# **ITU-R Radiocommunication** Study Groups 2025





This ITU-R Study Group booklet was produced by the

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ISBN: 978-92-61-40131-3 (electronic version)

# ITU-R RADIOCOMMUNICATION STUDY GROUPS

2025

ITU Headquarters Geneva, Switzerland

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

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# The International Telecommunication Union

# The ITU mission

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 194 Member States and a membership of over 1000 companies, universities, and international and regional organizations. Established 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 ITUR 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.

itu.int

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

For 160 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, 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. 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, deep-space research and even lunar communications.

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), IMT-2030 (6G), Digital Television and sound Radio, High Definition Television (UHDTV) and HDR specifications for the world.

Radiocommunication Assembly 2023 (RA-23) approved a The 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, including the use of IMT technologies for fixed wireless broadband; highlighted the importance to consider long-term space sustainability to ensure a sustainable use of frequencies and associated non-GSO orbits by space radiocommunication services; 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 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. Another important milestone achieved at RA-23 was the approval of Resolution ITU-R 72 on "Promoting gender equality and equity and bridging the contribution and participation gap between women and men in ITU-R activities".

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 (WRC-23) to achieve the global connectivity goals for shaping the digital communication ecosystem of the 21st century. WRC-23 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 2027 (WRC-27) is planned to be held during the fourth quarter of 2027.

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).

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

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:

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- 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

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.

# 14 ITU-R Membership

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:

- 194 ITU Member States, which constitute the Union, set its mandate and contribute to the work of ITU as a whole;
- Over 1000 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.

On the basis of the input material from the ITU-R 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 5 000 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	Radio-wave 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.

There is an additional group established by the Radiocommunication Assembly dealing with terminology and vocabulary-related issues.

CCV Coordination Committee for Vocabulary

www.itu.int/go/ITU-R/ccv

# 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 (WPT);

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- 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-27 are the preliminary studies for WRC-31 to consider potential new allocations to the fixed, mobile, radiolocation, amateur, amateur-satellite, radio astronomy, Earth exploration-satellite (passive and active) and space research (passive) services in the frequency range 275-325 GHz in the Table of Frequency Allocations of the Radio Regulations.

# 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.

Working Party 1B may also contribute to the preparatory studies for WRC-27 with respect to the unauthorized operations of earth stations.

# 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:

- Preparation of the next edition of the Spectrum Monitoring Handbook;
- 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;
- 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 radiofrequency 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.

#### itu.int/pub/R-HDB

## Handbooks

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 maintain 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 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**

# **Radio-wave 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 WPs is to draft Recommendations in the ITU-R P Series for subsequent adoption by SG 3 and approval by the Member States. The WPs also develop Handbooks that provide descriptive and tutorial material, especially useful for developing countries. A further task of the WPs is to provide, through SG 3, propagation information and advice to other ITU-R SGs 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

Working Party 3J provides information and develops models describing the fundamental principles and mechanisms of radio-wave propagation in non-ionized media. Such material is used as the basis of propagation prediction methods developed by the other WPs. 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 SG 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

Working Party 3K is responsible for developing prediction methods for terrestrial point-toarea 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 shortrange 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 environments (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

Working Party 3L studies all aspects of radio-wave 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. Working Party 3L is improving methods to quantify such effects, taking into account their temporal and geographical variability. The WP 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. Working Party 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. Working Party 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

Working Party 3M addresses radio-wave 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-thehorizon 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. Working Party 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.

Working Party 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 SG 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.

Working Party 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 WPs 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 Radio-wave Propagation over the Surface of the Earth (www.itu.int/pub/R-HDB-13)

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

Handbook on the lonosphere and its Effects on Radio-wave 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 Radio-wave 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 Radio-wave propagation information for designing terrestrial point-topoint links (www.itu.int/pub/R-HDB-54) supplies background and supplementary information on radio-wave 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 WPs maintain a number of **Reports** (www.itu.int/pub/R-REP) relating to radio-wave propagation and various field strength measurement aspects. It also maintains a number of datasets and software products in support of radio-wave propagation models from several **ITU-R Recommendations** (www.itu.int/pub/R-REC) and the development of new and improvement of existing radio-wave 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, including the related use of links in the inter-satellite service, as applicable.

### 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).<sup>1</sup>

<sup>&</sup>lt;sup>1</sup> 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 broadcastingsatellite 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 off-axis e.i.r.p. density from non-axially symmetric or active phased array earth station antennas transmitting to geostationary-satellite orbit networks operating in the fixed-satellite service in the 27.5-30 GHz frequency band.
- Functional description to be used in developing software tools for determining conformity of non-geostationary-satellite orbit fixed-satellite service systems or networks in Q/V band with criteria contained in No. 22.5L of the Radio Regulations.
- Measured radiation patterns to support the development of the reference BSS earth station antenna gain patterns in the context of their use in the computation of epfd statistics in Recommendation ITU-R S.1503.
- Maximum allowable aggregate interference levels from time-variant sources from other services into fixed-satellite service links.
- Modelling and simulation of non-GSO FSS systems for use in sharing and compatibility studies.
- A methodology for the assessment of interference between non-GSO systems, and between non-GSO systems and GSO networks.
- Methodology to assess average degradation in throughput and increase in unavailability for a non-geostationary system, due to the interference caused by another non-geostationary system operating co-frequency.
- Possible methodologies for use during coordination when an assignment to a non-geostationary FSS satellite system and an assignment to a geostationary network are involved.
- 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.
- Technical work relating to the GSO ES gain patterns used by Recommendation ITU-R S.1503.
- Analytical method for determining the statistics of interference between non geostationary satellite orbit fixed-satellite service systems and other nongeostationary satellite orbit fixed satellite service systems or geostationary satellite orbit fixed satellite service networks.

- Methodology to assess the interference environment in relation to Nos. **9.12**, **9.12A** and **9.13** of the Radio Regulations when non-geostationary-satellite orbit fixed-satellite service systems are involved.
- Aggregate equivalent power flux-density into geostationary satellite networks in the fixed-satellite service from multiple non-geostationary satellite systems in the Ku and Ka frequency bands.
- Examples of technical procedures for addressing any exceedance of aggregate equivalent power flux-density into geostationary satellite networks in the fixed-satellite service from multiple non-geostationary satellite systems in the Ku and Ka frequency bands.
- Technical studies on the epfd limits in Article 22, including the epfd limits referred to in No. 22.5K, in order to ensure the continued protection of GSO FSS and BSS networks.
- ITU-R satellite communications and technologies handbook.
- ITU-R Handbook on best practices for the sustainable use of frequencies and associated non-GSO orbits by space radiocommunication services.

Amongst those items on which Working Party 4A is engaged in preparation for WRC-27 are the studies on:

- Use of the frequency bands 47.2-50.2 GHz and 50.4-51.4 GHz (Earth-to-space), or parts thereof, by aeronautical and maritime earth stations in motion communicating with space stations in the fixed-satellite service and develop regulatory measures, as appropriate, to facilitate the use of the frequency bands 47.2-50.2 GHz and 50.4-51.4 GHz (Earth-to-space), or parts thereof, by aeronautical and maritime earth stations in motion communicating with geostationary space stations and non-geostationary space stations in the fixed-satellite service.
- Possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes.
- Use of the frequency band 51.4-52.4 GHz to enable use by gateway earth stations transmitting to non-geostationary-satellite orbit systems in the fixed-satellite service (Earth-to-space).
- Primary allocation to the fixed-satellite service (space-to-Earth) in the frequency band 17.3-17.7 GHz and a possible new primary allocation to the broadcasting-satellite service (space-to-Earth) in the frequency band 17.3-17.8 GHz in Region 3, while ensuring the protection of existing primary allocations in the same and adjacent frequency bands, and to consider equivalent power flux-density limits to be applied in Regions 1 and 3 to nongeostationary-satellite systems in the fixed-satellite service (space-to-Earth) in the frequency band 17.3-17.7 GHz.
- Regulatory measures, and implementability thereof, to limit the unauthorized operations of non-geostationary-satellite orbit earth stations in the fixedsatellite and mobile-satellite services and associated issues related to the service area of non-geostationary-satellite orbit satellite systems in the fixedsatellite and mobile-satellite services.

Technical and regulatory measures for fixed-satellite service satellite networks/systems in the frequency bands 37.5-42.5 GHz (space-to-Earth), 42.5-43.5 GHz (Earth-to-space), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) for equitable access to these frequency bands.

# 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 earthstation 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. This includes the development of the detailed specifications of the satellite radio interfaces of International Mobile Telecommunications-2020 (IMT-2020) and the work on the future development of satellite IMT-2030, part of the non-terrestrial-network (NTN) components of IMT.

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 pointto-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.

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

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 and bands 7/8 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.
- Aggregate radio frequency interference event potentials from multiple Earth exploration-satellite service systems on radionavigation-satellite service receivers operating in the 1 215-1 300 MHz frequency band.

<sup>&</sup>lt;sup>2</sup> WP 4C also deals with the performance issues related to RDSS.

- Systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz.
- Development of the MSS and RDSS parts of the Satellite Communications and Technologies Handbook.
- Unwanted emissions in the RAS band from space-to-Earth transmissions from MSS satellites.
- 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-27 are the studies on:

- Space-to-space links in mobile-satellite service (MSS) allocations in the frequency bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 645.5 MHz, 1 646.5-1 660 MHz, 1 670-1 675 MHz and 2 483.5-2 500 MHz.
- Possible allocations to the mobile satellite service and possible regulatory actions in the frequency bands 1 427-1 432 MHz (space-to-Earth), 1 645.5-1 646.5 MHz (space-to-Earth) (Earth-to-space), 1 880-1 920 MHz (space-to-Earth) (Earth to-space) and 2 010-2 025 MHz (space-to-Earth) (Earth-to-space) required for the future development of low-data-rate nongeostationary mobile satellite systems.
- Studies on possible new allocations to the mobile-satellite service between 694/698 MHz and 2.7 GHz for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage.
- Possible additional allocations in the frequency bands 2 010-2 025 MHz (Earth-to-space) and 2 160-2 170 MHz (space-to-Earth) in Regions 1 and 3 and 2 120-2 160 MHz (space-to-Earth) in all Regions to the mobile-satellite service.
- Possible allocations to the radionavigation-satellite service (space-to-Earth) in the frequency bands [5 030-5 150 MHz and 5 150-5 250 MHz] or parts thereof.
- Consider regulatory measures, and implementability thereof, to limit the unauthorized operations of non-geostationary-satellite orbit earth stations in the mobile-satellite services and associated issues related to the service area of non-geostationary-satellite orbit satellite systems in the mobilesatellite services.

## Handbooks

#### itu.int/pub/R-HDB

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

Handbook on Small Satellites (www.itu.int/pub/R-HDB-65) provides a comprehensive reference of the applicable regulatory procedures for small satellites, including nanosatellites and picosatellites

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.

# 34 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:

- WP 5A Land mobile service above 30MHz<sup>3</sup> (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

<sup>&</sup>lt;sup>3</sup> Including the exact frequency of 30 MHz.

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

Working Party 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 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 for transportation industry, utility radiocommunication, railway systems and intelligent transport systems (ITS) are becoming part of our daily life. The latter is essential in improving the safety and efficiency of our roads and highways and also the public protection and disaster relief service (PPDR) is under the purview of WP 5A.

Land mobile services for communication with aircrafts will be handled by WP 5D holistically, also including non-IMT systems.

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 some of them with recent revisions. 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.

Related to the preparatory work for the next World Radiocommunication Conference (WRC-27), WP 5A has not been assigned any studies as responsible group.

## 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

Working Party 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).

Related to the preparatory work for the next World Radiocommunication Conference (WRC-27), WP 5B has been assigned the following studies as responsible group:

- WRC-27 agenda item 1.8 Resolution 663 (Rev.WRC-23):
  - Studies on globally harmonized spectrum for the RLS, in particular for those millimetric and sub-millimetric wave RLS systems and applications above 231.5 GHz;
  - Sharing and compatibility studies (in-band and adjacent bands) for active millimetric and sub-millimetric wave RLS systems and applications with other services in the frequency range 231.5-275 GHz, while ensuring protection for the current use and further development of the incumbent services allocated to this frequency range;
  - Sharing and compatibility studies (in-band and adjacent bands) for RLS applications with EESS (passive), space research service (passive) and RAS applications in the frequency range 275-700 GHz, while maintaining protection for the passive service applications identified in RR No. 5.565;
  - Sharing and compatibility studies (in-band and adjacent bands) for RLS applications with fixed service and land mobile service.
- WRC-27 agenda item 1.9 Resolution 411 (WRC-23):
  - Studies on the introduction of new technologies that enhance performance, including, but not limited to, new classes of emission, wideband systems (see *recognizing c*), *d*) and *e*)), etc., to the aeronautical mobile (OR) service systems in the frequency ranges considered in Appendix 26 of the Radio Regulations;
  - The definition of the relevant technical and operational characteristics and conduct sharing and compatibility studies with existing aeronautical mobile (OR) service systems and with other incumbent services that are allocated on a primary basis in the same or adjacent frequency bands;
  - Based on ITU Radiocommunication Sector (ITU-R) studies, the identification of any potential modifications to Appendix 26 of the Radio Regulations, without modifying the existing area allotments in *recognizing f*), and while taking into account that the current use of the narrowband systems shall remain unchanged and shall not be impacted nor precluded by the revision of Appendix 26.

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

Working Party 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.

Related to the preparatory work for the next World Radiocommunication Conference (WRC-27), WP 5C has been assigned the following studies as responsible group:

- WRC-27 agenda item 1.10 Resolution 775 (WRC-23):
  - Appropriate studies to determine power flux-density (pfd) and equivalent isotropically radiated power (e.i.r.p.) limits to be included in Article **21** of the Radio Regulations for satellite services (fixed-satellite service (FSS), mobile-satellite service (MSS) and broadcasting-satellite service (BSS)) to protect the current and planned fixed and mobile services in the frequency bands 71-76 GHz and 81-86 GHz.

## 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 IMT-2000, IMT-Advanced, IMT-2020 and IMT-2030.

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 development and introduction of several generations of public mobile networks (known as 3G, 4G, 5G, 6G...) based on standards derived from the IMT concept, initially applied at IMT-2000 (3G). Now, nearly 2025 years later, there are several billions IMT subscribers in the world but at the same time 2.6 billion people still "offline" (unconnected from the internet)<sup>4</sup>.

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) and **Recommendation ITU-R M.2150** (www.itu.int/rec/R-REC-M.2150) provides detailed specifications of the terrestrial radio interfaces of IMT-2020.

**Recommendation ITU-R M.2160** (www.itu.int/rec/R-REC-M.2160) describes in detail the framework and overall objectives of the future development of IMT for 2030 and beyond.

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.

Related to the preparatory work for the next World Radiocommunication Conference (WRC-27), WP 5D has been assigned the following studies as responsible group:

- WRC-27 agenda item 1.10 Resolution 256 (WRC-23):
  - Appropriate studies of technical, operational and regulatory issues pertaining to the possible use of the terrestrial component of IMT in the frequency bands listed in resolves to invite the ITU Radiocommunication Sector;

<sup>&</sup>lt;sup>4</sup> https://www.itu.int/en/mediacentre/Pages/PR-2024-11-27-facts-and-figures.aspx

Sharing and compatibility studies, with a view to ensuring the protection of services to which the frequency band is allocated on a primary basis, including protection of stations operating in international waters or airspace which cannot be registered in the MIFR, without imposing additional regulatory or technical constraints on those services, and also on services in adjacent bands, for the frequency bands: 4 400-4 800 MHz, 7 125-8 400 MHz and 14.8-15.35 GHz.

## 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 A tutorial on frequency adaptive communication systems in the HF bands (www.itu.int/pub/R-HDB-64)

Frequency adaptive communication systems (also known as "HF adaptive Systems") first appeared in the 1980s and have been developed because of the unique characteristics of HF communications and its increasing requirement for stable and reliable communication. This Handbook is a tutorial that explains the development and deployment of HF adaptive systems, describes the essential parts of an adaptive network, and addresses relevant regulatory and operational considerations from today.

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 Deployment of IMT-2000 Systems (https://www.itu.int/pub/R-HDB-60) addresses a variety of issues related to the deployment of IMT-2000 systems, to inform and guide key decision-makers on critical aspects concerning third-generation mobile communication systems, to facilitate decisions on the selection of options and strategies for the introduction of their IMT-2000 networks.

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 International Mobile Telecommunications (www.itu.int/pub/R-HDB-62) explains International Mobile Telecommunications (IMT) and provides general information on the evolution of IMT and the introduction of the IMT-2000, IMT-Advanced and IMT-2020 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 and is currently working on IMT-2030 for the 6G.



# **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
		<u> </u>	

- WP 6B Broadcast service assembly and access
- WP 6C Programme production and quality assessment

The work of SG 6 and its WPs 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

Working Party 6A covers the activities in the area of terrestrial broadcasting system characteristics, channel coding/decoding, modulation/demodulation for sound, video, multimedia and interactivity. It also covers network and frequency planning, implementation, protection and sharing with other radiocommunication services. For this, it deals with characteristics of transmitting and receiving antennas, evaluation methods of service areas, transmitter and receiver reference performance requirements, and impact of source coding in terrestrial emission. Working Party 6A also covers applications ancillary to broadcasting and programme-making as utilized in broadcasting (ENG, SAB/SAP and PMSE), and impact of EMF and EMC regulation on broadcasting networks.

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 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
- Adoption of 5G based broadcasting systems and development of relevant spectrum and network planning and performance criteria.

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

Working Party 6B is responsible for areas bridging programme production and distribution. These include interfaces in the production chain and to the various delivery media (terrestrial, satellite, cable, internet, etc.) together with source coding and multiplexing of audio and video content, data services, metadata, middleware, service information, and access control. These topic areas are applicable to all broadcasting services, including multimedia/interactive and converged services, for both fixed and mobile terminals. WP 6B is also responsible for broadcaster requirements for Electronic News Gathering (ENG), Services Ancillary to Broadcasting / Services Ancillary to Programme-making (SAB/SAP), Programme Making and Special Events (PMSE) and performance objectives for broadcasting satellite services.

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 SG21, 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.

WP 6B also studies broadcasting of multimedia and data applications for mobile reception including 5G broadcasting, and sage scenarios and key technologies of 5G-based UHDTV/HDTV contribution and ENG.

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

Working Party 6C studies issues and develops solutions associated with programme production and the international exchange of content for radio and television broadcasting service applications including multimedia/interactive and converged services, for both fixed and mobile terminals. This includes signal formats for the making and exchange of content, and ways to evaluate the quality of experience (QoE) of the content, which is a critical element in the choice of the parameters for an end-to-end media ecosystem.

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 on viewing conditions for HDR and SDR monitoring in close proximity within a single-master HDR/SDR production environment will be considered. WP 6C will continue to take an active role in the Intersector Rapporteur Groups IRG-AVQA and IRG-AVA during the 2024-2027 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.

## 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 UHDTV) 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.1114 Systems for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz
- BS.1615 Planning parameters for digital sound broadcasting at frequencies below 30 MHz
- BS.1660 Technical basis for planning of terrestrial digital sound broadcasting in the VHF band
- BS.2107 Use of International Radio for Disaster Relief frequencies for emergency broadcasts in the High Frequency bands

#### Television broadcasting

- BT.1698 Evaluating fields from terrestrial broadcasting transmitting systems operating in any frequency band for assessing exposure to non-ionizing radiation
- BT.1833 Broadcasting of multimedia and data applications for mobile reception by handheld receivers
- BT.2016 Error-correction, data framing, modulation and emission methods for terrestrial multimedia broadcasting for mobile reception using handheld receivers in VHF/UHF bands
- BT.2033 Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands
- BT.2036 Characteristics of a reference receiving system for frequency planning of digital terrestrial television systems

#### Electronic news gathering

• BT.1871 User requirements for wireless microphones

#### Audio

- BS.1352 File format for the exchange of audio programme materials with metadata on information technology media
  BS.1873 Serial multichannel audio digital interface for broadcasting studios
  BS.2125 A serial representation of the Audio Definition Model
  BS.2127 Audio Definition Model renderer for advanced sound systems
- BS.2143 Transport method for non-Pulse-Code Modulation audio signals and data over digital audio interfaces for programme production and exchange

#### Television image

 BT.1203 User requirements for generic video bit-rate reduction coding of digital TV signals for an end-to-end television system BT.2073 Use of the high efficiency video coding for UHDTV and HDTV broadcasting applications

#### Transport and multimedia

- BT.1775 File format with editing capability, for the exchange of metadata, audio, video, data essence and ancillary data for use in broadcasting
- BT.2074 Service configuration, media transport protocol, and signalling information for MMT-based broadcasting systems
- BT.2075 Integrated broadcast-broadband system
- BT.2153 The use of componentized workflows for the exchange of nonlive television programmes
- BT.2154 High-level system architecture for immersive video for presentation on various types of display devices

#### Quality assessment

- BT.500 Methodology for the subjective assessment of the quality of television images
- BS.1285 Pre-selection methods for the subjective assessment of small impairments in audio systems
- BS.1387 Method for objective measurements of perceived audio quality
- BS.1770 Algorithms to measure audio programme loudness and truepeak audio level
- BS.1909 Performance requirements for an advanced sound system for use with or without accompanying picture
- BS.2126 Methods for the subjective assessment of sound systems with accompanying picture
- BT.1702 Guidance for the reduction of photosensitive epileptic seizures caused by television
- BT.2163 Objective measurement algorithm for evaluation of the brightness of high dynamic range television

# **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. It studies as well radiocommunication systems for use with manned and unmanned spacecraft, communication links between planetary bodies and the use of data relay satellites.

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.

Study Group 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;
- lunar, Lagrangian, deep space research systems and space-very long baseline interferometry, including their associated earth stations;
- 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.

- 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

Working Party 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:

- Maintenance, realization and dissemination of Coordinated Universal Time (UTC);
- 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.
- The content and structure of time signals.

# ITU-R Working Party 7B – Space radiocommunications applications

Working Party 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

Working Party 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 groundbased 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

Working Party 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 singledish telescopes such as the new 500m diameter FAST telescope in China, to large distributed arrays such as the new Square Kilometre 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.

Report ITU-R TF.2511 on **Content and structure of time signals to be disseminated by radiocommunication systems and various aspects of current and potential future reference time scales, including their impacts and applications in radiocommunication (www.itu.int/pub/R-REP-TF.2511). This Report addresses information regarding content and structure of time signals to be disseminated by radiocommunication systems and various aspects of current and potential future reference time scales, including their impacts and applications in radiocommunication.** 

Report ITU-R RS.2456 on **Space weather sensor systems using radio spectrum** (www.itu.int/pub/R-REP-RS.2456). This Report provides a summary of space weather sensor systems using radio spectrum which are used for detection of solar activity and the impact of solar activity on the Earth, its atmosphere and its geospace.

Report ITU-R RA.2501 on **Technical and operational characteristics of the existing and planned Geodetic Very Long Baseline Interferometry** (www.itu.int/pub/R-REP-RA.2507). This Report provides technical and operational characteristics of the existing and planned Geodetic Very Long Baseline Interferometry (VLBI) network. VLBI is the foremost observation technique for producing high-accuracy reference frames. High angular resolution is of fundamental importance for the realization of space-fixed and Earth-fixed reference systems as well as for the determination of current Earth orientation parameters (EOP). Reliable and precise reference frames and EOP are fundamental for accurate positioning used in navigating in space and on Earth, mapping, locating frontiers and borders, managing land boundaries, as well as in research and science.

# **Coordination Committee for** for Vocabulary

www.itu.int/go/ITU-R/ccv

The Coordination Committee for Vocabulary (CCV) is in charge of validating, translating and harmonizing terminology managed by the Radiocommunication Sector. The CCV is part of the ITU Coordination Committee for Terminology (ITU CCT).

Coordination and approval in close collaboration with the Radiocommunication Study Groups, the General Secretariat (Conferences and Publications Department) and other interested organizations (mainly the International Electrotechnical Commission (IEC)), concerning:

- vocabulary, including abbreviations and initials;
- related subjects (quantities and units, graphical and letter symbols).

The terminology managed by the Radiocommunication Sector, notably being completed and updated by the data supplied by the Radiocommunication Study Groups, is included in the ITU Terms and Definitions Database.

The ITU Coordination Committee for Terminology (ITU CCT) was created following the adoption of Resolution 1386 at the 2017 session of Council. The ITU CCT consists of the ITU-R Coordination Committee for Vocabulary (ITU-R CCV) and the ITU-T Standardization Committee for Vocabulary (ITU-T SCV), functioning in accordance with relevant resolutions of the Radiocommunication Assembly and World Telecommunication Standardization Assembly respectively, and representatives of ITU-D, working in close collaboration with the ITU General Secretariat.

## **Deliverables from the CCV**

The CCV maintains a number of **Recommendations** (www.itu.int/pub/R-REC) relating to vocabulary and related subjects.

# Conference Preparatory Meetings

itu.int/go/itu+r/cpm

In accordance with Resolution ITU-R 2-9, the Conference Preparatory Meeting (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-27 and WRC-31 can be consulted online at https://www.itu.int/en/ITU-R/study-groups/rcpm/Pages/wrc-27-studies.aspx

# Radiocommunication Bureau

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itu.int/go/itur

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.

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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 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 and technical institutions.

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 the six official UN languages (Arabic, Chinese, English, French, Russian, Spanish) or can be ordered directly from the ITU website: www.itu.int/en/publications/ITU-R/

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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 IMT-2030), television digital broadcasting (e.g. 5G-based UHDTV/HDTV) 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 Sectors 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 and training modules.

## 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: <u>membership@itu.int</u> or <u>brsgd@itu.int</u> or <u>itu-r\_membership@itu.int</u> <u>www.itu.int/join/</u>

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# **ITU-R references**

ITU-R Study Groups
Coordination Committee for Vocabulary (CCV)
ITU-R Recommendations
ITU-R Reports
ITU-R Questions
ITU-R Resolutions
ITU-R Opinions
General Publications
Service Publications
ITU-R Conferences Publications

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