadcasting-satellite service

The World Administrative Radio Conference 1977 (WARC SAT-77) developed detailed plans and procedures for the broadcasting-satellite service, to permit the development of satellite television broadcasting in Regions 1 and 3.

1978 Enhanced reliability for aeronautical communications

As a result of a rapid increase in air travel and transportation, the volume of aeronautical communication had grown enormously. The World Administrative Radio Conference on the Aeronautical Mobile (R) Service (**WARC-Aer2**) revised the Frequency Allotment Plan for the aeronautical mobile (R) service to enhance the reliability of aeronautical communications.

1982 Global standard for digital television

Adoption of Recommendation **ITU–R BT.601** on "Studio encoding parameters of digital television for standard 4:3 and widescreen 16:9 aspect ratios", paved the way for the development of digital TV.

1983 Framework for maritime distress and safety systems

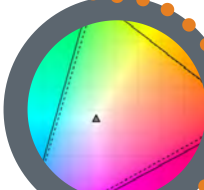
The first session of the World Administrative Radio Conference for the mobile services (**WARC MOB-83**) created the framework for the development of the Future Global Maritime Distress and Safety System.

1985 Use of the geostationary-satellite orbit (1st session)

The First Session of the World Administrative Radio Conference in 1985 (**WARC ORB-85**), set out the principles, methods and technical parameters to be used for planning the use of the geostationary-satellite orbit and the planning of space services utilizing it.

1988 Use of the geostationary-satellite orbit (2nd session)

The Second Session of the World Administrative Radio Conference in 1988 (**WARC ORB-88**) on the use of the geostationary-satellite orbit developed an Allotment Plan that provided each ITU Member country with one orbital position and associated frequencies for one national satellite providing domestic services, thus providing equitable and guaranteed access by all countries to the geostationary satellite orbit and the space services utilizing this orbit.



1990 Global standard for High Definition Television (HDTV)

Adoption of Recommendation **ITU–R BT.709**: HDTV standards for production and international programme exchange, enabled the development of high-definition television broadcasting globally.

1992 ITU paves the way to a wireless world

ITU first adopted spectrum allocations and identifications for future public land mobile telephone systems (FPLMTS) at the World Administrative Radio Conference held in 1992 (**WARC-92**). These decisions for FPLMTS, renamed International Mobile Telecommunications (IMT) in 1995, laid the foundation for the successful development of 3G mobile broadband networks.

The creation of three ITU Sectors

An Additional Plenipotentiary Conference in Geneva in 1992 streamlined ITU into three Sectors:

- **ITU–T** (the ITU Telecommunication Standardization Sector);
- **ITU–R** (the ITU Radiocommunication Sector); and
- **ITU–D** (the ITU Telecommunication Development Sector).

The International Radio Consultative Committee (CCIR), established in 1927, was integrated in the ITU's Radiocommunication Sector (ITU–R).

1995 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 was approved by ITU in 1995.

2000 Global standard for International Mobile Telecommunications

ITU approved the first global standard for IMT at the ITU Radiocommunication Assembly held in 2000 (**RA-2000**). The IMT-2000 (3G) standard enabled global roaming and greatly reduced cost, triggering the dramatic growth in mobile communications.

2006 From analogue to digital television

At the ITU Regional Radiocommunication Conference (**RRC-06**) a regulatory framework for the transition from analogue to digital television was agreed by 119 ITU countries of Africa, Europe, Central Asia and Middle East. **See video**.

2007 Radio spectrum for IMT mobile broadband

The World Radiocommunication Conference 2007 (**WRC-07**) identified globally harmonized frequency bands at 450 MHz, 800 MHz and 2.3 GHz for use by IMT, enabling operation of mobile broadband mobile on a global basis.

2012 Global Standards for IMT-Advanced mobile broadband (4G) and Ultra-High Definition Television (UHDTV)

- The ITU Radiocommunication Assembly 2012 (**RA-12**) agreed specifications for **IMT-Advanced** – the global platform for the generation of interactive mobile broadband services which is largely deployed worldwide (commonly known as 4G).
- Adoption of Recommendation **ITU–R BT.2020-0**: Parameter values for ultra-high definition television systems for production and international programme exchange, paved the way for the development of UHDTV globally.
- CCIR and ITU–R Study Group's important role in setting the foundations for international broadcasting was recognized by the US National Academy of Television Arts & Sciences, which gave Emmy Awards to the Union in 1983 and 2012.

2015 Radio spectrum allocated for global flight tracking and mobile broadband

Following the disappearance of Malaysia airlines flight MH370, the World Radiocommunication Conference 2015 (**WRC-15**) allocated spectrum to enable satellite reception of tracking signals to improve aircraft tracking in particular for polar, oceanic and remote areas. It also identified globally harmonized frequency bands at 700 MHz, 1.5 GHz and 3.5 GHz for use by IMT, enabling operation of mobile broadband on a global basis for 4G and 5G generations. Given the growing demand for broadband satellite communications to mobile platforms on land sea, and in the air, the Conference also set conditions for the operation of earth stations in motion, paving the way for satellite systems to provide global broadband connectivity on mobile platforms.

2016 High dynamic range for television and celebrations of the 110 years of the Radio Regulations

ITU celebrated 110 years of the Radio Regulations. See the **entire digital collection** of the Radio Regulations since 1906. See the ITU News Magazine edition: "**Celebrating the Radio Regulations**".

Adoption of Recommendation **ITU–R BT.2100-0** Image parameter values for High Dynamic Range Television (HDR-TV) for use in production and international programme exchange, set the scene for a new generation of television.

ITU Celebrates 90th Anniversary of the ITU–R CCIR/Study Groups

The **90th Anniversary of the CCIR/ITU Radiocommunication** (ITU–R) Study Groups coincides with the anniversary of the signing on 25 November 1927, of the Final Acts of the **International Radiotelegraph Conference** in Washington, 1927, which created CCIR.

ITU–R Study Groups at a glance

The ITU Radiocommunication Sector (ITU–R) Study Groups

World experts in radiocommunications, dedicated to studies in:

- The efficient management and use of the spectrum/orbit resource by space and terrestrial services
- Characteristics and performance of radio systems
- Operation of radio stations
- Radiocommunication aspects of distress and safety matters

plus:

- Preparatory studies for world and regional radiocommunication conferences
- Developing global standards (**Recommendations**)
- **Publishing best practices**, including reports and handbooks

More than 5000 specialists worldwide participate in the work of ITU–R Study Groups

See

ITU-R Handbooks

ITU-R Reports

ITU-R Recommendations

1 Spectrum management

Spectrum management is the combination of administrative and technical procedures necessary to ensure the efficient utilization of the radio-frequency spectrum by all radiocommunication services defined in the ITU Radio Regulations and the operation of radio systems, without causing harmful interference.

3 Radiowave propagation

Propagation of radio waves in ionized and non-ionized media and the characteristics of radio noise, for the purpose of improving radiocommunication systems.

4 Satellite services

Systems and networks for the fixed-satellite service, mobile-satellite service, broadcastingsatellite service and radiodetermination-satellite service.

5 Terrestrial services

Systems and networks for fixed, mobile, radiodetermination, amateur and amateur-satellite services.

6 Broadcasting service

Radiocommunication broadcasting, including vision, sound, multimedia and data services principally intended for delivery to the general public.

7 Science services

"Science services" refer to the standard frequency and time signal, space research (SRS),space operation, Earth exploration-satellite (EESS), meteorological-satellite (MetSat), meteorological aids (MetAids) and radio astronomy (RAS) services.

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> *ITU–R's work to ensure efficient global spectrum use is a passion that the GSMA shares.*
>
> Mats Granryd

ITU–R – Making spectrum work

Mats Granryd

Director General, **GSMA**

Mobile is a global platform, delivering connectivity into the hands of more than five billion people globally and, perhaps more importantly, creating huge social and economic opportunities to citizens in all corners of the world. Mobile's rapid and unparalleled success would not have been possible without the ITU Radiocommunication Sector (ITU–R) and particularly the work of the ITU–R Study Groups, which carry out the studies in support of the decisions of the Sector and adopt the global harmonized standards for mobile transmissions.

Mobile – A young industry's achievements

Earlier this year, the mobile industry connected its five billionth unique subscriber. Reaching this landmark is a tremendous achievement for an industry that is only a few decades old. It reflects the trillions of dollars that mobile operators have invested in networks, services and spectrum. This investment allows spectrum to bring the power of mobile broadband to people around the globe and help deliver on the promises of the United Nations Sustainable Development Goals.

In addition to the direct impact on the lives of users, mobile networks are critical to national prosperity. In 2016, the mobile industry generated USD 3.3 trillion in economic value – 4.4 per cent of global GDP – and contributed USD 450 billion to public funding. Harmonization of mobile spectrum through the ITU Radiocommunication Sector (ITU–R) is the fuel that powers this economic engine. This is why ITU–R's work to ensure efficient global spectrum use is a passion that the GSMA shares.

Creating the opportunity for mobile growth has long been the subject of the World Administrative Radio Conferences (WARCs) and now World Radiocommunication Conferences (WRCs) run by the ITU–R. The ITU–R was an early leader in recognizing the need for harmonized spectrum for mobile in the 1980s, resulting in a 230 MHz identification of spectrum in 1992.

This spectrum ultimately formed the backbone for 3G technologies that are available all over the world today.

Spectrum for mobile broadband

Keeping pace with a rapidly growing and evolving industry, and the expectations of citizens globally, mobile was once again on the agenda eight years later. **WRC-2000** identified, among others, the 2.6 GHz band, which would become a primary capacity spectrum for mobile broadband.

Later, **WRC-07** achieved another important milestone in the history of mobile. For the first time, lower frequency bands that had historically been part of the TV broadcast bands were made available for mobile broadband. That decision opened the door for connecting hundreds of millions of people in rural areas using this important coverage spectrum below 1 GHz.

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Identified also at WRC-07, and expanded at **WRC-15**, the C-band is poised to be a key band for the delivery of 5G services. It will be one of the first bands to carry 5G traffic, making it critically important for mobile operators seeking to offer the power of next-generation mobile services to consumers and businesses.

These wide regional or global identifications of spectrum, achieved through difficult negotiations managed under the umbrella of the ITU–R, have allowed new technology roll-out to accelerate. They have created vast ecosystems of mobile devices with economies of scale passed onto consumers. This affordability has been crucial in widening the availability of broadband to citizens all over the world.

Spectrum harmonization is only possible when industry stakeholders and governments work hand-in-hand in the framework provided by the ITU–R. The identification of specific bands for mobile use at WRCs is an important first step, followed by the adoption of global standards in ITU–R Study Group 5 and by national implementation by governments and deployment by mobile operators.

Additional spectrum — central to further mobile growth

Working together, we have the opportunity to achieve another milestone in mobile communications for the world's citizens. Additional spectrum is central to expanding and upgrading mobile broadband services — and core to the future success of 5G. Most notably, the speed, reach and quality of 5G services will be heavily dependent on governments and regulators supporting timely access to the right amount and type of spectrum, and, importantly, under the right conditions.

The next two years are critical to delivering the additional capacity vital to 5G growth. Governments and regulators hold the key to realizing the potential of 5G as they work to agree on new mobile bands above 24 GHz when the ITU–R convenes **WRC-19**. In the process, they will be helping mobile operators to provide exciting and innovative new services, further supporting national economies and delivering on the targets on the United Nations Sustainable Development Goals.

The amazing impact the mobile industry has had on lives and economies around the globe is only possible through collaboration. Working together, we can connect everyone and everything to a better future.

"The ITU–R Study Groups bring sustainability to the overall radiocommunication ecosystem."

Aarti Holla

ITU–R Study Groups – Supporting the development of the satellite sector

Aarti Holla

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

For decades, the ITU Radiocommunication Sector (ITU–R) Study Groups have supported the development of the satellite sector. By developing worldwide regulations, harmonized standards and best practices for the use of spectrum, the Study Groups bring sustainability to the overall radiocommunication ecosystem.

By inviting all 193 Member States and every industrial sector to participate, the ITU–R Study Groups provide a focal point for spectrum experts of all disciplines to share their expertise and experience on radiocommunication services. As such, they represent a comprehensive and unique source of knowledge in all fields of spectrum management, with decisions based on bridges of cooperation between experts from diverse disciplines such as broadcasting, mobile, satellite, science and also propagation.

Through this broad representation, ITU–R Study Groups are a fair, solid and resource-efficient way of addressing a growing number of technical and regulatory issues to support the development of new radiocommunication systems while achieving essential objectives such as:

- **Efficient spectrum management:** By providing the fundament for well-balanced, well-informed and globally applicable spectrum decisions, the ITU–R Study Groups give the best chance to ITU Member States to efficiently manage the spectrum needed to meet the UN's 2030 Sustainable Development Goals (SDGs).

- **"Best practices" for regulators:** ITU–R Study Groups enable ITU Member States to efficiently manage their spectrum by encouraging "best practices" for their regulators.

- **Evolution of technology:** ITU–R Study Groups support the evolution of technology and encourage Member States to adopt regulations for new state-of-the-art technologies and standards.

Ultimately, ITU–R Study Group deliverables support the adoption of reliable communications across the globe, of which satellite communications is one. Broadband connectivity via satellite for example, helps to ensure inclusive and equitable education; bring health care to those who might otherwise never receive treatment; and achieve gender equality and empowerment of women and girls through training and new opportunities. Better education brings a higher standard of living for parents and their children while telehealth raises life expectancy and improves the quality of life overall.

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Satellite technology is central to numerous endeavours impacting various SDGs: improving access to information, education, health, finance and commercial opportunities, and supporting global challenges such as climate change, which all ultimately serve to improve global society as a whole.

ITU–R Study Groups are also paramount in supporting key technological trends and the emergence of new systems that will provide new connectivity options and drive lower costs.

- **Non-geostationary constellations:** Recent advances in technology both in the space and ground segments of satellite networks, have led to multiple proposals for constellations using non-geostationary satellite orbits (NGSOs). The ITU–R Study Groups will be at the epicenter of spectrum and orbital use decisions for such constellations.

- **Very High Throughput Satellites (VHTS):** Incorporating new technologies that will provide hundreds of Gbps of capacity.

- **Mobility in general (such as earth stations in motion (ESIMs)) and the desire to be connected at all times in all places:** ITU–R Study Groups will continue to play a vital role in ensuring continuous spectrum access for these systems.

At a time when new technologies require harmonization and certainty in order to drive vital infrastructure investment, one of the main challenges for ITU–R Study Groups is to ensure co-existence of satellite and terrestrial infrastructure. This is particularly needed for the implementation of 5G which will be an ecosystem of multiple, diverse networks complementing each other to ensure universal access to reliable, ubiquitous and secure broadband connectivity.

ESOA remains committed to contributing to ITU–R Study Groups as they foster the cooperation amongst regulators and stakeholders necessary to ensure everyone can access truly ubiquitous, mobile broadband, remembering that satellite systems are the only technology offering true geographic ubiquity and resilience on land, sea, and in the air.

“UHDTV is the most powerful media the world has known – thanks to the ITU–R Study Groups.”

Noel Curran

ITU–R Study Groups – The gold standard for technology

Noel Curran

Director General Designate, European Broadcasting Union (**EBU**)

It’s easy to see why our members support and encourage the ITU Radiocommunication Sector (ITU–R) Study Groups. The 73 national broadcasters in the EBU understand that common worldwide technical standards and regulated frequency channels, free of interference, create a well served and informed public, drive up competition, and drive down consumer equipment costs.

We know that creating consensus on standards or frequency plans can be more than difficult. Common standards are not always possible; but we insist that, “the game is worth the candle”.

Frequency planning studies

International frequency plans are giant jigsaw puzzles that call for a range of studies into the elements that will make up the plan.

ITU received the prestigious **Emmy Award** from the US National Academy of Television Arts and Sciences at the 2012 Consumer Electronics Show on 12 January 2012 in Las Vegas for the "Standardization of Loudness Metering for Use in Broadcast Audio", developed by Study Group 6.

The ITU–R has been the beacon for frequency planning studies for broadcasting since 1927. The EBU has played its full role in the ITU–R Study Groups in providing the tools and technical parameters that make frequency plans possible. The ITU–R needs to ensure viewers receive broadcasting services free of interference and noise. This includes recommending limits for radiation from electrical equipment liable to emit noise and interference. Harmonization of technical parameters contributes also to large scale equipment production, ensuring lower costs for consumers.

Multimedia and media accessibility

The ITU–R has not neglected multimedia, adding to television and radio services, and providing services to help those with reduced abilities. Early systems of "Teletext" have migrated to today's hybrid broadcast-broadband that draw on the strengths of broadcasting and broadband Internet. As we move into a world with an aging population, providing services that are accessible, using elements such as subtitling, audio descriptors, signing, becomes increasingly important.

The evolution of television and radio

Television has moved from the small dim black and white screen in the corner to today's huge screen on the wall with ultra-high definition. Through all its stages, the ITU–R Study Groups have been there debating the options and striving for common standards. Radio too has evolved from crackly MW/LW sets, through FM, stereo, to digital radio thanks to the ITU–R and its Study Groups.

A time it was. In the late 1970s, common sense broke out and the world realized what the multiplicity of analogue television standards cost the public. There was a common will to create a single worldwide television standard. Success came. It was a turning point in media technology. It happened because of the forum the ITU–R Study Groups provided – and the respect with which their work is held in the industry. The agreed system, Recommendation 601, forms the basis of all television systems developed since then. It brought an **Emmy Award** to ITU–R Study Group 6.

ITU's Dean of TV Standards – the remarkable Professor Mark Krivocheev (former Chairman of Study Group 6) – is interviewed on the future of digital TV during ITU's celebration of 40 years of digital TV (1972–2012)

Read more about Professor Mark Krivocheev's outstanding achievements at ITU in studies in the field of broadcasting.

In recent years, the ITU–R agreed the specification for Ultra High Definition Television and Advanced Sound Systems, including a whole range of features designed to immerse the viewers in the programmes they are watching. In terms of its impact, its power to hold and interest the viewer, UHDTV is the most powerful media the world has known – thanks to the ITU–R Study Groups.

Sound advice – small as well as big revolutions

The coming of digital sound gave more freedom to broadcasters to set sound signals for radio or television services, and (alas) more opportunities for different settings. This is solved by an ITU–R process called loudness control, developed by ITU–R Study Group 6, which won a well-deserved Emmy Award for it.

The constituents of the ITU–R Study Groups

There is a myriad of individuals who have forged the ITU–R Study Groups into what they are today. We cannot mention them all, but only cite the remarkable Professor Mark Krivocheev, who chaired the CCIR/ITU–R Study Group 6 for many years in its formative years and has been participating in the work of ITU–R Study Group 6 for 70 years. The ITU–R Study Groups include the permanent ITU staff and hundreds of worldwide delegates who contribute to its work. The EBU warmly acknowledges them.

> **"WMO Members' abilities to meet their mandate now relies more heavily than ever on the support of ITU–R and its Study Groups."**
>
> Petteri Taalas

ITU–R Study Groups – Spectrum for meteorology

Petteri Taalas

Secretary General, World Meteorological Organization (**WMO**)

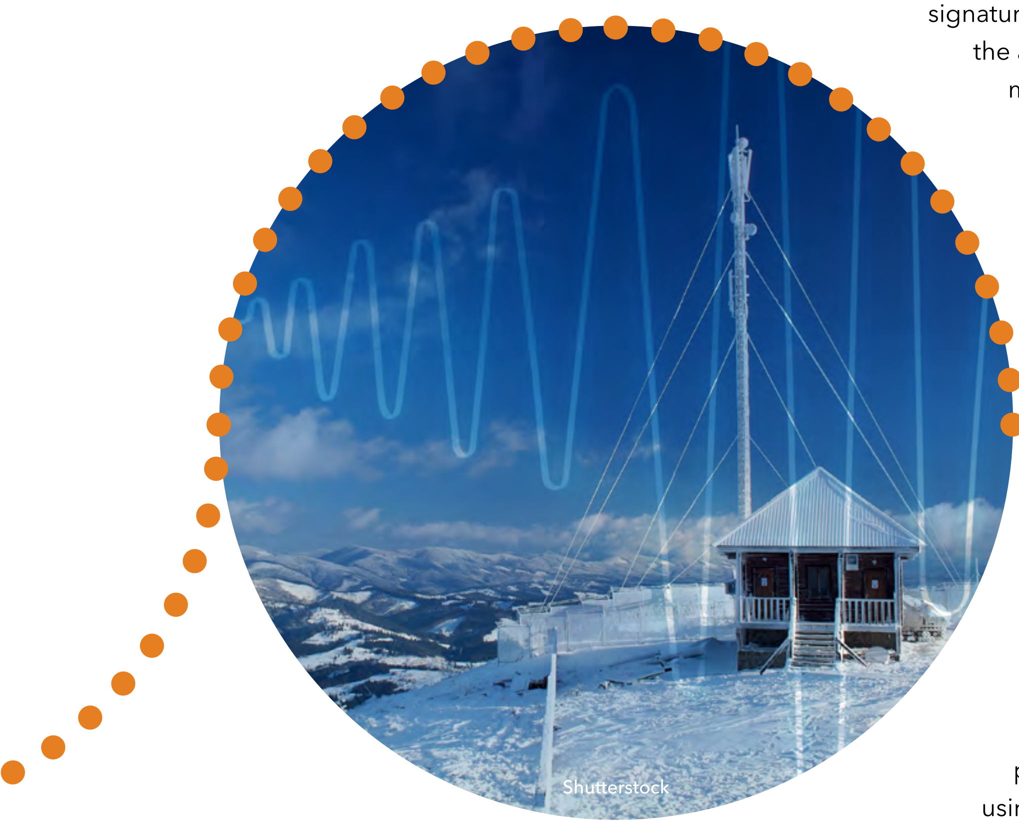
WMO and ITU have had a long and close relationship right from their early years.

WMO, formerly the International Meteorological Organization (IMO), in the mid to late 19th century, relied on the ability to take observations of weather related elements, gather these together and map them out to show their spatial characteristics and variations. Analysis of collective observations allowed scientists to better understand the physical behaviour of the atmosphere and oceans.

Over time, research based on these analyses led to the creation of conceptual models that could be used by meteorologists to anticipate a future state of the atmosphere based on an analysis of its current state. In order to provide services based on this new science, meteorologists needed to gather observations as quickly as possible to be able to create analyses of the weather in near real time. Real time collection of data was made possible by the use of telegraph systems to submit encoded messages of observations to central collection points.

With this strong dependency of meteorology on telegraphic services, it should be no surprise that many early observing stations were also telegraphic offices, and daily observations were linked to telegraphic stations working hours. For example, daily rainfall totals are still measured from 9 am to 9 am in many countries.

Utilizing international telegraphic infrastructure, IMO developed and led the collaborative mechanisms that enabled meteorologists to promptly share nationally collected data with each other well into the 20th century. This allowed wider, more timely coverage that facilitated operational activities and further research, which in turn led to better predictions and a wider range of services.



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History of a fruitful relationship

While the relationship between ITU and IMO started with the telegraphic collection of observations, it was the use of wireless radio communications to collect observations from remote stations and to distribute forecasts and warnings that led to the CCIR (International Radio Consultative Committee) and IMO relationship. Wireless communications are very dependent on the transmission properties which in turn are dependent on radio wave propagation and on the appropriate sharing of the spectrum among other users.

The relationship between CCIR and IMO grew further as the science of remote sensing developed. Remote sensing is primarily the science of understanding the electromagnetic signatures of elements or activities in the atmosphere from their transmitted, reflective or refractive radiative properties. For example, the use of wireless communications led to the discovery of spherics, a technique for mapping interference on wireless transmission by lightning in thunderstorms. By identifying the direction of the source and timing of the crackling interference heard on radios at multiple points allowed meteorologists to map the position of thunderstorms using trigonometry.

Meteorologists were then able to use conceptual models to identify cold fronts and other weather systems remotely further enhancing their ability to identify the current state of the atmosphere. The science of lightning detection has developed significantly and is now an important source of information for warning services. As recently as World Radiocommunication Conference 2012 (**WRC-12**), it benefited from new specific frequency allocations for passive lightning sensors under Meteorological Aids service.

What did the advances in radiolocation technology bring?

Use of the electromagnetic spectrum to remotely sense atmospheric parameters grew rapidly with advances in radiolocation technology. For example, the observed noise in returned signals during the development of radar for detecting aircraft in the early 20th century led to the development of weather radar. The ability to view the Earth from Space-based platforms following the launch of Sputnik in the mid-20th century soon after the establishment of WMO from IMO, led to the ability to measure many elements in the atmosphere using remote sensing. Combined with advances in computing and modelling technology, these remote sensing and advance communications have been a major contributor to the advances in the ability to analyse the state of the environment and accurately predict future states on a global basis in real-time.

This in turn has led to far more reliable forecasts and action-orientated services from National Meteorological and Hydrological Services, that are needed to further the United Nations Sustainable Development Goals impacted on by continuing high likelihood and impact of weather and climate-related extreme events.

In addition to their impact on remote sensing, essential to the improvements in the accuracy and timeliness of services, Space- and Earth-based platforms are critical components of WMO's information collection and distributions services that enable society to benefit immediately from the WMO community's science research and services.

WMO and ITU–R Study Groups – Essential cooperation

WMO Members' abilities to meet their mandate now relies more heavily than ever on the support of ITU–R and its Study Groups in managing spectrum globally. This cooperation is essential for supporting Meteorological Satellite Services (Metsat), Meteorological Aids Services (Metaids), Radiolocation Services (covering weather radar and wind profilers) and the Earth exploration-satellite service (EESS). Although WMO works with all ITU–R Study Groups, the main activity is led through Study Group 7 for Science Services.

> ***"An ITU-R Study Group worked out how DME (distance measuring equipment) could be protected."***
>
> Dominic Hayes

Paving the way for satellite navigation

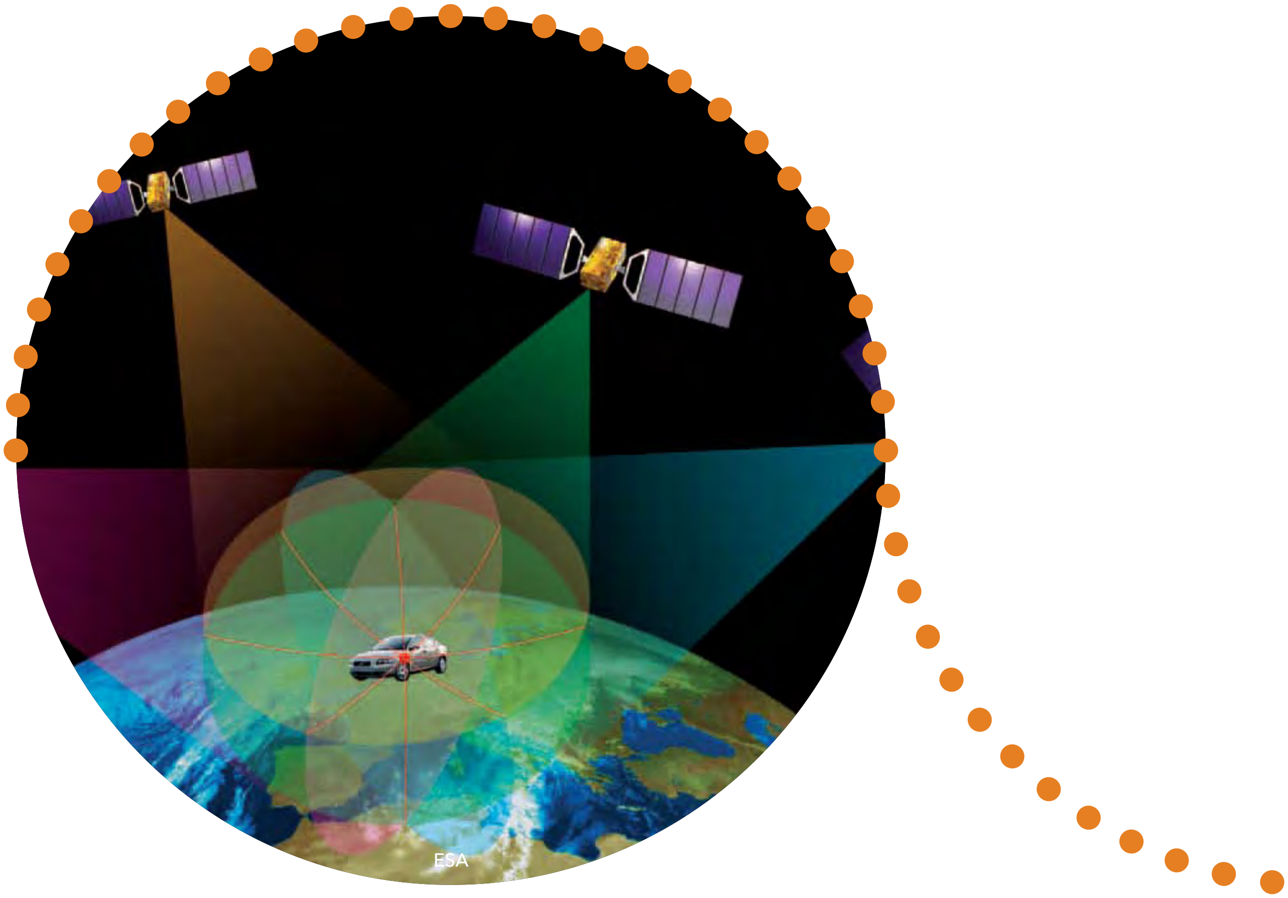
Dominic Hayes

Signals and Frequencies Manager, European Commission (**EC**), and
Convenor, WRC Resolution 609 Consultation Meeting

Radionavigation satellite service, even in its acronym form, RNSS, is rather a mouthful for an average person and probably meaningless; strange, as it underpins the multi-billion dollar navigation and timing industry. Say satellite navigation or "satnav" and the same person is more likely to be on your wavelength, but rightly or wrongly "GPS", is what most people associate with RNSS – even if using another global satellite navigation system (GNSS) such as GLONASS, Galileo or BeiDou (or regional QZSS or NAVIC systems) on their smart phone or in their car.

Laying the foundations for satellite navigation

ITU has been instrumental in laying the foundations for satnav, for even if super-accurate clocks are the beating hearts of each navigation satellite, it is the radio frequencies that are the arteries conveying the navigation signals to users and connecting the system together. Without a stable radio environment and availability of suitable frequencies, satellite navigation signals could not be pumped around the globe.



Today, the vast majority of satnav devices use a single frequency range set aside for RNSS in the distant past. Sandwiched between frequencies used for low-powered portable satellite communications and quiet-as-a-mouse radio astronomers, it is a relatively peaceful radio neighbourhood, perfect for receiving the extremely low power signals, from RNSS satellites more than 20 000 km above our heads, using nothing more than a small antenna in your smartphone.

Even as someone familiar with RNSS systems, I find it staggering that satellite navigation works at all — testament to the brilliance and ingenuity of the GPS and GLONASS designers back in the 1970s and 80s.

However, that single RNSS band has become rather crowded, so if we want even better and more reliable satnav performance in future, new frequency bands are required… This is just what experts concluded back in the late 90s and after much hard work, three new frequency ranges were set aside for RNSS at the World Radiocommunication Conference (WRC) in 2000.

The importance of protecting systems

But the hard work did not stop there, because the new frequencies were already being used by other radio systems. Therefore the experts had to work out how RNSS should operate so as not to cause problems for those other systems. "DME", or distance measuring equipment, is one such system, a primary aviation navigation aid operating in frequencies almost exclusively used by aviation and designated as a safety service; this made it all the more important for RNSS to demonstrate that it would not harm existing systems. An ITU–R Study Group worked out how DME could be protected and this was then enshrined in the Radio Regulations at WRC-03. At that time it was unknown how many RNSS systems would share the frequencies with the safety critical system, so the WRC also resolved that the relevant RNSS interests should meet regularly to confirm that the combined RNSS radio signals do not harm DME operations. The "Resolution 609 Consultation Meeting" takes place once per year to do just that, and I have the honour to be its current convenor – a role previously occupied by illustrious colleagues from the US, France, Japan and China. My vice convenor is from Nigeria, demonstrating that it's not just the long-established space players that have an interest in representing satellite navigation.

On the verge of 'GNSS 2.0'

Although the new RNSS frequencies were set aside in 2000, it's only recently that the RNSS systems are starting to use those new frequencies for anything other than tests (such is the long development time of satellite systems). This year, the first dual frequency satnav chip aimed at the mass market was released. This uses the longstanding RNSS frequency, but also adds one of the new frequencies. So, with a host of new satnav systems becoming fully operational in the next few years and dual frequency satnav enabling more accurate, precise and reliable navigation for things such as autonomous vehicles, I'm convinced we are on the verge of "GNSS 2.0".

Today, thanks in part to the stable radio environment fostered by ITU, satnav tells the world where it is, where it's been and where to go. But in future, it's likely to do much, much more.

> ***"I would like to express ICAO's deep appreciation for the contributions of the ITU and its Study Groups to our work."***
>
> Fang Liu

Assuring aviation's role as lever for global development

Dr Fang Liu

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

Today, 100 000 flights depart each day, and each flight has never been safer. This has been achieved through ICAO's regulatory framework, which includes international standards for communication, navigation and surveillance systems. These leverage safety-related factors unlike those of any other frequency spectrum user. This specificity means that the ITU's cooperation with ICAO is of superlative importance to the endurance of aviation's continuous improvements to safety and efficiency.

These improvements are critical to the delivery of the significant socio-economic developmental benefits enabled by ICAO-compliant air connectivity. In other words, continued progress on these issues, with ITU's support, represent profoundly strategic contributions to the realization of the UN's Agenda 2030 Sustainable Development Goals.

As sister agencies within the UN system, ICAO and ITU are facing significant but surmountable challenges as we assure aviation's role as lever for global development, literally and figuratively lifting millions out of poverty. Already, we anticipate that global air traffic volumes will double within twenty years. While this growth represents a terrific opportunity, it will also call for the allocation of significant political, financial and technical resources to ensure it can be sustainably managed and translated into socio-economic outcomes.

New aviation technologies – Unmanned aircraft systems

In addition to this, a variety of new aviation technologies are being deployed. A great example here are Unmanned Aircraft Systems (UAS). UAS can achieve everything from the vitally pragmatic, such as the delivery of time-crucial medicines in remote and highly-developed regions alike, to the supremely ethereal, by way of photography that changes our perceptions of ourselves and the world we live in. These technologies are opening hitherto unimaginable opportunities. In many ways, with these new technologies, we find ourselves in the same situation as the visionaries who devised the foundational structure for air transport over seventy years ago. In the same way as these visionaries, we should safeguard the resources these technologies need to ensure the realization of their full potential. And it is the case with aviation as we know it today, these technologies will need access to spectrum.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Here, the ITU and its very successful and expertly managed Radio Regulation Study Groups (ITU–R) come into focus. Aeronautical spectrum is often seen as very desirable by other spectrum users seeking access to global markets. In this context, the ITU–R Study Groups and their associated Working Parties provide the necessary forum for balanced deliberations, ensuring the World Radiocommunication Conferences (WRC) make informed decisions. From ICAO's perspective, the ITU–R Study Groups are therefore an essential backbone.

Examples of ITU/ICAO collaboration

Moreover, ITU–R Study Group 5 (Terrestrial Services) and its Working Party 5B (Aeronautical, Maritime and Radiodetermination), are addressing Resolution 155 (WRC-15).

This defines conditions for utilization of the fixed satellite service for control and non-payload communications of UAS. This resolution requires ICAO to develop standards for such radio links before 2023, a task which ICAO is currently undertaking with the assistance of our Remotely Piloted Aircraft Systems Panel. These studies are a good example of the interdependency of the two organizations. Again, this is just one example. To give another example that will speak deeply to all of us, Working Party 5B will play a fundamental role in the implementation of ICAO's Global Aeronautical Distress and Safety System (GADSS), developed in response to tragic loss of flight MH-370.

This year, we are celebrating the 90th anniversary of the ITU Study Groups. On the behalf of ICAO, I would like to express ICAO's deep appreciation for the contributions of the ITU and its Study Groups to our work, as well our confidence that this profoundly collegial cooperation will continue for decades to come in support of the global community that we mutually serve.

"The work of the Study Groups and their Working Parties has been of utmost importance for the maritime community."

Kitack Lim

ITU-R standards – Advancing maritime communications

Kitack Lim

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

The International Maritime Organization (IMO) is a much younger organization than ITU. It was established in 1948, as the Inter Governmental Maritime Consultative Organization (IMCO), and it changed its name in 1982 to IMO.

ITU and IMO, both specialized agencies of the United Nations, have worked together since 1959, when IMO began its work following entry into force of the IMO Convention.

Already in January 1960, the IMCO Council agreed to maintain close, but informal, liaison with intergovernmental organizations, including ITU.

Over the years, the ITU Radiocommunication Bureau and the IMO Secretariat have established and strengthened these informal contacts and established formal collaboration. IMO and ITU currently cooperate very effectively in the area of maritime radiocommunications.

From the outset, representatives of the IMO Secretariat have participated in meetings of the International Radio Consultative Committee (CCIR) and ITU–R Study Groups. The work of the Study Groups and their Working Parties has been of utmost importance for the maritime community, in particular in recognizing and protecting interference free radiocommunications for maritime safety of life and search and rescue services. This work has resulted in many ITU–R Recommendations and reports and has provided a technical basis for input to the World Radiocommunication Conferences.

ITU–R Study Group standards for maritime communications

ITU–R Study Groups have standardized technical characteristics and channeling arrangements for different type of maritime communications, ranging from narrow band telegraphy and digital selective calling systems, through to the standards for Automatic Identification System (AIS) and data transmission applications. A current focus is on e navigation related issues, which might result in the need for regulatory measures in the near future. Some of these standards and frequency plans have become an integral part of the ITU Radio Regulations (**RR**), such as Recommendation **ITU–R M.1171** or HF and VHF channeling arrangements contained in Appendices 17 and 18 to the RR.

IMO

The Global Maritime Distress and Safety System

Intensive work in the ITU–R Study Groups and their Working Parties (WP) has been hugely relevant for IMO, for example, when IMO adopted the Global Maritime Distress and Safety System (GMDSS) in 1988, following the 1983 and 1987 World Administrative Radio Conferences for the Mobile Services (**WARC MOB-83** and **WARC MOB-87**).

The GMDSS today ensures rapid alerting of search and rescue services in the event of an incident, anywhere on the oceans.

The maritime community has particular interest in the ongoing work undertaken in ITU–R Study Group 5 (terrestrial services), in particular, WP-5B dealing with issues related to the maritime mobile service, including the GMDSS. Also of great relevance is the work undertaken in Study Group 4 (satellite services), in particular, WP-4C dealing with the mobile satellite service (MSS).

Both WP-5B and WP-4C are currently conducting studies with respect to supporting the introduction of additional satellite systems into the GMDSS, ahead of the 2019 World Radiocommunication Conference (**WRC-19**). IMO is in the process of reviewing the GMDSS and recognizing a particular additional mobile satellite system, which could support the GMDSS. The regulatory protection of this safety of life at sea communication system needs to be decided by WRC-19.

The Joint IMO/ITU Experts Group on Maritime Radiocommunication Matters

To assist the work in the ITU–R Study Groups, as well as the work in IMO's Sub Committee on Navigation, Communications and Search and Rescue (NCSR), ITU and IMO have established the Joint IMO/ITU Experts Group on Maritime Radiocommunication Matters.

The purpose of the Experts Group is to advise on the development of future requirements for maritime radiocommunications, taking into account the operational needs as defined by IMO and the regulatory needs as defined by ITU. Currently, the Experts Group plays an important role in the preparation of the maritime related agenda items for WRC-19 and the ongoing work on the modernization of the GMDSS and the implementation of e navigation.

Against a background of continuous growth in demand for spectrum from almost all radiocommunication services, 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, in particular for the GMDSS, and in continuing its close collaboration with ITU.

I congratulate ITU as it celebrates 90 years of the CCIR/ITU–R Study Groups and look forward to further work together as the world of communications moves inexorably towards an increasingly digital era, with both the opportunities and challenges this presents.

"There is almost 20 years of history in the ITU of work dedicated to ensuring available spectrum for critical communications."

Tony Gray

Addressing a critical need

Tony Gray

Chief Executive, TETRA and Critical Communications Association (TCCA)

Is the size of a market related to its importance? In the commercial world, the answer would have to be yes, but in our critical communications world the answer is a definite no. And therein lies the issue of spectrum requirements for Public Protection and Disaster Relief (PPDR) safety services.

Our wide protection and support network for critical communications

The worldwide network of first responders such as the police, fire and ambulance services, civil defence forces, border guards, armed forces, search and rescue teams and other invaluable organizations are our protection and support during events that threaten our lives and security, our communities, our property, our environment — our peace.

Compared to the billions of commercial users, the professional critical communications user base is very small – but it is crucial. Those professionals cannot work effectively without their trusted communications, and spectrum is critical to the efficient delivery of those communications services.


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ITU ensures available spectrum for critical communications

There is almost 20 years of history in the ITU of work dedicated to ensuring available spectrum for critical communications. Based on a proposal from the Indian Administration and supported by the Asia Pacific Telecommunity (APT), ITU **WRC-2000** in Istanbul acknowledged the urgent need for harmonization of spectrum needs of public safety agencies.

ITU–R Study Groups were asked to undertake a detailed study and prepare for a **WRC-03** agenda to harmonize the narrowband, wideband and broadband spectrum requirements of PPDR agencies.

Studies carried out in ITU–R during 2000–2003 lead to the development of **ITU–R Report M.2033** on Public Safety requirements. This report documented the current and future needs of the Public Safety agencies worldwide in that period.

Based on these studies, WRC-03 adopted Resolution 646 which, among other things, adopted the definition of PPDR as: Public Protection – maintenance of law and order, protection of life and property and emergency situations on a daily basis (the same meaning as Public Safety); and Disaster Relief – relief from a serious disruption of the functioning of society, posing a significant widespread threat to human life, health, property or the environment.

A number of frequency bands were identified for advanced public safety solutions to meet the needs of PPDR agencies. These agencies and related organizations were encouraged to utilize relevant ITU–R Recommendations in planning spectrum use and implementing technology and systems supporting PPDR. The benefits of spectrum harmonization were listed to include increased potential for interoperability in PPDR situations, and manufacturers encouraged to take into account the harmonized bands in future equipment designs, including the need for countries to operate within different parts of the identified bands.

As a follow up to the WRC-03 Resolution 646, ITU–R Study Group 5, in particular working parties 5A and 5D, developed a number of reports and recommendations. These included guidance on frequency arrangements for PPDR in bands identified in Resolution 646, guidance on radio interface standards for use by PPDR operations in some parts of the UHF band in accordance with Resolution 646, and the use of International Mobile Telecommunications for broadband PPDR applications.

Enhanced services from 2012

WRC-12 recognized that in today's broadband age, PPDR agencies would be looking to broadband wireless communications to supplement and enhance their services, and adopted an agenda item to further update Resolution 646 to meet the spectrum needs of broadband PPDR.

As requested by WRC-12, ITU–R carried out further studies on PPDR, and based on these, WRC-15 revised Resolution 646 and harmonized 694–894 MHz (700-800) as the global frequency range for broadband PPDR. Further studies are now being carried out in WP-5A to develop harmonized frequency arrangements in various bands as asked for by WRC-15.

Many countries around the world have started implementing broadband PPDR based on the results of ITU–R studies and in particular adopted 694–894 as the frequency band for public safety LTE. We are very grateful to all those who have supported the call to ensure critical communications spectrum has a voice. As a result, we can look forward to a future where the contribution of our community to the safety of societies is recognized and protected.

"The work of ITU–R Study Group 7, as well as the other Study Groups, is invaluable in trying to meet the challenges of our ever changing world."

John Zuzek

Enabling science services and enhancing knowledge

John Zuzek

National Spectrum Program Manager, National Aeronautics and Space Administration (**NASA**) and ITU–R Study Group 7 Chairman

Everyone is familiar with the myriad of uses of the radio spectrum for telecommunications applications from broadcast television for our information and entertainment, wireless services which connect us through our mobile devices all over the world, to satellite communications systems and more.

But there is a set of radio services that are quite different and unique from those for which we are most familiar. In the ITU–R and its predecessor, the CCIR, these special radio services are known as the science services.

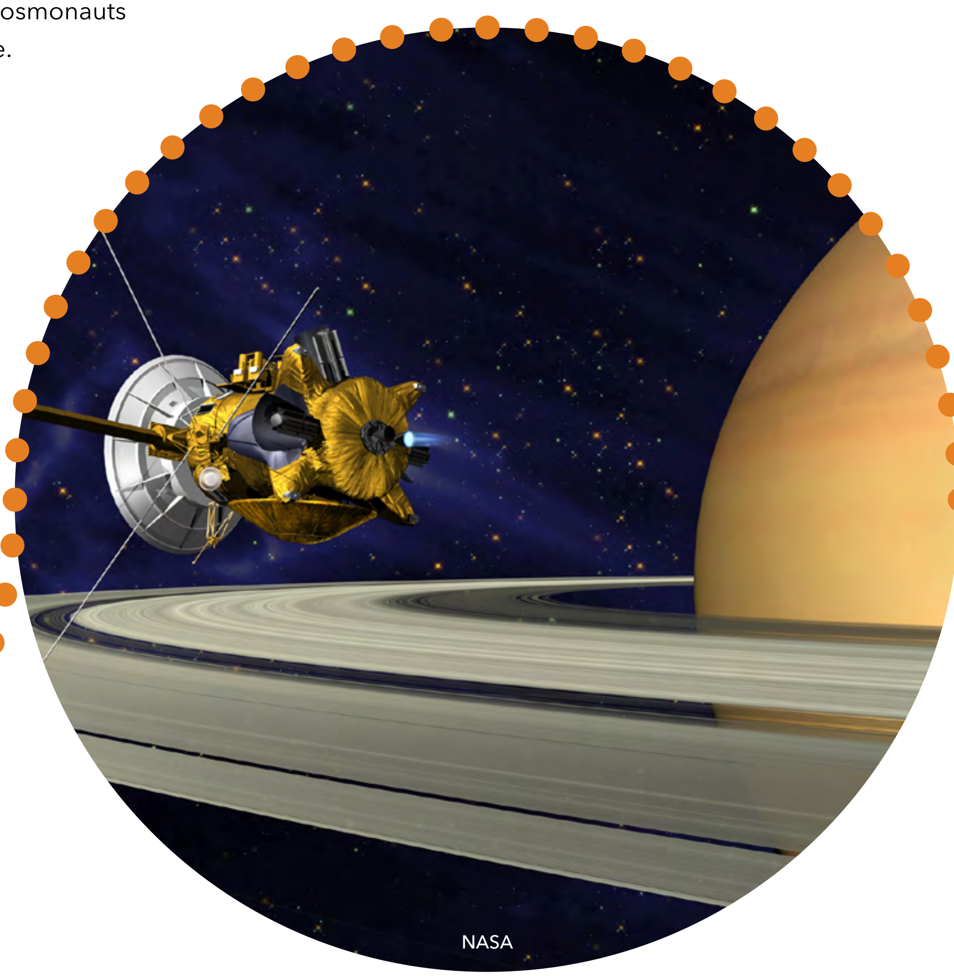
While the operation of radio systems in the science services is certainly similar to more well-known radiocommunication services in that they transmit and receive information, their purpose is rather different.

The information gathered, transmitted and received by these systems does not in itself provide obvious quantifiable economic benefits, directly fuel economic growth, or provide entertainment for most of the population. Instead, systems operating in the science services provide something of inestimable value to humankind: knowledge.

Systems operating in the science services enable us to distribute standard time and frequency information, obtain important data about the Earth and its atmosphere, provide vital information for weather forecasting, study other planets and extraterrestrial bodies, explore our solar system, peer into the depths of the cosmos, and communicate with astronauts and cosmonauts working in space.

Study Group 7's early years

Before its transformation into ITU–R Study Group 7, CCIR Study Group II dealt with matters of space research and radio astronomy as those were the earliest ventures into using radio waves for scientific purposes. Within ITU–R Study Group 7, the original CCIR topics were further defined to cover 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.



NASA

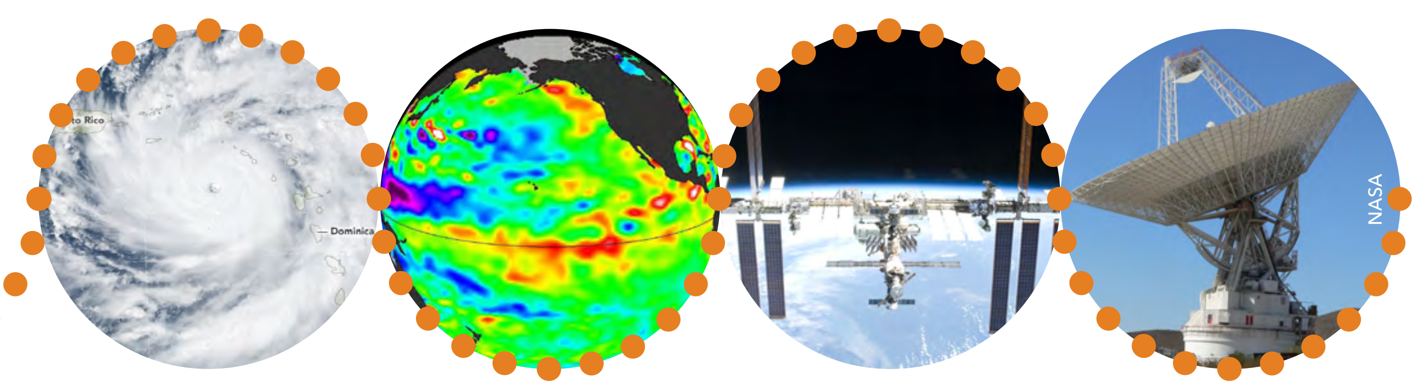
Many of the CCIR Reports and Recommendations provided the foundations for the important work of ITU–R Study Group 7 today. The original CCIR documentation provided the technical and scientific basis for preferred frequency bands, performance criteria, protection and interference criteria, and potential for sharing frequency bands allocated to other radiocommunication services. This information subsequently provided the basis for various World Administrative Radio Conferences (WARCs) to allocate various frequency bands to science services, such as the space research, Earth exploration-satellite, meteorological-satellite, and radio astronomy services.

Study Group 7 today

Today, ITU–R Study Groups continue the work of CCIR to provide the technical basis for decisions at World Radiocommunication Conferences in an increasingly complex and varied radiocommunication environment. Additionally, the ITU–R Study Groups all have to continuously update the technical information, performance standards, and protection criteria for the radio systems under their purview.

Within Study Group 7, the participants must work diligently to recognize the needs and growth of the telecommunications communities dealt with in other Study Groups while continuing to protect the vital scientific uses of the radio spectrum. The global scientific community needs to continue to participate in the important work of Study Group 7 so that the ITU–R Handbooks, Reports and Recommendations produced are accurate, up to date, and understandable to the larger radiocommunication community in which we operate.

As technology development continues at what seems to be an increasingly rapid pace, the challenges of incorporating new radiocommunication technologies into the existing and evolving radio environment becomes increasingly difficult. Efficient use of the radio spectrum in combination with protection of existing spectrum usage have always been hallmarks of the ITU–R. For the scientific community, the work of the ITU–R Study Group 7, as well as the other Study Groups, is invaluable in trying to meet the challenges of our ever changing world both now and in the future.



> ***"Engagement with spectrum management and the ITU–R has been vastly rewarding for radio astronomy."***
>
> Harvey Liszt

Enabling radio astronomy through ITU–R

Harvey Liszt

Chair, **IUCAF**

Cosmic radio waves from the core of the Milky Way were discovered by Karl Jansky in 1933 while he traced sources of radiocommunication noise for Bell Laboratories. Cosmic radio emissions were studied as a hobby by Grote Reber while he was working for Raytheon in the early years of WWII, but neither man's work had much impact on astronomy at the time. However, when the war ended, many physicists and engineers trained in radar and communications turned their attention to cosmic radio emissions and created the modern science of radio astronomy.

Compact, discrete sources of broadband radio emission were found to be scattered uniformly over the sky. Today, we understand them to be powered by massive black holes in the centers of distant galaxies. In 1953, groups in the United States, the Netherlands and Australia observed strong emission from a discrete spectral line of atomic hydrogen, the 21 cm H I line at 1420.40575 MHz. This allowed astronomers for the first time to trace material all the way across the vast expanse of our Galaxy, which is heavily obscured by interstellar dust in visible light.

Karl Jansky with his antenna in Holmdel, New Jersey, USA in 1932.

Discovery of this H I emission brought an interesting twist. Unlike the broadband sources of cosmic radio emissions, the H I line could only be observed over a particular range of frequencies. To preserve the ability to use those frequencies, it was recognized that some sort of formal protection would be needed, and radio astronomy and spectrum management were joined.

First spectrum band allocated for radio astronomy

Throughout the 1950's the CCIR created Recommendations urging protection of specific frequency bands for radio astronomy. To assist in this work at WARC-1959, the ICSU Indisciplinary Body IUCAF was formed with support from the International Astronomical Union, URSI, and COSPAR.

As a result, radio astronomy was recognized as a radio service and the spectrum band 1400–1427 MHz was exclusively allocated to radio astronomy, except in a handful of nations. In other bands, radio astronomy was mentioned in ways that did not afford much protection: spectrum management had not yet fully assimilated the presence of an extraordinarily sensitive, purely passive (listen-only) radio service that listened to the heavens.

ITU–R's golden standard protection criteria

In the intervening years, radio astronomy matured both as a radio science and as a radio service. ITU–R protection criteria, Recommendations and Reports were developed, and, most importantly, other frequency allocations were made for use by radio astronomy and a small group of newer, passive radio services.

The Five-hundred-meter Aperture Spherical Radio Telescope (FAST in Qiannan, Guizhou, China. It observes spectrum from 70 MHz to 3 GHz.

The 100 m Robert C. Byrd Green Bank Telescope in Green Bank, West Virginia, USA, a modern radio telescope that observes the 21 cm H I line under the protection of the Radio Regulations.

The listen-only spectrum band created for the H I line of radio astronomy is now used for global satellite measurement of soil moisture and ocean salinity, making vital contributions to climate studies. Protection criteria developed in ITU–R have been recognized as the gold standard and adopted world-wide, fostering the creation of national radio quiet zones around new telescopes.

It is inconceivable that radio astronomers would still be observing the 21 cm H I line, whose worth to astronomy is inestimable, in the absence of the protections obtained through spectrum management. Engagement with spectrum management and the ITU–R has been vastly rewarding for radio astronomy, allowing it to flourish even as the radio spectrum accommodated an ever-growing variety of uses.

"This phenomenal pace of progress could not have happened without the hard work, perseverance and coordination skills of CCIR/ITU–R Study Groups."

Dietmar Vahldiek

The CCIR/ITU–R — Ninety years of radiotelecommunications innovation and management

Dietmar Vahldiek

Executive Vice President Monitoring and Network Testing, Member of Management Board, **Rohde & Schwarz**

The CCIR/ITU–R traces its beginnings to the founding of the International Radio Consultative Committee – or CCIR, from its French name *Comité consultatif international pour la radio* – at the November 1927 International Radiotelegraph Convention in Washington, DC. At the time, its primary mission was to manage radio frequency spectrum across international boundaries in order to avoid signal interference caused by the growing number of radio stations around the world.

Only six months before, Charles Lindbergh had successfully completed the world's first solo flight across the Atlantic by flying from New York to Paris in 33 hours and 30 minutes – without the help of modern navigational equipment. Ninety years later, pilots are assisted by an array of navigational technologies – including satellites and ground-based equipment. Passengers can watch television and communicate with friends and colleagues around the world using wireless technologies.

Rohde & Schwarz is proud to have contributed to this effort and extends its gratitude to the tens of thousands of engineers, consultants, administrative staff members and other individuals who have invested their time, energy and intelligence into this truly indispensable effort. Without them, the world as we know it would not exist.

For a global, mobile information-based society, the wireless exchange of information is self-evident. It belongs to our modern lifestyle, as it is omnipresent in the business sector, vital for modern industry applications, public protection and many other fields.

This phenomenal pace of progress could not have happened without the hard work, perseverance and coordination skills of CCIR/ITU–R Study Groups and the standards they create and maintain. Their work has played a key role in advancing radio technology by harmonizing what might have developed into communications chaos and by channeling innovation into predictable, reasonable pathways.

ITU's increased scope of activities

Over the past 90 years, the organization's primary mission has never wavered but the scope of its activities has increased significantly. Its place in the world's standards infrastructure has also changed. Until 1992, CCIR published international standards, recommendations, reports and handbooks describing best practices in radiocommunications and on the optimum use of spectrum.

Among these were the global standards for analogue and digital television and sound broadcasting. In 1992, the CCIR was merged into the International Telecommunication Union's Radiocommunication Sector (ITU–R), which continued this work.

Today, as we celebrate the CCIR/ITU–R Study Groups' 90th anniversary, the wireless ecosystem keeps developing with high speed. The standardization and regulation efforts the ITU–R is mandated with have to keep pace – and they will. Currently more than 5000 specialists participate in the work of the ITU–R Study Groups to perform this task on different topics.

They prepare standards and regulations to handle the huge and growing range of wireless services and systems. As the technical possibilities will progress, the number of users and applications will grow. ITU–R enables the wireless ecosystem to deal with the limited natural resource of spectrum and keeping the connected world safe.

A rising need for equitable regulation of spectrum resources

Regardless of further increases in the efficiency of communications systems, the need for suitable frequency band regulation will continue to rise. Appropriation of the limited resource must not exclusively be based on economic or political strength and needs to be balanced to preserve all legitimate interests in our societies to ensure their long-term sustainability.

Only an organization such as ITU, which represents all nations, can provide an equitable balance that allows all nations to benefit from further economic and technological development. The experts in the Study Groups bring in the knowledge, the diversity and the vision to make it right.

Rohde & Schwarz has codetermined and advanced the rapid development of radiocommunications for more than 80 years. We look forward to continuing the fruitful exchange and cooperation within ITU, to jointly help shape the requirements for efficient, interference-free and high-performance communications in the wireless ecosystem the world has become.

"ITU–R maintains the standard for International Morse code characters and operational provisions."

Timothy St. J. Ellam

The International Amateur Radio Union and CCIR/ITU–R

Timothy St. J. Ellam

President, International Amateur Radio Union (**IARU**)

The International Amateur Radio Union, founded in 1925, is the global federation of national amateur radio associations with member-societies in 140 ITU Member States. The IARU was admitted to participation in the work of the International Radio Consultative Committee (CCIR) by the International Radiotelegraph Conference, Madrid, 1932.

It has been and continues to be a regular contributor to the CCIR and the ITU Radocommunication Sector (ITU–R) Study Groups and Working Parties on behalf of more than three million licensees of the amateur and amateur-satellite services throughout the world.

A mutually beneficial relationship

The relationship is mutually beneficial. The amateur and amateur-satellite services offer, to private citizens who demonstrate their qualifications, the opportunity to intercommunicate and experiment with radio transmission to increase their personal knowledge and skills. Radio amateurs apply their skills in services to the public, notably by providing communications at no cost with their own equipment in the event of natural disasters. They share what they learn with one another and with the wider telecommunications community, in part through ITU–R Recommendations and Reports.

ITU–R Study Group 5 and Working Party 5A (WP-5A) are home to both the amateur and the amateur-satellite services. While this is a departure from the usual practice of assigning responsibility for satellite services to Study Group 4 it reflects the unique nature of amateur radio. The frequency allocations to the amateur and amateur-satellite service are made on a primary and secondary basis in a number of frequency bands throughout Article 5 of the **Radio Regulations**, the same classes of emission are used in both services, and most administrations grant privileges in both services to their amateur licensees. Recommendation **ITU–R M.1732**, "Characteristics of systems operating in the amateur and amateur-satellite services for use in sharing studies," was developed and is kept up to date in WP-5A. The IARU also participates as appropriate in other Working Parties of Study Group 5.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Radio amateurs – their concerns

While their experimental pursuits involve the use of advanced digital coding and signal processing techniques for recovering information from extremely weak signals, radio amateurs are also the largest group of regular users of the International Morse code.

ITU–R maintains the standard for International Morse code characters and operational provisions, updating Recommendation **ITU–R M.1677** as recently in 2009 with the addition of "@" (the "commercial at" or "arobase" symbol) to the set of defined characters.

Unwanted radiations leading to interference, sometimes called spectrum pollution, is an area of growing concern to radio amateurs. The radio spectrum is an irreplaceable natural resource. Unintended and unnecessary radio frequency emissions from poorly maintained electric power lines and poorly designed electronic devices and systems can cause interference that degrades the capacity of the radio spectrum to support communication. The efforts of ITU–R Working Party 1A therefore are of vital importance to all radiocommunication services. As new technologies such as Wireless Power Transmission are developed it is essential that the highest possible priority is given to the development and implementation of standards to prevent radio spectrum pollution.

Since the first amateur radio satellite

The first amateur radio satellite was launched in 1961, just four years after Sputnik 1. Since then, approximately 100 satellites built by and for radio amateurs have been placed in orbit. The amateur-satellite service provides a hands-on educational platform for university students who are the next generation of space communications engineers. However, increasing numbers of non-geostationary satellites with short duration missions that are inconsistent with the objectives of the amateur-satellite service are being proposed for operation in the limited amateur-satellite allocations. The IARU appreciates the efforts of Working Party 7B and other concerned WPs to identify more suitable spectrum for telemetry, tracking and command of these satellites at the World Radiocommunication Conference in 2019 (**WRC-19**), consistent with Resolution 659 (**WRC-15**).

The IARU congratulates the ITU–R Study Groups for continuing to build on the magnificent record of the CCIR in furthering the advancement of radiocommunication.