

ITU-R Radiocommunication Study Groups 2020



This ITU-R Study Group booklet was produced by the

**Radiocommunication Bureau of the
International Telecommunication Union (ITU)**

Place des Nations
CH-1211 Geneva 20
Switzerland

**Administration Division of the
Informatics, Administration and Publications Department (IAP)**

Telephone: + 41 22 730 5810
Facsimile: + 41 22 730 5785
E-mail: ITU-R-Communications@itu.int

ISBN:

978-92-61-30931-2 (paper version)

978-92-61-30941-1 (electronic version)

ITU-R RADIOCOMMUNICATION STUDY GROUPS

2020

ITU Headquarters
Geneva, Switzerland

www.itu.int/go/itu-r/sg



© ITU, 2020

International Telecommunication Union (ITU), Geneva

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Denominations and classifications employed in this publication do not imply any opinion on the part of the International Telecommunication Union concerning the legal or other status of any territory or any endorsement or acceptance of any boundary. Where the designation "country" appears in this publication, it covers countries and territories.

Summary

	<i>Page</i>
The ITU mission.....	5
The ITU vision.....	6
ITU and Radiocommunications	7
Radiocommunication Sector.....	10
World Radiocommunication Conferences	11
Radiocommunication Assemblies (RA)	11
Radio Regulations Board.....	12
Radiocommunication Advisory Group (RAG)	13
ITU-R Membership	14
ITU-R Study Groups	15
Study Group 1 – Spectrum management.....	17
Study Group 3 – Radiowave propagation.....	21
Study Group 4 – Satellite services	27
Study Group 5 – Terrestrial services	34
Study Group 6 – Broadcasting service	41
Study Group 7 – Science services	47
Conference Preparatory Meetings (CPM)	54
Radiocommunication Bureau	55
World and Regional Radiocommunication Seminars and Workshops.....	56
Publications	57
Why become an ITU-R Member?.....	58
Drive the future: Joint the International Telecommunication Union.....	60
Address and contacts	61
ITU-R References	62

The International Telecommunication Union

The ITU mission

[itu.int](https://www.itu.int)

Bringing the benefits of ICT to all the world's inhabitants

The International Telecommunication Union (ITU) is the specialized United Nations agency for information and communication technologies (ICTs), driving innovation in ICTs together with 193 Member States and a membership of over 900 companies, universities, and international and regional organizations. Established over 150 years ago in 1865, ITU is the intergovernmental body responsible for coordinating the shared global use of the radio spectrum, promoting international cooperation in assigning satellite orbits, improving communication infrastructure in the developing world, and establishing the worldwide standards that foster seamless interconnection of a vast range of communications systems. From broadband networks to cutting-edge wireless technologies, aeronautical and maritime navigation, radio astronomy, oceanographic and satellite-based earth monitoring as well as converging fixed-mobile phone, Internet and broadcasting technologies, ITU is committed to connecting the world. ITU fulfils this fundamental mission through its three Sectors: the Radiocommunication Sector (ITU-R), the Telecommunication Standardization Sector (ITU-T) and the Telecommunication Development Sector (ITU-D).

ITU's work in the sphere of radiocommunications is focused in the ITU-R Sector, which works towards a worldwide consensus in the use of space and terrestrial radiocommunication services and a vast and growing range of wireless services and applications, including popular new mobile communication technologies.

ITU-R plays an essential custodian role in the management of the radio-frequency spectrum and satellite orbits, finite natural resources that are increasingly in demand from a large number of services such as fixed, mobile, broadcasting, amateur, space research, meteorology, and global positioning. These include systems monitoring and communication services that ensure safety of life on land, at sea and in the skies.

Improving communications and the use of ICTs amongst the peoples of the world by harmoniously developing telecommunication and radiocommunication tools and processes lies at the heart of the work of ITU.

By connecting the world and fulfilling everyone's fundamental right to communicate, we strive to make the world a better and safer place

For over 150 years ITU has worked to improve telecommunication infrastructure in the developing world, establishing the worldwide standards that foster seamless interconnection of a vast range of communications systems. Since the start of international radio usage, it has coordinated the shared global use of the radio spectrum and satellite orbits. Now it is addressing the global challenges of our times, such as mitigating climate change and strengthening cybersecurity.

To ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum and satellite orbits, ITU organizes World Radiocommunication Conferences (WRCs) that are held every three to four years to review and revise the Radio Regulations, the international treaty governing the use of the radio frequency spectrum and the satellite orbits. Regional Radiocommunication Conferences (RRCs) are also held to establish agreements and plans for an ITU Region or for a group of countries concerning a particular radiocommunication service in associated frequency band(s).

ITU also organizes worldwide and regional exhibitions and forums, such as ITU Telecom World, bringing together the most influential representatives of government and the telecommunications and ICT industry to exchange ideas, knowledge and technology for the benefit of the global community, and in particular the developing world.

From broadband Internet to latest-generation wireless technologies, from aeronautical and maritime navigation to radio astronomy and satellite-based meteorology, from convergence in fixed-mobile telephony, Internet access, data, voice and TV broadcasting to next-generation networks, ITU is committed to connecting the world.

ITU is committed to connecting all the world's people – wherever they live and whatever their means. Through our work, we protect and support everyone's right to communicate.

Since the last decade of the 20th century the world has witnessed extraordinary growth in the use of wireless communication systems, from cellular and cordless phones and radio-based fleet management systems to radio and television broadcasting, cognitive radio, spectrum monitoring and International Mobile Telecommunications 2020. At the same time, radio has become a vital technology for a growing number of essential public services such as satellite navigation and intelligent transport systems, global positioning systems, environmental monitoring, emergency radiocommunication systems and even deep-space research.

At the heart of this wireless world, the ITU Radiocommunication Sector (ITU-R) is mandated by ITU Membership to determine the technical characteristics and operational procedures for a huge and growing range of wireless services and systems. ITU-R also plays a vital role in the preparation of standards presented in “ITU-R Recommendations” for the management of the radio-frequency spectrum – a finite natural resource that is increasingly in demand due to the rapid development of new radio-based services and technologies, such as the enormous growth of mobile and related communications, and in enabling cutting edge technologies through globally harmonized standards, e.g. ITU-R has been the primary source of the basic specifications for IMT-2000 (3G), IMT-Advanced (4G), IMT-2020 (5G), Digital Television and sound Radio, High Definition Television (HDTV), Ultra High Definition Television (UHDTV) and HDR specifications for the world.

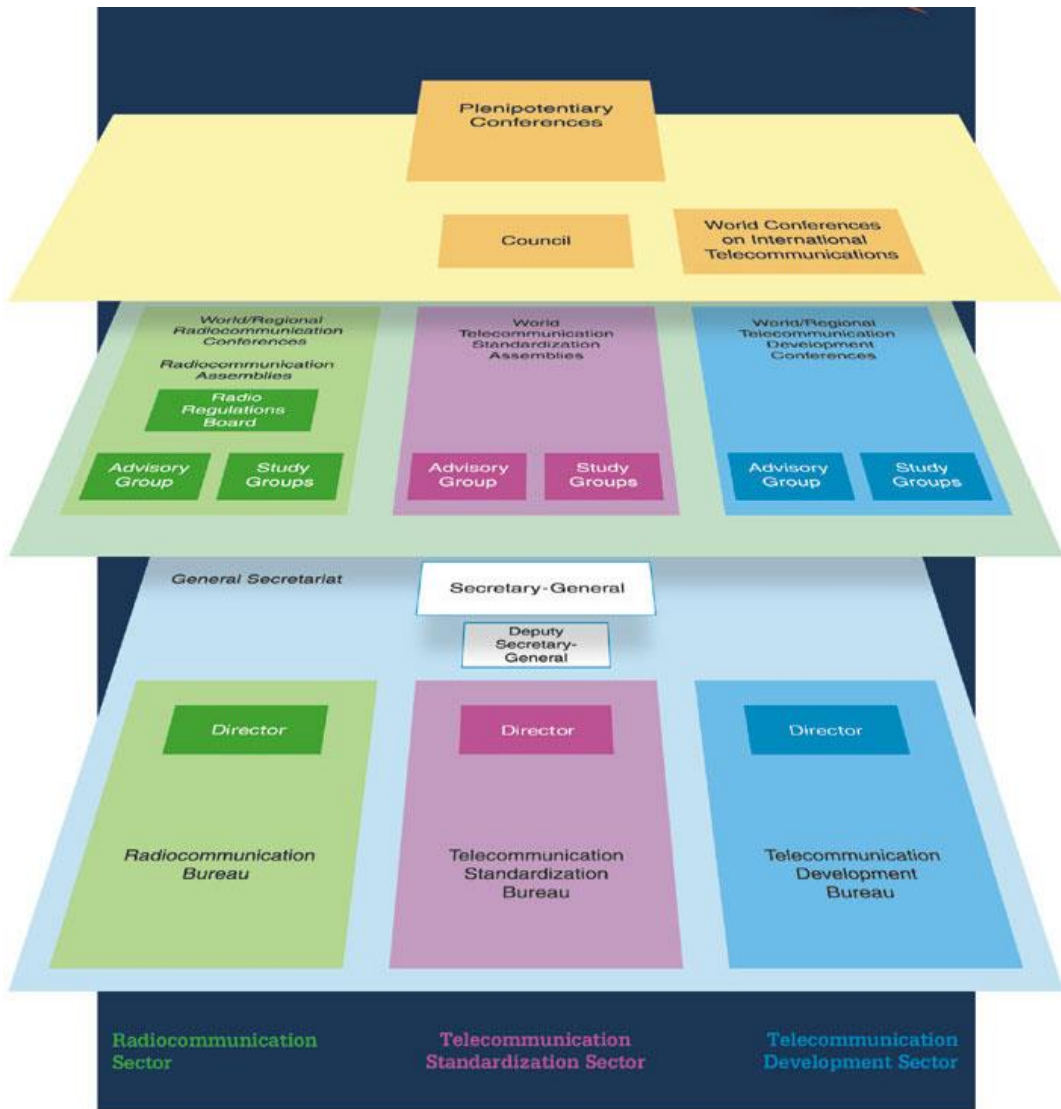
The Radiocommunication Assembly 2019 (RA-19) approved a series of Recommendations and Resolutions for new and emerging technologies; evolved convergence and a number of industries and services and ongoing enhancements for the continued development of global mobile broadband communications (International Mobile Telecommunications (IMT-2020 – also known as 5G); developed railway radiocommunications systems between train and trackside (RSTT), which are vital to provide improved railway traffic operations in a high-speed environment; made enhancements to television, sound and multimedia broadcasting systems while outlining a roadmap for developing countries and promoting accessibility for persons with disabilities and specific needs; advanced technologies for short-range devices (SRD) in support of the Internet of Things (IoT) as well as the deployment of international public telecommunications via satellite in developing countries to foster affordable and universal access, particularly through global coverage and delivery of next-generation broadband technologies along with a focus on capacity-building.

In its role as global spectrum coordinator, the Radiocommunication Sector develops and adopts the “ITU Radio Regulations” – a complete set of rules that serve as a binding international treaty governing the use of radio-frequency spectrum and satellite orbits adopted by more than 190 Member States. The international treaty, known as the Radio Regulations, was revised and updated by the World Radiocommunication Conference 2019 (WRC-19) to achieve the global connectivity goals for shaping the digital communication ecosystem of the 21st century. WRC-19 addressed issues related to frequency allocation and frequency sharing for the efficient use of spectrum and orbital resources, thus ensuring high quality radiocommunication services for mobile broadband and satellite communications, maritime and aeronautical transport as well as for scientific purposes related to the environment, meteorology and climatology, disaster prediction, mitigation and relief. Recent ITU-R achievements include worldwide allocations of spectrum for operation of 24-hour thunderstorm/lightning detection systems and oceanographic radars.

The next World Radiocommunication Conference 2023 (WRC-23) is planned to be held during the 4th Quarter of 2023.

The Sector also operates, through its Radiocommunication Bureau, as a central registrar on the right to international recognition to use the radiofrequency spectrum, maintaining the “Master International Frequency Register” (MIFR) that currently includes around 3.14 million records for terrestrial stations and over 2,200 satellite networks.

In addition, ITU-R is responsible for coordinating efforts to ensure that the communication, broadcasting and meteorological satellites in the world's increasingly crowded skies can co-exist without causing harmful interference to one another's services. In this role, the Union facilitates agreements between both operators and governments and provides practical tools and services to help national frequency spectrum managers carry out their day-to-day work.



Radiocommunication Sector

The Mission

itu.int/go/itu-r

The ITU Radiocommunication Sector specializes in facilitating international collaboration to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum and satellite orbits, by:

- holding World and Regional Radiocommunication Conferences and Seminars to expand and adopt Radio Regulations and Regional Agreements covering the use of the radio-frequency spectrum;
- approving ITU-R Recommendations, developed by ITU-R Study Groups (SG) in the framework set by Radiocommunication Assemblies, on the technical characteristics and operational procedures for radiocommunication services and systems;
- coordinating activities to eliminate harmful interference between radio stations of different countries;
- maintaining the Master International Frequency Register (MIFR); and
- offering tools, information and seminars to assist national radio-frequency spectrum management;
- carry out studies and adopt recommendations on radiocommunication matters.

World Radiocommunication Conferences

itu.int/go/itu-r/wrc

World Radiocommunication Conferences (WRCs) review and revise the Radio Regulations, the international treaty governing the use of the radio frequency spectrum and the satellite orbit. Revisions are made on the basis of an agenda determined by the ITU Council, which takes into account recommendations made by previous world radiocommunication conferences.

WRCs consider the results of the studies on options to improve the international spectrum regulatory framework based on the effectiveness, appropriateness and impact of the ITU Radio Regulations with respect to the evolution of existing, emerging and future applications, systems and technologies. WRCs make decisions on the most profitable and efficient ways to exploit the limited resource of radio frequency spectrum and manage satellite orbits, which will be critical and increasingly valuable for the development of the global economy in the 21st Century.

WRCs also address any radiocommunication matter of worldwide character, instruct the Radio Regulations Board and the Radiocommunication Bureau, and review their activities, and determine the topics for study by Radiocommunication Assemblies and the Study Groups in preparation for future radiocommunication conferences.

Radiocommunication Assemblies

itu.int/go/itu-r/ra

Radiocommunication Assemblies (RAs) are responsible for the structure, programme and approval of radiocommunication studies. They are normally convened every four years and may be associated in time and place with World Radiocommunication Conferences (WRCs). The Assemblies provide the necessary technical basis for the work of WRCs, respond to other requests from ITU conferences, and suggest suitable topics for the agenda of future WRCs. They also approve and issue ITU-R Recommendations and Questions developed by the Study Groups, set the programme for and disband or establish Study Groups according to need.

Radio Regulations Board

itu.int/go/itu-r/rrb

The Radio Regulations Board (RRB) consists of twelve members thoroughly qualified in the field of radiocommunications and possessing practical experience in the assignment and utilization of frequencies. The members of the RRB are elected at the Plenipotentiary Conference to serve, not as representing their respective Member States nor a region, but as custodians of an international public trust. They perform their duties independently and on a part-time basis, normally meeting up to four times a year, in Geneva.

The Board:

- approves Rules of Procedure, used by the Radiocommunication Bureau in applying the provisions of the Radio Regulations and registering frequency assignments made by the Member States;
- addresses matters referred by the Bureau which cannot be resolved through application of the Radio Regulations and Rules of Procedure;
- considers reports of unresolved interference investigations carried out by the Bureau at the request of one or more administrations and formulates Recommendations;
- provides advice to Radiocommunication Conferences and the Radiocommunication Assemblies;
- considers appeals against decisions made by the Radiocommunication Bureau regarding frequency assignments;
- performs any additional duties prescribed by a competent conference or by the Council.

The Director of the Bureau is the Executive Secretary of the Radio Regulations Board.

Radiocommunication Advisory Group

itu.int/go/itu-r/rag

13

The Radiocommunication Advisory Group (RAG) is tasked to:

- review the priorities and strategies adopted in the Sector;
- monitor progress of the work of the Study Groups;
- provide guidance for the work of the Study Groups;
- recommend measures to foster cooperation and coordination with other organizations and with the other ITU Sectors.

The RAG provides advice on these matters to the Director of the Radiocommunication Bureau (BR). Radiocommunication Assemblies (RAs) may refer specific matters within its competence to the RAG. The RAG may be authorized to act on behalf of the RA between two Assemblies.

Member States of ITU and Sector Members participate actively in the work of the Radiocommunication Sector. Since its opening to the private sector, the ITU membership represents a cross-section of the industry, from the world's largest manufacturers, carriers, operators and system integrators to small, innovative players of the new information and communication technology field.

Current members include:

- 193 ITU Member States, which constitute the Union, set its mandate and contribute to the work of ITU as a whole;
- Some 900 companies, universities, and international and regional organizations. They represent a cross-section of the global ICT sector, from the world's largest manufacturers and carriers to small, innovative players working with new and emerging technologies, along with leading R&D institutions and Academia. These include operating agencies, scientific or industrial organizations, financial and developmental institutions, other entities dealing with telecommunication matters, regional and other international telecommunication, standardization, financial or developmental organizations;
- In its efforts to ensure the widest participation in the enhancement of worldwide communications and that the interests of all stakeholders are taken into consideration, ITU encourages new entities and organizations to join the Union as Sector Members, Associates and Small and Medium Enterprises (SMEs). In addition, ITU seeks to further develop intellectual cooperation with educational institutions and universities.

Radiocommunication Study Groups

ITU-R Study Groups

itu.int/go/itu-r/sg

The ITU-R Study Groups develop the technical bases for decisions taken at World Radiocommunication Conferences (WRCs) and develop global standards (Recommendations), Reports and Handbooks on radiocommunication matters.

ITU-R Study Groups are established and assigned study Questions by a Radiocommunication Assembly (RA) to prepare draft Recommendations, etc. for approval by ITU Member States.

Except for ITU-R Recommendations incorporated by reference in the ITU Radio Regulations, compliance with ITU-R Recommendations is not mandatory. However, all ITU-R Recommendations are developed by world experts in radiocommunications, thereby enjoying a high reputation and worldwide implementation, having the status of international standards in their domain of application.

Studies focus on the following:

- 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.

Furthermore, ITU-R Study Groups carry out preparatory studies for Regional Radiocommunication Conferences (RRCs). On the basis of the input material from the Study Groups, alongside any new material submitted by ITU Member States and ITU-R Sector Members, the Conference Preparatory Meeting (CPM) prepares a Report on the technical, operational and regulatory or procedural matters to be considered by a given Conference.

Study Groups accomplish their work in cooperation with other international radiocommunication organizations. Particular attention is paid to the radiocommunication needs of developing countries.

More than 5000 specialists from administrations, the telecommunications industry as a whole and academic organizations throughout the world, participate in the work of the Study Groups on topics such as efficient management and use of the spectrum/orbit resource, radio systems characteristics and performance, spectrum monitoring and emergency radiocommunications for public protection and disaster relief.

At present, there are six Study Groups (SGs) specializing in the following areas:

SG 1	Spectrum management	www.itu.int/ITU-R/go/rsg1
SG 3	Radiowave propagation	www.itu.int/go/ITU-R/rsg3
SG 4	Satellite services	www.itu.int/ITU-R/go/rsg4
SG 5	Terrestrial services	www.itu.int/go/ITU-R/rsg5
SG 6	Broadcasting service	www.itu.int/ITU-R/go/rsg6
SG 7	Science services	www.itu.int/ITU-R/go/rsg7

Subgroups, known as Working Parties (WPs) and Task Groups (TGs) are established to study the Questions assigned to the different Study Groups.

Study Group 1

Spectrum management

itu.int/go/itu-r/sg1

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.

Scope

Spectrum management principles and techniques, general principles of sharing, spectrum monitoring, long-term strategies for spectrum utilization, economic approaches to national spectrum management, automated techniques and assistance to developing countries in cooperation with the Telecommunication Development Sector.

Structure

Three Working Parties (WPs) carry out studies on Questions assigned to Study Group (SG) 1:

- WP 1A Spectrum engineering techniques
- WP 1B Spectrum management methodologies and economic strategies
- WP 1C Spectrum monitoring

The goals of ITU-R Working Parties 1A, 1B and 1C activities are to develop and maintain ITU-R Recommendations, Reports, Handbooks and Opinions relevant to spectrum engineering techniques, spectrum management fundamentals and spectrum monitoring, respectively.

ITU-R Working Party 1A – Spectrum engineering techniques

itu.int/go/itu-r/wp1a

Spectrum engineering techniques, including unwanted emissions, frequency tolerance, technical aspects of sharing, computer programs, technical definitions, Earth-station coordination areas and technical spectrum efficiency.

Current study topics in close collaboration with interested parties in ITU-R, ITU-T, ITU-D and other SDOs (e.g. IEC/CISPR) on issues of mutual interest, include:

- Wireless power transmission;
- EMC-related interference and coexistence of wired telecommunication with radiocommunication systems, including aggregation effect and the egress of radiated interference from buildings;
- Definition of the spectral properties of transmitter emissions;
- Impact on radiocommunication systems from wireless and wired data transmission technologies used for the support of power grid management systems;
- Technical and operational characteristics of the active services operating in the range 275-3 000 GHz;
- Characteristics for use of visible light for broadband communications;
- General principles and methods for sharing between radiocommunication services or between radio stations;
- Characteristics of the unwanted emissions in the out-of-band and spurious domains for digital modulation technology used in broadband communication systems.

Amongst those items on which Working Party 1A is engaged in preparation for WRC-23 are the preliminary studies for WRC-27 towards a spectrum allocation to the radiolocation service in the frequency band 231.5-275 GHz and an identification for radiolocation applications in the frequency range 275-700 GHz.

ITU-R Working Party 1B – Spectrum management methodologies and economic strategies

itu.int/go/itu-r/wp1b

Spectrum management fundamentals, including economic strategies, spectrum management methodology, national spectrum management organization, national and international regulatory framework, alternative approaches, flexible allocations and long-term strategies for planning.

Current study topics in close collaboration with interested parties in ITU-R, ITU-T, ITU-D, and other SDOs include:

- Long-term strategies for spectrum utilization;
- Alternative methods of national spectrum management;

- Spectrum redeployment as a method of national spectrum management;
- Innovative regulatory tools for shared use of spectrum;
- Economics aspects on spectrum management;
- Assessment of spectrum efficiency and economic value;
- Methodologies for assessing or predicting spectrum availability;
- Harmonization for short-range devices;
- Implementation and use of cognitive radio systems.

Amongst those items on which Working Party 1B is engaged in preparation for WRC-23 are the studies on topics related to space weather sensors, to the use of IMT systems for fixed wireless broadband, and to the protection of stations of the aeronautical and maritime mobile services located in international airspace and waters from other stations located within national territories .

ITU-R Working Party 1C – Spectrum monitoring

itu.int/go/itu-r/wp1c

Spectrum monitoring, including the development of techniques for observing the use of the spectrum, measurements techniques, inspection of radio stations, identification of emissions and location of interference sources.

Current study topics in close collaboration with interested parties in ITU-R, ITU-T, ITU-D and other SDOs, include:

- Methods and techniques used in space radio monitoring;
- Spectrum monitoring evolution (e.g. use of drones and small satellites);
- Direction finding;
- Electromagnetic field measurements to assess human exposure;
- Population coverage measurement with public wireless networks;
- Reporting harmful interference.

National spectrum management comprises the structures, capabilities, procedures and regulations necessary for each country to fulfil its objective to control the use of the radio-frequency spectrum on its territory and within its geographical borders. Within the framework of international treaty agreements (Radio Regulations), each government has the flexibility and autonomy to regulate the spectrum and its usage. In this perspective, each administration shall develop the relevant laws and carry out the duties of spectrum management. The usage of the frequency spectrum, which has increasingly important economic value, is best harmonized in an environment where a spectrum management system provides stability but, at the same time, facilitates user access to the spectrum.

Effective management of the limited spectrum resource encompasses the goals and objectives of a spectrum management system, a spectrum management structure and the spectrum management authority with responsibility to regulate and monitor spectrum use and to enforce the pertinent regulations.

With a view to assisting ITU Members States in general and developing countries in particular, with their national spectrum management activities, Study Group 1 and its Working Parties developed a number of ITU-R Handbooks which are available free of charge in electronic format:

The **Handbook on National Spectrum Management** (www.itu.int/pub/R-HDB-21) covers spectrum management fundamentals, spectrum planning, spectrum engineering, frequency authorization, spectrum use, spectrum control and automation for spectrum management activities. The Handbook describes the key elements of spectrum management and is intended for the use by administrations of both developing and developed countries.

A very popular work is the **Handbook on Spectrum Monitoring** (www.itu.int/pub/R-HDB-23). It covers all essential features of spectrum monitoring techniques and activities, including the establishment of monitoring facilities. The principles governing this handbook show that spectrum monitoring requires equipment, personnel and procedures. The handbook is an essential accessory for all administrations and spectrum monitoring agencies in the world, both for developing and developed countries.

A complement to both above-mentioned handbooks is the **Handbook on Computer-aided Techniques for Spectrum Management (CAT)** (www.itu.int/pub/R-HDB-01). The topic of national spectrum management has evolved and become the central hot spot in the activities of all telecommunication administrations. This is particularly true for developing countries, where the dramatic development of ICT technologies and their wide application have led to a heavy increase in related spectrum usage. This handbook contains basic material and numerous models for developing efficient projects that will assist in implementing automated spectrum management as soon as possible.

Other deliverables from ITU-R Study Group 1

Study Group 1 and its Working Parties maintains a number of **Recommendations** (www.itu.int/pub/R-REC) and **Reports** (www.itu.int/pub/R-REP) in the SM series relating to Spectrum Management related topics.

In addition, Study Group 1 and its Working Parties are working closely with relevant ITU-T and ITU-D Study Groups, as well as with the ITU Telecommunication Development Bureau (BDT), in particular in response to Resolution 9 of the ITU World Telecommunication Development Conference (WTDC), to assist developing countries in fulfilling their national spectrum management functions.

Study Group 3

Radiowave propagation

itu.int/go/itu-r/sg3

Scope

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

Structure

The following four Working Parties (WPs) carry out studies on the Questions assigned to Study Group (SG) 3:

WP 3J	Propagation fundamentals
WP 3K	Point-to-area propagation
WP 3L	Ionospheric propagation and radio noise
WP 3M	Point-to-point and Earth-space propagation

The principal aim of the Working Parties is to draft Recommendations in the ITU-R P Series for subsequent adoption by Study Group 3 and approval by the Member States. The Working Parties also develop Handbooks that provide descriptive and tutorial material, especially useful for developing countries. A further task of the Working Parties is to provide, through Study Group 3, propagation information and advice to other ITU-R Study Groups in their preparation of the technical bases for Radiocommunication Conferences. Such information typically concerns identifying relevant propagation effects and mechanisms and providing propagation prediction methods. The predictions are needed for the design and operation of radiocommunication systems and services and also for the assessment of frequency sharing between them.

ITU-R Working Party 3J – Propagation fundamentals

WP 3J provides information and develops models describing the fundamental principles and mechanisms of radiowave propagation in non-ionized media. Such material is used as the basis of propagation prediction methods developed by the other Working Parties. Recognizing the natural variability of the propagation medium, WP 3J prepares texts describing the statistical laws relevant to propagation behaviour and the means of expressing the temporal and spatial variability of propagation data.

Propagation over terrain and obstacles involves methods for calculating diffracted fields over smooth and irregular earth, and quantifying the effect of vegetation along the propagation path. Maps of ground conductivity are maintained, as they are important for prediction procedures applying to frequencies at medium frequency (MF) and below.

One of the principal areas of study in WP 3J concerns propagation through the neutral atmosphere, encompassing the propagation effects both in the clear air and when precipitation is present. To this end, the WP devotes much effort to the global mapping of radiometeorological parameters used for quantifying such effects for prediction procedures. Clear-air effects include atmospheric refraction and attenuation due to atmospheric gases, these in turn requiring vertical profiles of temperature and water vapour with their spatial and temporal variation. Similarly, for the assessment of attenuation and depolarization due to precipitation, precise global mapping of rainfall intensity and rain height are required, as well as models of specific attenuation of rain. WP 3J also studies the effects of cloud and fog.

Since an objective of Study Group 3 is to provide prediction procedures that are applicable worldwide, it is very important that any underlying radiometeorological data are representative of the different climates of the world and that their spatial and temporal resolution are adequate. Furthermore, inter-annual and seasonal variabilities become a critical issue as radiocommunication systems are more and more flexible.

In support of the development of mobile broadband systems, particularly for short-range urban environments and at higher frequencies, WP 3J also studies the effect of building materials on propagation. This supports studies in WPs 3K and 3M to predict both system performance and inter-system interference for indoor and outdoor radio services.

ITU-R Working Party 3K – Point-to-area propagation

WP 3K is responsible for developing prediction methods for terrestrial point-to-area propagation paths. In the main, these are associated with terrestrial broadcasting and mobile services, short-range indoor and outdoor communication systems (e.g. radio local area networks, RLAN), and with point-to-multipoint wireless access systems.

In the VHF and UHF bands, field strength prediction takes account of the effects of terrain in the vicinity of the transmitter and receiver, and of the refractive nature of the atmosphere. Allowance is also made for location variability for land area coverage prediction with account taken of local clutter surrounding the receiver. Consideration is also given to mixed paths crossing both land and sea. A consolidated prediction procedure has been developed – suitable for broadcasting, land mobile, maritime mobile and certain fixed services (e.g. those using point-to-multipoint systems) – that represents a major tool for the frequency planning of broadcasting and mobile services, particularly in the range 1-6 GHz, and for coordination when frequency sharing is involved.

At higher frequencies (typically from around 1 to 450 GHz), the emphasis is on short-range systems, either indoor or outdoor, as might be used by RLAN and personal mobile communications. The WP develops Recommendations that describe relevant propagation mechanisms such as reflection, scattering and diffraction associated with buildings, or with obstacles within buildings, all of which give rise to effects such as attenuation and multipath. The latter plays a vital part in the channel modelling of a radio link, with which an assessment of performance quality may be obtained. For outdoor situations, models are developed describing different types of environment (urban to rural) and expressions are developed for quantifying the resulting path loss. Propagation into or out of buildings is also an important topic, with the growth of mobile broadband systems.

With the growing interest in delivery of broadband services through local access networks, WP 3K studies the propagation effects associated with millimetric radio systems (e.g. operating around 20-50 GHz) used for point-to-multipoint distribution. Prediction of area coverage has to address the effects of buildings, their spatial distribution, attenuation and scattering from vegetation, and attenuation by rain. Methods to quantify the relevant propagation effects such as attenuation and distortion due to multipath are a key area of study in WP 3K.

ITU-R Working Party 3L – Ionospheric propagation and radio noise

WP 3L studies all aspects of radiowave propagation in and through the ionosphere, as well as ground wave propagation at the lower frequencies and radio noise external to the receiver. Recommendations are maintained describing a reference model of ionospheric characteristics and maximum usable frequencies associated with the various ionospheric layers. Short-term and long-term ionospheric forecasting, with guidance on the use of ionospheric indices, is addressed.

As regards propagation prediction methods, Recommendations are maintained containing prediction procedures for ionospheric propagation in bands from ELF to VHF. Those for computing skywave propagation at LF, MF and HF play an important role in frequency planning, both for quantifying the wanted signal as well as for interference assessment. At higher frequencies, there are also methods for computing the field strength due to meteor-burst propagation as well as propagation via sporadic E. The HF ionospheric propagation prediction procedure has been reviewed in detail and a computer code (ITURHFPROP) has been developed and tested, and is maintained. This provides predictions of circuit performance and includes the effects of the ionosphere on digitally modulated transmissions.

With the increasing use of satellite systems, particularly for global navigation purposes and for those using low-Earth orbits, the effects of the ionosphere on slant propagation paths at VHF and UHF frequencies demand considerable attention. For example, the additional and variable time delay associated with propagation through the ionosphere is of major concern for navigation satellite systems; likewise, trans-ionospheric scintillation can be a significant factor on the link budget of systems operating well above 1 GHz. WP 3L is improving methods to quantify such effects, taking into account their temporal and geographical variability.

The Working Party studies ways for the improvement of the accuracy of ionospheric propagation prediction, taking account of long-term changes in the ionosphere and of the current availability of data. WP 3L also addresses the topic of radio noise arising from both natural and man-made sources and provides information to quantify the effect of noise on the performance of radio systems.

At MF and lower frequencies ionospheric and ground wave propagation modes are both important. WP 3L also maintains the Recommendation on ground wave propagation and has provided advice in a handbook on this same subject.

Radio noise received through the receiver antenna is of great importance in determining the performance of radio systems and WP 3L studies and maintains a measurement databank of radio noise arising from both natural and man-made sources.

ITU-R Working Party 3M – Point-to-point and Earth-space propagation

WP 3M addresses radiowave propagation over point-to-point terrestrial paths and Earth-space paths, both for wanted and unwanted signals.

The fundamental prediction methods of WP 3J, such as the refractivity of the atmosphere, gaseous attenuation or diffraction over irregular terrain, are used by WP 3M to develop prediction methods for specific types of radio links. For satellite propagation paths, use is also made of trans-ionospheric information developed in WP 3L.

For terrestrial paths, prediction methods are developed for both line-of-sight and over-the-horizon links, taking account of mechanisms that can give rise to fading, enhancement, or distortion of the wanted signal. The predictions, generally expressed in terms of a statistical distribution of propagation loss or outage, provide vital information for terrestrial link planning in the fixed service (FS).

Similarly, propagation impairments on slant paths from satellites are addressed in prediction procedures to quantify the relevant effects and provide an assessment of overall propagation loss, fading behaviour or signal depolarization. WP 3M maintains Recommendations for the fixed-satellite service (FSS), the mobile-satellite service and the broadcasting-satellite service. Additional factors specific to the environment near the earth station are considered, such as shadowing and blockage by buildings. For mobile-satellite and non-GSO systems, the movement of the receiver or changes in the elevation angle are taken into account.

WP 3M is also studying propagation for optical communications on Earth-space and terrestrial paths, using information from WP 3J on atmospheric effects at optical frequencies.

To test its prediction procedures, WP 3M relies on databanks of measurement data. Databanks are maintained for terrestrial and Earth-space paths, based on long-term measurements submitted by the membership, and assessed by Study Group 3 for accuracy and statistical validity.

A further major responsibility of WP 3M is the prediction of signals likely to cause interference. These signals, often propagating via short-term mechanisms such as ducting and rain scatter, can give rise to unacceptably high interference levels in shared frequency bands. Prediction methods are maintained to allow users to quantify the interference level, at a desired percentage of time, either from one point on the Earth's surface to another, or between a space station and a point on Earth. In cooperation with WPs 3J and 3K, WP 3M is extending these interference prediction methods to account for the effect of building materials, to support sharing studies between indoor and outdoor radiocommunication systems.

WP 3M is also responsible for developing the propagation method for determining the Earth-station coordination area when frequencies are shared.

This is an internationally accepted methodology – used by administrations in their planning and deployment of terrestrial and earth stations (in the FS and FSS respectively) when sharing the same frequency band.

Handbooks

itu.int/pub/R-HDB

ITU-R Study Group 3 and its Working Parties developed a number of ITU-R Handbooks:

Handbook on ITU-R Propagation prediction methods for interference and sharing studies (www.itu.int/pub/R-HDB-58) provides technical information and guidance needed for sharing studies and interference assessments using selected ITU-R P-Series RF propagation models and prediction methods. The handbook is intended to be used in conjunction with ITU-R P-Series Recommendations to assist in performing interference analyses and prediction methods on radiocommunication service systems.

Handbook on Radiometeorology (www.itu.int/pub/R-HDB-26) provides general information on radiometeorology and covers the following topics: physical characteristics of the atmosphere, atmospheric refraction, particle scattering, atmospheric gaseous attenuation and dispersion, hydrometeor attenuation, radio emissivity, cross-polarization and anisotropy and statistical aspects of atmospheric processes.

Handbook on Curves for Radiowave Propagation over the Surface of the Earth (www.itu.int/pub/R-HDB-13)

Handbook on Terrestrial Land Mobile Radiowave Propagation in the VHF/UHF bands (www.itu.int/pub/R-HDB-44) gives the technical basis for predicting radiowave propagation in terrestrial point-to-point, point-to-area and point-to-multipoint mobile networks.

Handbook on the Ionosphere and its Effects on Radiowave Propagation (www.itu.int/pub/R-HDB-32) provides radio planners and users with a guide on ionospheric properties and propagation effects in order to assist in the design of related radiocommunication systems.

Handbook on Radiowave Propagation Information for Predictions for Earth-to-Space Path Communications (www.itu.int/pub/R-HDB-27) supplies background and supplementary information on Earth-to-space propagation effects in order to assist in the design of different Earth-space communication systems.

Handbook on Radiowave propagation information for designing terrestrial point-to-point links (www.itu.int/pub/R-HDB-54) supplies background and supplementary information on radiowave propagation effects, and serves as a companion volume and guide to the ITU-R Recommendations that have been developed by Radiocommunication Study Group 3 to assist in the design of terrestrial communication systems.

Handbook on Ground wave propagation (www.itu.int/pub/R-HDB-59) is of special interest for communication, particularly broadcasting, at the lower frequencies where the mode has been in use for more than 90 years. It deals with fundamentals and theory, wide-scale considerations and prediction methods used for compatibility assessments and planning procedures. Smaller scale variability, which may be of major importance in assessing the quality of services, is also treated. The topics of measurements and phase are also covered.

Other deliverables from ITU-R Study Group 3

Study Group 3 and its Working Parties maintain a number of **Reports** (www.itu.int/pub/R-REP) relating to radiowave propagation and various field strength measurement aspects. It also maintains a number of datasets and software products in support of radiowave propagation models from several **ITU-R Recommendations** (www.itu.int/pub/R-REC) and the development of new and improvement of existing radiowave propagation models.

Study Group 4

Satellite services

itu.int/go/itu-r/sg4

Scope

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

Structure

Three Working Parties (WPs) carry out studies on Questions assigned to Study Group (SG) 4:

- WP 4A Efficient orbit/spectrum utilization for the fixed-satellite service (FSS) and broadcasting-satellite service (BSS)

- WP 4B Systems, air interfaces, performance and availability objectives for the fixed-satellite service (FSS), broadcasting-satellite service (BSS) and mobile-satellite service (MSS), including IP-based applications and satellite news gathering (SNG)

- WP 4C Efficient orbit/spectrum utilization for the mobile-satellite service (MSS) and the radiodetermination-satellite service (RDSS).¹

¹ WP 4C also deals with the performance issues related to RDSS.

ITU-R Working Party 4A – Efficient orbit/spectrum utilization for the fixed-satellite service (FSS) and broadcasting-satellite service (BSS)

The major study areas of Working Party 4A are orbit/spectrum efficiency, interference and coordination and related aspects for FSS and BSS. Its work has significant relevance to the preparatory work for World Radiocommunication Conferences.

Current study topics include:

- Maximum permissible levels of interference in a satellite network in the fixed-satellite service (GSO) in the broadcasting-satellite service (GSO) caused by other co-directional non-GSO FSS systems operating in the 50/40 GHz frequency bands.
- Sharing and compatibility between earth stations in motion operating with geostationary FSS networks and current and planned stations of the FS in the frequency bands 27.5-29.5 GHz and 17.7-19.7 GHz.
- Sharing and compatibility between earth stations in motion operating with geostationary FSS networks and [current and planned] stations of the MS in the frequency band 27.5-29.5 GHz.
- Earth stations in motion (ESIM) compatibility with non-GSO MSS feeder links in the bands 19.3-19.7 GHz and 29.1-29.5 GHz.
- Statistical methodologies to estimate the interference from land earth stations in motion (L-ESIM) communicating with geostationary space stations in the fixed-satellite service into fixed service (FS) stations operating in the frequency band 27.5-29.5 GHz.
- Protection of EESS (passive) and RAS systems from non GSO fixed satellite systems operating in the 37.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz frequency bands.
- Compatibility studies between IMT systems and BSS (sound) systems in the band 1 452-1 492 MHz in different countries in Regions 1 and 3.
- Protection criteria for fixed-satellite service networks operating in frequency below 86 GHz for time-invariant and time-variant interference in the context of sharing studies with other co-primary services.
- Geostationary satellite system characteristics to be considered in frequency sharing analyses within the broadcasting-satellite and fixed-satellite services between GSO and non-GSO FSS satellite systems in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz.
- Functional description to be used in developing software tools for determining conformity of non-geostationary-satellite orbit fixed-satellite service systems or networks with limits contained in Article 22 of the Radio Regulations.
- Reference FSS earth-station antenna radiation patterns for use in interference assessment involving non-GSO satellites in frequency bands between 10.7 GHz and 30 GHz.

- Reference BSS earth station antenna patterns for use in interference assessment involving non-GSO satellites in frequency bands covered by RR Appendix 30.
- Appropriate treatment of spill-over lobe in non-GSO/GSO interference calculations and resolve conflicting guidance.
- Technical feasibility of non-GSO-to-GSO satellite links.
- Technical feasibility and examples of FSS non-GSO-to-GSO inter-satellite service.
- ITU-R small satellite handbook.
- Tolerances for the orbital characteristics of non-GSO space stations in the FSS [and BSS].
- Mitigation techniques between non-GSO FSS systems in the bands 36-37 GHz and 50.2-50.4 GHz.
- Regulatory provisions for the modification of notices relative to non-geostationary systems operating in the FSS, MSS and BSS above 10 GHz subject to Section II of Article 9 of the Radio Regulations.
- Development of a methodology to validate the technical emission parameters contained within submissions of FSS satellite networks not subject to RR Appendix 30B.
- Long-term interference from non-GSO FSS systems into GSO FSS.

Amongst those items on which Working Party 4A is engaged in preparation for WRC-23 are the studies on:

- Operation of earth stations on aircraft and vessels communicating with geostationary space stations in the fixed-satellite service in the frequency band 12.75-13.25 GHz (Earth-to-space);
- Use of the frequency bands 17.7-18.6 GHz and 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) by earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service;
- Technical and operational issues, and regulatory provisions for satellite-to-satellite links in the frequency bands 11.7-12.7 GHz, 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz;
- Primary allocation to the fixed-satellite service in the space-to-Earth direction in the frequency band 17.3-17.7 GHz in Region 2;
- Possible changes to the advance publication, coordination, notification and recording procedures for frequency assignments pertaining to satellite networks, in order to facilitate rational, efficient and economical use of radio frequencies and any associated orbits, including the geostationary-satellite orbit.

ITU-R Working Party 4B – Systems, air interfaces, performance and availability objectives for the fixed-satellite service (FSS), broadcasting-satellite service (BSS) and mobile-satellite service (MSS), including IP-based applications and satellite news gathering (SNG)

Working Party 4B carries out studies on performance, availability, air interfaces and earth-station equipment of satellite systems in the FSS, BSS and MSS. This group has paid particular attention to the studies of Internet Protocol (IP)-related system aspects and performance and has developed new and revised Recommendations and Reports on IP over satellite to meet the growing need for satellite links to carry IP traffic. This group has close cooperation with the ITU Telecommunication Standardization Sector.

Working Party 4B is also developing new Recommendations and/or Reports on integrated systems and hybrid satellite-terrestrial networks.

Working Party 4B is the responsible group for all the studies related to the satellite component of IMT, including the development of new Recommendations and/or Reports on the satellite radio interface technologies.

This group also deals with SNG, which entails the use of transportable and portable earth stations for temporary and occasional transmission of video and/or sound signals, data and auxiliary signals from remote locations.

Current study topics include:

- Performance, availability requirements, transmission aspects and quality of service architectures of the Internet Protocol networks carried over satellite.
- Generic performance requirements for satellite systems operating above 15 GHz.
- Performance requirements for broadband access systems, including point-to-multipoint applications.
- Satellite aspects of improving reliability and security of telecommunications networks, including support of emergency services.
- Architecture and performance aspects of hybrid and integrated satellite applications with nomadic wireless and mobile users.
- Performance requirements for digital television transmission schemes such as DVB and its variants for SNG usage.
- Implementations of adaptive coding and modulation, including additional methodologies and metrics to assess the degradation in spectrum efficiency (throughput or capacity) of satellite links. Studies should analyse the efficacy of such methodologies and metrics.
- Technical characteristics of MSS terminals in vehicles and handheld devices and their associated implementation.
- Performance and availability that can be achieved by MSS terminals.

- Issues related to the satellite component of Next Generation Access Technologies.
- Transmission systems for UHDTV and other satellite broadcasting applications in 12 GHz, 21 GHz and between 17.3 GHz and 42.5 GHz.

ITU-R Working Party 4C – Efficient orbit/spectrum utilization for the mobile-satellite service (MSS) and the radiodetermination-satellite service (RDSS)²

Studies conducted within Working Party 4C are aiming at a more efficient use of the orbit/spectrum resources by MSS and RDSS systems. This includes analysing various interference situations between such systems but also with systems operating in other radiocommunication services, developing coordination methodologies, describing the potential use of MSS and RDSS systems for specific purposes like emergency situations, maritime or aeronautical telecommunications, time distribution, etc.

ITU-R Recommendations and Reports on these study items are elaborated and maintained by Working Party 4C, who also significantly contributes to the preparatory work for World Radiocommunication Conferences (WRCs).

Current study topics include:

- Technical characteristics of mobile satellite systems in the frequency bands below 3 GHz for use in developing criteria for sharing between the mobile-satellite service (MSS) and other services.
- Use of RNSS receiver characteristics in assessment of interference from pulsed sources in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands.
- Protection of radionavigation-satellite service receiving earth stations operating in the frequency bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz from spurious emissions of IMT stations in the frequency bands below 3 GHz.
- Adjacent band compatibility studies of IMT systems in the mobile service in the band below 1 518 MHz with respect to systems in the mobile-satellite service in the frequency band 1 518-1 525 MHz.
- Adjacent band compatibility studies of IMT-Advanced systems in the mobile service in the band below 1 518 MHz with respect to systems in the mobile satellite service in the frequency band above 1 518 MHz.
- Non-geostationary satellites operating space-to-space links in mobile-satellite service (MSS) allocations in the 1-3 GHz range.
- Unwanted emissions in the RAS band from space-to-Earth transmissions from MSS satellites.

² WP 4C also deals with the performance issues related to RDSS.

- Coexistence and compatibility study between the terrestrial component and the satellite component of IMT in the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz in different countries.
- Sharing and coexistence studies between the mobile-satellite service and terrestrial IMT systems in the 2 655-2 690 MHz frequency band.
- Calculation method to determine aggregate interference parameters of pulsed RF systems operating in and near the bands 1 164-1 215 MHz and 1 215 1 300 MHz that may impact radionavigation-satellite service airborne and ground based receivers operating in those frequency bands.

Amongst those items on which Working Party 4C is engaged in preparation for WRC-23 are the studies on:

- Spectrum needs and potential new allocations to the mobile-satellite service in the frequency bands 1 695-1 710 MHz, 2 010-2 025 MHz, 3 300-3 315 MHz and 3 385-3 400 MHz for future development of narrowband mobile-satellite systems;
- Consideration of possible regulatory actions to support the modernization of the Global Maritime Distress and Safety System and the implementation of e-navigation;
- Technical and operational measures to be applied in the frequency band 1 240-1 300 MHz to ensure the protection of the radionavigation-satellite service (space-to-Earth).

Handbooks

[itu.int/pub/R-HDB](http://www.itu.int/pub/R-HDB)

ITU-R Study Group 4 and its Working Parties developed a number of ITU R Handbooks:

Handbook on Mobile-satellite service (MSS) (www.itu.int/pub/R-HDB-41) provides a brief survey and introduction to the field of MSS

Supplements No. 1, 2, 3 and 4 to Handbook on Mobile-satellite service (MSS) (www.itu.int/pub/R-HDB-51):

Supplement 1 – Systems aspects of digital mobile Earth Station

Supplement 2 – Methodology for the derivation of interference and sharing criteria for the Mobile-satellite services

Supplement 3 – Interference and noise problems for maritime mobile-satellite systems using frequencies in the region of 1.5 and 1.6 GHz

Supplement 4 – Technical aspects of coordination among mobile-satellite systems using the geostationary-satellite orbit

Handbook on Satellite Communications (FSS) (www.itu.int/pub/R-HDB-42) gives a comprehensive description of all issues relative to satellite communication systems operating in the fixed-satellite service (FSS)

DSB Handbook – Terrestrial and satellite digital sound broadcasting to vehicular, portable and fixed receivers in the VHF/UHF bands (www.itu.int/pub/R-HDB-20) describes the system and service requirements for digital sound broadcasting (DSB) to vehicular, portable and fixed receivers, the related propagation factors, the techniques employed in the digital sound broadcasting systems, and considers relevant planning parameters and sharing conditions.

ITU-R Special publication: Specifications of transmission systems for the broadcasting-satellite service (www.itu.int/pub/R-HDB-16)

Other deliverables from ITU-R Study Group 4

Study Group 4 and its Working Parties maintains a number of **Recommendations** (www.itu.int/pub/R-REC) and **Reports** (www.itu.int/pub/R-REP) relating to the fixed-satellite service, the broadcasting-satellite service, the mobile-satellite service and the radiodetermination-satellite service.

Study Group 5

Terrestrial services

itu.int/go/itu-r/sg5

Scope

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

Structure

Four Working Parties (WPs) carry out the studies on Questions assigned to Study Group (SG) 5 and one Task Group (TG) which conducts studies on WRC-19 Agenda item 1.13:

- WP 5A Land mobile service above 30MHz³ (excluding IMT); wireless access in the fixed service; amateur and amateur-satellite services
- WP 5B Maritime mobile service including the Global Maritime Distress and Safety System (GMDSS); the aeronautical mobile service and the radiodetermination service
- WP 5C Fixed wireless systems; HF and other systems below 30 MHz in the fixed and land mobile services
- WP 5D IMT systems

³ Including the exact frequency of 30 MHz.

ITU-R Working Party 5A – Land mobile service excluding IMT; amateur and amateur-satellite service

WP 5A is responsible for studies related to the land mobile service, excluding IMT and including wireless access in the fixed service, and is also responsible for studies related to the amateur and amateur-satellite services.

Mobility is becoming an ever-increasing requirement and characteristic of today's communications. In addition to commercial wireless access systems, including radio local area networks (RLANs), specialized land mobile applications such as intelligent transport systems (ITS) are becoming essential in improving the safety and efficiency of our roads and highways.

A key objective of WP 5A is to facilitate, through appropriate studies, equitable access to the radio spectrum by the land mobile and the amateur services, providing benefits that are made possible by implementing radio solutions to the communication needs. WP 5A is also very active in the development and standardization of new technologies for land mobile systems.

The amateur services continue to provide an opportunity for approximately 3 million duly authorized persons throughout the world to use radiocommunications for personal applications without any pecuniary interest. Activities include technical experimentation and communications between licensed amateurs and disaster communications. There have been more than 40 amateur-constructed low-Earth orbit and highly elliptical orbit satellites launched in the amateur-satellite service. Studies carried out by WP 5A on the amateur services concern technical and operational characteristics, sharing studies and, when requested, preparation for World Radiocommunication Conference agenda items.

Another important effort undertaken within WP 5A is the production of a series of volumes for the Land Mobile Handbook. The Handbook covers all categories of land mobile applications such as cellular phone, broadband wireless access, fixed wireless access, dispatch and paging systems, and intelligent transport systems. Five volumes have already been published. The purpose of this Handbook is to assist the ITU membership in the decision-making process involving planning, engineering and deployment of land mobile systems around the world.

ITU-R Working Party 5B – Maritime mobile service including the Global Maritime Distress and Safety System (GMDSS); the aeronautical mobile service and the radiodetermination service

WP 5B is responsible for studies related 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. It studies communication systems for the maritime mobile and aeronautical mobile services and radar and radiolocation systems for the radiodetermination service.

WP 5B is the lead group for developing and maintaining ITU-R Recommendations, Reports and Handbooks that enable effective operation and protection for different applications, including distress and safety applications of the above services, while permitting sharing of the limited spectrum resources with other services operating within the allocated bands.

The maritime mobile service, by the very nature of its remote operations, is critically dependent on radio spectrum for the conduct of its business activities, as well as providing a vital link to search and rescue authorities and ships and aircraft during distress incidents and other potentially dangerous conditions. In close cooperation with the International Maritime Organization (IMO), WP 5B also develops drafts 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).

With respect to the aeronautical mobile service, the provision of air traffic control and other communications related to safety and regularity of flight are dependent on radio spectrum. Therefore, Recommendations relating to protection and sharing criteria are studied by WP 5B on a continuous basis, with respect to proposed new sharing scenarios and to take into account innovations in technology. In accordance with its mandate, Working Party 5B carries out studies and develops Recommendations related to new aeronautical applications such as unmanned aircraft systems.

Different aspects related to the development and operation of applications belonging to the radiodetermination service (including radiolocation and radionavigation) are also part of the WP 5B agenda. 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. While these systems operate within the current frequency allocations, proposals for sharing with new systems that require significant new spectrum allocations are being made in preparation for future World Radiocommunication Conferences. This requires the development of specific Recommendations addressing the characteristics of all known radar systems, potential enhancements made possible by the introduction of new technology and standardized measurement and mitigation techniques for each proposed new sharing scenario.

Taking into account the increasing importance of climate monitoring, WP 5B pays special attention to the development and maintenance of ITU-R Recommendations related to the operation of ground-based meteorological radars employed for weather, water and climate monitoring and prediction. These radars play a critical role in the 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.

Working Party 5B maintains strong cooperation with the International Civil Aviation Organization (ICAO), the International Maritime Organization (IMO) and the World Meteorological Organization (WMO).

Working Party 5C – Fixed wireless systems; HF systems in the fixed and land mobile services

WP 5C is responsible for studies related to fixed wireless systems and HF systems in the fixed and land mobile services. It studies performance and availability objectives, interference criteria, RF channel/block arrangements, system characteristics and sharing feasibility. (Note that for fixed wireless access (FWA) systems, work related to public access systems for potentially large deployment coverage is carried out in WP 5A.)

Performance and availability objectives for fixed wireless systems are established with the aim of integrating these systems in the public network. Close coordination with ITU-T on this issue is required for consistency with relevant ITU-T Recommendations.

Establishing interference criteria for FS systems due to various sources of interference is essential in the preparation of technical texts for future radiocommunication conference items on frequency sharing with other radio services.

WP 5C also standardizes the RF arrangements (including those based on frequency blocks) in the various frequency bands allocated to the FS. These arrangements allow homogeneous patterns to be used, which is desirable for interconnecting systems on international circuits and to minimize mutual interference.

Fixed wireless system characteristics are also studied. Along with the interference criteria, knowledge of the system characteristics is vital for the work of WP 5C in assessing the impact of sharing with other services on a primary basis, in all the bands allocated to the FS.

The scope of WP 5C also covers use of frequency bands below 30 MHz by the fixed and land mobile services. Particular topics include adaptive HF systems, HF fixed service characteristics, including interference objectives and protection criteria, and interference evaluation in co-channel sharing feasibility studies.

ITU-R Working Party 5D – IMT Systems

WP 5D is responsible for the overall radio system aspects of the terrestrial component of International Mobile Telecommunications (IMT) systems, comprising the current IMT-2000, IMT-Advanced and IMT-2020.

For the last 30 years, ITU has been coordinating efforts of governments and the industry in the development of a global broadband multimedia international mobile telecommunications system, known as IMT. Since the year 2000, the world has seen the introduction of the first family of standards derived from the IMT concept: IMT-2000. There are currently several billions IMT subscribers in the world and these systems are continuing to expand and evolve.

IMT provides a global platform on which to build the next generations of mobile services – fast data access, unified messaging and broadband multimedia – in the form of exciting new interactive services.

Recommendation ITU-R M.2012 (www.itu.int/rec/R-REC-M.2012) provides detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications Advanced (IMT-Advanced).

Recommendation ITU-R M.2083 (www.itu.int/rec/R-REC-M.2083) describes in detail the framework of the future development of IMT for 2020 and beyond, including a broad variety of capabilities associated with envisaged usage scenarios.

WP 5D has the prime responsibility within ITU-R for issues related to the terrestrial component of IMT, including technical, operational and spectrum-related issues to meet the objectives of future IMT systems and works closely with Working Parties 4B and 4C on issues related to the satellite component of IMT and with other Working Parties as necessary.

WP 5D is the lead group for the overall maintenance of existing, and the development of new, Recommendations on the terrestrial component of IMT. This activity also involves liaison with ITU-T on the network-related standardization activities of IMT and with ITU-D in relation to the application of IMT in developing countries. Strong cooperative efforts with external organizations and well-known standards development organizations are also maintained.

Handbooks

itu.int/pub/R-HDB

ITU-R Study Group 5 and its Working Parties developed a number of ITU R Handbooks:

Handbook on Amateur and Amateur-satellite services (www.itu.int/pub/R-HDB-52) provides general information about the amateur and amateur-satellite services. It also includes a compendium of existing ITU texts of relevance to the amateur and amateur-satellite services. This Handbook is intended to present, in one document, information about the amateur services for administrations and amateur radio organizations.

Handbook on Digital Radio-Relay Systems (www.itu.int/pub/R-HDB-24) represents a comprehensive summary of basic principles, design parameters and current practices for the design and engineering of digital radio-relay systems.

Handbook on Frequency adaptive communication systems and networks in the MF/HF bands (www.itu.int/pub/R-HDB-40) assists planners and decision-makers in the deployment of adaptive MF/HF systems in the fixed service, for both commercial and government users in developed and particularly developing countries. It provides material on current present technological capabilities in the field of adaptive MF/HF communications.

Handbook on Land Mobile (including Wireless Access) Volume 1: Fixed Wireless Access (www.itu.int/pub/R-HDB-25) assists in the decision making process involving planning, engineering and deployment of wireless access based land mobile systems, especially in the developing countries. It should also provide adequate information that will assist in training engineers and planners in regulating, planning, engineering, and deployment aspects of these systems.

Handbook on Land Mobile (including Wireless Access) Volume 2: Principles and Approaches on Evolution to IMT-2000/FPLMTS (www.itu.int/pub/R-HDB-30) provides an overview of principles and approaches to be considered in the evolution of existing and emerging systems towards IMT-2000. IMT-2000 are third generation mobile systems which are scheduled to start service around the year 2000, subject to market considerations.

Handbook on Land Mobile (including Wireless Access) – Volume 3: Dispatch and Advanced Messaging Systems (www.itu.int/pub/R-HDB-47) assists in the decision-making process involving planning, engineering and deployment of land mobile systems, especially in the developing countries. It should also provide adequate information to assist in training engineers and planners in regulating, planning, engineering and deployment aspects of these systems. Volume 3 on Dispatch and Advanced Messaging Systems provides information on state-of-the-art technology in terrestrial land mobile paging and advanced messaging and dispatch as well as descriptions of typical systems. The technical content is intended for use by administrations and operators in both developing and developed countries.

Handbook on Land Mobile Handbook (including Wireless Access) – Volume 4: Intelligent Transport Systems (www.itu.int/pub/R-HDB-49) provides a summary of the use of wireless communications in intelligent transport systems (ITS), current and under development, around the globe, including architecture, systems, and applications. This is a rapidly developing sector, which is still partly in its infancy.

Handbook on Land Mobile (including Wireless Access) – Volume 5: Deployment of Broadband Wireless Access Systems (www.itu.int/pub/R-HDB-57) overall purpose is to assist in the decision-making process involving planning, engineering and deployment of wireless-based land mobile systems, especially in developing countries. It also provides information that will assist in training engineers and planners in the regulating, planning, engineering and deployment aspects of these systems.

Handbook on Migration to IMT-2000 Systems – Supplement 1 (Revision 1) of the Handbook on Deployment of IMT-2000 Systems (www.itu.int/pub/R-HDB-46) expands on the first edition of the ITU Handbook - Deployment of IMT- 2000 Systems and updates much of the work that has occurred since the release of the Handbook. It addresses the subject of evolution and migration from current mobile systems towards IMT-2000. ITU-R has developed this work in response to ongoing liaison and interaction with the ITU-D and ITU-T Sectors and sees this material as the natural extension of the information presented in the Handbook.

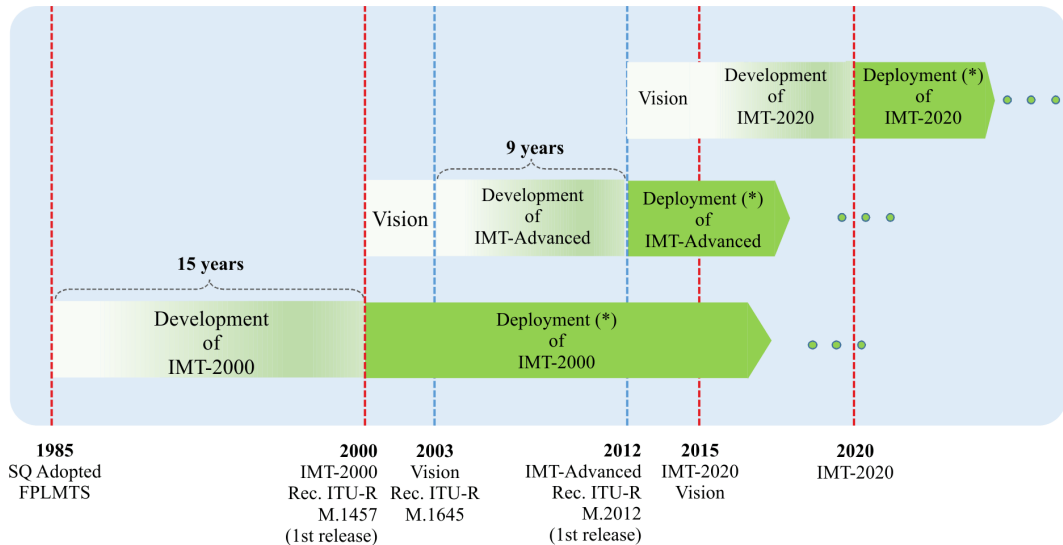
Handbook on IMT-2000: Special Edition on CD-ROM (www.itu.int/pub/R-HDB-37) is of particular interest to experts involved in IMT-2000 radio and network standards development and also to all those interested in a deeper understanding of the global scene of personal mobile communications. It contains a complete set of ITU texts on IMT-2000 and other related topics and includes Recommendation ITU-R M.1457 which describes the detailed specifications of the radio interfaces of IMT-2000.

Handbook on Global Trends in International Mobile Telecommunications (www.itu.int/pub/R-HDB-62) identifies International Mobile Telecommunications (IMT) and provides the general information such as service requirements, application trends, system characteristics, and substantive information on spectrum, regulatory issues, guideline for the evolution and migration, and core network evolution on IMT. The purpose of this Handbook is to provide general guidance to relevant parties on issues related to the deployment of IMT systems and to the introduction of their IMT 2000 and IMT Advanced networks.

Handbook on Guidance for bilateral/multilateral discussions on the use of frequency range 1 350 MHz – 43.5 GHz by fixed service systems (www.itu.int/pub/R-HDB-61) summarizes the existing technical approaches to resolve compatibility and sharing issues within fixed service stations. The objective is to provide a guide addressing best practices from those administrations already having knowledge and experience in developing such agreements. Examples are provided to facilitate the sharing of fixed service deployed in the neighbouring countries.

Other deliverables from ITU-R Study Group 5

Study Group 5 and its Working Parties maintains a number of **Recommendations** (www.itu.int/pub/R-REC) and **Reports** (www.itu.int/pub/R-REP) relating to the fixed, mobile, radiodetermination, amateur and amateur-satellite services.. Study Group 5 is also responsible of the development of IMT.



(*) Deployment timing may vary across countries.

M.2083-01

Development of International Mobile Telecommunications (IMT)

Study Group 6

Broadcasting service

itu.int/go/itu-r/sg6

Scope

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

Broadcasting makes use of point-to-everywhere information delivery to widely available consumer receivers at home, in cars or in portable use. When return channel capacity is required (e.g. for access control, interactivity, etc.), broadcasting typically uses an asymmetrical distribution infrastructure that allows high-capacity information delivery to the public with lower capacity return link to the service provider (by using the so-called converged terminals). The work of the Study Group includes the production and distribution of programmes (vision, sound, multimedia, data, etc.) as well as contribution circuits among studios, information gathering circuits (ENG, requirements for SNG, etc.), primary distribution to delivery nodes, and secondary distribution to consumers.

The Study Group, recognizing that radiocommunication broadcasting extends from the production of programmes to their delivery to the general public, studies those aspects related to production and radiocommunication end-to-end, including the international exchange of programmes as well as the overall quality of service.

Structure

Three Working Parties (WPs) carry out studies on Questions assigned to Study Group (SG) 6:

- WP 6A Terrestrial broadcasting delivery
- WP 6B Broadcast service assembly and access
- WP 6C Programme production and quality assessment

A Task Group has been created to address a specific WRC agenda item:

Task Group 6/1 (TG 6/1) – WRC-23 agenda item 1.5

The work of SG6 and its Working Parties is facilitated by various Rapporteurs, Rapporteur Groups and Correspondence Groups, as well as Inter-Sector Rapporteur groups.

ITU-R Working Party 6A – Terrestrial broadcasting delivery

WP 6A covers terrestrial broadcasting system characteristics including channel coding/decoding and modulation/demodulation, frequency planning and sharing for sound, video, multimedia and interactivity, characteristics of transmitting and receiving antennas, evaluation methods of service areas, transmitter and receiver reference performance requirements, and requirements for source coding for terrestrial emission.

Current activities include protection of terrestrial broadcasting services, development of next generation television, sound and multimedia broadcasting systems, emergency broadcasting, electronic news gathering (ENG), and contributions to Green ICT.

Several areas have been established in WP 6A new work items, including:

- Methods for introduction of new systems, technologies and applications in terrestrial broadcasting service
- Advanced network planning and transmission methods for enhancements of terrestrial broadcasting
- Assistance for administrations transitioning from analogue to digital sound and TV broadcasting
- Co-existence calculations for terrestrial broadcasting using Monte Carlo simulations.

ITU-R Working Party 6B – Broadcast service assembly and access

WP 6B covers the area that bridge programme production and content distribution. These include the interfaces required in the production chain to the various delivery media (terrestrial, satellite, cable, internet, etc.) together with source coding and multiplexing of content, metadata, middleware, service information, and access control. This is applicable to all delivery services, including multimedia/interactive and converged services, for both fixed and mobile terminals. WP 6B is also responsible for determining broadcaster requirements for Electronic News Gathering (ENG) as well as requirements for the delivery of content to end-users whatever the method of distribution. It has become clear that SG 6 needs to accelerate studies on the full integration of the internet into a future broadcasting ecosystem such that the consumer may remain unaware and unconcerned as to how the content is received.

Work items are in progress on the use of Internet Protocol (IP) interfaces for the transport of content including the definition of appropriate IP profiles, and on the further harmonization of Integrated Broadcast-Broadband (IBB) applications. Further studies on systems for enabling access to broadcast and cooperative media for persons with disabilities are planned, including exploration the application of technologies driven by artificial intelligence (AI).

While video and audio source coding and multiplexing methods are usually standardized by MPEG and ITU-T SG 16, WP 6B has a role in adapting such methods to digital broadcasting bearing in mind audience expectations for high quality, performance and functionality. Studies to assess the implications of video coding beyond HEVC are being considered. Audio work is to include further development of the Audio Definition Model which will need to take account of new use cases including interactivity-control metadata to be presented to the listener and new elements that will be required for the transport of advanced immersive audio-visual (AIAV) content in IP-based broadcasting systems.

ITU-R Working Party 6C – Programme production and quality assessment

WP 6C covers the “presentation layer” for radio and television content production and international exchange for broadcast services. This includes signal formats used for the production of programmes, methods to evaluate sound and image quality, and guidance on the use of new technologies that are now being used in the end-to-end “presentation layer”. WP 6C will continue to expand its study of topics related to accessibility to media and will be accessing all its past, current and future work to ensure compliance with UN Convention on the Rights of Persons with Disabilities and ITU Resolution 175 (Rev. Dubai, 2018).

WP 6C has identified four key areas where it can contribute to the studies into the accessibility of media, related to content creation and international programme exchange (exchange of content between broadcasters, internet distributors and packaged media formats);

- Seeing (e.g. enhanced video, described video, photosensitive epileptic seizure mitigation, tactile representation)
- Hearing (e.g. object audio, signing, captions, enhanced text, haptic audio representation)
- Understanding (e.g. cognitive services, dialogue slowing, simplified text)
- Participating (mobility interface options).

Recommendations concerning audio quality evaluation will be assessed for possible consolidated into a new common Recommendation where evaluation methodologies are application based. A new Recommendation will be considered giving guidance for the assessment of AIAV systems, where sound and image interaction is a critical parameter in the perceived quality of experience of the content. WP 6C will continue to take an active role in the Intersector Rapporteur Groups IRG-AVQA and IRG-AVA during the 2020-2023 study period. Work will continue to develop into new areas especially where related to subjective quality assessment and production data requirements which will also include Reports on the use of AI in programme production. There is expected to be further updated guidance for operational practices in HDR television production as experience continues to grow both with production and with international programme exchange.

ITU-R Task Group 6/1 – WRC-23 Agenda item 1.5

Task Group 6/1 is responsible for the development of draft CPM text under WRC-23 Agenda item 1.5. This is to review the spectrum use and spectrum needs of existing services in the frequency band 470-960 MHz in Region 1 and to consider possible regulatory actions in the frequency band 470-694 MHz in Region 1 on the basis of the review in accordance with Resolution 235 (WRC-15).

Rapporteurs, Rapporteur Groups and Correspondence Groups

Study Group 6 and its working parties also support various Rapporteurs, Rapporteur Groups and Correspondence Groups, as well Inter-Sector Rapporteur Groups. A full list can be found on the SG webpage.

Handbooks

itu.int/pub/R-HDB

ITU-R Study Group 6 and its Working Parties developed a number of ITU R Handbooks:

DTTB Handbook – Digital terrestrial television broadcasting in the VHF/UHF bands (www.itu.int/pub/R-HDB-39) provides guidance to engineers responsible for the implementation of digital terrestrial television broadcasting and combines material dealing with digital and analogue television systems and planning aspects of this new topic.

Handbook on HF Broadcasting System Design (www.itu.int/pub/R-HDB-33) provides practical and illustrative guidance (even to radio engineers not having been previously exposed to the specific task of HF broadcasting service planning). Considerable effort has been made to meet the expectations of HF broadcasting engineers from the developing world. This publication includes relevant texts from existing ITU-R Recommendations as well as advanced material.

Handbook on Digital Terrestrial Television broadcasting networks and systems implementation (www.itu.int/pub/R-HDB-63) provides assistance in technical and service issues such as networks and systems, audiovisual quality and quality of transmission, as well as on other issues of interest for the introduction of digital terrestrial TV broadcasting (from multimedia systems to UHD TV) in different countries.

Other deliverables from ITU-R Study Group 6

Study Group 6 and its Working Parties maintain a number of **Recommendations** (www.itu.int/rec/R-REC-BT/en, www.itu.int/rec/R-REC-BS/en) and **Reports** (www.itu.int/pub/R-REP-BS/en) relating to the broadcasting service.

Recently developed **Recommendations** include:

Sound broadcasting

- BS.450-4 Transmission standards for FM sound broadcasting at VHF
- BS.1114-11 Systems for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz

- BS.1660-8 Technical basis for planning of terrestrial digital sound broadcasting in the VHF band
- BS.2107-0 Use of International Radio for Disaster Relief (IRDR) frequencies for emergency broadcasts in the High Frequency (HF) bands

Television broadcasting

- BT.1206-3 Spectrum limit masks for digital terrestrial television broadcasting
- BT.1368-13 Planning criteria, including protection ratios, for digital terrestrial television services in the VHF/UHF bands
- BT.1877-2 Error-correction, data framing, modulation and emission methods for second generation of digital terrestrial television broadcasting systems
- BT.2036-3 Characteristics of a reference receiving system for frequency planning of digital terrestrial television systems

Electronic news gathering

- BT.1871-2 User requirements for wireless microphones
- BT.1872-3 User requirements for broadcast auxiliary services including digital television outside broadcast, electronic/satellite news gathering and electronic field production

Audio

- BS.1196-8 Audio coding for digital broadcasting
- BS.1548-7 User requirements for audio coding systems for digital broadcasting
- BS.2051-2 Advanced sound system for programme production
- BS.2076-2 Audio Definition Model
- BS.2088-1 Long-form file format for the international exchange of audio programme materials with metadata
- BS.2094-1 Common definitions for the Audio Definition Model
- BS.2102-0 Allocation and ordering of audio channels to formats containing 12-, 16- and 32-tracks of audio
- BS.2125-0 A serial representation of the Audio Definition Model
- BS.2127-0 Audio Definition Model renderer for advanced sound systems

Television image

- BT.814-4 Specifications of PLUGE test signals and alignment procedures for setting of brightness and contrast of displays
- BT.2100-2 Image parameter values for high dynamic range television for use in production and international programme exchange
- BT.2111-1 Specification of colour bar test pattern for high dynamic range television systems

- BT.2123-0 Video parameter values for advanced immersive audio-visual systems for production and international programme exchange in broadcasting

Transport and multimedia

- BT.1120-9 Digital interfaces for studio signals with 1 920 × 1 080 image formats
- BT.1122-3 User requirements for codecs for emission and secondary distribution systems for SDTV, HDTV, UHDTV and HDR-TV
- BT.1366-3 Transmission of time code and control code in the ancillary data space of a digital television stream according to Recommendations ITU-R BT.656, ITU-R BT.799, ITU-R BT.1120 and ITU-R BT.2077
- BT.1852-1 Conditional-access systems for digital broadcasting
- BT.2054-1 Multiplexing and transport schemes in multimedia broadcasting systems for mobile reception
- BT.2055-1 Content elements in multimedia broadcasting systems for mobile reception
- BT.2074-1 Service configuration, media transport protocol, and signalling information for MMT-based broadcasting systems
- BT.2075-2 Integrated broadcast-broadband system
- BT.2077-2 Real-time serial digital interfaces for UHDTV signals
- BT.2133-0 Transport of advanced immersive audio-visual (AIAV) content in IP-based broadcasting systems

Quality assessment

- BT.500-14 Methodology for the subjective assessment of the quality of television pictures
- BS.1283-2 A guide to ITU-R Recommendations for subjective assessment of sound quality
- BS.1284-2 General methods for the subjective assessment of sound quality
- BT.1702-2 Guidance for the reduction of photosensitive epileptic seizures caused by television
- BT.2095-0 Subjective assessment of video quality using Expert Viewing Protocol
- BT.2124-0 Objective metric for the assessment of the potential visibility of colour differences in television
- BS.2126-0 Methods for the subjective assessment of sound systems with accompanying picture
- BS.2132-0 Method for the subjective quality assessment of audible differences of sound systems using multiple stimuli without a given reference

Study Group 7

Science services

itu.int/go/itu-r/sg7

Scope

“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.

The systems linked with Study Group 7 are used in activities that are a critical part of our everyday life such as:

- global environment monitoring – atmosphere (including greenhouse gases emissions), oceans, land surface, biomass, etc.;
- weather forecasting and climate change monitoring and prediction;
- detection and tracking of many natural and man-made disasters (earthquakes, tsunamis, hurricanes, forest fires, oil leaks, etc);
- providing alerting/warning information;
- damage assessment and planning relief operations.

SG 7 also encompasses systems for the study of outer space:

- satellites for studying the sun, the magnetosphere and all the elements of our solar system;
- spacecraft for human and robotic exploration of extraterrestrial bodies;
- Earth and satellite-based radioastronomy to study the universe and its phenomena.

Study Group 7 develops ITU-R Recommendations, Reports and handbooks that are used for development and ensuring non-interference operation of space operation, space research, Earth-exploration and meteorological systems (including the related use of links in the inter-satellite service), radio astronomy and radar astronomy, dissemination, reception and coordination of standard-frequency and time-signal services (including the application of satellite techniques) on a worldwide basis.

Structure

Four Working Parties (WPs) carry out studies on Questions assigned to Study Group (SG) 7, and one Joint Task Group (JTG) conducts related studies on WRC-15 Agenda items 1.1 and 1.2

- WP 7A Time signals and frequency standard emissions: Systems and applications (terrestrial and satellite) for dissemination of standard time and frequency signals;
- WP 7B Space radiocommunication applications: Systems for transmission/reception of telecommand, tracking and telemetry data for space operations, space research, Earth exploration-satellite, and meteorological satellite services including the related use of links in the inter-satellite service;
- WP 7C Remote sensing systems: active and passive remote sensing applications in the Earth exploration-satellite service and systems of the MetAids service, as well as ground based passive sensors, space weather sensors and space research sensors, including planetary sensors;
- WP 7D Radio astronomy: radio astronomy and radar astronomy sensors, both Earth-based and space-based, including space very long baseline interferometry (VLBI).

ITU-R Working Party 7A – Time signals and frequency standard emissions

WP 7A covers standard frequency and time signal services, both terrestrial and satellite. Its scope includes the dissemination, reception and exchange of standard frequency and time signals and coordination of these services, including the application of satellite techniques on a worldwide basis.

The goals of WP 7A activities are to develop and maintain ITU-R Recommendations and Reports in the TF Series and Handbooks relevant to standard frequency and time-signal (SFTS) activities, covering the fundamentals of the SFTS generation, measurements and data processing. These ITU-R Recommendations are of paramount importance to telecommunication administrations and industry, to which they are first directed. They also have important consequences for other fields, such as radionavigation, electric power generation, space technology, scientific and meteorological activities and cover the following topics:

- Terrestrial SFTS transmissions (including HF, VHF, UHF broadcasts), television broadcasts, microwave link; coaxial and optical cables;
- Space-based SFTS transmissions/ (including navigation satellites) and communication satellites and meteorological satellites;
- Time and frequency technology, (including frequency standards and clocks), measurement systems, performance characterization, time scales and time codes.

ITU-R Working Party 7B – Space radiocommunications applications

WP 7B is responsible for the transmission and reception of telecommand, tracking and telemetry data for space operation, space research, Earth exploration-satellite, and meteorological satellite services. It studies communication systems for use with manned and unmanned spacecraft, communication links between planetary bodies and the use of data relay satellites.

WP 7B enables both scientific studies and technology programmes by intelligent use of the radio-frequency spectrum.

WP 7B develops and maintains the Recommendations to enable sharing of the limited orbital and spectrum resources. The technical and operational characteristics of spacecraft are also studied, defining the preferred frequency bands, bandwidths required, protection and sharing criteria for spacecraft, and orbital locations for data relay satellites. The resulting SA Series ITU-R Recommendations and Reports assist administrations, national space agencies and industry in the planning of systems that share frequency allocations used by space radio systems.

Space research, by the very nature of its remote operations, is critically dependent on the radio spectrum for the conduct of its activities.

Extreme distances characterize deep space activities, with some current missions in excess of 11 billion km from the Earth. These extraordinary distances require the use of sophisticated communication equipment and advanced technologies to achieve reliable communication links.

The expansion of radiocommunications using low-Earth orbit, coupled with the requirement for continuous communication, has led to the use of data relay satellites. Placed in geostationary orbit, a data relay satellite can provide continuous communication between a low-Earth orbiting spacecraft and a single earth station, and can support multiple spacecraft simultaneously with low to very high data rate requirements.

With respect to manned missions, the most challenging communication systems are those embedded in the space suits of astronauts engaged in space walks. The fact that the communication system must be integrated into the space suit severely limits the physical size and power consumption of such systems.

It is crucial for understanding the Earth and its natural phenomena, including climate change, that active and passive sensor data obtained from Earth exploration-satellites is disseminated, while the transmission of weather-related observations from meteorological satellites provides global or regional coverage for weather models, including cloud coverage, infrared, and water vapor images.

ITU-R Working Party 7C – Remote sensing systems

WP 7C covers remote sensing applications in the Earth exploration-satellite service (EESS), both active and passive, systems of the MetAids service, as well as ground based passive sensors, space weather sensors and space research sensors, including planetary sensors.

The objectives of WP 7C activities are to develop and maintain ITU-R Recommendations, Reports and handbooks relevant to remote sensing in Earth-exploration and meteorological activities. This includes the assessment of spectrum requirements and protection criteria for the above services and the establishment of sharing criteria with other services. The resulting RS Series ITU-R Recommendations are of paramount importance to administrations, international and national space agencies, as well as industry.

The Earth-exploration active sensors on-board satellites include systems such as altimeters, scatterometers and synthetic aperture radars to carry out:

- scientific and meteorological measurements of soil moisture, forest biomass, precipitation, surface winds, ocean topography, clouds structure, etc;
- measurements related to environmental protection and management of natural and man-made disaster situations (e.g. flooding, earthquakes, oil spills);
- Earth imaging at medium and high resolution for commercial and security applications.

The Earth-exploration passive sensors are used for a variety of terrestrial and atmospheric measurements, including important environmental data such as soil moisture, salinity, ocean surface temperature, water vapour profiles, temperature profiles, ocean ice, rain, snow, ice, winds, atmospheric chemicals, etc. Because of the required measurement accuracy down to fractions of one Kelvin, as well as the inability of the sensor to distinguish between natural and man-made radiation, a very high level of protection against interference from active services is necessary to obtain successful results.

The space research active and passive sensors are conceptually similar to the sensors used for Earth exploration, but are used either for the exploration of other planetary bodies of our solar system or for radio astronomical measurements from space.

The meteorological services comprise primarily the MetSat service and the MetAids service (the latter covering a variety of types of meteorological equipment), radiosondes, dropsondes and rocketsondes. MetAids are flown worldwide for the collection of upper atmosphere meteorological data for weather forecasts and severe storm prediction, collection of ozone level data, and measurement of atmospheric parameters for various applications.

WP 7C is also considering ground-based (incl. airborne) passive sensors, their technical and operational characteristics and corresponding protection requirements as they are becoming increasingly important in the observation and monitoring of the Earth environment and phenomena affecting it.

Furthermore, WP 7C is investigating about space weather observations with ground-based and/or space-based sensors in terms of the applicable radio services space weather observations would have to be categorized in, the corresponding frequency allocations and their technical and operational characteristics and protection requirements. According to the WMO definition, space weather encompasses the conditions and processes occurring in space, including on the sun, in the magnetosphere, ionosphere and thermosphere, which have the potential to affect the near-Earth environment.”

ITU-R Working Party 7D – Radio astronomy

WP 7D covers the radio astronomy service. Its scope includes radio astronomy and radar astronomy sensors, both Earth-based and space-based, including space very long baseline interferometry (VLBI).

The goals of WP 7D activities are to develop and maintain the RA Series ITU-R Recommendations and Reports and Handbook relevant to radio and radar astronomy, covering their spectrum requirements, protection and sharing criteria. These Recommendations and Reports, as well as the Handbook on Radio Astronomy, are of paramount importance to administrations, national and international space agencies and industries, to which they are first directed.

Radio Astronomy observations involve the detection of extremely faint radio signals from the cosmos over the whole radio spectrum, and therefore require the most sensitive radio telescope systems. Such systems are very susceptible to radio frequency interference from other radio services and hence careful management of the radio spectrum is of extreme importance to radio astronomy.

The radio astronomy service uses very diverse instruments ranging from very large single-dish telescopes such as the new 500m diameter FAST telescope in China, to large distributed arrays such as the new Square Kilometer Array (SKA) now under construction in Australia and South Africa. These telescopes employ extremely sensitive cryogenically cooled receivers and require advanced digital electronics and computer systems, often pioneering new technologies. WP 7D must develop the protection criteria for such services and work within the ITU to enable adequate protection for radio astronomy observations.

Handbooks

itu.int/pub/R-HDB

ITU-R Study Group 7 and its Working Parties developed a number of ITU R Handbooks:

ITU/WMO Handbook on the “Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction (www.itu.int/pub/R-HDB-45) was developed in cooperation with the Steering Group on Radio Frequency Coordination of the World Meteorological Organization (WMO) and provides comprehensive technical information on the use of radio-based devices and systems, including meteorological and Earth exploration-satellites, radiosondes, weather radars, wind profiler radars, spaceborne remote sensing for weather and climate monitoring and forecasting.

Handbook on Earth-Exploration Satellite Service (www.itu.int/pub/R-HDB-56) describes the Earth exploration-satellite service (EESS), its technical characteristics, its applications, its spectrum requirements, as well as its benefits and provides full and comprehensive information on the development of EESS systems. Specifically, it provides basic definitions, sheds light on the technical principles underlying the operation of systems and presents their main applications to assist administrations in the spectrum planning, engineering and deployment aspects of these systems.

Handbook on Radio Astronomy (www.itu.int/pub/R-HDB-22) is concerned with aspects of radio astronomy relevant to frequency coordination, i.e. the management of radio spectrum usage in order to minimize interference between radiocommunication services. It covers areas such as radio astronomy characteristics, preferred frequency bands, special radio astronomy applications, vulnerability to interference from other services, as well as issues associated with the sharing of radio spectrum with other services. The search for extraterrestrial intelligence and ground-based radar astronomy are also considered in the Handbook.

Handbook on Selection and Use of Precise Frequency and Time Systems (www.itu.int/pub/R-HDB-31) describes basic concepts, frequency and time sources, measurement techniques, characteristics of various frequency standards, operational experience, problems and future prospects.

Handbook on Satellite Time and Frequency Transfer and Dissemination (www.itu.int/pub/R-HDB-55) provides detailed information on the applied methods, technologies, algorithms, data structure and practical use of frequency and timing signals provided by satellite systems.

Handbook on Space Research Communications (www.itu.int/pub/R-HDB-43), presents the basic technical and spectrum requirements for the many different space research programmes, missions and activities. It discusses space research functions and technical implementations, factors that govern frequency selection for space research missions, and space research protection and sharing considerations.

Other deliverables from ITU-R Study Group 7

Study Group 7 and its Working Parties maintains a number of **Recommendations** (www.itu.int/pub/R-REC) and **Reports** (www.itu.int/pub/R-REP) relating to relating to the science services. Recent developments include:

Recommendation ITU-R RS.1883 on **Use of remote sensing systems in the study of climate change and the effects thereof** (www.itu.int/rec/R-REC-RS.1883). This Recommendation encompasses guidelines on the provision of satellite-provided remote sensing data for studying climate change.

ITU-R Report RS. 2178 **The essential role and global importance of radio spectrum use for Earth observations and for related applications** (<https://www.itu.int/pub/R-REP-RS.2178>).

Conference Preparatory Meetings

itu.int/go/itu-r/cpm

In accordance with Resolution ITU-R 2-8, the CPM shall hold two sessions during the interval between WRCs.

The first session is for the purpose of organizing the preparatory studies to be carried out by responsible and contributing groups of the ITU-R Study Groups, and preparing a structure for the draft CPM Report, based on the agenda for the next WRC and the preliminary agenda for the subsequent WRC. This session takes into account any directives which may have come from the previous WRC.

The second session shall prepare a consolidated report to be used in support of the work of World Radiocommunication Conferences, based on:

- the presentation, discussion, rationalization, and updating of material from responsible groups, addressing WRC agenda items (see also No. 156 of the Convention), while taking into account contributions from ITU Member States and Radiocommunication Sector Members concerning the regulatory, technical, operational and procedural matters to be considered by such conferences;
- the inclusion, to the extent practicable, of reconciled differences in approaches as contained in the source material, or, in the case where all efforts to reconcile differences have been exhausted, alternative approaches with their justifications could be included.

Information from the responsible groups in charge of the ITU-R preparatory studies for WRC-23 and WRC-27 can be consulted online at www.itu.int/go/rcpm-wrc-23-studies

Radiocommunication Bureau

The Radiocommunication Bureau (BR) is the executive arm of the Radiocommunication Sector, and is headed by an elected Director who is responsible for the organization and coordination of the work of the Sector. The Director of the BR is assisted by a team of high-calibre engineers, computer specialists and managers who, together with administrative staff, make up the Radiocommunication Bureau.

The Radiocommunication Bureau:

- provides administrative and technical support to Radiocommunication Conferences, Assemblies and Study Groups, including Working Parties and Task Groups;
- applies the provisions of the Radio Regulations and various Regional Agreements;
- records frequency assignments for all services and associated orbital characteristics for space services, and maintains the Master International Frequency Register;
- provides advice to Member States on the equitable, effective and economical use of the radio frequency spectrum and satellite orbits, and investigates and assists in resolving cases of harmful interference;
- coordinates the preparation, editing and dispatch of circulars, documents and publications developed within the Sector;
- provides technical information, organizes regional seminars and workshops on national frequency management and radiocommunications, and works closely with the ITU Telecommunication Development Bureau in assisting developing countries.

World and Regional Radiocommunication Seminars and Workshops

itu.int/go/itu-r/seminars

The Radiocommunication Bureau (BR) organizes world seminars on spectrum management every two years in Geneva, as well as regional seminars aiming at the particular needs of developing countries.

The main objectives of BR seminars and workshops are:

- to provide assistance to Member States in spectrum management activities, e.g. through training, information meetings, seminars, development of handbooks and the provision of tools for automated spectrum management; and
- to expand the assistance offered to Member States in coordinating and registering frequency assignments and in applying the Radio Regulations, with special attention to developing countries and Member States that have recently joined the Union.

One of the objectives pursued by the BR is to hold regional seminars in a way to equitably cover all ITU Regions. Administrations that are interested in hosting a regional seminar may contact the BR and, subject to availability of time and resources, the BR undertakes all the necessary steps to organize the event. The BR also organizes, upon request, individual training sessions in Geneva. This training is usually held in conjunction with important ITU-R meetings and the BR tries to regroup them over a one-week period.

With over 4000 published titles, ITU is the main publisher of texts dealing with telecommunication technology and regulation, providing also general information in that regard. ITU-R's publications constitute an essential reference source for all those wishing to remain abreast of the rapid and complex changes occurring in the world of international radiocommunications such as State entities, public and private telecommunication operators, manufacturers, scientific or industrial bodies, international organizations, consultancies, universities, technical institutions, etc.

The IAP Department edits and publishes regulatory texts such as the Radio Regulations, the Final Acts of World Radiocommunication Conferences and the Rules of Procedure, as well as ITU-R handbooks, Reports and Recommendations drawn up by the Radiocommunication Study Groups.

Publications are available in paper format, on CD-ROM or online, in six languages (Arabic, Chinese, English, French, Russian, Spanish) or can be ordered directly from the ITU website: www.itu.int/en/publications/ITU-R/

To obtain a full catalogue or place an order by telephone, please contact the ITU Sales Service on +41 22 730 6141.

Why become an ITU-R Member?

itu.int/members

ITU Membership represents a cross-section of the telecommunications and information and communication technology (ICT) industry, from the world's largest manufacturers and carriers to small, innovative new players working in revolutionary or new fields such as wireless communications (e.g. IMT-2020 and beyond), television digital broadcasting (e.g. 3DTV, UHDTV) or future satellite systems (e.g. for remote sensing, emergency communications or intelligent transport systems).

Founded on the principle of international cooperation between government and the private sector, ITU represents a unique global forum through which government and industry can work towards consensus on a wide range of issues affecting the world's present and future communications industries.

ITU Membership represent an invaluable means of establishing a common understanding among potential business partners, national administrations and other ITU Members. There are currently three forms of ITU Membership:

ITU Member State

If the State is a Member of the United Nations, it can become a Member State of the ITU by acceding to its Constitution and Convention. If, however, a State is not a Member of the United Nations, then the application for membership needs to have a secured approval by two-thirds of the Member States of the Union.

ITU Sector Member

ITU Sector Members are entities and organizations which join one or more ITU Sector and benefit from the impartial, universal and global nature of the International Telecommunication Union and participate in creating the new environment needed to address the constantly changing and evolving telecommunication world.

ITU Sector Members receive the invitations with related documentation to all ITU events and thereby have access to various meetings at which decision-makers and potential partners are engaged in discussions that can result in business opportunities and joint ventures.

ITU Sector Members may be involved with the organization and co-sponsorship of seminars and workshops, providing experts and lecturers, training facilities, etc.

Associates and SMEs

Associate Members are entities or organizations who join a single ITU Sector, for example the ITU-R Sector, and take part in the work of a selected single ITU-R Study Group and its subordinate groups. Associates take part in the process of preparing ITU-R Recommendations (standards) before their eventual adoption.

Associates can have access to all related documentation in their chosen ITU-R Study Group, as well as to other Study Groups, as required by the work programme. Associates are not involved in voting for, or in the approval of Questions and Recommendations.

An ITU-R Associate Member may also serve as Rapporteur within the selected ITU-R Study Group, except for liaison activities, which are to be handled separately.

Other ITU Membership benefits:

- Access to publications, documents, information and statistics;
- TIES (Telecom Information Exchange Services) accounts that allow members to access restricted databases, documents and technical databases;
- Discounts off the catalogue price for purchase of any ITU publication (except those available from the ITU Electronic Bookshop);
- Access to a large volume of restricted data such as draft documents, statistics, development plans, training modules, etc.

As of January 2020, SMEs can participate as Associates in any of the three Sectors of the Union with reduced fees. To be eligible for these reduced fees, companies must be approved by their respective Member State as meeting national criteria for an SME. In addition, companies must also have fewer than 250 employees as well as annual revenues below a maximum of CHF 15 million. The SME background note is available at www.itu.int/en/join/smes/Documents/SMEs%20background%20info_rev21.04.pdf

Academia

Academia, universities and associated research establishments concerned with the development of telecommunications/ICTs are also admitted to participate in the work of the three Sectors of ITU.

In today's fast-moving environment, membership of the ITU gives governments and private organizations a unique opportunity to meet and make important valued contributions to the technological developments rapidly reshaping the world around us!

Complete information on ITU Membership benefits is available at www.itu.int/en/join/Pages/benefits.aspx

Drive the future:

Join the International Telecommunication Union

TO BECOME AN ITU MEMBER:

Please contact ITU or ITU-R Membership or the ITU-R Study Group Department:

E-mail: membership@itu.int or brsgd@itu.int
or itu-r_membership@itu.int
www.itu.int/join/

Address and Contacts

Official correspondence should be sent to:

**Radiocommunication
Study Group Department**

International Telecommunication Union
1211 Geneva 20, Switzerland

E-mail: brsgd@itu.int
Telephone: + 41 22 730 5816
Facsimile: + 41 22 730 5806
itu.int/go/itu-r/address-contacts

Head of Department: **Mr. Sergio BUONOMO**

	Counsellor or Secretary	Chairman
WRC – World Radiocommunication Conference	Mr. Mario MANIEWICZ mario.maniewicz@itu.int Tel. +41 22 730 5940	
RA – Radiocommunication Assembly	Mr. Sergio BUONOMO sergio.buonomo@itu.int Tel. +41 22 730 6229	
RAG – Radiocommunication Advisory Group	Ms. Joanne WILSON joanne.wilson@itu.int Tel. +41 22 730 5940	Mr. Daniel OBAM daniel.obam@ties.itu.int Tel: +254 20 2719953
SG 1 – Spectrum management	Mr. Philippe AUBINEAU philippe.aubineau@itu.int Tel. +41 22 730 5992	Mr. Wael SAYED wsayed@tra.gov.eg Tel. +20 2 35344356
SG 3 – Radiowave propagation	Mr. David BOTHA david.botha@itu.int Tel. +41 22 730 5548	Ms. Carol WILSON carol.wilson@csiro.au Tel. +61 2 9372 4264+
SG 4 – Satellite services	Mr. Nelson MALAGUTI nelson.malaguti@itu.int Tel. +41 22 730 5198	Mr. Victor STRELETS strelets@niir.ru Tel +7 495 645 06 14
SG 5 – Terrestrial services	Mr. Uwe LOEWENSTEIN uwe.loewenstein@itu.int Tel. + 41 22 730 6046	Mr. Martin FENTON martin.fenton@ofcom.org.uk Tel.+44 207 783 4365
SG 6 – Broadcasting service	Mr. Ruoting CHANG Ruoting.chang@itu.int Tel. +41 22 730 5806	Mr. Yukihiro NISHIDA nishida.y-fe@nhk.or.jp Tel. +81 3 5494 3351
SG 7 – Science services	Mr. Vadim NOZDRIN vadim.nozdrin@itu.int Tel. +41 22 730 6016	Mr. John ZUZEK john.e.zuzek@nasa.gov Tel. +1 216 4333 469
CCV – Coordination Committee for Vocabulary	Mr. Nelson MALAGUTI nelson.malaguti@itu.int Tel. +41 22 730 5198	Mr. Christian RISSONE rissone@anfr.fr Tel. +33 2 9834 1235
CPM – Conference Preparatory Meeting	Mr. Philippe AUBINEAU philippe.aubineau@itu.int Tel.+41 22 730 5992	Ms. Cindy-Lee COOK cindycook.itu@gmail.com Tel. +1 3432911928

Chairmen and Vice-Chairman contact details:

www.itu.int/go/ITU-R/cvc/RSG and www.itu.int/go/ITU-R/cvc/RAG

ITU-R references

ITU-R Study Groups	www.itu.int/go/ITU-R/sg
Coordination Committee for Vocabulary (CCV)	www.itu.int/go/ITU-R/ccv
ITU Terms and Definitions	www.itu.int/go/ITU-R/term-db
ITU Patent Statement & Licensing Declaration Information	www.itu.int/pub/R-SOFT-PAT
ITU-R Recommendations	www.itu.int/pub/R-REC
ITU-R Reports	www.itu.int/pub/R-REP
ITU-R Questions	www.itu.int/pub/R-QUE
ITU-R Resolutions	www.itu.int/pub/R-RES
ITU-R Opinions	www.itu.int/pub/R-OP
General Publications	www.itu.int/pub/R-GEN
Service Publications	www.itu.int/pub/R-SP
ITU-R Conferences Publications	www.itu.int/pub/R-ACT

International
Telecommunication
Union

Place des Nations
CH-1211 Geneva 20
Switzerland
www.itu.int

ISBN: 978-92-61-30941-1



Published in Switzerland
Geneva, 2020

Photo credits: ©ITU/ D. Woldu, Shutterstock