Introduction to International Radio Regulations

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Abstract

These notes introduce the ITU Radio Regulations and related UN and WTO agreements that specify how terrestrial and satellite radio should be used in all countries over the planet. Access to the existing information infrastructure, and to that of the future Information Society, depends critically on these regulations. The paper also discusses few problems related to the use of the radio frequencies and satellite orbits. The notes are extracted from a book under preparation, in which these issues are discussed in more detail.

Contents

1 Background

After a hundred years of extraordinary development, radio is entering a new era. The converging computer and communications technologies add "intelligence" to old applications and generate new ones. The enormous impact of radio on the society continues to increase although we still do not fully understand all consequences of that process. There are numerous areas in which the radio frequency spectrum is vital. National defence, public safety, weather forecasts, disaster warning, air-traffic control, and air navigation are a few examples only. Radio and television broadcasting have become the main source of everyday information for most people of the world. They play a principal role in meeting information needs of illiterate people unable to read, a large part of the world's population.

The number of terrestrial and space radio stations grows without precedence and the frequency demand follows that trend. The ITU has recorded more frequency assignments in the last few years than during the whole previous history of radio. Liberalization, privatization, competition, and deregulation trends encourage the introduction of new services and new technologies. In the next few years, new High Altitude Platforms (HAP) and constellations of low-orbiting (LEO) satellites are expected to be launched to fulfil the promise of universal worldwide communication services accessible anywhere, anytime, and at an affordable cost. It is widely accepted that the uses made of the RF spectrum will be the main engine of economic growth and improvement of the living standard in the next few decades.

One of the difficulties radiocommunication confronts is the apparent spectrum congestion and scarcity of radio frequencies. Most of the suitable frequencies have already been used in many regions of the world and new demands exceed what can be accommodated. In some frequency bands and geographical regions there is no place for new radio stations and new services. The same concerns the geostationary satellite orbit. The issue is critical to all radio-dependent activities. The growing disproportion between the demand for radio frequencies and orbital positions on one hand, and what is apportioned on the other, calls for reconsideration of the existing ways these resources have been used. As radio has an immense impact on many aspects of our life, the issue deserves serious considerations by a wider community. This paper reviews some elements that may be helpful in such considerations.

Table 1. Changing approach to the radio frequency spectrum.

Year	Major events	Approach
Now	Global Information Infrastructure * Information Society concept * Wireless computer LAN, WAN * Wireless Internet. * Digital high-definition television (DTV, HDTV) * Digital audio broadcasting (DAB) * Ultra-Wide Band (UWB) systems * Constellations of low-orbiting satellites (LEO) * High Altitude Platforms (HAP)	Privatization of spectrum/ orbit resources? Free Spectrum/Orbit markets?
1995	Record spectrum auctions in USA: 258M USD/MHz	
1995	Major ITU reform. The ITU membership open to non-governmental entities. The IFRB replaced by part-time Radio Regulations Board (RRB).	Direct participation of private sector in international regulation process
1989	Creation of trade-able rights in radio frequencies in New Zealand	Spectrum is a sellable commodity in some countries
1978	First wireless public phone	
1965	First commercial communication satellite	
1963	First World Space Radiocommunication Conference	The geostationary satellite orbit included into spectrum concept
1958	First data transmission via satellite	
1957	First artificial Earth satellite	
1949	First public paging system.	
1949	The ITU became the United Nations' specialized agency for telecommunications	Spectrum is a "common heritage of mankind"
1947	Creation of International Frequency Registration Board (IFRB) and International Frequency List	Spectrum use is to be coordinated and registered and controlled internationally
1939	First commercial TV	
1932	Integration of Radio, Telegraph & Telephone regulatory activities in the framework of the International Telecommunication Union (ITU)	Spectrum is regulated by an intergovernmental organization
1927	Creation of International Radio Consultative Committee (CCIR) with membership open to non-governmental entities, to study questions related to radio communications. International Frequency Allocation Table covers 10 kHz - 60 MHz	Spectrum is allocated to separate services
1925	"...no more spectrum available" declares a US Secretary of Commerce	Spectrum is a scarce resource and requires conservation
1921	First broadcasting network	
1910	First aviation radio	
1906	First Radiotelegraph Conference in Berlin (27 States)	Spectrum is a shared resource requiring coordination among all its users
1901	First transatlantic wireless transmission	Spectrum is an inexhaustible natural resource from which everybody can profit freely
1895	First experiments with wireless communications (Marconi, Popov)	Spectrum is a physical object of no value
1888	First experiments with radio waves (Hertz)	
1873	Concept of radio waves (Maxwell)	Spectrum is an abstract concept of no practical value
1822	Concept of spectrum (Fourier)	

1.1 Basic concepts

What is the RF spectrum? This simple question has more than one answer, as our approach to the spectrum changes, as shown in Table 1. Originally, the spectrum was only an abstract mathematical idea introduced by Jean-Baptiste Fourier (1768-1830). At the beginning, the Fourier's spectrum concept was strongly criticized and considered as a strange curiosity of doubtful value. Only when Peter Dirichlet (1805-1859) and Georg Riemann (1826-1866) resolved the doubts, it was generally accepted to become now a powerful tool used in many branches of theoretical sciences. In the meantime, experimental radio science and technology have been developed and the RF spectrum has become also a measurable physical object: a spectrum analyzer is now a basic instrument in any radio laboratory.

Table 2. The ITU frequency bands.

Band No.	Symbol	Frequency	Wavelength
4	VLF	Very Low Frequency 3 to 30 kHz	Myriametric waves 100 to 10 km
5	LF	Low Frequency 30 to 300 kHz	Kilometric waves 10 to 1 km
6	MF	Medium Frequency 300 to 3000 kHz	Hectometric waves 1000 to 100 m
7	HF	High Frequency 3 to 30 MHz	Decametric waves 100 to 10 m
8	VHF	Very High Frequency 30 to 300 MHz	Metric waves 10 to 1 m
9	UHF	Ultra High Frequency 300 to 3000 MHz	Decimetric waves 100 to 10 cm
10	SHF	Super High Frequency 3 to 30 GHz	Centimetric waves 10 to 1 cm
11	EHF	Extremely High Frequency 30 to 300 GHz	Millimetric waves 10 to 1 mm
12	THF	Tremendously High Frequency 300 to 3000 GHz	Decimillimetric waves 1 to 0,1 mm

The ability to carry energy and messages at a distance, with the speed of light and at no cost, made the spectrum of radio waves a valuable resource from which everybody can profit. Free access to it, from any place and at any time, added much to its attractiveness. The spectrum has become treated as a natural resource, a common heritage of humanity. Not so long ago, another abstract concept, the geostationary

satellite orbit (GSO), has been integrated with the original conception of the radio spectrum. Our attitude to the radio spectrum changes, as does our understanding of its value and social role.

Since the First Radiotelegraph Conference, Berlin, 1906, all governments interested have committed themselves to develop common rules and regulations concerning the use of the radio frequency spectrum and to follow these rules in practice. The ITU Member States update periodically these rules and regulations at radiocommunication conferences, to satisfy current needs. The access to the spectrum is now strictly regulated nationally and internationally. To use a specific frequency band or orbital position, one has to pass through a process of coordination, authorization, licensing, etc., as agreed among Administrations.

Internationally, the use of spectrum resources is free, but most countries introduced a system of fees for using the spectrum. A few countries went even further, creating the RF spectrum market. The spectrum has now its price but the market approach has not been universally accepted. There is a growing debate over whether spectrum is a free common heritage of humankind, a scarce natural resource, a renewable and reusable commodity, or a saleable, auction-able, rentable piece of real estate. According to a French jurist J.D. Bedin "the frequency spectrum is technology, industry, money, culture, and power" [Dougan 1992].

1.1.1 Spectrum Metrics

The RF spectrum is a multi-dimensional concept. It is widely agreed in scientific community that its dimensions involve radio frequency bandwidth, time span, geometrical volume, and - for space applications - a segment of the satellite orbit. There have been suggestions that other quantities, such as polarization, are also its dimensions. The argument for including these quantities is that two systems using orthogonal parameters do not interfere with each other. Horizontally and vertically polarized radiowaves, and spread-spectrum systems with orthogonal codes are examples. However, these suggestions have not been universally accepted. The Radio Regulations are built around the frequency allocation table that traditionally differentiates only between frequency bands and administrative regions, see Table 2 and the Annex.

1.1.2 Spectrum Use

"Used" means "denied to others". It is important to differentiate between the active and passive spectrum uses. The active ones involve radiation of RF energy whereas passive applications are based on the absorption of that energy. A broadcasting transmitter is an example of active usage whereas a radioastronomic observatory is an instance of passive one. The service area around a transmitter in which the usable signal can be received is usually smaller than the area in which the same transmitter

can cause unacceptable interference to neighbouring systems. It is the area that is denied to other potential users that is related to spectrum congestion. The same concerns the frequency bandwidth and time denied to other users, see Figure 1.

It is important to differentiate between the physical denial and administrative denial [Berry 1985]. The spectrum space is physically denied if it is filled with sufficient RF power to interfere with other proposed operations. The space may also be denied administratively by spectrum management rules and radio regulations. Administrative denial is applied to simplify spectrum management and often represents practical approximations to physical denial. It is a means to reserve spectrum for passive applications, that is, for receiving radio stations. In that convention the transmitters and receivers use the spectrum in a complementary way. A protected transmitter denies use of a specific amount of spectrum space to receivers wishing to receive other communications. A protected receiver denies some amount of the space to transmitters whose operation would interfere with it. The spectrum administratively denied by a specific system may differ from that denied physically.

1.1.3 EMC

A compatible operation of radiocommunication systems implies two conditions. First, the radio system at hand must operate correctly in its electromagnetic environment. Second, the operation of that system must not introduce intolerable disturbance to its environment. These are the conditions of electromagnetic compatibility (EMC). They assure what the language of politics qualifies as '*peaceful co-existence'*. The criteria of 'correct operation', 'intolerable disturbance' and 'electromagnetic environment' are application-dependent. Generally, the '*electromagnetic environment*' includes radio waves of any origin, natural and man-made, intended and unintended.

The EMC theory says that each radio system can be associated with some specific '*sphere of influence*' in a multidimensional (multivariable) space within which no other outsider station should operate. The sphere of influence is known as the area denied to other systems. Transmitters deny space to extrinsic receivers and receivers deny it to extrinsic transmitters. The variables involved are application dependent. They include time and the length, width, and height of three-dimensional geometrical space that we know from everyday experience. In addition, they embrace the frequency, polarization, direction and power of the electromagnetic wave used, and other parameters.

A simplified interpretation of EMC conditions is shown in Figure 1. Only three variables are shown: the frequency, the North-distance and the East-distance. For simplicity, a non-directional station is assumed. The radio station under consideration is inside the cylindrical volume shown. No extrinsic station is allowed

to operate within that volume, as a collision occurs otherwise. The associated frequency band is shown on the vertical axis, and the geographic area denied to other systems is shadowed on the North-distance - East-distance plane. EMC theory involves a large variety of physical phenomena in a complex manner, but we will leave aside all these meticulous considerations and focus on basic concepts only.

The frequency band and geographic area occupied are denied to other stations because of harmful interference. For actual systems, the forbidden volume has much more complex shape, as shown in Figure 2. The figure presents computer simulations of operation of the LEOSAT-1 satellite system near Buenos Aires, where the existing terrestrial microwave stations use the same frequency (18 GHz band). The figure represents only two variables: the North-distance and the East-distance. The microwave stations can cause severe interference to the satellite user terminals, and the interference zones must be excluded from the satellite service. These exclusion zones, shadowed in the figure, occupy 37% of the reference circle of 40 km diameter.

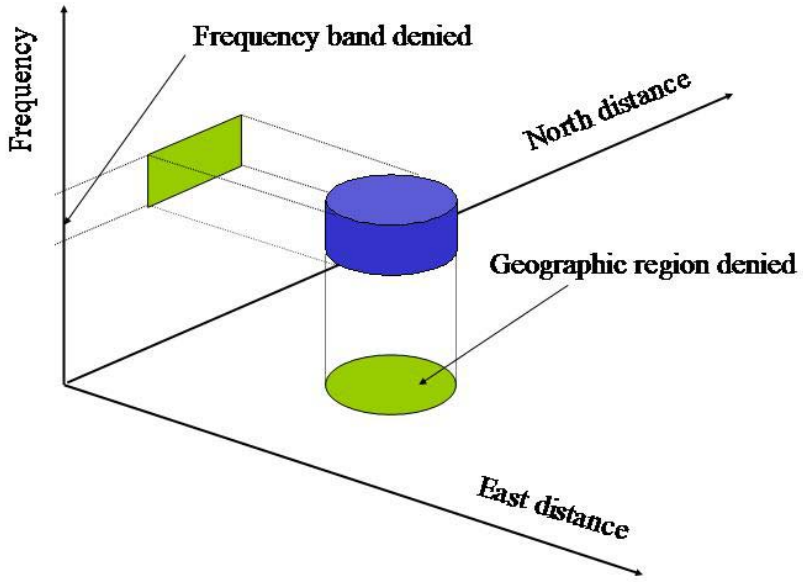

Figure 1. A radio station can be associated with a specific volume it 'occupies' in multi-dimensional space.

1.2 Sharing the Spectrum

1.2.1 Free-Pasture Model

Common resources such as the radio frequencies and geostationary-satellite orbit have one disadvantage which can be best explained on a model of free pasture. Because the pasture is open to all and free of charge, and because each cattle is a source of income, it is to be expected that everybody keeps his herd on it, and that each herdsman tries to maintain as many cattle as possible. Such an arrangement works well until the number of beast reaches the carrying capacity of the pasture. At this point, the scenario develops following the inherent logic of the commons, as described by Hardin:

"As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks 'What is the utility to me of adding one more animal to my herd?' This utility has one negative and one positive component:

1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.

2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of -1.

Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another... But this is the conclusion reached by each and every rational herdsman sharing a commons.

Therein is a tragedy. Each man is locked into a system that compels him to increase his herd without limit - in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons." [Hardin 1968]

Is that model applicable to the radio frequencies and the geostationary- satellite orbit? Certainly the pasture and the radio spectrum are quite different, but there are some analogies. The spectrum, like the open pasture, cannot be fenced. Until now it has been available (for states) free of charge. It has a limited carrying capacity, the limits resulting from the laws of physics, and the available technology and capital. A portion of spectrum resource used by one system is denied to other systems. If, therefore, we replace the word '*animal'* in the Hardin's text by 'r*adio station'* and

'*herdsman'* by '*Administration'*, we obtain a simplified global model of unrestricted use of the spectrum/ orbit resources.

A quantitative analysis of spectrum congestion and resultant transmission capacity loss due to mutual coupling of the links (based on a generalisation of Shannon's law) has shown that the total capacity of a set of radio links tends to zero when their number increases without limits (Struzak 2002). The conclusion is that the concept of free use of the spectrum resources may work well only if the number of the resource users is small in comparison with the resource carrying capacity.

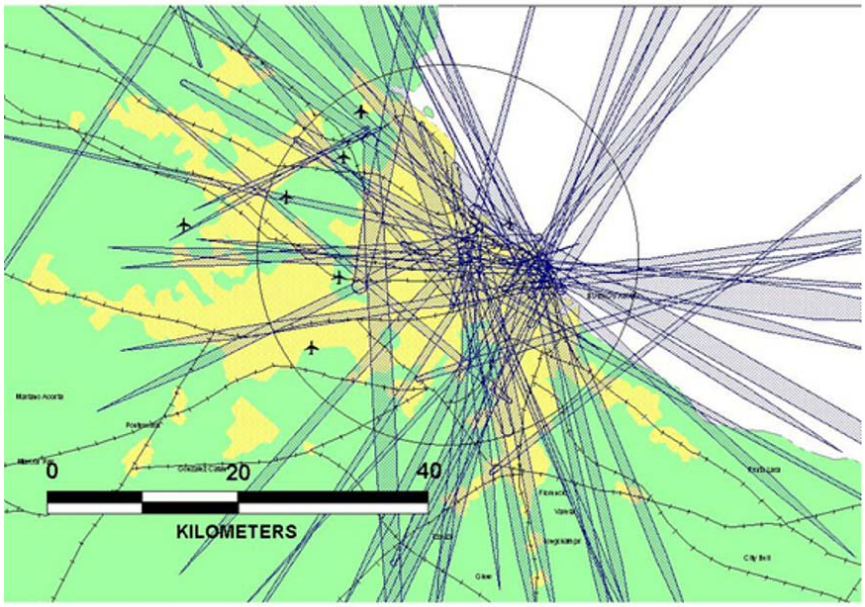

Figure 2. Service area of the planned LEOSAT-1 satellite system in the region of Buenos Aires (Results of computer simulation). Shadowed areas are excluded from the service because of interference from terrestrial microwave links. They occupy 37% of the 40 km reference circle shown. Exclusion regions due to satellite-generated interference to terrestrial systems are not shown. (Courtesy of T. Hayden).

Our past indicates that the approach to our resources changes, as does our understanding of their value and social role. We have discovered that many common resources, considered long time as being inexhaustible, have become scarce. Firstly, the commons in food gathering were abandoned. Farmland has been enclosed, and

there is no free farmland now. Later, open pastures and free hunting and fishing areas have been restricted. Then, using the commons as a place for waste disposal has been abandoned and restrictions on the disposal of sewage are now widely accepted throughout the world. A concept of environmental protection was developed, and restrictions were also imposed on the pollution of land, water and air. Not so long ago, the radio frequencies and geostationary satellite orbit were added to the list of critical resources.

The issue of rational use, sharing, conservation, and protection of limited common resources has become an essential element, on national and world-wide scales. When discussing their future, several possible approaches can be indicated:
"We might sell them off as private property. We might keep them as public property, but allocate the right to enter them. The allocation might be on the basis of wealth, by the use of an auction system. It might be on the basis of merit, as defined by some agreed-upon standards. It might be by lottery. Or it might be on a first-come, first-served basis... " [Hardin 1968].

Any of these options implies an organizational framework necessary for coordination and negotiations among the parties interested. For common benefit, these parties have to agree common rules to be observed in sharing the resource, and mechanisms to settle unavoidable conflicts.

1.2.2 Preferences

Which of the approaches listed above is the best one? Each of them can be questionable, dependent on the criteria applied. The final answer results from human preferences of goals and hierarchies of values. In practice, it is often impossible to separate technical aspects of resource sharing from their economical, social and political contexts, and from the interests affected by them. The problem of sharing scarce resources cannot be solved by technical means, without involving systems of human values and ideas. Tradition and past experience play a significant role here:

"Every adoptable set of resource process will be one which is valued by some population in terms of that population's own system of activities. ... Where a resource process involves beliefs and techniques that are incongruous with a people's system of activities, it will not be adopted by that people, however superior it may be by other criteria." [Firey, 1977]

However, in a pluralistic society the goals and hierarchies of values are often inconsistent and conflicting:

"...The hierarchies of values and preferences of each individual are inconsistent among themselves and different individuals and ... groups have different hierarchies

of preferences which are partially in conflict with those of other groups and individuals. Furthermore, the capacities of different groups to implement their preferences ... are widely different" [Brooks 1972].

Inconsistency means here that progress toward realization of one value or goal is destructive of another value or goal held by the same individual or group, and the lack of consistency may be not obvious to the individual or group concerned. *Conflicting* goals or values mean such goals or values of two groups that cannot be served by the same policies: what enhances one will degrade the other.

The way in which the spectrum/ orbit resources are used follows the technological, economic, political and social changes in the world. Our past experience shows that societies follow the example of a leading or dominating nation and accept more or less voluntarily its "mode of life" and hierarchy of values.

1.2.3 Competition and Cooperation

The first uses of radio waves were military, to communicate with warships at sea. Soon, however, military secrets were abandoned under the pressure of private business rushing to exploit the “nobody land” of civilian radio. It was at the turn-out of the century that competition in radio communication started. In a liberal environment, without any control, regulation, and negotiations, soon mutual interference began to paralyze the operation of systems. Two tendencies appeared, one diverging and another converging. The diverging one was the competition among the operators, service suppliers and equipment manufacturers. It was leading to separate communication networks, mutual interference, and incompatible equipment. The converging force came from users, who wanted to communicate freely one with another, independently of the service or equipment supplier. Their pressure forced the service providers and equipment manufacturers to cooperate. The partisans of liberal capitalism would probably say it was the “invisible hand of free market” that forced the cooperation.

Finally, all parties came to a conclusion that coordination of their activities is necessary for common benefit. Such coordination activities started on a national scale, with strong governmental involvement. A global nature of the problem required, however, an international cooperation. Only two years after the first transatlantic wireless communication had astonished the world, the first international conference was called to coordinate the spectrum resource use. It was the so-called “preliminary conference” held in Berlin, in 1903. That conference marked the end of the first period of liberalism and uncontrolled rivalry in radio communications.

There were several separate maritime radio communication networks in operation at that time. However, because of competition, no communication was possible

between the networks of different operators, and the following story is a good illustration of the problem. When Prince Henry of Prussia attempted to send President Theodore Roosevelt of the United States a courtesy message via radio while crossing the ocean in 1902, he was refused the service. The shore radio station, operated by the Marconi Company, was forbidden by its owner to deal with a ship station of the German competitor, in spite of the fact that there were no technical obstacles for the two stations to work together. Not without the influence of that incident, the Berlin International Radiotelegraph Conference of 1906 ruled that a communication service with ships must be provided regardless of the system used.

1.2.4 First agreements

The Berlin conference agreed upon the principles of radio spectrum management. One of major steps at the conference was the establishment of the International Bureau in Bern to register the operating frequencies of radio stations to control the spectrum occupancy and avoid mutual interference. It was the first attempt to manage the radio frequency spectrum, worldwide. The register of the occupied frequencies was named later “The Bern List”.

International treaties are all part of a world-wide game governments agree to play following certain rules. Agreement is an inevitable ingredient here, and there is nothing to force nations to abide by these rules. And governmental delegations represent interests of their citizens, including private sector interests. If competitive forces are stronger than cooperative ones, no progress could be made.

At the Berlin conference, it was not possible, due to conflict of interests, to reach consensus on issues related to inter-communication. Great Britain and Italy, where Marconi had a strong say, did not agree to final agreements and made reservations. Soon, a test of life showed in full light its tragic consequences. It was the well-known disaster of Titanic in April 1912. The Titanic was the most luxurious, most modern, and largest ship at that time, claimed as being unsinkable. During its maiden voyage with richest passengers on the board, it hit an iceberg and sank on the night of 14-15 April 1912, making it one of the deadliest peacetime maritime disasters. The story was revived by the movie under the same title that won 11 Academy Awards in 1997. Inquiries alleged that another liner was nearby and could have helped had its radio operator been on duty to receive the distress signals of the "Titanic".

Only three months later, and not without the influence of public opinion, the second radio conference was held in London. It finally settled the problem of inter-communication between ships on the sea: the reservations were removed. To a large degree, it was under the pressure of public opinion, shocked by the *Titanic* disaster just before the conference.

The World War I interrupted international cooperation for few years. Radio science and technology, harnessed to military applications, got an enormous impetus. When the war finished, all the scientific progress, technical developments and operational experience gained during the war time could be used again in peaceful service for the humanity. In new circumstances, the old international agreements regulating the use of radio waves were not appropriate.

The next international radio conference was called to Washington in 1927. The problem of frequency demand exceeding the available spectrum resource appeared sharply there, and the unending battle of frequencies had started. At that time, spark-type transmitters were in use. They occupied wide frequency bands, much wider than needed to transmit the information. (It is interesting to note that modern spread-spectrum techniques again use frequency band much wider then minimum necessary to transmit information, but discussion of that issue goes beyond the scope of the lecture.)The demand for a complete outlawing of spark-type transmitters was pressed strongly, but not passed because of conflict interests.

The spectrum shortage problem was settled in Washington by two actions. On the one hand, more stringent technical standards were imposed, to limit the radiation out-of the band necessary for transmission of information. On the other hand, the spectrum resource limits defined in old radio regulations were moved to embrace additional portions of spectrum, not yet regulated. That approach has been copied at all later radio conferences.

The drawing up of the first Frequency Allocation Table, regulating the use of the spectrum, was considered as one of the most important results of the Washington conference. Another one was to set up the International Frequency registration Board and International Radio Consultative Committee, CCIR. Its aim was to study technical ad operational issues relevant to radiocommunications and to issue recommendations on them. Later, under the pressure of service and equipment suppliers, administrations allowed the non-governmental sector to participate directly in the work of the ITU-CCIR. In the following years, the involvement of that sector increased. In 1992 one-third of entities participating in the CCIR work were nongovernmental.

1.3 Spectrum management

1.3.1 Background

The concept of spectrum management embraces all activities related to planning, allocation, assignment, use, and control of the radio frequency spectrum and satellite orbit resources. Three major objectives have been shaping spectrum management:

minimize conflicts, convey policy goals, and rationalize the use of the spectrum/ orbit resources. An alternative concept involves profit maximization only (Figure 3).

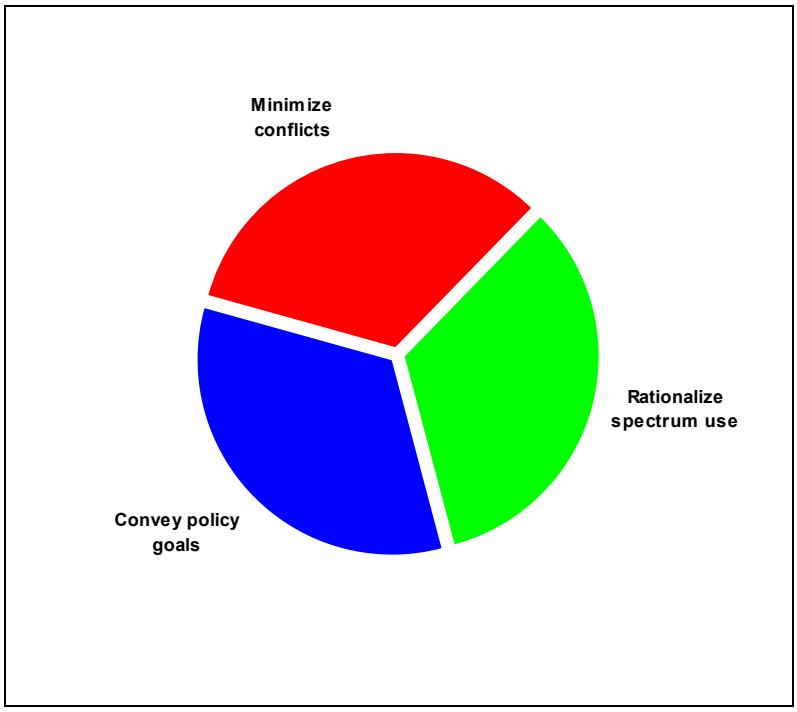

Figure 3. Three major objectives have been shaping spectrum management. An alternative concept involves profit maximization.

The society is composed of various groups, each with its particular interests, goals and views on how to use and manage the available resources (Figure 4). As a consequence of the scarcity, conflicts arise between those who have access to the resources and those who have not. Conflicts arise also between the proponents of competing uses of the spectrum as well as between those who manage the spectrum and those who use it. These conflicts are of various natures: commercial, political, physical interference, etc. [Huang 1993].

For those whose needs have already been satisfied, spectrum management should assure the continuation of the existing status. Any modification would threaten their acquired benefits. On the other hand, for newcomers, the principal aim of spectrum management would be to change the way the spectrum is apportioned and to eliminate obstacles that prevent them to enter the market. What is the best for one

group is not necessarily good for another. The spectrum management rules and regulations tend to reflect the relative balance of powers of the competing interest groups. As demand on the spectrum increases, the management tasks grow more complex.

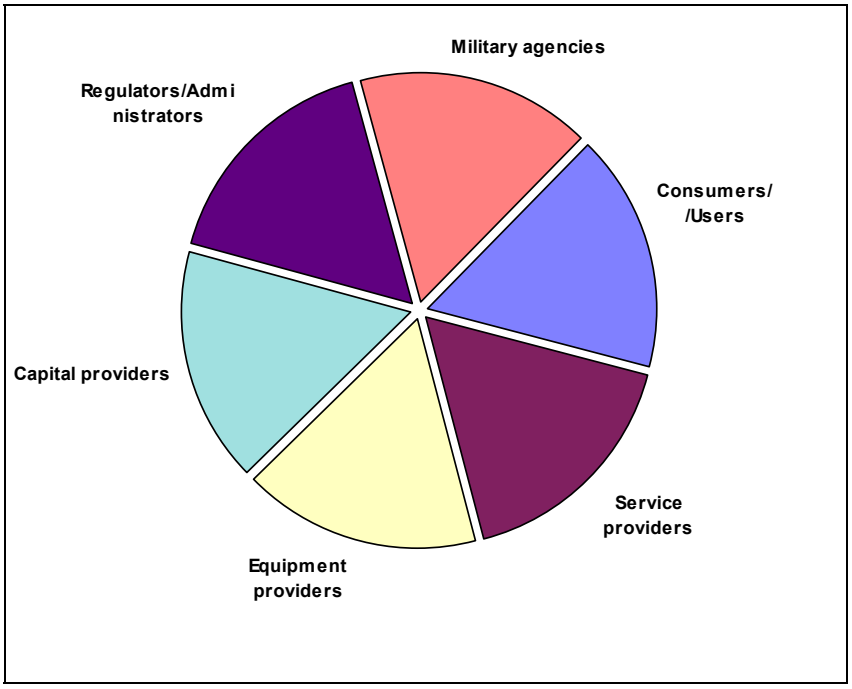

Figure 4. Major players in spectrum management. They are active in every ITU Member States, which involves also national interests and politics.

Few elements add international aspects to spectrum management tasks:

1. The development of international wireless services,
2. The threat of cross-border interference,
3. The pressure of equipment manufacturers and service providers for worldwide markets.

International spectrum management is presently voluntary and the International Telecommunication Union (ITU) creates its framework. The ITU Radio Regulations have been created step-by-step since the very beginning of radio. Each time a serious problem is recognized by the majority of ITU Members, the existing regulations are reviewed at an intergovernmental conference. However, only minimum modifications necessary to solve the problem at hand are agreed at each conference, leaving fundamental principles essentially untouched. One reason is that the process of intergovernmental conferences is often more about the art of politics and public relations than an exercise in economics and engineering, as the ITU Secretary General noted [Tarjanne 1992].

1.3.2 International Telecommunication Union (ITU)

The use of the radio frequency spectrum is now coordinated and regulated world-wide through the International Telecommunication Union (ITU). The ITU is a specialized agency of the United Nations since 1947, but its history goes back to 17 May 1865 when the International Telegraph Convention was signed. It is thus the oldest of all international organizations existing today, but its structure, working methods and regulations have been regularly revised, updated and extended to keep pace with new technologies, new services, and new needs. Since 1906, all uses made of radio are negotiated and regulated at the world level in the framework of the ITU. In 1963, the first World Space Radiocommunication Conference integrated the satellite orbit with the radio frequency spectrum into a combined concept of the spectrum and orbit resources that has entered permanently the ITU agenda.

The purposes of ITU are formulated in the Constitution and Convention which have the treaty status. They include, among others: "*... facilitating peaceful relations, international cooperation among peoples and economic and social development..., effect allocation of bands of the radio-frequency spectrum, the allotment of radio-frequencies and registration of radio-frequency assignments and any associated orbital positions in the geostationary-satellite orbit in order to avoid harmful interference between radio stations of different countries... coordinate efforts to eliminate harmful interference between radio stations of different countries and to improve the use made of the radio-frequency spectrum and of the geostationary satellite orbit for radio-communication services;...*" This activity must, however, not interfere with the principle of sovereignty, and *" ...the sovereign rights of each country to regulate its telecommunications"*.

Allocation deals with frequency bands and services. It means designation of a given frequency band for its use by one or more radiocommunication services or applications, terrestrial or space. Allotment refers to frequency channels and geographic regions. It means designation of a specific radio frequency channel (‘radio frequency’) for use over a specified geographical area. Assignment deals with

frequency channels and radio stations. It means authorization given by an administration for a radio station to use a radio frequency channel. Another major duty of ITU is the coordination of efforts to eliminate harmful interference between radio stations of different countries and to improve the use made of the radio frequency spectrum and satellite orbits. The agreed general rule of rational use of the resources is *"... to limit the number of frequencies and the spectrum used to the minimum essential to provide in a satisfactory manner the necessary services. To that end, [the ITU member countries] shall endeavour to apply the latest technical advances as soon as possible."*

The Constitution and Convention determine also working arrangements and the rights and obligations of the Union's members. The membership includes governments, scientific and industrial establishments, as well as private sector enterprises. It is a relatively new arrangement. Previously, the private sector could not participate directly in the work of the ITU (except for the participation in the work of CCIR and CCITT). The only possibility for private companies was to be a part of governmental delegation. In the time of this writing, the ITU membership consists of 189 Member States and about 700 non-governmental entities. The constitution and convention are reviewed at the Plenipotentiary Conferences called every four years or so. The most recent one took place in Marrakech, Morocco, in 2002. Each ITU member state, big or small, rich or poor, has a single voice, and there is a tradition in the ITU to reach agreement on controversial issues by consensus. One of major responsibilities of the union is the allocation of bands of the radio-frequency spectrum and registration of radio-frequency assignments and associated orbital characteristics of satellites.

Changes in the world require the policies and structure of ITU to be reviewed time to time. In this connection, the Members of the Union meet, at regular intervals, at a Plenipotentiary Conference. This is the supreme authority which lays down the general policy and structure of the ITU, reviews the Union's work and revises the Convention itself, if it considers this necessary. It also establishes the calendar of all ITU conferences, and sets a limit on expenditure until the next Plenipotentiary Conference. The Plenipotentiary Conferences of 1992 and 1994 have introduced major changes in functioning of the Union, marking the end of one era in the history of the ITU. The "new" ITU follows closer the liberalization trend seen around the world. Its functions have been separated in the three Sectors:

- Telecommunication Development Sector,
- Telecommunication Standardization Sector and
- Radiocommunication Sector.

1.3.3 ITU Radiocommunication Sector

To keep pace with technological, economic, and political changes, the ITU periodically reviews the spectrum management rules. Fig. 5 illustrates the process of global spectrum management in the ITU, in force since 1993. It forms a closed-loop system built around consensus-seeking studies and negotiations. The supporting organizational framework for international spectrum management is concentrated in the ITU Radiocommunication Sector. Its mission is, inter alias, to ensure rational, equitable, and economical use of the radio-frequency spectrum by all radiocommunication services, including those using the geostationary-satellite orbit, to solve international conflicts, and to carry out studies on radiocommunication matters. The mission is accomplished by

- ensuring meeting the specific needs of Members through Radiocommunication Conferences and Radio Regulations
- coordinating efforts to eliminate harmful interference between radio stations of different countries
- making recommendations on technical and operational radiocommunication matters through Radiocommunication Assemblies and Study Groups.
- maintaining Master International Frequency Register
- assisting Administrations in solving problems related to the use of radio frequencies and satellite orbits

The Sector consists of the following organs:

- World and Regional Radiocommunication Conferences
- Radio Regulations Board
- Radiocommunication Assemblies & Study Groups
- Radiocommunication Advisory Group
- Radiocommunication Bureau.

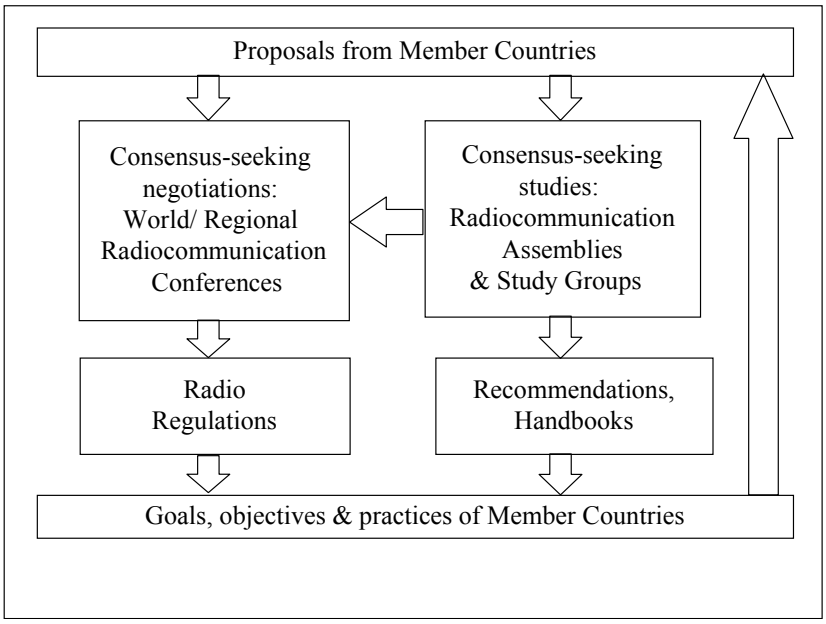

Figure 5. The ITU spectrum management process

1.3.4 ITU Radiocommunication Conferences

As the radio waves do not stop on political borders, international aspects of use of radio waves have been involved since the very beginning. For that reason, radiocommunication conferences have been organized to avoid or to minimize potential conflicts between states exploiting mechanism of multilateral coordination and negotiations. In the early years of radio, an administration was generally required to co-ordinate with one administration only. Later, the spectrum scarcity resulted in a necessity to co-ordinate among three and more Administrations. The negotiations with one may lead to modifying the characteristics of the network. This, in turn, often makes necessary re-negotiations with the other, and even the involvement of a third party, new in the processing. Such an iterative co-ordination and search-for-agreement process became absorbing much effort and time and lead to multilateral radio conferences. Following the tradition originated in Berlin, London, and Washington, the use of the radio frequency spectrum continues to be based on negotiations and consensus among all Members of ITU at radio Conferences. The general principles are:

- the radio frequency spectrum and satellite orbits are public resources, to which each country has equitable and free access;

- the use of the spectrum resource is based on mutually agreed regulations and administrative allocation of frequency bands and positions in the geostationary satellite orbit;
- the principles of electromagnetic compatibility (EMC) have to be followed by all parties (this term was introduced later).
- the regulations and frequency allocations are set through the mechanisms of consultations, negotiations, and consensus.

The Radio Conferences review and negotiate the current and expected usage of radio frequencies. They may establish and revise the frequency allocations, operational rules, standards, and relevant procedures. A collection of legal, administrative, operational and technical arrangements agreed by all parties at the Conferences are included into the ITU Radio Regulations. These Regulations are binding on all parties, and only the Conferences have the authority to revise them.

The participants in the Conferences are official governmental delegations of the ITU Member Countries. Each has one voice, independently of its size or economic significance. The Conferences are also open to the United Nations, international organizations, regional telecommunication organizations, intergovernmental organizations operating satellite systems, the specialized agencies of the United Nations, and the International atomic Energy Agency. The national delegations represent interests of all domestic groups, but there is a growing pressure to allow non-governmental entities a more direct involvement. Since 1993, non-governmental entities authorized by their countries to participate in the work of the Radiocommunication Sector are admitted also to radio conferences.

The Radiocommunication Conferences may be world-wide or regional, general or specialized. The general WARCs are authorized to deal with virtually all aspects of spectrum use. The specialized WARCs dealt with particular services and/or particular portions of the spectrum. The regional conferences are held to solve specific spectrum use problems within particular geographic regions. Some Radiocommunication Conferences are convened to negotiate and agree international frequency plans for certain application, geographical regions, and frequency bands which are subject to *a priori* planning. A frequency plan is a table, or more generally, a function that assigns appropriate characteristics to each of the radio stations at hand. It may be one, a few, or all characteristics by which radiocommunications can be distinguished one from another. Examples are: the operating frequency, power radiated, antenna location, height and radiation-pattern, polarization, service area, etc. Initially, in the early days of radio, only the frequency was assigned, and this explains the traditional name "frequency planning".

In *a priori* frequency plans, specific frequency bands (and geographic areas) are reserved for particular applications well in advance of their real use. Individual regions may have various allotment plans for specific services (e.g., broadcasting), within their respective areas. *A priori plans* make a one-time distribution of the spectrum resource on the basis of the expected or declared needs of all parties interested. That approach has been used, for instance, for the sound and television broadcasting in Europe and in Africa, and for some satellite services. The techniques used for that purpose are discussed in the following sections. Critics of the *a priori* planning indicate that it freezes technological progress. Indeed, technological progress is very fast, and implementation of the plan may require several years. Technology known at the time of creation of the frequency plan may be obsolete at the time of its implementation. Another difficulty is the impossibility to predict future requirements with a needed degree of accuracy. Plans based on unrealistic data have no value at all.

The radio spectrum is available at no cost at international conferences, and there is no mechanism to limit the requirements. Although the ITU Convention calls for minimizing the use of the spectrum resource, *" ... each country has an incentive to overstate its requirements, and there are few accepted or objective criteria for evaluating each country's stated need. In fact, the individual country itself may have only the dimmest perception of its needs over the time period for which the plan is to be constructed ... Under these circumstances, it is easy to make a case that allotment plans are not only difficult to construct, but when constructed will lead to a waste of resources as frequencies and orbit positions are 'warehoused' to meet future, in-determinate needs...*" [Robinson 1980].

For the major part of its history, the ITU focused almost exclusively on the technical and operational standards necessary for smooth and interference-free international telecommunications (including tariffs). With the time, some issues related to policy matters and social impacts of telecommunications have been added to its agenda. Recently, the ITU initiated the World Policy Forums (WTPF). At these forums, all ITU members, states and private entities, discuss key policy and regulatory matters trying to elaborate a common position. The final documents agreed at the forum have no binding force, but serve as recommendation to be taken into consideration by the competent ITU body. The first WTPF held in 1996 debated the development and implementation of global mobile personal communications by satellite. The second forum, held in 1998, dealt with accounting rates. For 2003, the ITU is preparing the World Summit on Information Society. One may expect that modern technology will be discussed as one of the means that will contribute to closing the information gap.

1.3.5 Radio Regulations Board

The Radio Regulations Board is an elected collective body that approves technical criteria used by the Radiocommunication Bureau in the applications decisions of radio conferences and in applications of Radio Regulations between the radio conferences. It also provides advice to radio conferences and may perform any additional duties relating to the utilization of frequencies and the use of satellite orbits, within the competence of ITU-R.

1.3.6 ITU-R Study Groups

In addition to the international radio regulations, the ITU produces also recommendations concerning technical and operational matters and accounting rates, but these have no treaty status. They must be followed only if they are explicitly referred to in the Radio Regulations, or are included in the national regulations. The recommendations will not be dealt with here.

More than 1'500 specialists from telecommunication organizations and administrations around the world participate in the work of the eight study groups of the sector. They

- draft the technical bases and regulatory and procedural steps for consideration at radiocommunication conferences
- develop ITU-R recommendations on the technical characteristics of operational procedures for radiocommunication services and systems
- compile handbooks on spectrum management and on emerging radio services and systems

These studies are performed by the ITU-R members on a voluntary basis.

2 ITU Agreements

2.1 Radio Regulations

The Radio Regulations originated at the International Radio Conference, Atlantic City, 1947. They replaced the Service Regulations established at the first International Radiotelegraph Conference in Berlin in 1906 (and modified thereafter). The original Berlin regulations counted only 12 pages, whereas the current Radio Regulations occupy over 2000 pages, not counting a thick volume of Rules of Procedures. The Rules of Procedures are not part of the treaty, but are necessary for the implementation of its provisions in the ITU headquarters, as approved by the Radio Regulations Board. The provisions of Radio Regulations can be modified only by a competent World Radiocommunication Conference (WRC). Since the Atlantic City conference, they were updated a number of times. These updates embraced not only an increasing sweep of radio frequencies, but also a widening range of services, following the changing needs of member states. Figure 6 shows how the volume of

the Radio Regulations increased in response to the growth of various radio systems and rising complexity of interactions among them.

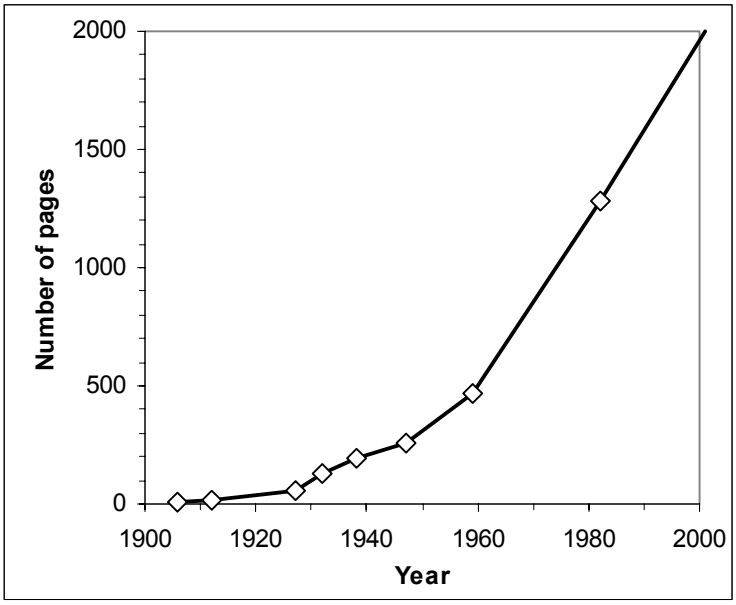

Figure 6. Increase of the volume of Radio Regulations in the years 1906 – 2001.

Space telecommunications issues were included into the Radio Regulations for the first time at the radio conference held in Geneva in 1971. The most recent WRC dealing with satellites was held in Istanbul, Turkey, in 2000; the next one is planned for 2003. The Radio Regulations define the allocation of radio frequencies to specific uses. They also specify operating procedures for stations and restrictions imposed, as well as detailed coordination, examination, notification and recording procedures. The aim is to assure an efficient use of radio frequencies and orbital positions, and international recognition of national frequency assignments. Not all frequency assignments need to be registered internationally. The uses that by their nature cannot cause interference across the border (low-power applications, short-range devices), or are immune to interference and do not require international recognition, do not need to be notified within the ITU. The Radio Regulations contain also frequency allotment plans for a number of services, including plans for broadcasting-satellite service.

2.1.1 Orbits

In the case of satellite systems, the space denied involves also elements of satellite orbit. Due to laws of physics, orbits of objects launched into space are open or closed, depending on the object's velocity. Open orbits (parabolas and hyperboles) are orbits of objects that escape the Earth attraction and run away. The velocity necessary for escaping is about 11 km/s at an altitude of 200 km, and decreases at higher altitudes. Objects at lower velocities either circulate the globe periodically as artificial Earth satellites at closed (elliptical) orbits, or fall down to the Earth. The Radio Regulations require the orbital parameters and frequencies of satellites to be registered in the ITU Master International Frequency Register.

These parameters must be kept within tight tolerances during the whole lifetime of the satellite. Usually, the orbital position of satellite must be corrected periodically (e.g. once a week or once a month) to compensate for the perturbations due to irregularities of gravitational fields of the Earth, and the attraction forces of the Moon and Sun. Geographical region irradiated by the satellite depends on the antenna radiation pattern and satellite position. Both have to be coordinated among the states irradiated by the satellite station. This is to be verified by the ITU using the methods and criteria specified in the Radio Regulations. The regulations forbid irradiating foreign territories without explicit agreement of competent administration, unless the incident power density is sufficiently low.

Synchronous orbits are orbits in which a satellite move in the same direction as the Earth and has the same period of 24 hours (more precisely 23 h 56 min 4.1 s). A synchronous orbit that is circular and lies in the equatorial plane is known as geostationary orbit (GSO), and satellites in it – as geostationary satellites. A satellite in a non-equatorial geosynchronous orbit will, when observed from a fixed point on the Earth, appear to move northward and southward. If the synchronous orbit is not perfectly circular, the difference in angular velocities of the Earth and satellite change in time, and the satellite will appear to move eastward and westward. The combination of these two motions will produce a figure-8 pattern as seen from the Earth.

Of all orbits, the geostationary orbit has generated greatest interest. It is at the altitude of about 36 thousand kilometres (theoretically 35'786 above the Equator or 42164 km from the Earth centre). The distance and direction from any point on the earth to a geostationary satellite do not change in time, except for some fluctuations due to the orbit perturbations. This has significant implications, as the directive antenna used to communicate with a stationary satellite does not need any tracking mechanism. Consequently, its construction is simpler, its reliability is higher, and its cost is lower than that of a comparable antenna for communication with any non-geostationary satellite. No other orbit offers comparable benefits.

However, with a fixed distance between neighbouring satellites, the number of possible satellite positions on the GSO is limited. For instance, the satellite separation of two degrees implies maximum of 180 separate satellite positions (as the GSO angular dimension is 360 degrees and 360/2=180). As new satellites are launched in the geostationary orbit every year, old satellites must be moved into other orbits. Some countries that expect to launch geostationary satellites in future worry that there may be no free place for them when they will be ready to launch. They therefore insist to make early reservations of the orbital positions and associated frequency bands they need. This is done in the form of frequency plans discussed in a section below.

A serious shortcoming of the geostationary orbit is that it is not visible from regions in far north and in far south, so that these regions cannot be served by geostationary satellites. To cover these regions, polar, or inclined orbits must be used. If the Earth were not rotating, a satellite in the polar orbit would travel along the same North-South meridian form one geographical pole to another. With East-West rotation of the Earth, the sub-satellite point traces more complex lines over the Earth surface. The same concerns the inclined orbits. Of all inclined orbits, the most famous is that of the Russian satellite 'Molnya', launched in 1965. This is an elliptic orbit inclined 63.4 degrees in relation to the equatorial plane. Its period is 12 hours, so that the satellite visits the same places at the same hours of the day. With the perigee (the orbital lowest point) of 500 km and apogee (the highest point) of about 39 thousand kilometres, the satellite moves very slowly in the sky near the apogee. Its angular velocity there approached that of the Earth rotation around its axis. The satellite behaves thus like a geostationary satellite, being 'practically geostationary' during 5 to 6 hours. In this orbit, it takes about 11 hours to travel across the north hemisphere and only about one hour to pass over the other hemisphere.

Low Earth orbits (LEO) are orbits in the altitude range 500 to 2'000 km, and Medium Earth Orbit (MEO) are those at altitudes of 8'000-20'000 km above the Earth. Figure 7 shows the difference between LEO satellites that make dozens of revolutions around the Earth per day, and MEO satellite that make few revolutions, and the geostationary satellites that apparently does not move at all. LEO satellites offer lower power requirements and shorter propagation delays than can be achieved geostationary satellites, or MEO satellites. Two LEO groups have emerged, *Little LEO* for data-communications satellites and *Big LEO* for data-and-voice communications, each using pre-assigned frequency ranges. Satellite systems offering true global coverage use polar orbits and a number of 'cooperating' satellites. As an individual non-geostationary satellite can be 'seen' only during a part of its period, another satellite must continue the service on its place. For instance, the Iridium Satellite System uses a constellation of 66 satellites in six orbital planes inclined 86.4 degrees. At time of writing it was the only provider of truly global,

truly mobile satellite voice and data solutions with complete coverage of the Earth, including deserts, oceans, and Polar Regions.

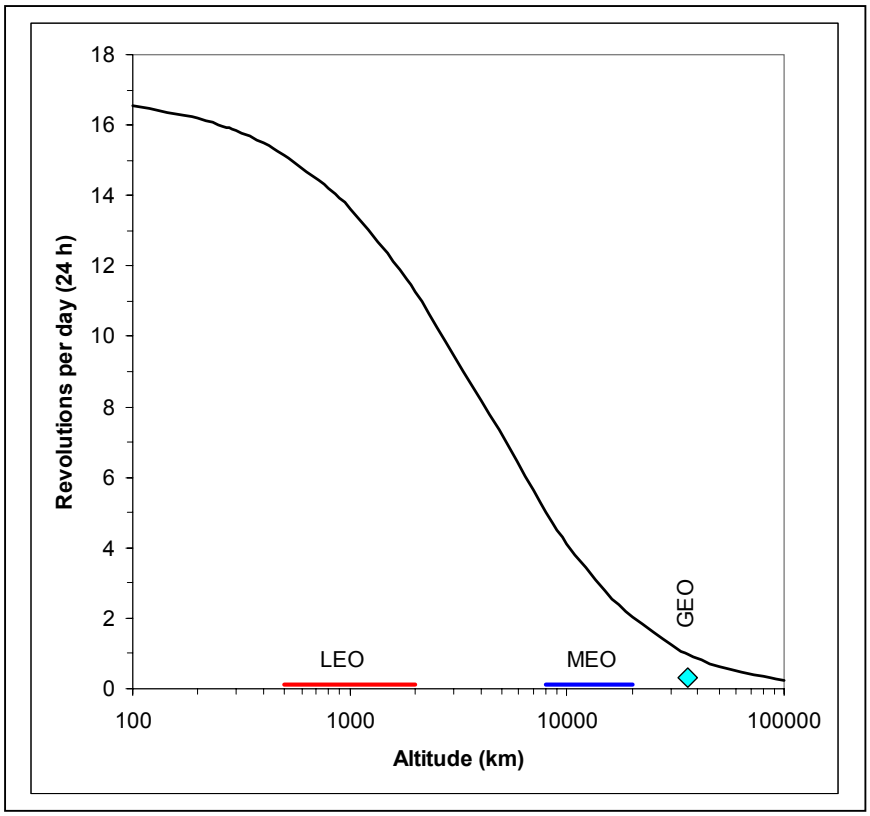

Figure 7. Number of revolutions of satellite versus its altitude above the Earth (circular orbit). LEO: Low Earth Orbit; MEO: Medium Earth Orbit; GEO: Geostationary Orbit.

2.1.2 Services

Radio Regulations are based on a concept of Radiocommunication Service. Such a service is defined as transmission, emission, and/or reception of radio waves for telecommunication purposes. For instance, Table 3 lists satellite services. Some services are active whereas others are passive. Active services use equipments that radiate radio waves. Passive services use non-radiating devices only. Radio Astronomy, considered within the Union as radiocommunication service, is an example of passive service. Passive services that use signals of natural origin, like

Radio Astronomy, require special protection, as they cannot choose the operating frequency. The choice has been made by Nature.

Table 3. Satellite services defined in the Radio Regulations.

Aeronautical mobile-satellite (OR) service [*off-route*]
Aeronautical mobile-satellite (R) service [*route*]
Aeronautical mobile-satellite service
Aeronautical radionavigation-satellite service
Amateur-satellite service
Broadcasting-satellite service
Earth exploration-satellite service
Fixed satellite service
Inter-satellite service
Land-mobile satellite service
Maritime mobile-satellite service
Maritime radionavigation-satellite service
Meteorological-satellite service
Mobile-satellite service
Radiodetermination-satellite service
Radiolocation-satellite service
Radionavigation-satellite service
Space operation service
Space research service
Standard frequency and time –satellite service

Each service is treated separately. The radio frequency spectrum is insufficient to allocate a separate frequency band for an exclusive use by each radiocommunication service. Some bands must be shared by two or more services. In such a case, one of the services may have the status of primary service whereas the other services have the status of secondary service. Stations of a secondary service shall not cause harmful interference to stations of primary services to which frequencies are already assigned or may be assigned later. They cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned later. However, they can claim protection from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned later. When two or more services of equal status have to use the same frequency band, the principle of seniority applies, known also as the 'first-come, first served' rule. That principle, however does not apply to frequency bands included in the approved frequency plans and other special agreements.

2.1.3 Regions

For the purpose of radio regulations, the world has been divided into three geographical regions (Figure 8). Region 1 includes the whole Europe, Africa, Middle East and northern part of Asia. Region 2 covers the Americas, and Region 3 - the southern part of Asia, Australia and Oceania. In addition, defined are the African Broadcasting Area, European Broadcasting Area, and European Maritime Area. Each region has its individual frequency allocations but some services have worldwide frequency allocations, i.e. identical in all three regions. Global allocations are desirable to avoid incompatibilities in border regions and to create large markets for equipment and services. The divided world does impede trans-regional services and trade: with different frequency allocations, radio designed to work in one region would usually not work in another region. The reasons why such a division was decided have not been disclosed. No physical or technical phenomena justify it. One only may speculate that the original purpose was to protect monopolistic markets in regions of economic and political influence.

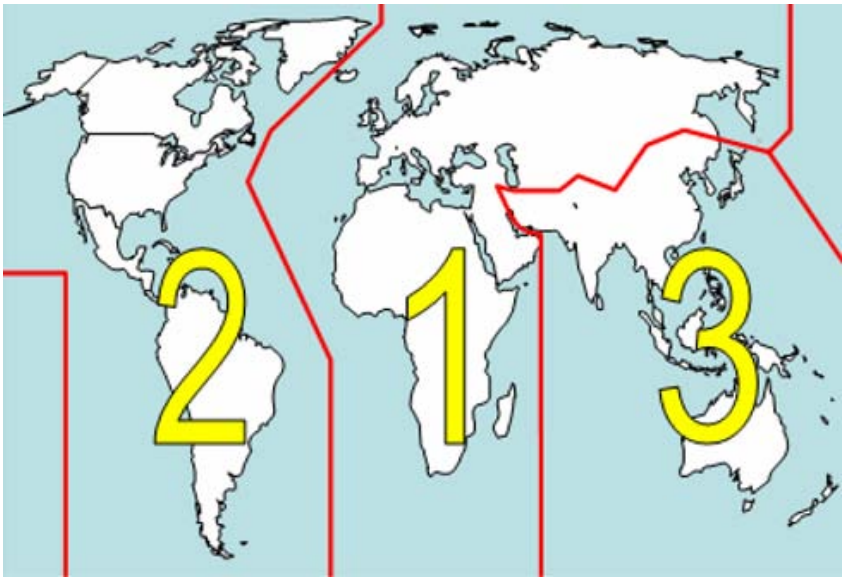

Figure 8. For the purpose of Radio Regulations, the world has been divided into three geographical regions numbered 1, 2, and 3.

2.1.4 Frequency Allocations

The radio frequency spectrum has been divided into a number of specific frequency bands allocated to specific services in each of the three regions. A competent conference may allocate a specific frequency band to a service that has convincingly demonstrated its need for that band and that the new allocation will be compatible with the existing uses of that band and adjacent bands. The conference may also modify earlier allotments ('spectrum re-farming'). The frequencies below 9 kHz or above 275 GHz were not allocated at the time of this writing. The allocations between 9 kHz and 275 GHz are defined in the Table of Frequency Allocations and Footnotes to it (see the Annex). Some of the footnotes specify additional constraints on the use of frequency bands while others provide additional or alternate frequency allocations to individual countries or group of countries. Each use made of frequencies subject specific restrictions. For a given service, the frequency allocations and restrictions may depend on the communication direction. For instance, uplinks and downlinks may use different frequency bands subject different restrictions.

The division of the frequency spectrum into small portions to separate various services has historical justification, but not always matches the needs of modern technology. For instance, the spread-spectrum systems use correlation methods to separate wanted signals from unwanted ones and are, by their very nature, broadband, whereas most of classic systems are narrowband. With narrow frequency bands allocated, potential capabilities of the spread-spectrum systems are sometimes not fully exploited. An Ultra Wideband (UWB) system can use bandwidth of 1.5 GHz or more (fractional bandwidth greater than 0.25) which extends over a number of individual frequency bands defined in the Radio Regulations. UWB proponents claim that their system can co-exists with all of the current services. However, the issue is open, as those dealing with GPS, radioastronomy, and some other passive services do not share that opinion. The issue will be discussed at one of the forthcoming WRCs.

2.1.5 Frequency Plans

The Radio Regulations contain also frequency assignment plans for some services, frequency bands, and regions. Such a plan, if related to space, defines frequency and position of the satellite-born station in the orbit. A variation of the planning process is the allotment plan which specify the uses made over a specific area without defining precise location of stations (as in the assignment plan). Allotment is converted into a specific assignment before bringing it into use. A country may use its assignment without involving full coordination procedures, as necessary coordination had been done earlier, when the plan was negotiated.

Frequency bands and orbital positions included in frequency plans and reserved for use by specific states or group of states. This is sometimes strongly criticized, as wasting precious resources and creating artificial congestion. The reserved frequency bands may remain unused for many years and for various reasons. At the same time, other applications cannot find free frequencies. The Radio Regulations contain the Plan for the Broadcasting-Satellite Service in the frequency bands 11.7-12.2 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2). The plan, originally produced in 1977, was modified a number of times, last time in 2000. It defines a set of characteristics, such as the satellite positions in the geostationary orbit, frequency channels, and space station antenna pointing and radiation characteristics. It also specifies the procedures for coordination, notification, examination and recording in the Master International Frequency Register. Moreover, it defines power flux-density limits to protect terrestrial services from space-borne interference. Similar frequency plans exist for the associated feeder links (in the frequency bands 14.-14.8 GHz and 17.3-18.1 GHz in Regions 1 and 3, and 17.3-17.8 GHz in Region 2) and for the fixed-satellite service in the frequency bands 4.500-4800 MHz, 6725-7025 MHz, 10.70-10.95 GHZ, 11.20-11.45 GHz and 12.75-13.25 GHz.

2.1.6 "Forbidden" Frequencies

The Frequency Allocation Table of Radio Regulations allocates some frequency bands for use by passive services such as radio astronomy or Earth exploration-satellite service (passive). Table 4 lists these bands. All emissions are prohibited in these frequency bands and the uses made of the adjacent frequency bands (spill-over including) must not extend specific frequency and power limits. The last column of the table identifies the relevant footnote to the Table of Frequency Allocations.

2.1.7 "Free" Frequencies

The Radio Regulations allocates some frequency bands for non-telecommunication purposes. These are known as 'ISM frequencies', 'free-radiation frequencies', or 'non-licensed' bands. They are listed in Table 5. The last column of the table identifies the relevant footnote to the Table of Frequency Allocations. The abbreviation 'ISM' means industrial, scientific, domestic and medical applications. Note that the use of specific ISM bands requires special authorization (RR 5.138). Some ISM bands have been used also by interference-immune communication systems, such as low-power wireless local area networks (WLANs). However, systems operating within these bands are unprotected and must accept interference.

Table 4. Frequency bands in which all emissions are prohibited.

Lower Frequency	Upper frequency	Unit	RR Footnote
1400	1427	MHz	5.340
2690*	2700	MHz	5.340
10.68*	10.7	GHz	5.340
15.35*	15.4	GHz	5.340
23.6	24	GHz	5.340
31.3	31.5	GHz	5.340
31.5*	31.8	GHz	5.340
48.94*	49.04	GHz	5.340
50.2*	50.4	GHz	5.340
52.6	54.25	GHz	5.340
86	92	GHz	5.340
100	102	GHz	5.340
109.5	111.8	GHz	5.340
114.25	116	GHz	5.340
148.5	151.5	GHz	5.340
164	167	GHz	5.340
182*	185	GHz	5.340
190	191.8	GHz	5.340
200	209	GHz	5.340
226	231.5	GHz	5.340
250	252	GHz	5.340

*) with some exceptions

3 UN Space Agreements

The development of telecommunications has been strongly influenced by space activities. The Space Era has began when the first artificial earth satellite was launched by the Soviet Union in 1957. This event was prepared by earlier publications of Arthur C. Clarke of Great Britain, Herman Potocnik (1892-1928), an Austro-Hungarian of Slovene origin and Konstantin Tsiolkovsky (or Ciolkowski), (1857-1935), a Russian scientist of Polish origin. The Soviet's monopoly did not last for long time. The first American satellite, Explorer 1, was put in the orbit only a few months later. Both satellites were products of military research laboratories. Explorer 1 was designed, built, and launched under the direction of Wernher Von Braun, the ex-prisoner-of-war and the creator of the famous series of German rocket missiles V1 and V2 that were used in the attempt to destroy London during the World War II.

The first satellites were small and short living when compared with the modern International Space Station (ISS) see Table 6. The table illustrates the progress made: the satellite mass increased more that thousand times! The ISS is shown in Figure 9.

It is the largest and most complex international scientific project in history. With its lifetime cost estimated for ~US$100 billion, it is also the most expensive and controversial project. The ISS serves as an Earth-orbiting laboratory drawing upon the scientific, technological and financial contribution of 16 nations: Brazil, Canada, the eleven members of the European Space Agency, Japan, Russia, and the USA.

Table 5. Frequency bands allocated to ISM applications.

Lower Frequency	Upper Frequency	Unit	RR Footnote
6.765	6.795	MHz	5.138
13.553	13.567	MHz	5.150
26.957	27.283	MHz	5.150
40.66	40.70	MHz	5.150
433.05*	434.79*	MHz	5.138
902**	928**	MHz	5.150
2.4	2.5	GHz	5.150
5.725	5.875	GHz	5.150
24	24.25	GHz	5.150
61	61.5	GHz	5.138
122	123	GHz	5.138
244	246	GHz	5.138

*) In some countries of Region 1. **) In Region 2

During the first nine years of the space history, 1957 to 1965, only two countries were able to launch satellites: the USSR and the United States. They collected invaluable data on the space environment and its effects on equipment and on living organisms. The Explorer 1 mission evidenced an unusual concentration of cosmic radiation in some region around the Earth. That region has been called the Van Allen radiation belt after James A. Van Allen of the University of Iowa who designed the experiment. This discovery was of great importance. The satellite orbits are designed to avoid the Van Allen belt as much as feasible, since electronics, and hence satellite lifetime in the orbit, is strongly affected by the radiation, and millions of dollars are at stake.

Relations among nations change. We have seen throughout history how cooperation between nations changes into competition, peace into war, forth and back, affecting strongly activities of individuals and nations. The USSR and the USA, ex-allies

during the World War II, turned into enemies when the war was over. Soon after the Charter of the United Nations, claiming a new peaceful order among nations, was approved in 1945, the 'cold war' started. Each superpower worked on new weapons to assure its worldwide dominance. In that competition, satellites served as a deterring propaganda element. A heavier satellite in the sky meant a more powerful rocket engine and bigger nuclear bomb carried to and dropped at any place on the Earth.

Figure 9. Artist's rendering of the International Space Station following the undocking of the Space Shuttle Atlantis. Still being build, the station will accommodate six astronauts making scientific experiments at an altitude of 200 to 600 km. (Courtesy of NASA)

The arms race resulted in a menace of mutual annihilation, which in turn generated a need for some survival assurance. Spy satellite technologies were thus developed to monitor military activities with required precision. A degree of cooperation in space became both possible and necessary to solve problems the space era brought with it. For instance, a satellite, its crew, or its component parts could land on a foreign territory, under foreign jurisdiction. Or, a satellite crew could need assistance that only the other state could deliver. Such situations never happened before the space era and thus mutual responsibilities and obligations of the both states involved were undefined. In the meantime, other states became also interested in space activities. The USA-USSR space domination was broken in 1965. France launched its satellite on 26 November 1965, using its own rocket and becoming thus the third space power in the world. In 1971, each of the two blocks involved in the cold war created an intergovernmental satellite operating organization: Intelsat and Intersputnik

respectively. Later, other similar organizations originated, see Table 6. International cooperation in space has accelerated.

Table 6. The first and the largest artificial satellites of the Earth.

	Sputnik 1 (USSR)	Explorer 1 (USA)	ISS (International)
Launch date	4 October 1957	31 January 1958	31 October 2000
Form	Sphere	Cylinder	Complex
Diameter, m.	0.58	0.15	---
Length, m.	---	~2	~88
Width, m	---	---	~108
Mass, kG.	83	14	~430'000*
Min altitude above Earth, km.	227	358	~200
Max altitude above Earth, km.	945	2550	~600
Orbit period, min.	96	115	90
Mission length	21 days	112 days	25 years*
*) The ISS hardware has not yet been completed at the time of writing			

The first satellites were developed by governmental (military) research laboratories, and the governmental monopoly lasted seven years after Sputnik 1. The monopoly was broken 10 July 1962 when Telstar I, the first non-governmental satellite was launched in the USA. Developed by the AT&T private company, the Telstar I was the prototype for a constellation of satellites that AT&T intended to develop and operate. The constellation would consists of 50 to 120 satellites at random orbits at the height of the order of 10'000 kilometres and would provide service 99.9 per cent of the time between any two points on earth. The cost of the space part of such a system was estimated in 1961 at US$500 million. The project was halted when the Kennedy Administration decided to give the monopoly on satellite communications to Comsat.

Telstar I was the first telecommunication satellite with transponders, and the first satellite that transmitted the live broadcasts between the United States and Europe. At that time, the satellite provided almost 10 times the capacity of the submarine telephone cables for about 1/10th the price. The cable-satellite price-difference was maintained until the laying the first fibre-optic cable laid across the Atlantic in the late 1980s. Satellites were especially competitive in point-to-multi-point (broadcasting) applications, and that advantage continues. Canada began domestic satellite service in 1972. It was joined by the United States (1974), Indonesia (1976), Japan (1978), India (1982), Australia (1985), Brazil (1985), Mexico (1985), and others. The satellite industry, dominated for long time by governments, began to move fast towards the free market. Even Intelsat, Eutelsat, and Inmarsat (that were

originally created as intergovernmental entities) have been reconstituted as private companies.

Table 7. International Agreements on Space-related Organizations.

1971	Intelsat	Agreement Relating to the International Telecommunications Satellite Organization -Intelsat (www.intelsat.com)
1971	Intersputnik	Agreement on the Establishment of the Intersputnik International System and Organization of Space Communications (www.intersputnik.com)
1975	ESA	Convention for the Establishment of a European Space Agency (www.esa.int)
1976	Arabsat	The Agreement of the Arab Corporation for Space Communications - Arabsat (www.arabsat.com)
1976	Intercosmos	Agreement on Cooperation in the Exploration and Use of Outer space for Peaceful Purposes (Intercosmos)
1976	Inmarsat	Convention on the International Maritime Satellite Organization - Inmarsat (www.inmarsat.org)
1982	Eutelsat	Convention Establishing the European Telecommunications Satellite Organization - Eutelsat (www.eutelsat.org)
1983	Eumetsat	Convention for the Establishment of a European Organization for the Exploitation of Meteorological Satellites – Eumetsat (www.eumetsat.de)

3.1 Space Treaties

This section reviews major multilateral international agreements that have been negotiated in the framework of the United Nations (UN). This organization, founded in 1945 to promote peace, security, and economic development is now composed of most of the countries of the world. A first significant step in developing international cooperation in space was the adoption by the General Assembly of the United Nations in 1963 of the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space. It was the birth of international space law, uniting the customary law and international treaties. Customary law bases on commonly observed practices in the past. A treaty is a formal explicit agreement negotiated between two or more sovereign states, binding for the states that have ratified it (i.e., national laws in these states must be in accordance with the treaty). Treaties base on the principle of *good faith* and principle of *not doing any harm to the treaty signatories*, as Titus Spoelstra, CRAF Frequency Manager/Secretary, formulated it shortly [Spoelstra 2002].

International law deals with the state and its relationships with individuals or with other states. In contrast, private law deals with the legal rights of private individuals.

Non-governmental entities (private companies, individual persons, foundations) under international law are legal objects, not subjects. If a private company of one state enters in conflict with a company of another state, the conflict becomes a public case in terms of international law. Disputes between the states may be settled according to procedures established by the relevant treaties, by negotiation through diplomatic channels, via arbitration, or by any other method mutually agreed. Violating international treaties usually experiences only a moral sanction: the public opinion of the civilized world. In some cases, however, economic or even military sanctions can be applied. Table 8 lists major treaties relevant to space activities. The year indicated in the table is the year when the treaty was opened for signature (its entry into force was usually a few years later), or the year of adoption of the principle by the UN General Assembly. The table indicates also the internet Web page address where the original text of the agreement can be consulted.

The Outer Space Treaty (OST) furthered the purposes and principles of the Charter of the United Nations of 1945. It furnished a general legal basis for the peaceful uses of outer space and provided a framework for the developing law of outer space. Outer space is considered a *common heritage of humanity.* It identifies few basic principles concerning the exploration and use of outer space. Among these principles, freedom of scientific investigation, exploration, and use is at the top of the list. International cooperation is strongly encouraged. Another principle proclaims exploration and use to be carried out for the common benefit and in the interests of all countries, rich and poor. The OST also states that outer space is not subject to national appropriation. Further, it declares activities to be pursued in accordance with international law and uses for peaceful purposes only. Moreover, it requires space activities to be duly authorized and continuously supervised by the state, even if these activities are performed by a private entity. According to further articles of the Treaty, each state that launches or procures the launching of an object into outer space retains jurisdiction and control over that object during and after the mission, and is liable for any damage caused by it or by its component parts. This requirement should be seen in conjunction with the Liability Convention and Registration Convention.

Table 8. Major International Agreements Related to Space Activities.

1963	Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space http://www.oosa.unvienna.org/SpaceLaw/lpostxt.htm
1967	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty) http://www.oosa.unvienna.org/treat/ost/ost.html
1968	Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement) http://www.oosa.unvienna.org/SpaceLaw/rescuetxt.htm
1972	Convention on International Liability for Damages Caused by Space Objects (Liability Convention) http://www.oosa.unvienna.org/SpaceLaw/liability.htm
1974	Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite (Brussels Convention) http://www.wipo.org/clea/docs/en/wo/wo025en.htm
1975	Convention on Registration of Objects Launched into Outer Space (Registration Convention) http://www.oosa.unvienna.org/SORegister/registxt.htm
1979	Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) http://www.oosa.unvienna.org/SpaceLaw/moon.html
1982	The Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting http://www.oosa.unvienna.org/SpaceLaw/dbstxt.htm
1986	The Principles Relating to Remote Sensing of the Earth from Space http://www.oosa.unvienna.org/SpaceLaw/rstxt.htm
1992	UN – The Principles Relevant to the Use of Nuclear Power Sources in Outer Space http://www.oosa.unvienna.org/SpaceLaw/nps.html
1998	General Agreement on Trade in Services – Annex to the Fourth Protocol of the General Agreement on Trade and Services http://www.wto.org/english/docs_e/legal_e/legal_e.htm
2001	Radio Regulations (on sale at www.itu.int)
2002	International Telecommunication Constitution and Convention http://www.itu.int/publications/cchtm/cns.html

Other articles impose on the states the requirement to avoid harmful contamination of outer space and celestial bodies. Adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter must also be avoided. If a state has reason to believe that an activity or experiment planned by it or its nationals in outer space would cause potentially harmful interference with activities of other state in the peaceful exploration and use of outer space, it shall undertake appropriate international consultation before proceeding with any such activity or experiment. The treaty imposes the requirement to inform the public and the international scientific community on space activities and to promote international cooperation. It also sets a legal framework for setting and operation of bases on the Moon.

The other treaties developed further certain general concepts included in the 1967 Outer Space Treaty. Regarding the 1975 Registration Convention, there are proposals of unification of national registers and clarification of certain terms, such as 'launching state'. Regarding the 1979 Moon Agreement, there are suggestions to review its provisions concerning the exploitation of moon resources, to make it more adapted to today's international scenario. After 1959, data on objects launched into outer space became distributed by the Committee on Space Research (COSPAR). These are available also via the World Wide Web (http://nssdc.gsfc.nasa.gov/spacewarn/spacewarn.html). Most of space-related treaties refer explicitly to the *Related International Agreements,* namely the International Telecommunication Union (ITU) Constitution and Convention and the ITU Radio Regulations that we already discussed in an earlier section. Some issues relevant to space activities are also negotiated in the framework of the World Trade Organization (WTO). These will be treated in separate sections.

4 WTO Trade Agreements

This section reviews two multilateral agreements reached within the World Trade Organization (WTO). WTO is a UN forum developed to promote free markets and trade liberalization through dispute settlements and multilateral trade negotiations and agreements aimed at abolishing trade obstacles.

4.1 GATS

In 1997, the WTO completed the round of negotiations on basic telecommunication services, in the framework of General Agreement on Trade in Services (GATS). Immediately after the agreement was reached on basic services, a new negotiations round started on additional services. Indeed, modern digital communication systems make the basic and the value-added services indistinguishable. The objective is an open worldwide telecommunication services market, advantageous to all, without unduly regulations and restrictions. In such a market, the public telecommunications networks can be accessed under non-discriminatory terms and at cost-oriented and affordable rates.

4.2 TRIPS

WTO is also involved in the Agreement on Trade Related aspects of Intellectual Property Rights (TRIPS Agreement) to protect patents on, for example, communication equipment and software developments. The negotiations are not easy. In his inaugural address to the 2000 forum on Intellectual Property Policy and Strategy in the 21st Century held in New Delhi, Thiru Murasoli Maran, the Indian Minister for Trade and Commerce, provided a stinging critique of the agreement. It unduly protected the economic interests of right owners and ignored the basic human values, he said. Instead of advancing creativity and a larger vision of global benefits, the TRIPS Agreement was promoting inequities and injustices, in his opinion. He

regarded the agreement as a component of technological protectionism aimed at consolidating an international division of labour, where the rich countries of the north generate innovations and the poor countries of the south constitute the market for the resulting products and services. Anyway, the WTO introduced new elements of business reality, to which neither national regulations, nor the ITU treaties were well prepared. In spite of all critics, the WTO agreements are expected to facilitate the evolution of truly global telecommunication services and service providers, and accelerate the convergence of telecommunication, electronics, and entertainment sectors.

5 Topics for Discussion

This section deals with some challenges the society is confronting today. New inventions and new applications are emerging continuously. At the same time, the trend of liberalization and privatization is progressing. The first space treaties and radio treaties were created when the private sector was not yet directly interested in these agreements. Many of the spectacular radio and satellite applications we witness today were considered science fiction at that time. When the space treaties were signed, no one ever expected problems with space tourism, orbital debris or with paper satellites. Very few were thinking on enormous potential benefits of common projects serving the whole humanity, the rich and the poor, such as a worldwide emergency communication network for instance.

5.1 Astonishing Applications

Space tourism belongs to the category of most astonishing applications. Not so long ago, it was a pure fantasy, but now the era of space tourism is a reality. Millions of dollars have already been invested in projects of suborbital tourist vehicles, orbital hotels and lunar cruise ships. Some American and Japanese business predictions suggest that space tourism could be a US$10 billion-per-year industry within two decades or so.

The space tourism era has begun on 28 April 2001, when Dennis Tito started his visit to the International Space Station on the board of Russian vehicle, for a price estimated for ‘only’ US$20 million a week. As Mr. Tito was an American businessman, one could think that space tourism can attract only people from the “Rich North”. However, the world's second paying guest in space come from the “Poor South”. Mark Shuttleworth, an African citizen, started his journey on 25 April 2002, for a figure similar to that paid by his predecessor. After his “historic mission”, as the press named it, thousands of people gathered 10 June 2002 in Cape Town to welcome him as a national hero. And all this happens in times when there is a chronic lack of funds to solve environmental problems, eradicate famine and misery, or improve public health care and education. That indicates how much different are hierarchies of values and preferences in our divided society.

5.2 Emergency Communications

Two billion people are affected per decade, and losses reach US$740 billion, due to windstorms, floods, and other disasters that touch both the rich and the poor with no difference. These are data from the World Disasters Report 2000. In the field, reliable communications is often a matter of life or death, and special emergency communication systems have already been created in many countries. However, terrestrial systems are rarely operational where disaster occurs, and if they are there, their terrestrial components are usually destroyed during the disaster. The necessary equipment must be transported, often from distant places, and deployed each time they are needed. Moreover, the current emergency telecommunications is a patchwork of various technologies, equipment, and protocols, not always working together smoothly, as summarized in the Report on Emergency Telecommunications [Struzak 2000]. There is an urgent need for a global satellite broadband emergency communication network, as stipulated in that report. The current technology is capable to build such a network; what is missing is the political will and financial support. The suggested global broadband emergency communication/ information infrastructure, permanently present in the sky and universally accessible from any point on the Earth, would play an important role in timely warning and in effective disaster preparedness.

The proposed system could transmit satellite images of hurricanes, flooding, or fires to any place where they are needed. Figures 10 and 11 are examples of such images. Material threats and losses could be evaluated immediately and objectively by international experts, no matter at what distance from the disaster area they actually might be. The population threatened could timely be warned and evacuated from the area affected. The evacuation plans could be updated quickly to match the changing situation, and the disaster relief activities can be planned more precisely and with no delay. If only one percent of these losses could be avoided due to the proposed emergency communication/ information system, it would mean 20 million affected people less and US$7.5 billion material losses less. It is just the population of a country like Australia and the GPD of a country like Iceland. One may also speculate that such a common system would cost less than the total cost of a number of individual national systems operating separately. However, such analysis has never been made.

Figure 10. Three consecutive satellite views of hurricane Andrew on 23, 24 and 25 August 1992 showing its path from East to West over the Florida peninsula. The hurricane caused 26 deaths and US$26'75 billions in damage. Such images help to prepare people and goods threatened to survive the disaster. (Courtesy of NASA)

A LEO satellite network, like the failed Teledesic system, could ideally serve as global emergency communication/ information system. Its cost would be about a half of the budget of the Apollo project that culminated in the displaying the US national flag on the Moon. This comparison of the Apollo and Teledesic projects leads to reflections on the hierarchy of values of our society. It was easier to find US$19 billion to put the flag on the Moon than to find a half of that amount for a global emergency communication system that matches ideally the noble goals and declarations included in international treaties. The Teledesic failure illustrated basic limits of the social system that prefers "profit over people", as Noam Chomsky, professor at Massachusetts Institute of Technology, formulated in his book under the same title [Chomsky 1999].

Figure 11. Two consecutive images of the Elbe River (Germany) taken on 14 and 20 August 2002. The river is visible as a thin line from the lower right corner to the upper left corner of the upper image. The lower image shows the flooding in full progress. The summer 2002 floods in Europe have killed more than 100 people and have led to US$20 billion in damage. Such images help to evacuate people and goods threatened and to evaluate the disaster effects. (Courtesy of NASA)

5.3 "Paper satellites" and "Illegal Satellites"

'Paper Satellites' is the name invented for satellite systems that are submitted for notification in the ITU but never will really operate. This results in a significant waste of time and effort spent on the coordination, examination and notification process in the ITU and in administrations involved. It also blocks access to spectrum and orbital resources and produces their virtual scarcity. The ITU receives 400 to 500 requests for coordination and notification each year whereas only 10 to 20 satellites are actually launched yearly. About 1'200 satellites are waiting coordination (as of September 2002), according to Robert Jones, Director, ITU Radiocommunication Bureau [Jones 2001]. With such a long queue, delay processing reaches in some cases up to 6 years or so. It is rather a long time. In that time, four generations of electronic technology change according to the Moore's Law (which says that the number of transistors on integrated circuits -- a rough measure of computer

processing power -- doubles every 18 months). Satellite business sometimes cannot wait so long. Consequently, some satellites are coordinated outside the ITU process, or launched before the process is concluded, which evidently introduces chaos. Formally, the Radio Regulations allow for such a practice on the express condition that it "*shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of [...] these Regulations.*"

The huge world demand for satellite services has seen steady increase, reflecting the growing economic value of the spectrum/ orbit resources. It has resulted in increasing competition, spectrum/orbit congestion, and in a scramble for desirable orbital slots. This rush could increase further with new services planned such as the third generation mobile telephony or broadband access systems. There may be various reasons behind the 'overfilling'.

The overfilling might because the submitting organizations expect that some of the proposals will be rejected as unacceptable during the coordination process. A satellite operator may submit multiple variants of the planned system for coordination as it increases chances of favourable findings, and it costs nothing or near to nothing. Finally, only one of them will actually be launched, whereas the remaining will become 'paper satellites'. Or they may intend to reserve some orbit positions for potential future applications or commercial arrangements. As a number of years may pass between the submission date and the launch date, many things may happen in the meantime, on which the operator may have no influence. Bankruptcy or launch failures are examples. When the investors withdraw, all planned satellites became 'paper satellites'. Finally, there may be also other reasons why the coordinated and notified satellite is actually not launched.

Opinion is also growing that some administrations tend to initiate the coordination procedure within the ITU system for more orbital positions (or spectrum) than really needed. But within the sovereignty principle, there is no objective way to judge whether the submitted demand is "real" or not, "justified" or not. Anyway, overfilling blocks the available spectrum resources, multiplies non-existing networks with which coordination is required, and increases complexity and coordination burdens. The reliability of the database is deteriorating and it is increasingly difficult to assess the real status of the available resources.

The problem of satellite notification backlog has been known within the ITU for years, and various remedies were sought. However, instead of improving the process, discussions focused on how to limit the number of submissions received. One proposal was to discourage 'overfilling' by the processing fees. In spite of the protests of satellite operators and some developing countries, the plenipotentiary

conference in Minneapolis approved the fee principle in 1998. However, if the fee is small in comparison with the other costs to be born before the satellite finds its place in the orbit it can have only a limited impact. If, on the contrary, the fees will constitute a substantial part of the total costs, they will gravely restrict the free access to spectrum/orbit resources, which is guaranteed in the ITU Constitution, Convention, and Radio Regulations. Every sovereign country-member of ITU has the right to submit as many satellite systems notifications as it feels appropriate without asking for somebody's permission and nobody can take that right away from it as long as the current ITU Constitution, Convention, and Radio Regulations are in force. Only automation of the examination, coordination, notification and monitoring process could probably solve the backlog problem, as I proposed just before the World Radiocommunication Conference Geneva 1993 [Struzak 1993]. There are technical means ready to be used for that purpose, what is only missing is the political will and financial contribution of the ITU members.

The same effects have been observed for some years with terrestrial transmitters, especially those operating in the short-wave bands. There have been no strong incentives to limit the number of transmitters notified to obtain the international recognition according the Radio Regulations. Should any limiting mechanism be introduced? Should the assignments not used for some period be cancelled and opened for new applications?

Quite opposite problems are with satellites (generally: radio systems) that operate but are not registered as required. There is growing concern about cases of satellites launched before the regular coordination process is properly concluded, or even initiated. Furthermore, a number of satellites have been re-positioned without required re-coordination. It may indicate that, for operational reasons, the time required for coordination (re-coordination) under the current Regulations may be too long. Even though not-registered, or "illegal" terrestrial transmitters have been observed since the first radio regulations were agreed, the problem becomes much more critical with satellite-based transmitters. First, the range of satellite transmitters is usually much greater than that of terrestrial transmitters. Second, it is practically impossible to identify the entity responsible for the operation of the transmitter if it operates in the outer space. While each country commits itself to comply with the ITU regulations, it also reserves its sovereignty in dealing with the spectrum matters, and no explicit penalties are foreseen if a country does not follow these regulations. Should non-observance of the regulations be internationally penalized? How?

5.4 GSO Ownership

The geostationary-satellite orbit is generally considered as a part of outer space and common heritage of humanity, but some states reject that idea. Brazil, Colombia, Congo, Ecuador, Indonesia, Kenya, Uganda, and Zaire, the eight countries traversed

by the Equator, proclaimed the segments of the GSO over their territories to be under their sovereignty. Only the segments of the GSO over the open seas are common heritage of humanity and can be accessed freely, according to their declaration of 3 December 1976, known as Bogotá Declaration (from the name of city where it was signed). The devices to be placed permanently on the geostationary orbit over an equatorial state shall require previous and expressed authorization on the part of that state, and the operation of the device should conform to the national law of the country over which it is placed. Such an authorization may involve licensing process and appropriate fees. However, the equatorial states do not object to the free orbital transit of satellites following the provisions of Radio Regulations, when these satellites pass through space outside their geostationary orbit.

The signatories of Bogotá Declaration justify the national sovereignty over the GSO by the fact that the GSO depends exclusively on natural gravitational phenomena generated by the Earth. Therefore, they conclude, it must be considered as a natural Earth's resource and not as a part of the outer space. Further, they refer to "*the right of the peoples and of nations to permanent sovereignty over their wealth and natural resources that must be exercised in the interest of their national development and of the welfare of the people of the nation concerned*," set forth in Resolution 2692 (XXV) of the UN General Assembly. The Bogotá declaration questions at this occasion the terms of the Outer Space Treaty. Its signatories believe that these terms were elaborated when developing countries could not count on adequate scientific advice and were thus unable to evaluate omissions and consequences of the proposals, which were prepared by the industrialized powers for their benefit. Further, they consider that the 1967 Outer Space Treaty does not concern the geostationary satellite orbit, as there is no valid or satisfactory definition of outer space.

Indeed, legal discussions on the delimitation between the Earth and outer space have not been concluded to the full satisfaction of all parties interested. Actually, no physical border exists that could help the lawyers, as there is a continuous transition from the Earth atmosphere to outer space and further to deep space, which is defined in the Radio Regulations as space at distances from the Earth equal to, or greater than, 2 million km. Without sharp physical criteria, lawyers have to invent other acceptable criteria, and a number of proposals have been suggested. One proposal refers to the lowest altitude at which a satellite can orbit without burning or falling down because of friction of the atmosphere, and it is about 100 km. Another proposal involves the highest altitude up to which a subjacent state is able to maintain effective control over its airspace. That limiting altitude depends on technology being at the disposal of the state. Until now, none of the Bogotá Declaration signatories has been able to control effectively the GSO and their declaration has been disregarded by all non-equatorial states. However, the significance of geographical position of states

has been included in radio agreements. Both, the Radio Regulations and the ITU Constitution and Convention stipulate that, in using frequency bands for radio services,

"Members shall bear in mind that radio frequencies and the geostationary-satellite orbit are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of these [Radio] Regulations, so that countries or groups of countries may have equitable access to both, taking into account the special needs of the developing countries and the geographical situation of particular countries." [Collection.. 1999]

However, in view of lacking commonly agreed binding interpretation of this wording, each state is free to understand it as it feels it appropriate.

5.5 Orbital debris

Space debris near the Earth, known also as 'orbital debris' consists of natural micrometeoroids and of man-made objects that do not serve any useful purpose, now or in the foreseeable future. During the forty years of space exploration, the near-Earth environment has served as a gigantic rubbish collector. Almost all objects that have been launched in outer space are still there and will remain for many years to come. Only few escaped towards other celestial bodies, felled on the Earth, or burned in the atmosphere. What forces satellite to fall down is the air drag, but the drag decreases with altitude, and at high altitudes is negligible. Table 9 lists orbital lifetimes for selected circular orbits. At the geostationary altitude, no effective natural removal mechanism exists, except for solar radiation pressure. Practically, objects located in the geostationary orbit will remain in its vicinity indefinitely, if not moved at the end of mission.

Table 9. Circular orbits lifetime.

Orbit altitude (km)	Lifetime
200	1-4 days
600	25-30 years
1000	2000 years
2000	20'000 years
30'000 (GSO)	Indefinite

(According to W. Flury, The Space Debris Environment of the Earth, in D. McNally: *The Vanishing Universe*, Cambridge University Press 1994, p. 128, 130)

A few countries do radar, optical, and infrared surveillance of space for security reasons. The smallest tractable objects are of about 10 cm in diameter at low

altitudes and about 1m at the geostationary orbit. They all are catalogued. From all man-made objects catalogued, only about six percent are operational satellites. The rest are dead satellites (21%), upper stages (16%), fragments of upper stages and fragments of satellites (45%), and other abandoned objects (12%), according to Walter Flury of European Space Operations Centre [Flury 1994]. They all move at hyper-velocities averaging 36 thousand km/h (10 km/s). The total number of these objects is counted in the millions of pieces, increasing with every new launch of a space object and with each new satellite explosion and fragmentation accidental or due to anti-satellite tests in outer space. Some of the objects launched come back to the Earth, especially after the invention of re-utilizable space vehicles, but the creation rate of debris has outpaced the removal rate. The debris population in low Earth orbit grows at an average rate of approximately five percent per year, according to NASA estimations.

The threat of debris impact damage on satellites and spacecraft is a major growing concern. Medium size objects (0.1-10 cm in diameter) are the greatest challenge because they are not easily tracked and have kinetic energy high enough to cause catastrophic damage to spacecraft and satellites. For instance, a particle of 1 cm diameter and weight 10 gram moving 10 km/s has the kinetic energy of a 1.3-ton car running on a highway at the speed of 100 km/h. Penetration even a small particle through a critical component, such as the flight computer or propellant tank, can result in loss of the spacecraft. If a 10-cm object, weighing 1 kg collides with a typical 1,200-kg spacecraft bus, over one million fragments 1 mm in size and larger can be created, according to the NASA. This collision results in formation of a debris cloud, which poses a magnified impact risk to any other spacecraft in the orbital vicinity. Mutual collisions can multiply their number further. Encounters with clouds of smaller particles can also be devastating, as evidenced by the damages made to the Hubble Space Telescope. The debris tends to concentrate in some regions in space and, ultimately, these regions may become dangerous for future missions. They also may efficiently block the astronomical observations of some regions in the sky.

Maintaining the current design and operational practices could ultimately render some regions in space useless and even dangerous. International space law is not addressing explicitly the space debris issue. Ultimately, internationally regulations are needed concerning debris management and debris control.

5.6 Electricity from Space

New, cheap, and environmentally friendly electricity sources are now sought in several countries. The world's population is expected to reach 10 billion people by the year 2050, and the present energy sources will be insufficient to satisfy its needs, according to current projections. Among various ideas, the Space Solar Power (SSP)

concept has been studied. In the USA, the studies started during the oil crisis in the seventies, aiming at limiting the dependence of national economy on foreign oil. In 1974, a patent was granted in the USA for a solar power satellite, to collect power from the sun in space and then transmit it down to the Earth for use. The original patent indicated the microwave beam as the transmission medium, but later a laser beam alternative was also taken into consideration. For the conversion of sunlight to electricity, huge arrays of photovoltaic cells would be placed in a geostationary Earth orbit or on the Moon. Such arrays would be unaffected by cloud cover, atmospheric dust or by the Earth's twelve-hours day-night cycle. To reduce the necessary area of costly solar arrays, sunlight could be concentrated using giant mirrors or lens. The current photovoltaic technology offers energy conversion with efficiency rate reaching 50 percent or so, according to the NASA studies.

With such efficiency, about half of the absorbed Sun radiation could be converted into electricity using photovoltaic process. A large part of the remaining half, which would manifest itself as heat, could also be converted into electricity using thermoelectric devices. These would serve as thermal pumps removing heat from the photovoltaic panels and lowering their temperature. The electricity would then be converted to microwaves and beamed by composite space antenna towards a huge Earth antenna. The latter would contain a large number of receiving antennas combined with rectifiers and filters (called a rectenna) that would convert the microwave power into electrical current injected into the power network. To limit the health danger, the receiving antenna would be located in the desert or in mountains far away from populated areas. According to the proponents, the size of the microwave beam could be large enough to keep the power density within the safe limits. High-power laser beam has also been under study as a potential candidate to transport energy from the space system. According to the NASA, a space solar power system using today's technology could generate energy at a cost of 60 to 80 cents per kilowatt-hour, about ten times the current market price. They estimate that it would take 15 to 25 years of further research to nullify that difference. In 2001, Japan announced that also they plan to launch a giant solar power station by 2040.

However, both, the high-power microwave beam and laser beam create health and environmental problems, not solved yet. Moreover, both are potentially double-application technologies. A SSP station could easily be converted into a dangerous weapon and the current treaties prohibit locate weapons in outer space. Space weapons using solar energy are not a new idea. In times of the World War II, some German scientists were speculating the use of gigantic mirrors that could concentrate solar energy to set fire to enemy’s forest, crop fields and cities during the war time. Between wars, the mirrors could be used to control local weather conditions over a selected region. The size, complexity, environmental hazard, and cost of an SSP undertaking are daunting challenges.

5.7 Passive Services

All satellites have been sources of major concern for passive services, and especially for radioastronomy. Satellites and satellite constellations such as the Iridium system produce signals that may be billions times stronger than those exploited by radio astronomy. They can block the normal operations of sensitive sensors, or even damage them. Passive services benefit from some provisions of outer space law and Radio Regulations, but the degree of protection is insufficient. For instance, the Radio Regulations stipulate protection from services in other bands to *"be afforded the radioastronomy service only to the extent that such services are afforded protection from each other*" [RR 4.6]. This nullifies the principle of electromagnetic compatibility.

The way the unintended emissions due to unavoidable imperfections of equipment are treated often favourites the offending system at the expense of the victim one. These emissions include out-of-band emissions and spurious emissions (including unintended antenna sidelobes and unintended reception mechanisms). None of them carries useful information and the intended transmission would not loose a bit if they were eliminated. The problem is that such elimination involves additional efforts and costs.

Out-of-band emissions, a by-product of the modulation and encoding/decoding process, spill over frequency bands immediately adjacent to the band used by the intended transmission. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, etc. (excluding out-of-band emissions) and their products fall into bands that may be far away from the assigned frequency band. Spurious products can be generated not only within the equipment, but also due to non-linearities in the neighbourhood of transmitting antenna and in the propagation medium (e.g. in the ionosphere). The net effect of all these mechanisms is equivalent to the transfer of energy from the assigned frequency band to other bands (in the case of antenna sidelobes - from the assigned direction to other directions). Usually only a tiny part of the power of intended transmission escapes this way, but the escaped portion can be billion times stronger than signals used in the victim bands, jamming or blocking the victim service. Many passive services, like Radioastronomy, do not make any direct monetary profit. They lose each time when involved in conflict of interest with any commercial industry as the following examples illustrate.

Dr. Titus Spoelstra, mentioned earlier, gives instructive examples concerning the radio-related treaties. The US military satellite TEX launched in 1990 ended its mission in 1991, and its onboard transmitter was expected to cease its operation at the same date. However, the satellite has remained in the orbit and has continued to radiate useless signals. The reason was simple: the transmitter has not been equipped with the 'off' switch and the power system has continued to work longer than

planned. This polar-orbit satellite has visited every place on the Earth at least twice each 24 hours at an altitude of about 700 km, and its radiation blocked the radio astronomical observations in the 322.0-322.5 MHz frequency band allocated to the fixed, mobile and radio astronomy services. As the satellite decay is about one km every two years, it would take about one thousand years until it falls and burns in the atmosphere. It took six years, lot of effort, and international cooperation until the defective satellite was finally traced in 1998, and its silencing arranged. To keep it silent, the company responsible for the system must employ work force and tracking station and keep providing regularly the satellite with special commands. Should the satellite designers follow the Radio Regulations, they certainly would add a simple switch – it would change neither the cost, nor weight of the satellite.

Another example is the ASTRA-1D, a geostationary satellite used heavily in Europe for direct-to-home broadcasting. Due to its out-of-band emissions in adjacent frequency bands that extend far above the acceptable limits, the satellite produces harmful interference to radio astronomical observations. This has been discovered when the satellite was already in the orbit, and a complete cure of the problem has not been possible until now. In view of the high investments made in the satellite, a wide use of the service and political influence, the satellite operation will continue during its lifetime. If the project were properly coordinated and the satellite checked before launching, the problem would not appear.

A similar case is the mobile-satellite Iridium system, a constellation of 66 LEO satellites orbiting at the altitude of 780 km. It uses the 1616-1626.5 MHz band in space-to Earth direction. The Radio Regulations (Footnote 5.372) says explicitly that stations of the mobile-satellite service operating in this band shall not cause harmful interference to stations of the radio astronomy service using the band 1610.6 – 1613.8 MHz. In reality, the Iridium system does produce harmful interference due to its excessive out-of band radiations, according to the 2002 CRAF Handbook for Frequency Management. No complete cure of the problem was possible until now. Like in the case of the Astra system, because of high investments made in the satellites, a wide use of the service, and political influence, the system will continue during its lifetime. Again, coordination and checking before launching would eliminate the problem,

These examples show that the Radio Regulations are not known as widely, and observed as carefully as they should be. Moreover, they illustrate the limits of international agreements that are not supported by appropriate enforcement mechanisms.

5.8 Fragmentation, Data & Tools

The ITU Convention and Constitution recognize the sovereign rights of each State to regulate its telecommunication. Thus, the approach to spectrum management has been different in various countries, tailored to the specific needs and priorities of the country and its traditions. These elements are unique for each country and, consequently, the domestic regulations in one country are not necessarily compatible with those in another country. This creates substantial obstacles in developing a worldwide wireless services and global markets for equipment. The famous "footnotes" to the ITU Frequency Allocation Table are examples of such a fragmentation, as they actually mean different allocations. Other differences are hidden in technical standards and engineering details. In most cases, these differences are probably unintentional, but can serve as barriers against undesired import of goods and services across the borders. Figure 12 illustrates such a fragmentation in Africa. Fragmented spectrum management means in practice the fragmented markets for services and equipment.

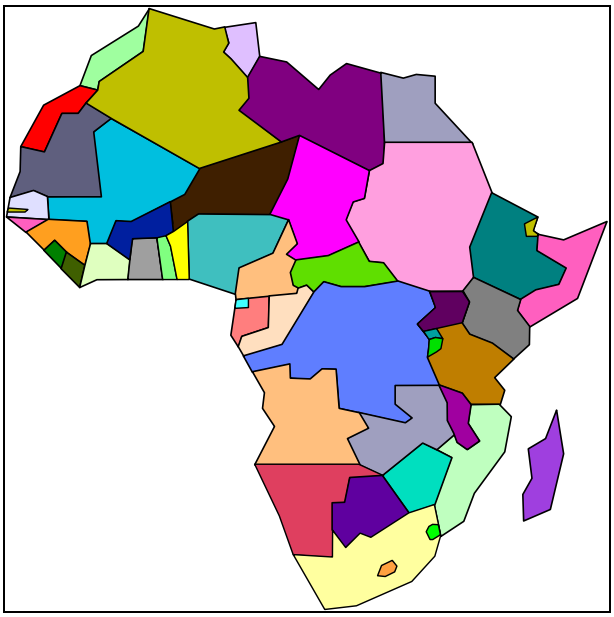

Figure 12. Spectrum management follows the political fragmentation. The ITU recognizes the sovereignty of each State to regulate its telecommunications. Consequently, national spectrum management practices are different in different countries. Such fragmentation creates substantial obstacles in creating trans-border services and markets.

That fragmentation has lead also to a paradoxical situation with emergency communications. If anywhere on the ocean a vessel with a crew of one is in distress, all related communications have absolute priority and are free of charge. The absolute priority of distress signals from the sea has been recognized worldwide since after 14 April 1912, when the 'Titanic' hit an iceberg and sunk.

However when, after an earthquake, some 10,000 persons are trapped under the debris of constructions, any custom official can prevent the rescue teams arriving from outside the affected country from bringing in their radios. And another official can prevent them from using these radios, until they obtain a license from the national spectrum management authority, whose building may just have collapsed in the earthquake. Also if they are nevertheless able to use their satellite terminal, they may be presented with telephone bills for tens of thousands of dollars. Such is the experience of those who provide international humanitarian assistance in the age of information super highways, says Hans Zimmermann, a high UN official [Zimmermann 1995].

Inadequate Data & Tools. The multidimensional character of the spectrum resource was mentioned earlier. In practice, however, most often the use of that resource continues to be measured in one or two dimensions only, the frequency and geographical position, or position on the geostationary satellite orbit. The Radio Regulations are built around the frequency allocation table that traditionally differentiate only between frequency bands, services, and administrative regions, leaving other parameters aside.

Reliable and easily accessible information about the actual usage of the spectrum is vital for service providers and equipment manufacturers, and is a key element in spectrum management. However, the needed information does not exist in an integrated form. It is dispersed among various separate bits of data, often incomplete and contradictory, in separate local, national, and ITU spectrum management systems. All parties concerned agreed in principle on the need to maintain and follow common standards to facilitate interchange of data, but the direct interworking of national spectrum management computer systems does not exist. The data elements required for national, bilateral and multilateral coordination are often kept separately and independently which results in unavoidable data inconsistencies. After years of such practices, the ITU master register, with about one million entries, contains an unknown proportion of unreliable records that have nothing to do with reality. The results of analyses based on such data are thus questionable, as is the need to maintain such databases. Unreliable or inaccessible data mean unknown resources, fictitious coordination and, consequently, fictitious spectrum resource scarcity and unused its portions.

Wider application of advanced mathematical methods and computer techniques involving also monitoring capabilities could increase efficiency, flexibility, and objectivity of spectrum management. Improved frequency planning tools, propagation prediction models and electromagnetic compatibility analysis models would widely be applied. Creation of common ITU Digital Terrain Elevation Model, worldwide, accessible for all ITU members, could facilitate frequency sharing at high frequencies. Modern techniques of simulation and virtual prototyping could allow for fast assessment of the resources available, comparison of alternative uses and selection of the best variant according to agreed criteria [Struzak 1992]. The system could offer immediate and user-friendly access to necessary data and tools. New computer-assisted techniques would make on-going, or dynamic, coordination practicable among all parties interested.

Integration of databases could solve the problems of data inconsistency and data access mentioned earlier. Current technology calls for one geographically distributed computer system integrating the fragmented local, national and ITU spectrum management systems. Instead of the multiple exchange of correspondence, the parties interested would do most of the coordination preparatory tasks by themselves, using modern computer network, automated software, following the Internet model. All components of such a system exist today, waiting to be assembled [Struzak 93, 94].

5.9 Spectrum scarcity?

Is the spectrum scarcity real? Is the lack of frequencies and places in the geostationary satellite orbit due to the growth of the population of radio stations or, perhaps, due to our wrong management? Is there any way to solve the scarcity problem? Such questions need to be answered. Certainly, the scarcity is in part due to equipment deficiencies. Spectrum resources are wasted because of spurious non-essential radiation from transmitting stations as well as from RF equipment used for various industrial, domestic, medical and scientific purposes. Spurious channels in receiving stations also contribute significantly to misuse of the spectrum wastage. Technological progress offers improvements; however, it should be stressed, capital-intensive commitments in older technologies demand protection. Further discussion of these issues, however, is beyond the scope of these notes.

There is growing opinion that the spectrum/orbit scarcity is in a great part due to a combined effect of inadequate approach to these resources, inappropriate rules and regulations, simplistic engineering models, tools and methods, and lack of precise data. Improved spectrum uses through refined technology are usually expensive, more expensive than those achieved through enhanced management. It suggests that our present spectrum management system needs to be critically reviewed. All parties, governments and private sector, are increasingly concerned about costs and value for

money. The requirements are simple: increase efficiency, cut costs, shorten decision-time, and improve transparency.

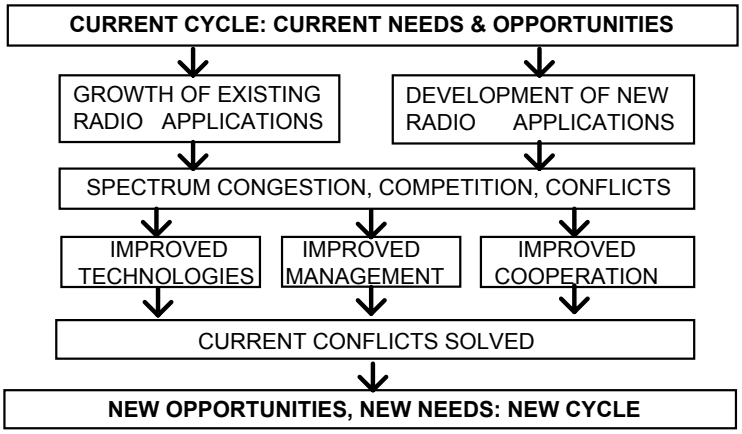

Figure 13. Cyclic character of spectrum scarcity.

Finally, we should note that spectrum scarcity is not a new issue. It was a US Secretary of Commerce who first declared: "There is no more spectrum available." The Secretary was Herbert Hoover. The year was 1925 [Dougan 1992]. Today, we are seeking new solutions to an old problem.

5.10 Monitoring & Enforcing

The Radio Regulations are effective to the degree to which they are respected. Like any law, they require an enforcement system. The responsibility of law enforcement agencies is to detect the law violation, apprehend the perpetrators, and provide evidence that will convince the court that the perpetrators are guilty beyond a reasonable doubt. In many instances, it is not difficult to identify the offenders, but there are also difficult cases that cannot be solved without sophisticated methods and equipment, without highly qualified experts and specialized organizations. The famous Scotland Yard and Interpol are examples of such specialized organizations, national and international, respectively. Such organizations have proved their utility above any doubts.

The issue of the Radio Regulations infringements belongs to the most difficult cases. In spite of the fact that such infringements are able to cause significant losses in multi-billion-dollar radio- and satellite-related industries and/or research activities, there is no equivalent of the Interpol, no international court, and no sanctions. Instead, the Radio Regulations encourage the usage of diplomatic procedures and appeal to goodwill of the governments. While it was the most appropriate course of

action when radiocommunication was a state monopoly and satellites did not exist, is seems highly impractical now, when there are hundreds of satellites operated by private international companies. The process is simply not adapted to the present day needs – it is too costly, too slow, too bureaucratic, too ineffective, simply -- too impractical.

Whereas the detection of an infringement of the Radio Regulations is usually easy, the identification of the perpetrator can be an extremely difficult task, as illustrated by the examples quoted earlier. Very expensive devices might be necessary for efficient identification, as well as highly qualified staff. Whereas some rich countries use their military antimissile defence surveying systems to monitor space-based radio systems, other countries have to build special installations from scratch, or to be fully dependent on foreign assistance. At a few discussions of this matter, I proposed the International Astronomical Union (IAU) to consider its role as an independent space monitoring organization ('Space Interpol') but the proposal has not found sufficient support. There are few arguments for such an arrangement. First, this organization unites the existing network of radio and optical telescopes, a part of which could be used to some monitoring/ surveillance tasks, which would minimize additional investments necessary. Second, the IAU has already united people of highest qualifications, which would minimize the necessary education/ training costs. Third, and most important, radio astronomers are interested in keeping order in outer space more than any other professional group.

The Radio Regulations contain a number of 'compromise' provisions on controversial issues, formulated during conferences in such a way that each of the negotiating parties could interpret them in its own way, to its own satisfaction. When two different interpretations of a provision are possible, that provision cannot be implemented by the ITU staff without being accused of favouritism. To avoid such situations, the Atlantic City Conference mentioned earlier established the International Frequency Registration Board (IFRB). The board was envisioned by its proponents as something of a cross between the Federal Communication Commission (FCC) of the USA and the International Court of Justice. Solving the implementation problems of Radio Regulations was one of the principal responsibilities of the board. The board might also be involved in the dispute settlements. In view of their high international responsibilities, the Board members must be elected by the plenipotentiary of member states, must be independent, must be '*thoroughly qualified'*, and must act as '*custodian of an international public trust'*. Later the IFRB was transformed later into the present Radio Regulations Board (RRB).

In reality, the board never achieved any status comparable to the original vision, in spite of the fact that individual Board members always enjoyed high professional prestige. While some member states wanted a strong Board, the others preferred the

opposite and did not allow performing all of its functions as the arbitrator of the radio uses of all nations of the world. The 1965 Montreux Plenipotentiary Conference reduced the size of the Board from 11 members to five. The conference might even have abolished the Board completely, had it not been supported by the developing countries. The Kyoto Plenipotentiary Conference of 1994 replaced the full-time IFRB by a part-time RRB, which meant a serious reduction of its power, and still there are some open problems related to its functioning.

5.11 Regulations vs. Flexible Use Doctrine?

How frequency bands and orbital positions are allocated and assigned by the ITU process, have important implications. For instance, the WTO commitments for market opening measures are all '*subject to availability of spectrum/ frequency*'. However, the relationship between the WTO and ITU has been ambiguous since the very beginning, when the WTO included telecommunication matters into its agenda. The two organizations share documents and observer status of certain official events, but they have different agendas, different approaches, and different methods of operation. One of significant differences is sanctions that may be imposed on a party that does not follow a WTO agreement. This, of course, implies a kind of international tribunal and appeal arrangements, an element missing in the ITU system. The ITU relationships are based on good will and consensus, whereas a violation of the WTO agreements may result in severe sanctions.

The WTO terms involve some issues monopolized earlier by the ITU. Among others, they involve technical abilities to interconnect to the public network, which may imply a forced use of standardized, open interfaces instead of proprietary ones. They also require the spectrum allocation/ assignment rules to be flexible enough to accommodate a variety of technologies. Full transparency and fairness in licensing procedures for the right to use the radio spectrum is another issue not fully solved within the ITU. It has been so because the issues related to national telecommunications have been considered internal matters to be decided by each sovereign member state. Borders between technology-related and commerce-related regulations are blurred, and so are borders between international and national issues. State representatives at the ITU radio conferences and study group proceedings represent national interest that involve differing industrial and spectrum policies aimed at creating advantages for national industries at the expense of foreign competitors. So far, however, no one has tested spectrum allocation proceedings basing on the WTO principles. However, Gerry Oberst, partner in a law firm, believes that frequency spectrum decisions will finally be dragged into the international trade arena; it is only a matter of time [Oberst 2000]. The current trends suggest that he perhaps might be right.

With the de-regulation wave, opinions are expressed the use of the radio frequency spectrum is over-regulated. The critics indicate that there is too many regulations, and that the administrative process is too slow, too complex, too expensive, inefficient and not sufficiently transparent. The partisans of liberalization want the regulatory system to be technology-neutral and reduced to a few basic rules that work in practice and are really necessary. A key issue here is to agree specifically what is "really necessary" and "working in practice". The liberals believe that most of the spectrum-related problems can be solved more effectively by bilateral negotiations between the interested parties and, even better, by the market mechanism.

One of proposals advocates the *flexible use doctrine*. In contrast to the rigid 'taboos' imposed by the present Radio Regulations, the license holder would be free to choose how he or she will use the resources, provided the interference levels in adjacent frequency bands and geographical areas are acceptable by the neighbours. License holders could negotiate any technical standards and interference levels they wish. The rights to use a portion of spectrum/orbit resources would be given with no time limits. This would legalize the current practices, as most of current temporary licenses have already been given practically forever, and the license renewal process became more a ritual than reality in many countries, as noted by Jon Peha, professor at Carnegie Mellon University [Peha 1998]. He indicated that 99'9 percent of all spectrum licenses in the United States were renewed successfully during the years from 1982 to 1989.

With the flexible use doctrine, first a spectrum/orbit market would exists, and then a secondary spectrum/orbit market would materialize so that the licenses could be sold and bought at will. This would guarantee that the resources are used by those who are capable to pay the highest price, to offer the service that is most valued, and to use the most cost-effective technology, according to the partisans of that approach. Proprietary right and free competition would replace the rigid regulatory mechanism. If this approach were to be applied internationally, it would require substantial revisions of the space and radio treaties discussed in previous sections.

However, privatization and liberal market approach may lead to socially undesired results. First and foremost, it cannot assure universal access, i.e. access to telecommunications in poor, remote, and/or sparsely-populated regions that cannot generate large profits. But it is not only that, as shows the recent story of the UMTS. In spite of the fact that systems were not yet ready to operate, eleven European countries sold the UMTS licenses for some US$100 billion, according to data published by Public Network Europe. The transactions were advised by the best world-class economists, after careful analysis of all factors, which should not be surprising in view of the amount of money involved. However, soon after paying the licenses, instead of boom predicted by the partisans of liberalization and privatization,

a number of companies bankrupted, contributing significantly to general crisis. Similarly, the experience gained in the past in the United States, the traditional fortress of liberal capitalism, also shows that liberal approach might not be the best one: "*Between 1894 and 1904, over six thousand independent telephone companies went into business in the United States*", reads the history of the AT&T displayed on the Web, "*But the multiplicity of telephone companies produced a new set of problems -- there was no interconnection, subscribers to different telephone companies could not call each other.*"

The interconnection problem began to be resolved only after 1913, when AT&T started to function "*as a legally sanctioned, regulated monopoly*." Following the theory of Theodore Vail, then the AT&T president, there was general belief at that time that government regulation is better that the competitive marketplace in the telecommunication sector "*provided it is independent, intelligent, considerate, thorough and just*". As a "regulated monopolist", AT&T's Bell System provided soon what "*was by all accounts the best telephone system in the world.* [...] *The percentage of American households with telephone service reached fifty percent in 1945, seventy percent in 1955, and ninety percent in 1969. Much of the leadership came by application of science and technology developed at AT&T's Bell.*"

What happened earlier to wired telephones, happened also to radiocommunications. Today, a hundred years after the Prince Henry's story of no-connection mentioned earlier, we witness similar problems with the multitude of proprietary technical standards. In seeking maximal profit, many equipment manufacturers and service providers oppose to all that could increase the cost of their products and services: common regulations, standards, and any control. The very nature of competition does not encourage closer cooperation or sharing intellectual property and know-how secrets. On the contrary, it tends to an unregulated monopoly. On the other hand, the users of radio want to communicate reliable, cheaply, and without interference, no matter who provides services or supplies the equipment. Common technical standards, interfaces and regulations are necessary to satisfy these requirements, as is also a degree of cooperation between the parties involved in the process. The treaties reviewed in the previous sections created a worldwide framework for such cooperation. However, in spite of the enormous progress made, we still see the radio world too much fragmented, incoherent, and irrational.

Over the years, various improvements have been proposed to the spectrum management on national and international scales, but few have been implemented that touch the fundamental rules. One of such rules has consisted in a separation of spectrum management from economic mechanisms. In the meantime, however, in some countries, the regulatory system is being replaced by a competitive market economy mechanism, to follow the changes in the political and technological

environment. For the time being, that action has been limited to few states and few selected frequency bands only.

Advocates of this idea indicate that market forces automatically match the demand to the available resource capacity and that market-based management is inexpensive[1]. Moreover, relying upon administrative decision-making is inferior to relying on market forces because decisions are arbitrary and often mistaken in determining what is the best interest of users [Webbing 1977]. The concept of spectrum management through market forces has as many supporters as opponents. Until now, however, no evidence has been published that selling the spectrum will solve the scarcity problem in a way acceptable for all parties involved. It should be noted that spectrum market might made radiocommunications more expensive, and may influence the existing balance between the wired- and wireless telecommunications.

The main event in recent years was a series of spectrum auctions conducted in the USA and then in Europe. These auctions mark a break with tradition. Earlier, licenses to use radio frequency for wireless communication services were awarded on the basis "first come - first served", by lottery, or by comparative hearings ("beauty contests"), almost for free. Now the governments are granting the licenses to the highest bidders.

The first auction in the USA held in 1994 concluded in assigning three 1-MHz bands around 900 MHz for a total of about US $650 million. In 1995, two pairs of 15-MHz bands around 1900 MHz for personal communication services were assigned for a total of US $7.74 thousand million [Bell 1996]. On top of this, the successful bidders have to pay expenses for relocating thousands of microwave transmission facilities that were already using that portion of the spectrum. These numbers, however, should not be generalized as the price depends on the demand and supply. Spectrum and real estate in the centre of New York or Tokyo will cost much more than somewhere in a far desert. However, consumers will always pay the final costs.

Selling the spectrum and liberal approach to spectrum in general, raised a question on how much does the RF spectrum cost? How much it contributes to the economy? [Goddard 1994, Kalman 1994]. One study showed that overall economic impact of the use of radio may exceed 1% of Gross Domestic Product, not counting the consumer surplus derived from the wireless services [NERA 1995], too difficult to evaluate. The data were collected in one developed country and the question is open as to which degree the conclusions can apply to other countries. Another study showed that inadequate spectrum management could cause economic losses evaluated

[1] It should be noted that the US Army alone spends nearly $40 million each year in frequency compatibility investigations [Dougan 1992].

for many tens of millions of pounds per year in a single country [DTI 1994]. One can argue whether or not it is adequate to describe the impact of RF spectrum in economic terms only, as it would be oversimplification to judge about the function of the human brain on the basis of its weight. (The brain weight is less than 2% of the total weight of the human body).

5.12 Representation, Access & Transparency?

International negotiations related to space, radio, and trade involve a number of complex issues that often necessitate in special studies. This is especially true in the case of Radio Regulations and World Radiocommunication Conferences (WRC). Numerous specialists have to be involved in such studies. Substantial efforts, time, and money have to be invested, as the results of studies done at home must be convincing to the majority of ITU member states participating in relevant working groups, task groups, and other meetings. Contrary to the conferences themselves, restricted to governmental delegations, the conference preparatory studies are open to all ITU members, including private companies. However, the active participation in these preparations is practically limited to experts from few developed countries and big and rich companies. Financial, technical, and human resources of many countries and non-governmental entities are insufficient to assure active participation in these preparations. For the same reasons, the consumers' participation is similarly restricted.

This under-representation may have significant effects. First, the interests of those absent may not be represented as adequately as they should be. Further, the complete documentation of these studies is not easily accessible, as it is exchanged only among the active participants. Who does not participate has only limited (if any) access to the documents, which actually means lack of transparency. As a consequence, contributions to complex negotiations from the non-participating parties can be only limited, as stated in the Bogotá Declaration mentioned earlier. There is also another issue. There is no official interpretation of the Radio Regulations, and their provisions are changed at every World Radio Conference. As a consequence, the Radio Regulations are very complex and there are a number of problems with their practical implementation. Restricted participation in the ITU activities and lacking transparency does augment and perpetuate that 'information gap'. On the other hand, the regulations must be well understood to enable their intelligent implementation. Actually, they must be followed in the same way as the traffic regulations are observed by all pedestrians and car drivers.

With disproportionate resources, the ITU members are advancing at different pace. It would be unrealistic to expect that developing countries or small enterprises could finance themselves their active participation in the ITU study groups in a degree comparable to that of rich countries and companies. That disparity, however, could

be alleviated in several ways. For instance, the relevant information could be made available freely via Internet. A number of international organizations already have followed that idea, but not the ITU. In the ITU, the members submit documents they produce at their own cost and risk for common and unrestricted use. However, after processing at the ITU headquarters, these documents become the intellectual property available only at a price (except for single copies delivered to administrations of member countries). No part of them can be reproduced without written permission. This makes that the ITU technical documents are unavailable at most of libraries, including the university ones. They are practically unknown for students that are supposed to follow them in their everyday work when they leave the university.

One explains that such restrictions are necessary to keep the ITU expenses minimal, but it is a misleading argument, as it improperly presents the problem. What we really need is to keep minimal the total costs related to radio regulations including their practical implementation in everyday activities. These, include the cost of documents needed by administrations, equipment manufacturers, service operators, universities and training centres, etc. The calculations should also take into account losses due to not-observation of radio regulations on a world-wide scale. I am convinced that free access to relevant information via Internet would offer significant net benefits, but nobody did analyze deeper that issue so far.

Another possibility would be to charge for the registration of the frequency/ orbit assignments and use a part of the amount collected to support activities of developing countries and small enterprises, including free access to information. A fee system could be used as an instrument to rationalize the use of scarce resources, to limit the excessive demand, to make "warehousing" of frequencies and orbital positions unattractive. The income from the fees could be used for special assistance for developing countries, for the maintenance of the spectrum management system and for its upgrading, for the financing of international research efforts aimed at conservation and improved use of the spectrum resources.

Such proposals were made at various occasions (among others by this author), but have not found sufficient support. To put it in perspective, the total annual income from the sale of ITU publications was about US$10 million in recent years, just about 1% of the yearly value of satellites launched. Free access to regulations is not a new idea. It was practised thousands of years ago by Babylonian king Hammurabi who ordered his regulations to be engraved in block stones and publicly displayed at major roads. It is ironic, that the ITU on the one hand calls for bridging the information gap between the information poor and information rich, on the other hand creates itself barriers in accessing its own information sources. So far, however, no one evaluated losses attributable to the lacking access to information.

6 Concluding Remarks

How the RF spectrum is managed, has profound impact on the society, on its education, culture, prosperity, and security. Radio-related and satellite-related industries have become multi-billion-dollar businesses; all being subject of national regulations and international agreements. These notes have offered a short review of some issues and challenges focusing on international radio regulations. National regulations must follow these regulations and related international agreements. The notes are extracted from a book under preparation, in which these issues are discussed in more detail.

Harmonization of national laws, rules, regulations and standards, and new spectrum-conserving technologies, as well as improvements in spectrum management is needed to allow for further development of various radio applications crucial for the future Information Society. Eventually, technology may remove the need for some functions now included in spectrum management. Future radio systems will be able to automatically coordinate among themselves the use of spectrum resources to avoid interference. Even today, self-adaptive systems are finding various cost-effective applications in that area. However, in view of enormous investments in the "old" equipment, the "new" systems will not be popular soon.

According to current regulations and treaties, the radio frequency spectrum and satellite orbits are considered as common heritage of humanity. The Outer Space treaties and Radio Regulations were first created when the radio and space activities were the governments' monopoly only, but the state monopoly is quietly ceasing. The privatization and liberalization wave is introducing new powerful players: multinational private enterprises. The influence of private entities is growing and the role of governments is changing. At the same time, we witness an unprecedented increase of the number of new systems and applications, which creates new problems and new legal situations. The growing congestion of the radio spectrum and orbital positions leads to increased competition. More and more experts believe that the present regulatory system needs to be changed. New policy concepts are appearing, such as the *flexible use doctrine,* which might undermine the *common heritage doctrine,* the fundament of the present treaties. Some general concepts, such as "*common benefit of all countries"* (used in the Outer Space Treaty), or "*special needs of the developing countries and the geographical situation of particular countries"* (used in the ITU treaties) might need to be clarified anew.

All this requires a wide discussion and re-evaluation of concepts, policies, and practices governing the uses made of the radio waves and satellites. How to best use the valuable spectrum/orbit resources is a multi-disciplinary problem. Engineers, economists, business executives, scientists, lawyers, and politicians should be involved in the discussion -- all intellectuals interested. None should remain

indifferent. Satellites are of special interest in remote or sparse-populated regions where they can enable teleeducation, telework, telemedicine, and other modern telecommunication services at affordable prices, bridging the 'Digital Gap'. As long as the spectrum/orbit is still considered a common heritage of the humanity, everybody has the right to express his/her ideas on how it should be best used for common benefit. When it will be fully privatized, such an opportunity will certainly be reduced.

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List of Abbreviations

BR	Radiocommunication Bureau, ITU (successor to CCIR and IFRB Secretariats)
CCIR	International Radio Consultative Committee of ITU
CSIS	Center for Strategic and International Studies, Washington, DC
DAB	Digital Audio (sound) Broadcasting
DTI	United Kingdom Department of Trade and Industry
DTV	Digital Television
EMC	Electro-magnetic Compatibility
GMPCS	Global Mobile Personal Communications Systems
GSO	Geostationary Satellite Orbit
HDTV	High Definition Television
IFRB	International Frequency registration Board of ITU
ITU	International Telecommunication Union, Geneva
OMCM	Orthogonal Multiple Carrier Modulation
PCN	Personal Communication Network
RF	Radio Frequency
RRB	Radio Regulations Board, ITU
UMTS	Universal Mobile Telecommunications System
WARC	World Administrative Radio Conference
COSPAR	Committee on Space Research
CRAF	Committee on Radio Astronomy Frequencies (ESF)
EMC	Electromagnetic Compatibility
ESA	European Space Agency
ESF	European Science Foundation
FCC	Federal Communication Commission (USA)
GATS	General Agreement on Trade in Services
GDP	Gross Domestic Product
GEO	Geostationary Orbit
GPS	Global Positioning System
GSO	Geostationary Satellite Orbit
IAU	International Astronomical Union
IFRB	International Frequency Registration Board (ITU)
ISM	Industrial, Scientific, Domestic and Medical applications.
ISS	International Space Station
ITU	International Telecommunication Union
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
NASA	National Aeronautics and Space Administration (USA)
OCHA	Office for the Coordination of Humanitarian Affairs (UN)
OST	Outer Space Treaty
PTR	Pacific Telecommunications Review

RR	Radio Regulations (ITU)
RRB	Radio Regulations Board (ITU)
SSP	Space Solar Power
TRIPS	Agreement on Trade Related Aspects of Intellectual Property Rights
UMTS	Universal Mobile Telecommunication Systems
UN	United Nations
USSR	Soviet Union
UWB	Ultra Wideband
VSAT	Very Small Aperture Terminal
WRC	World Radiocommunication Conference (ITU)
WTO:	World Trade Organization

ANNEX

Article 5 of the Radio Regulations (edition 2001)

As the Radio Regulations change after every Radio Conference, no warranty is made that this Annex contains the most recent legally binding version, and the reader is advised to consult the ITU (e.g. at their Web site www.itu.int). The complete volume(s) of the ITU material, from which the texts, reproduced, are extracted (and the most recent version of it) can be obtained from:

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ARTICLE 5

Frequency allocations

Introduction

5.1 In all documents of the Union where the terms *allocation*, *allotment* and *assignment* are to be used, they shall have the meaning given them in Nos. **1.16** to **1.18**, the terms used in the three working languages being as follows:

Frequency distribution to	French	English	Spanish
Services	Attribution (attribuer)	Allocation (to allocate)	Atribución (atribuir)
Areas or countries	Allotissement (allotir)	Allotment (to allot)	Adjudicación (adjudicar)
Stations	Assignation (assigner)	Assignment (to assign)	Asignación (asignar)

Section I – Regions and areas

5.2 For the allocation of frequencies the world has been divided into three Regions[1] as shown on the following map and described in Nos. **5.3** to **5.9**:

5.3 *Region 1:* Region 1 includes the area limited on the east by line A (lines A, B and C are defined below) and on the west by line B, excluding any of the territory of the Islamic Republic of Iran which lies between these limits. It also includes the whole of the territory of Armenia, Azerbaijan, Georgia, Kazakstan, Mongolia, Uzbekistan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan, Turkey and Ukraine and the area to the north of Russian Federation which lies between lines A and C.

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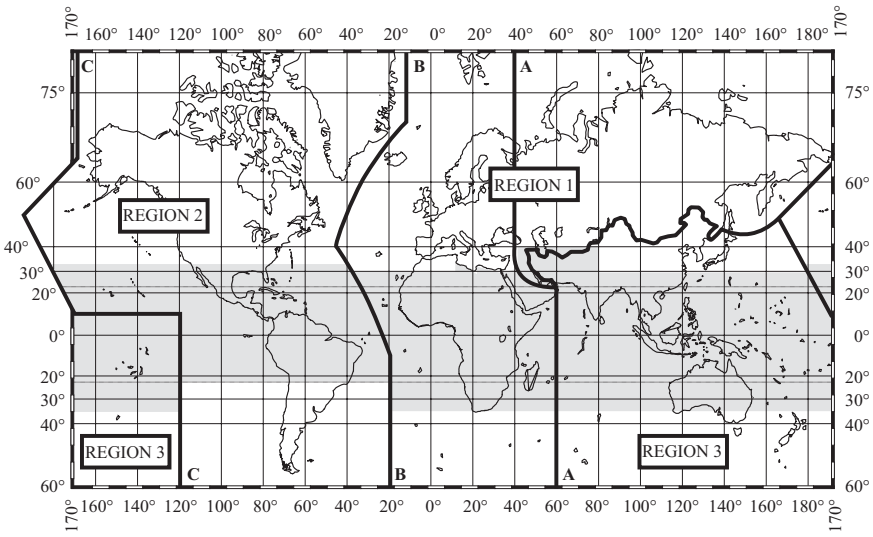
[1] **5.2.1** It should be noted that where the words "regions" or "regional" are without a capital "R" in these Regulations, they do not relate to the three Regions here defined for purposes of frequency allocation.



The shaded part represents the Tropical Zones as defined in Nos. **5.16** to **5.20** and **5.21**.

5-01

5.4 *Region 2:* Region 2 includes the area limited on the east by line B and on the west by line C.

5.5 *Region 3*: Region 3 includes the area limited on the east by line C and on the west by line A, except any of the territory of Armenia, Azerbaijan, Georgia, Kazakstan, Mongolia, Uzbekistan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan, Turkey and Ukraine and the area to the north of Russian Federation. It also includes that part of the territory of the Islamic Republic of Iran lying outside of those limits.

5.6 The lines A, B and C are defined as follows:

5.7 *Line A:* Line A extends from the North Pole along meridian 40° East of Greenwich to parallel 40° North; thence by great circle arc to the intersection of meridian 60° East and the Tropic of Cancer; thence along the meridian 60° East to the South Pole.

5.8 *Line B:* Line B extends from the North Pole along meridian 10° West of Greenwich to its intersection with parallel 72° North; thence by great circle arc to the intersection of meridian 50° West and parallel 40° North; thence by great circle arc to the intersection of meridian 20° West and parallel 10° South; thence along meridian 20° West to the South Pole.

5.9 *Line C:* Line C extends from the North Pole by great circle arc to the intersection of parallel 65° 30′ North with the international boundary in Bering Strait; thence by great circle arc to the intersection of meridian 165° East of Greenwich and parallel 50° North; thence by

great circle arc to the intersection of meridian 170° West and parallel 10° North; thence along parallel 10° North to its intersection with meridian 120° West; thence along meridian 120° West to the South Pole.

5.10 For the purposes of these Regulations, the term "African Broadcasting Area" means:

5.11 *a)* African countries, parts of countries, territories and groups of territories situated between the parallels 40° South and 30° North;

5.12 *b)* islands in the Indian Ocean west of meridian 60° East of Greenwich, situated between the parallel 40° South and the great circle arc joining the points 45° East, 11° 30′ North and 60° East, 15° North;

5.13 *c)* islands in the Atlantic Ocean east of line B defined in No. **5.8** of these Regulations, situated between the parallels 40° South and 30° North.

5.14 The "European Broadcasting Area" is bounded on the west by the western boundary of Region 1, on the east by the meridian 40° East of Greenwich and on the south by the parallel 30° North so as to include the northern part of Saudi Arabia and that part of those countries bordering the Mediterranean within these limits. In addition, Iraq, Jordan and that part of the territory of Syria, Turkey and Ukraine lying outside the above limits are included in the European Broadcasting Area.

5.15 The "European Maritime Area" is bounded to the north by a line extending along parallel 72° North from its intersection with meridian 55° East of Greenwich to its intersection with meridian 5° West, then along meridian 5° West to its intersection with parallel 67° North, thence along parallel 67° North to its intersection with meridian 32° West; to the west by a line extending along meridian 32° West to its intersection with parallel 30° North; to the south by a line extending along parallel 30° North to its intersection with meridian 43° East; to the east by a line extending along meridian 43° East to its intersection with parallel 60° North, thence along parallel 60° North to its intersection with meridian 55° East and thence along meridian 55° East to its intersection with parallel 72° North.

5.16 1) The "Tropical Zone" (see map in No. **5.2**) is defined as:

5.17 *a)* the whole of that area in Region 2 between the Tropics of Cancer and Capricorn;

5.18 *b)* the whole of that area in Regions 1 and 3 contained between the parallels 30° North and 35° South with the addition of:

5.19 i) The area contained between the meridians 40° East and 80° East of Greenwich and the parallels 30° North and 40° North;

5.20 ii) that part of Libya north of parallel 30° North.

5.21 2) In Region 2, the Tropical Zone may be extended to parallel 33° North, subject to special agreements between the countries concerned in that Region (see Article **6**).

5.22 A sub-Region is an area consisting of two or more countries in the same Region.

Section II – Categories of services and allocations

5.23 *Primary and secondary services*

5.24 1) Where, in a box of the Table in Section IV of this Article, a band is indicated as allocated to more than one service, either on a worldwide or Regional basis, such services are listed in the following order:

5.25 *a)* services the names of which are printed in "capitals" (example: FIXED); these are called "primary" services;

5.26 *b)* services the names of which are printed in "normal characters" (example: Mobile); these are called "secondary" services (see Nos. **5.28** to **5.31**).

5.27 2) Additional remarks shall be printed in normal characters (example: MOBILE except aeronautical mobile).

5.28 3) Stations of a secondary service:

5.29 *a)* shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

5.30 *b)* cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date;

5.31 *c)* can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

5.32 4) Where a band is indicated in a footnote of the Table as allocated to a service "on a secondary basis" in an area smaller than a Region, or in a particular country, this is a secondary service (see Nos. **5.28** to **5.31**).

5.33 5) Where a band is indicated in a footnote of the Table as allocated to a service "on a primary basis", in an area smaller than a Region, or in a particular country, this is a primary service only in that area or country.

5.34 *Additional allocations*

5.35 1) Where a band is indicated in a footnote of the Table as "also allocated" to a service in an area smaller than a Region, or in a particular country, this is an "additional" allocation, i.e. an allocation which is added in this area or in this country to the service or services which are indicated in the Table (see No. **5.36**).

5.36 2) If the footnote does not include any restriction on the service or services concerned apart from the restriction to operate only in a particular area or country, stations of this service or these services shall have equality of right to operate with stations of the other primary service or services indicated in the Table.

5.37 3) If restrictions are imposed on an additional allocation in addition to the restriction to operate only in a particular area or country, this is indicated in the footnote of the Table.

5.38 *Alternative allocations*

5.39 1) Where a band is indicated in a footnote of the Table as "allocated" to one or more services in an area smaller than a Region, or in a particular country, this is an "alternative" allocation, i.e. an allocation which replaces, in this area or in this country, the allocation indicated in the Table (see No. **5.40**).

5.40 2) If the footnote does not include any restriction on stations of the service or services concerned, apart from the restriction to operate only in a particular area or country, these stations of such a service or services shall have an equality of right to operate with stations of the primary service or services, indicated in the Table, to which the band is allocated in other areas or countries.

5.41 3) If restrictions are imposed on stations of a service to which an alternative allocation is made, in addition to the restriction to operate only in a particular country or area, this is indicated in the footnote.

5.42 *Miscellaneous provisions*

5.43 1) Where it is indicated in these Regulations that a service or stations in a service may operate in a specific frequency band subject to not causing harmful interference to another service or to another station in the same service, this means also that the service which is subject to not causing harmful interference cannot claim protection from harmful interference caused by the other service or other station in the same service. (WRC-2000)

5.43A 1*bis*) Where it is indicated in these Regulations that a service or stations in a service may operate in a specific frequency band subject to not claiming protection from another service or from another station in the same service, this means also that the service which is subject to not claiming protection shall not cause harmful interference to the other service or other station in the same service. (WRC-2000)

5.44 2) Except if otherwise specified in a footnote, the term "fixed service", where appearing in Section IV of this Article, does not include systems using ionospheric scatter propagation.

5.45 Not used.

Section III – Description of the Table of Frequency Allocations

5.46 1) The heading of the Table in Section IV of this Article includes three columns, each of which corresponds to one of the Regions (see No. **5.2**). Where an allocation occupies the whole of the width of the Table or only one or two of the three columns, this is a worldwide allocation or a Regional allocation, respectively.

5.47 2) The frequency band referred to in each allocation is indicated in the left-hand top corner of the part of the Table concerned.

5.48 3) Within each of the categories specified in Nos. **5.25** and **5.26**, services are listed in alphabetical order according to the French language. The order of listing does not indicate relative priority within each category.

5.49 4) In the case where there is a parenthetical addition to an allocation in the Table, that service allocation is restricted to the type of operation so indicated.

5.50 5) The footnote references which appear in the Table below the allocated service or services apply to more than one of the allocated services, or to the whole of the allocation concerned. (WRC-2000)

5.51 6) The footnote references which appear to the right of the name of a service are applicable only to that particular service.

5.52 7) In certain cases, the names of countries appearing in the footnotes have been simplified in order to shorten the text.

Section IV – Table of Frequency Allocations
(See No. **2.1**)

9-110 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
Below 9	(Not allocated) 5.53 5.54	
9-14	RADIONAVIGATION	
14-19.95	FIXED MARITIME MOBILE 5.57 5.55 5.56	
19.95-20.05	STANDARD FREQUENCY AND TIME SIGNAL (20 kHz)	
20.05-70	FIXED MARITIME MOBILE 5.57 5.56 5.58	
70-72 RADIONAVIGATION 5.60	**70-90** FIXED MARITIME MOBILE 5.57 MARITIME RADIO-NAVIGATION 5.60 Radiolocation	**70-72** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.57 5.59
72-84 FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60 5.56		**72-84** FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60
84-86 RADIONAVIGATION 5.60		**84-86** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.57 5.59
86-90 FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.56	5.61	**86-90** FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60
90-110	RADIONAVIGATION 5.62 Fixed 5.64	

5.53 Administrations authorizing the use of frequencies below 9 kHz shall ensure that no harmful interference is caused thereby to the services to which the bands above 9 kHz are allocated.

5.54 Administrations conducting scientific research using frequencies below 9 kHz are urged to advise other administrations that may be concerned in order that such research may be afforded all practicable protection from harmful interference.

5.55 *Additional allocation:* in Armenia, Azerbaijan, Bulgaria, Georgia, Kyrgyzstan, the Russian Federation, Tajikistan and Turkmenistan, the band 14-17 kHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.56 The stations of services to which the bands 14-19.95 kHz and 20.05-70 kHz and in Region 1 also the bands 72-84 kHz and 86-90 kHz are allocated may transmit standard frequency and time signals. Such stations shall be afforded protection from harmful interference. In Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Kazakstan, Mongolia, Uzbekistan, Kyrgyzstan, Slovakia, the Czech Rep., Russian Federation, Tajikistan, Turkmenistan and Ukraine, the frequencies 25 kHz and 50 kHz will be used for this purpose under the same conditions. (WRC-97)

5.57 The use of the bands 14-19.95 kHz, 20.05-70 kHz and 70-90 kHz (72-84 kHz and 86-90 kHz in Region 1) by the maritime mobile service is limited to coast radiotelegraph stations (A1A and F1B only). Exceptionally, the use of class J2B or J7B emissions is authorized subject to the necessary bandwidth not exceeding that normally used for class A1A or F1B emissions in the band concerned.

5.58 *Additional allocation:* in Armenia, Azerbaijan, Georgia, Kazakstan, Kyrgyzstan, the Russian Federation, Tajikistan and Turkmenistan, the band 67-70 kHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.59 *Different category of service:* in Bangladesh and Pakistan, the allocation of the bands 70-72 kHz and 84-86 kHz to the fixed and maritime mobile services is on a primary basis (see No. **5.33**). (WRC-2000)

5.60 In the bands 70-90 kHz (70-86 kHz in Region 1) and 110-130 kHz (112-130 kHz in Region 1), pulsed radionavigation systems may be used on condition that they do not cause harmful interference to other services to which these bands are allocated.

5.61 In Region 2, the establishment and operation of stations in the maritime radionavigation service in the bands 70-90 kHz and 110-130 kHz shall be subject to agreement obtained under No. **9.21** with administrations whose services, operating in accordance with the Table, may be affected. However, stations of the fixed, maritime mobile and radiolocation services shall not cause harmful interference to stations in the maritime radionavigation service established under such agreements.

5.62 Administrations which operate stations in the radionavigation service in the band 90-110 kHz are urged to coordinate technical and operating characteristics in such a way as to avoid harmful interference to the services provided by these stations.

5.63 (SUP - WRC-97)

5.64 Only classes A1A or F1B, A2C, A3C, F1C or F3C emissions are authorized for stations of the fixed service in the bands allocated to this service between 90 kHz and 160 kHz (148.5 kHz in Region 1) and for stations of the maritime mobile service in the bands allocated to this service between 110 kHz and 160 kHz (148.5 kHz in Region 1). Exceptionally, class J2B or J7B emissions are also authorized in the bands between 110 kHz and 160 kHz (148.5 kHz in Region 1) for stations of the maritime mobile service.

110-255 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
110-112 FIXED MARITIME MOBILE RADIONAVIGATION 5.64	**110-130** FIXED MARITIME MOBILE MARITIME RADIO-NAVIGATION 5.60 Radiolocation	**110-112** FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64
112-115 RADIONAVIGATION 5.60		**112-117.6** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.64 5.65
115-117.6 RADIONAVIGATION 5.60 Fixed Maritime mobile 5.64 5.66		
117.6-126 FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64		**117.6-126** FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64
126-129 RADIONAVIGATION 5.60		**126-129** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.64 5.65
129-130 FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64	5.61 5.64	**129-130** FIXED MARITIME MOBILE RADIONAVIGATION 5.60 5.64
130-148.5 FIXED MARITIME MOBILE 5.64 5.67	**130-160** FIXED MARITIME MOBILE 5.64	**130-160** FIXED MARITIME MOBILE RADIONAVIGATION 5.64
148.5-255 BROADCASTING 5.68 5.69 5.70	**160-190** FIXED	**160-190** FIXED Aeronautical radionavigation
	190-200 AERONAUTICAL RADIONAVIGATION	

5.65 *Different category of service:* in Bangladesh, the allocation of the bands 112-117.6 kHz and 126-129 kHz to the fixed and maritime mobile services is on a primary basis (see No. **5.33**). (WRC-2000)

5.66 *Different category of service:* in Germany, the allocation of the band 115-117.6 kHz to the fixed and maritime mobile services, is on a primary basis (see No. **5.33**) and to the radionavigation service on a secondary basis (see No. **5.32**).

5.67 *Additional allocation:* in Azerbaijan, Bulgaria, Mongolia, Kyrgyzstan, Romania and Turkmenistan, the band 130-148.5 kHz is also allocated to the radionavigation service on a secondary basis. Within and between these countries this service shall have an equal right to operate. (WRC-2000)

5.68 *Alternative allocation:* in Angola, Botswana, Burundi, the Congo, Malawi, Dem. Rep. of the Congo, Rwanda and South Africa, the band 160-200 kHz is allocated to the fixed service on a primary basis.

5.69 *Additional allocation:* in Somalia, the band 200-255 kHz is also allocated to the aeronautical radionavigation service on a primary basis.

5.70 *Alternative allocation:* in Angola, Botswana, Burundi, Cameroon, the Central African Rep., the Congo, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Oman, Dem. Rep. of the Congo, Rwanda, South Africa, Swaziland, Tanzania, Chad, Zambia and Zimbabwe, the band 200-283.5 kHz is allocated to the aeronautical radionavigation service on a primary basis.

200-495 kHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td></td><td>200-275
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td><td rowspan="2">200-285
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td></tr>
<tr><td>255-283.5
BROADCASTING
AERONAUTICAL RADIONAVIGATION
5.70 5.71</td><td>275-285
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile
Maritime radionavigation (radiobeacons)</td></tr>
<tr><td>283.5-315
AERONAUTICAL RADIONAVIGATION
MARITIME RADIONAVIGATION radiobeacons) 5.73
5.72 5.74</td><td colspan="2">285-315
AERONAUTICAL RADIONAVIGATION
MARITIME RADIONAVIGATION (radiobeacons) 5.73</td></tr>
<tr><td>315-325
AERONAUTICAL RADIONAVIGATION
Maritime radionavigation (radiobeacons) 5.73
5.72 5.75</td><td>315-325
MARITIME RADIONAVIGATION (radiobeacons) 5.73
Aeronautical radionavigation</td><td>315-325
AERONAUTICAL RADIONAVIGATION
MARITIME RADIONAVIGATION (radiobeacons) 5.73</td></tr>
<tr><td rowspan="2">325-405
AERONAUTICAL RADIONAVIGATION
5.72</td><td>325-335
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile
Maritime radionavigation (radiobeacons)</td><td rowspan="2">325-405
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td></tr>
<tr><td>335-405
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile</td></tr>
<tr><td>405-415
RADIONAVIGATION 5.76
5.72</td><td colspan="2">405-415
RADIONAVIGATION 5.76
Aeronautical mobile</td></tr>
<tr><td>415-435
MARITIME MOBILE 5.79
AERONAUTICAL RADIONAVIGATION
5.72</td><td colspan="2" rowspan="2">415-495
MARITIME MOBILE 5.79 5.79A
Aeronautical radionavigation 5.80
5.77 5.78 5.82</td></tr>
<tr><td>435-495
MARITIME MOBILE 5.79 5.79A
Aeronautical radionavigation
5.72 5.82</td></tr>
</table>

5.71 *Alternative allocation:* in Tunisia, the band 255-283.5 kHz is allocated to the broadcasting service on a primary basis.

5.72 Norwegian stations of the fixed service situated in northern areas (north of 60° N) subject to auroral disturbances are allowed to continue operation on four frequencies in the bands 283.5-490 kHz and 510-526.5 kHz.

5.73 The band 285-325 kHz (283.5-325 kHz in Region 1) in the maritime radionavigation service may be used to transmit supplementary navigational information using narrow-band techniques, on condition that no harmful interference is caused to radiobeacon stations operating in the radionavigation service. (WRC-97)

5.74 *Additional Allocation:* in Region 1, the frequency band 285.3-285.7 kHz is also allocated to the maritime radionavigation service (other than radiobeacons) on a primary basis.

5.75 *Different category of service:* in Armenia, Azerbaijan, Belarus, Georgia, Moldova, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan, Ukraine and the Black Sea areas of Bulgaria and Romania, the allocation of the band 315-325 kHz to the maritime radionavigation service is on a primary basis under the condition that in the Baltic Sea area, the assignment of frequencies in this band to new stations in the maritime or aeronautical radionavigation services shall be subject to prior consultation between the administrations concerned. (WRC-2000)

5.76 The frequency 410 kHz is designated for radio direction-finding in the maritime radionavigation service. The other radionavigation services to which the band 405-415 kHz is allocated shall not cause harmful interference to radio direction-finding in the band 406.5-413.5 kHz.

5.77 *Different category of service:* in Australia, China, the French Overseas Territories of Region 3, India, Indonesia (until 1 January 2005), Iran (Islamic Republic of), Japan, Pakistan, Papua New Guinea and Sri Lanka, the allocation of the band 415-495 kHz to the aeronautical radionavigation service is on a primary basis. Administrations in these countries shall take all practical steps necessary to ensure that aeronautical radionavigation stations in the band 435-495 kHz do not cause interference to reception by coast stations of ship stations transmitting on frequencies designated for ship stations on a worldwide basis (see No. **52.39**). (WRC-2000)

5.78 *Different category of service:* in Cuba, the United States of America and Mexico, the allocation of the band 415-435 kHz to the aeronautical radionavigation service is on a primary basis.

5.79 The use of the bands 415-495 kHz and 505-526.5 kHz (505-510 kHz in Region 2) by the maritime mobile service is limited to radiotelegraphy.

5.79A When establishing coast stations in the NAVTEX service on the frequencies 490 kHz, 518 kHz and 4 209.5 kHz, administrations are strongly recommended to coordinate the

operating characteristics in accordance with the procedures of the International Maritime Organization (IMO) (see Resolution **339 (Rev.WRC-97)**). (WRC-97)

5.80 In Region 2, the use of the band 435-495 kHz by the aeronautical radionavigation service is limited to non-directional beacons not employing voice transmission.

5.81 (SUP - WRC-2000)

5.82 In the maritime mobile service, the frequency 490 kHz is, from the date of full implementation of the GMDSS (see Resolution **331 (Rev.WRC-97)**), to be used exclusively for the transmission by coast stations of navigational and meteorological warnings and urgent information to ships, by means of narrow-band direct-printing telegraphy. The conditions for use of the frequency 490 kHz are prescribed in Articles **31** and **52**. In using the band 415-495 kHz for the aeronautical radionavigation service, administrations are requested to ensure that no harmful interference is caused to the frequency 490 kHz. (WRC-97)

495-1 800 kHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>495-505</td><td colspan="2">MOBILE (distress and calling)
5.83</td></tr>
<tr><td rowspan="3">505-526.5
MARITIME MOBILE 5.79 5.79A 5.84
AERONAUTICAL RADIONAVIGATION

5.72</td><td>505-510
MARITIME MOBILE 5.79</td><td rowspan="3">505-526.5
MARITIME MOBILE 5.79 5.79A 5.84
AERONAUTICAL RADIONAVIGATION
Aeronautical mobile

Land mobile</td></tr>
<tr><td>510-525
MOBILE 5.79A 5.84
AERONAUTICAL RADIONAVIGATION</td></tr>
<tr><td>525-535
BROADCASTING 5.86
AERONAUTICAL RADIONAVIGATION</td></tr>
<tr><td rowspan="2">526.5-1 606.5
BROADCASTING

5.87 5.87A</td><td>526.5-535
BROADCASTING
Mobile
5.88</td></tr>
<tr><td>535-1 605
BROADCASTING</td><td>535-1 606.5
BROADCASTING</td></tr>
<tr><td>1 606.5-1 625
FIXED
MARITIME MOBILE 5.90
LAND MOBILE

5.92</td><td>1 605-1 625
BROADCASTING 5.89

5.90</td><td rowspan="3">1 606.5-1 800
FIXED
MOBILE
RADIOLOCATION
RADIONAVIGATION</td></tr>
<tr><td>1 625-1 635
RADIOLOCATION

5.93</td><td rowspan="2">1 625-1 705
FIXED
MOBILE
BROADCASTING 5.89
Radiolocation
5.90</td></tr>
<tr><td>1 635-1 800
FIXED
MARITIME MOBILE 5.90
LAND MOBILE

5.92 5.96</td></tr>
<tr><td colspan="2">1 705-1 800
FIXED
MOBILE
RADIOLOCATION
AERONAUTICAL RADIONAVIGATION</td><td>5.91</td></tr>
</table>

5.83 The frequency 500 kHz is an international distress and calling frequency for Morse radiotelegraphy. The conditions for its use are prescribed in Articles **31** and **52,** and in Appendix **13**.

5.84 The conditions for the use of the frequency 518 kHz by the maritime mobile service are prescribed in Articles **31** and **52** and in Appendix **13**. (WRC-97)

5.85 Not used.

5.86 In Region 2, in the band 525-535 kHz the carrier power of broadcasting stations shall not exceed 1 kW during the day and 250 W at night.

5.87 *Additional allocation:* in Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe, the band 526.5-535 kHz is also allocated to the mobile service on a secondary basis.

5.87A *Additional allocation:* in Uzbekistan, the band 526.5-1 606.5 kHz is also allocated to the radionavigation service on a primary basis. Such use is subject to agreement obtained under No. **9.21** with administrations concerned and limited to ground-based radiobeacons in operation on 27 October 1997 until the end of their lifetime. (WRC-97)

5.88 *Additional allocation:* in China, the band 526.5-535 kHz is also allocated to the aeronautical radionavigation service on a secondary basis.

5.89 In Region 2, the use of the band 1 605-1 705 kHz by stations of the broadcasting service is subject to the Plan established by the Regional Administrative Radio Conference (Rio de Janeiro, 1988).

The examination of frequency assignments to stations of the fixed and mobile services in the band 1 625-1 705 kHz shall take account of the allotments appearing in the Plan established by the Regional Administrative Radio Conference (Rio de Janeiro, 1988).

5.90 In the band 1 605-1 705 kHz, in cases where a broadcasting station of Region 2 is concerned, the service area of the maritime mobile stations in Region 1 shall be limited to that provided by ground-wave propagation.

5.91 *Additional allocation:* in the Philippines and Sri Lanka, the band 1 606.5-1 705 kHz is also allocated to the broadcasting service on a secondary basis. (WRC-97)

5.92 Some countries of Region 1 use radiodetermination systems in the bands 1 606.5-1 625 kHz, 1 635-1 800 kHz, 1 850-2 160 kHz, 2 194-2 300 kHz, 2 502-2 850 kHz and 3 500-3 800 kHz, subject to agreement obtained under No. **9.21**. The radiated mean power of these stations shall not exceed 50 W.

5.93 *Additional allocation:* in Angola, Armenia, Azerbaijan, Belarus, Georgia, Hungary, Kazakstan, Latvia, Lithuania, Moldova, Mongolia, Nigeria, Uzbekistan, Poland, Kyrgyzstan,

Slovakia, the Czech Rep., the Russian Federation, Tajikistan, Chad, Turkmenistan and Ukraine, the bands 1 625-1 635 kHz, 1 800-1 810 kHz and 2 160-2 170 kHz and, in Bulgaria, the bands 1 625-1 635 kHz and 1 800-1 810 kHz, are also allocated to the fixed and land mobile services on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-2000)

5.94 and **5.95** Not used.

5.96 In Germany, Armenia, Austria, Azerbaijan, Belarus, Denmark, Estonia, Finland, Georgia, Hungary, Ireland, Israel, Jordan, Kazakstan, Latvia, Liechtenstein, Lithuania, Malta, Moldova, Norway, Uzbekistan, Poland, Kyrgyzstan, Slovakia, the Czech Rep., the United Kingdom, the Russian Federation, Sweden, Switzerland, Tajikistan, Turkmenistan and Ukraine, administrations may allocate up to 200 kHz to their amateur service in the bands 1 715-1 800 kHz and 1 850-2 000 kHz. However, when allocating the bands within this range to their amateur service, administrations shall, after prior consultation with administrations of neighbouring countries, take such steps as may be necessary to prevent harmful interference from their amateur service to the fixed and mobile services of other countries. The mean power of any amateur station shall not exceed 10 W. (WRC-2000)

1 800-2 194 kHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>1 800-1 810
RADIOLOCATION
5.93</td><td rowspan="2">1 800-1 850
AMATEUR</td><td rowspan="3">1 800-2 000
AMATEUR
FIXED
MOBILE except aeronautical mobile
RADIONAVIGATION
Radiolocation</td></tr>
<tr><td>1 810-1 850
AMATEUR
5.98 5.99 5.100 5.101</td></tr>
<tr><td>1 850-2 000
FIXED
MOBILE except aeronautical mobile
5.92 5.96 5.103</td><td>1 850-2 000
AMATEUR
FIXED
MOBILE except aeronautical mobile
RADIOLOCATION
RADIONAVIGATION
5.102</td><td>5.97</td></tr>
<tr><td>2 000-2 025
FIXED
MOBILE except aeronautical mobile (R)
5.92 5.103</td><td colspan="2" rowspan="2">2 000-2 065
FIXED
MOBILE</td></tr>
<tr><td>2 025-2 045
FIXED
MOBILE except aeronautical mobile (R)
Meteorological aids 5.104
5.92 5.103</td></tr>
<tr><td rowspan="2">2 045-2 160
FIXED
MARITIME MOBILE
LAND MOBILE
5.92</td><td colspan="2">2 065-2 107
MARITIME MOBILE 5.105
5.106</td></tr>
<tr><td rowspan="2">2 107-2 170
FIXED
MOBILE</td></tr>
<tr><td>2 160-2 170
RADIOLOCATION
5.93 5.107</td></tr>
<tr><td>2 170-2 173.5</td><td colspan="2">MARITIME MOBILE</td></tr>
<tr><td>2 173.5-2 190.5</td><td colspan="2">MOBILE (distress and calling)
5.108 5.109 5.110 5.111</td></tr>
<tr><td>2 190.5-2 194</td><td colspan="2">MARITIME MOBILE</td></tr>
</table>

5.97 In Region 3, the Loran system operates either on 1 850 kHz or 1 950 kHz, the bands occupied being 1 825-1 875 kHz and 1 925-1 975 kHz respectively. Other services to which the band 1 800-2 000 kHz is allocated may use any frequency therein on condition that no harmful interference is caused to the Loran system operating on 1 850 kHz or 1 950 kHz.

5.98 *Alternative allocation:* in Angola, Armenia, Azerbaijan, Belarus, Belgium, Bulgaria, Cameroon, the Congo, Denmark, Egypt, Eritrea, Spain, Ethiopia, Georgia, Greece, Italy, Kazakstan, Lebanon, Lithuania, Moldova, the Netherlands, Syria, Kyrgyzstan, the Russian Federation, Somalia, Tajikistan, Tunisia, Turkmenistan, Turkey and Ukraine, the band 1 810-1 830 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-2000)

5.99 *Additional allocation:* in Saudi Arabia, Austria, Bosnia and Herzegovina, Iraq, Libya, Uzbekistan, Slovakia, the Czech Rep., Romania, Slovenia, Chad, Togo and Yugoslavia, the band 1 810-1 830 kHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-2000)

5.100 In Region 1, the authorization to use the band 1 810-1 830 kHz by the amateur service in countries situated totally or partially north of 40° N shall be given only after consultation with the countries mentioned in Nos. **5.98** and **5.99** to define the necessary steps to be taken to prevent harmful interference between amateur stations and stations of other services operating in accordance with Nos. **5.98** and **5.99**.

5.101 *Alternative allocation:* in Burundi and Lesotho, the band 1 810-1 850 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis.

5.102 *Alternative allocation:* in Argentina, Bolivia, Chile, Mexico, Paraguay, Peru, Uruguay and Venezuela, the band 1 850-2 000 kHz is allocated to the fixed, mobile except aeronautical mobile, radiolocation and radionavigation services on a primary basis.

5.103 In Region 1, in making assignments to stations in the fixed and mobile services in the bands 1 850-2 045 kHz, 2 194-2 498 kHz, 2 502-2 625 kHz and 2 650-2 850 kHz, administrations should bear in mind the special requirements of the maritime mobile service.

5.104 In Region 1, the use of the band 2 025-2 045 kHz by the meteorological aids service is limited to oceanographic buoy stations.

5.105 In Region 2, except in Greenland, coast stations and ship stations using radiotelephony in the band 2 065-2 107 kHz shall be limited to class J3E emissions and to a peak envelope power not exceeding 1 kW. Preferably, the following carrier frequencies should be used: 2 065.0 kHz, 2 079.0 kHz, 2 082.5 kHz, 2 086.0 kHz, 2 093.0 kHz, 2 096.5 kHz, 2 100.0 kHz and 2 103.5 kHz. In Argentina and Uruguay, the carrier frequencies 2 068.5 kHz and 2 075.5 kHz are also used for this purpose, while the frequencies within the band 2 072-2 075.5 kHz are used as provided in No. **52.165**.

5.106 In Regions 2 and 3, provided no harmful interference is caused to the maritime mobile service, the frequencies between 2 065 kHz and 2 107 kHz may be used by stations of the fixed service communicating only within national borders and whose mean power does not exceed 50 W. In notifying the frequencies, the attention of the Bureau should be drawn to these provisions.

5.107 *Additional allocation:* in Saudi Arabia, Botswana, Eritrea, Ethiopia, Iraq, Lesotho, Libya, Somalia and Swaziland, the band 2 160-2 170 kHz is also allocated to the fixed and mobile, except aeronautical mobile (R), services on a primary basis. The mean power of stations in these services shall not exceed 50 W. (WRC-2000)

5.108 The carrier frequency 2 182 kHz is an international distress and calling frequency for radiotelephony. The conditions for the use of the band 2 173.5-2 190.5 kHz are prescribed in Articles **31** and **52** and in Appendix **13**.

5.109 The frequencies 2 187.5 kHz, 4 207.5 kHz, 6 312 kHz, 8 414.5 kHz, 12 577 kHz and 16 804.5 kHz are international distress frequencies for digital selective calling. The conditions for the use of these frequencies are prescribed in Article **31**.

5.110 The frequencies 2 174.5 kHz, 4 177.5 kHz, 6 268 kHz, 8 376.5 kHz, 12 520 kHz and 16 695 kHz are international distress frequencies for narrow-band direct-printing telegraphy. The conditions for the use of these frequencies are prescribed in Article **31**.

5.111 The carrier frequencies 2 182 kHz, 3 023 kHz, 5 680 kHz, 8 364 kHz and the frequencies 121.5 MHz, 156.8 MHz and 243 MHz may also be used, in accordance with the procedures in force for terrestrial radiocommunication services, for search and rescue operations concerning manned space vehicles. The conditions for the use of the frequencies are prescribed in Article **31** and in Appendix **13**.

The same applies to the frequencies 10 003 kHz, 14 993 kHz and 19 993 kHz, but in each of these cases emissions must be confined in a band of ± 3 kHz about the frequency.

2 194-3 230 kHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>2 194-2 300
FIXED
MOBILE except aeronautical mobile (R)
5.92 5.103 5.112</td><td colspan="2">2 194-2 300
FIXED
MOBILE

5.112</td></tr>
<tr><td>2 300-2 498
FIXED
MOBILE except aeronautical mobile (R)
BROADCASTING 5.113
5.103</td><td colspan="2">2 300-2 495
FIXED
MOBILE
BROADCASTING 5.113</td></tr>
<tr><td>2 498-2 501
STANDARD FREQUENCY AND TIME SIGNAL (2 500 kHz)</td><td colspan="2">2 495-2 501
STANDARD FREQUENCY AND TIME SIGNAL (2 500 kHz)</td></tr>
<tr><td>2 501-2 502</td><td colspan="2">STANDARD FREQUENCY AND TIME SIGNAL
Space Research</td></tr>
<tr><td>2 502-2 625
FIXED
MOBILE except aeronautical mobile (R)
5.92 5.103 5.114</td><td colspan="2">2 502-2 505
STANDARD FREQUENCY AND TIME SIGNAL</td></tr>
<tr><td>2 625-2 650
MARITIME MOBILE
MARITIME RADIONAVIGATION
5.92</td><td colspan="2" rowspan="2">2 505-2 850
FIXED
MOBILE</td></tr>
<tr><td>2 650-2 850
FIXED
MOBILE except aeronautical mobile (R)
5.92 5.103</td></tr>
<tr><td>2 850-3 025</td><td colspan="2">AERONAUTICAL MOBILE (R)
5.111 5.115</td></tr>
<tr><td>3 025-3 155</td><td colspan="2">AERONAUTICAL MOBILE (OR)</td></tr>
<tr><td>3 155-3 200</td><td colspan="2">FIXED
MOBILE except aeronautical mobile (R)
5.116 5.117</td></tr>
<tr><td>3 200-3 230</td><td colspan="2">FIXED
MOBILE except aeronautical mobile (R)
BROADCASTING 5.113
5.116</td></tr>
</table>

5.112 *Alternative allocation:* in Bosnia and Herzegovina, Cyprus, Denmark, Greece, Iceland, Malta, Sri Lanka and Yugoslavia, the band 2 194-2 300 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-2000)

5.113 For the conditions for the use of the bands 2 300-2 495 kHz (2 498 kHz in Region 1), 3 200-3 400 kHz, 4 750-4 995 kHz and 5 005-5 060 kHz by the broadcasting service, see Nos. **5.16** to **5.20**, **5.21** and **23.3** to **23.10**.

5.114 *Alternative allocation:* in Bosnia and Herzegovina, Cyprus, Denmark, Greece, Iraq, Malta, and Yugoslavia, the band 2 502-2 625 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-2000)

5.115 The carrier (reference) frequencies 3 023 kHz and 5 680 kHz may also be used, in accordance with Article **31** and Appendix **13** by stations of the maritime mobile service engaged in coordinated search and rescue operations.

5.116 Administrations are urged to authorize the use of the band 3 155-3 195 kHz to provide a common worldwide channel for low power wireless hearing aids. Additional channels for these devices may be assigned by administrations in the bands between 3 155 kHz and 3 400 kHz to suit local needs.

It should be noted that frequencies in the range 3 000 kHz to 4 000 kHz are suitable for hearing aid devices which are designed to operate over short distances within the induction field.

5.117 *Alternative allocation:* in Bosnia and Herzegovina, Cyprus, Côte d'Ivoire, Denmark, Egypt, Greece, Iceland, Liberia, Malta, Sri Lanka, Togo and Yugoslavia, the band 3 155-3 200 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-2000)

3 230-5 003 kHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>3 230-3 400</td><td colspan="2">FIXED
MOBILE except aeronautical mobile
BROADCASTING 5.113
5.116 5.118</td></tr>
<tr><td>3 400-3 500</td><td colspan="2">AERONAUTICAL MOBILE (R)</td></tr>
<tr><td rowspan="4">3 500-3 800
AMATEUR
FIXED
MOBILE except aeronautical mobile
5.92</td><td>3 500-3 750
AMATEUR

5.119</td><td rowspan="3">3 500-3 900
AMATEUR
FIXED
MOBILE</td></tr>
<tr><td rowspan="3">3 750-4 000
AMATEUR
FIXED
MOBILE except aeronautical mobile (R)</td></tr>
<tr><td>3 800-3 900
FIXED
AERONAUTICAL MOBILE (OR)
LAND MOBILE</td></tr>
<tr><td>3 900-3 950
AERONAUTICAL MOBILE (OR)
5.123</td><td>3 900-3 950
AERONAUTICAL MOBILE
BROADCASTING</td></tr>
<tr><td>3 950-4 000
FIXED
BROADCASTING</td><td>5.122 5.125</td><td>3 950-4 000
FIXED
BROADCASTING
5.126</td></tr>
<tr><td>4 000-4 063</td><td colspan="2">FIXED
MARITIME MOBILE 5.127
5.126</td></tr>
<tr><td>4 063-4 438</td><td colspan="2">MARITIME MOBILE 5.79A 5.109 5.110 5.130 5.131 5.132
5.128 5.129</td></tr>
<tr><td colspan="2">4 438-4 650
FIXED
MOBILE except aeronautical mobile (R)</td><td>4 438-4 650
FIXED
MOBILE except aeronautical mobile</td></tr>
<tr><td>4 650-4 700</td><td colspan="2">AERONAUTICAL MOBILE (R)</td></tr>
<tr><td>4 700-4 750</td><td colspan="2">AERONAUTICAL MOBILE (OR)</td></tr>
<tr><td>4 750-4 850
FIXED
AERONAUTICAL MOBILE (OR)
LAND MOBILE
BROADCASTING 5.113</td><td>4 750-4 850
FIXED
MOBILE except aeronautical mobile (R)
BROADCASTING 5.113</td><td>4 750-4 850
FIXED
BROADCASTING 5.113
Land mobile</td></tr>
<tr><td>4 850-4 995</td><td colspan="2">FIXED
LAND MOBILE
BROADCASTING 5.113</td></tr>
<tr><td>4 995-5 003</td><td colspan="2">STANDARD FREQUENCY AND TIME SIGNAL (5 000 kHz)</td></tr>
</table>

5.118 *Additional allocation:* in the United States, Japan, Mexico, Peru and Uruguay, the band 3 230-3 400 kHz is also allocated to the radiolocation service on a secondary basis.

5.119 *Additional allocation:* in Honduras, Mexico, Peru and Venezuela, the band 3 500-3 750 kHz is also allocated to the fixed and mobile services on a primary basis.

5.120 (SUP - WRC-2000)

5.121 Not used.

5.122 *Alternative allocation:* in Argentina, Bolivia, Chile, Ecuador, Paraguay, Peru and Uruguay, the band 3 750-4 000 kHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis.

5.123 *Additional allocation:* in Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe, the band 3 900-3 950 kHz is also allocated to the broadcasting service on a primary basis, subject to agreement obtained under No. **9.21**.

5.124 (SUP - WRC-2000)

5.125 *Additional allocation:* in Greenland, the band 3 950-4 000 kHz is also allocated to the broadcasting service on a primary basis. The power of the broadcasting stations operating in this band shall not exceed that necessary for a national service and shall in no case exceed 5 kW.

5.126 In Region 3, the stations of those services to which the band 3 995-4 005 kHz is allocated may transmit standard frequency and time signals.

5.127 The use of the band 4 000-4 063 kHz by the maritime mobile service is limited to ship stations using radiotelephony (see No. **52.220** and Appendix **17**).

5.128 In Afghanistan, Argentina, Armenia, Azerbaijan, Belarus, Botswana, Burkina Faso, the Central African Rep., China, Georgia, India, Kazakstan, Mali, Niger, Kyrgyzstan, Russian Federation, Tajikistan, Chad, Turkmenistan and Ukraine, in the bands 4 063-4 123 kHz, 4 130-4 133 kHz and 4 408-4 438 kHz, stations of limited power in the fixed service which are situated at least 600 km from the coast may operate on condition that harmful interference is not caused to the maritime mobile service. (WRC-97)

5.129 On condition that harmful interference is not caused to the maritime mobile service, the frequencies in the bands 4 063-4 123 kHz and 4 130-4 438 kHz may be used exceptionally by stations in the fixed service communicating only within the boundary of the country in which they are located with a mean power not exceeding 50 W.

5.130 The conditions for the use of the carrier frequencies 4 125 kHz and 6 215 kHz are prescribed in Articles **31** and **52** and in Appendix **13**.

5.131 The frequency 4 209.5 kHz is used exclusively for the transmission by coast stations of meteorological and navigational warnings and urgent information to ships by means of narrow-band direct-printing techniques. (WRC-97)

5.132 The frequencies 4 210 kHz, 6 314 kHz, 8 416.5 kHz, 12 579 kHz, 16 806.5 kHz, 19 680.5 kHz, 22 376 kHz and 26 100.5 kHz are the international frequencies for the transmission of maritime safety information (MSI) (see Appendix **17**).

5 003-7 350 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
5 003-5 005	STANDARD FREQUENCY AND TIME SIGNAL Space research	
5 005-5 060	FIXED BROADCASTING 5.113	
5 060-5 250	FIXED Mobile except aeronautical mobile 5.133	
5 250-5 450	FIXED MOBILE except aeronautical mobile	
5 450-5 480 FIXED AERONAUTICAL MOBILE (OR) LAND MOBILE	**5 450-5 480** AERONAUTICAL MOBILE (R)	**5 450-5 480** FIXED AERONAUTICAL MOBILE (OR) LAND MOBILE
5 480-5 680	AERONAUTICAL MOBILE (R) 5.111 5.115	
5 680-5 730	AERONAUTICAL MOBILE (OR) 5.111 5.115	
5 730-5 900 FIXED LAND MOBILE	**5 730-5 900** FIXED MOBILE except aeronautical mobile (R)	**5 730-5 900** FIXED Mobile except aeronautical mobile (R)
5 900-5 950	BROADCASTING 5.134 5.136	
5 950-6 200	BROADCASTING	
6 200-6 525	MARITIME MOBILE 5.109 5.110 5.130 5.132 5.137	
6 525-6 685	AERONAUTICAL MOBILE (R)	
6 685-6 765	AERONAUTICAL MOBILE (OR)	
6 765-7 000	FIXED Land mobile 5.139 5.138	
7 000-7 100	AMATEUR AMATEUR-SATELLITE 5.140 5.141	
7 100-7 300 BROADCASTING	**7 100-7 300** AMATEUR 5.142	**7 100-7 300** BROADCASTING
7 300-7 350	BROADCASTING 5.134 5.143	

5.133 *Different category of service:* in Armenia, Azerbaijan, Belarus, Georgia, Kazakstan, Latvia, Lithuania, Moldova, Uzbekistan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 5 130-5 250 kHz to the mobile, except aeronautical mobile, service is on a primary basis (see No. **5.33**).

5.134 The use of the bands 5 900-5 950 kHz, 7 300-7 350 kHz, 9 400-9 500 kHz, 11 600-11 650 kHz, 12 050-12 100 kHz, 13 570-13 600 kHz, 13 800-13 870 kHz, 15 600-15 800 kHz, 17 480-17 550 kHz and 18 900-19 020 kHz by the broadcasting service is limited to single-sideband emissions with the characteristics specified in Appendix **11** or to any other spectrum-efficient modulation techniques recommended by ITU-R. Access to these bands shall be subject to the decisions of a competent conference. (WRC-97)

5.135 (SUP - WRC-97)

5.136 The band 5 900-5 950 kHz is allocated, until 1 April 2007, to the fixed service on a primary basis, as well as to the following services: in Region 1 to the land mobile service on a primary basis, in Region 2 to the mobile except aeronautical mobile (R) service on a primary basis, and in Region 3 to the mobile except aeronautical mobile (R) service on a secondary basis, subject to application of the procedure referred to in Resolution **21 (Rev.WRC-95)**. After 1 April 2007, frequencies in this band may be used by stations in the above-mentioned services, communicating only within the boundary of the country in which they are located, on the condition that harmful interference is not caused to the broadcasting service. When using frequencies for these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations.

5.137 On condition that harmful interference is not caused to the maritime mobile service, the bands 6 200-6 213.5 kHz and 6 220.5-6 525 kHz may be used exceptionally by stations in the fixed service, communicating only within the boundary of the country in which they are located, with a mean power not exceeding 50 W. At the time of notification of these frequencies, the attention of the Bureau will be drawn to the above conditions.

5.138 The following bands:

6 765-6 795 kHz	(centre frequency 6 780 kHz),
433.05-434.79 MHz	(centre frequency 433.92 MHz) in Region 1 except in the countries mentioned in No. **5.280**,
61-61.5 GHz	(centre frequency 61.25 GHz),
122-123 GHz	(centre frequency 122.5 GHz), and
244-246 GHz	(centre frequency 245 GHz)

are designated for industrial, scientific and medical (ISM) applications. The use of these frequency bands for ISM applications shall be subject to special authorization by the administration concerned, in agreement with other administrations whose radiocommunication services might be affected. In applying this provision, administrations shall have due regard to the latest relevant ITU-R Recommendations.

5.139 *Different category of service:* in Armenia, Azerbaijan, Belarus, Georgia, Kazakstan, Latvia, Lithuania, Moldova, Mongolia, Uzbekistan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 6 765-7 000 kHz to the land mobile service is on a primary basis (see No. **5.33**).

5.140 *Additional allocation:* in Angola, Iraq, Rwanda, Somalia and Togo, the band 7 000-7 050 kHz is also allocated to the fixed service on a primary basis.

5.141 *Alternative allocation:* in Egypt, Eritrea, Ethiopia, Guinea, Libya and Madagascar, the band 7 000-7 050 kHz is allocated to the fixed service on a primary basis. (WRC-97)

5.142 The use of the band 7 100-7 300 kHz in Region 2 by the amateur service shall not impose constraints on the broadcasting service intended for use within Region 1 and Region 3.

5.143 The band 7 300-7 350 kHz is allocated, until 1 April 2007, to the fixed service on a primary basis and to the land mobile service on a secondary basis, subject to application of the procedure referred to in Resolution **21 (Rev.WRC-95)**. After 1 April 2007, frequencies in this band may be used by stations in the above-mentioned services, communicating only within the boundary of the country in which they are located, on condition that harmful interference is not caused to the broadcasting service. When using frequencies for these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations.

7 350-13 360 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
7 350-8 100	FIXED Land mobile 5.144	
8 100-8 195	FIXED MARITIME MOBILE	
8 195-8 815	MARITIME MOBILE 5.109 5.110 5.132 5.145 5.111	
8 815-8 965	AERONAUTICAL MOBILE (R)	
8 965-9 040	AERONAUTICAL MOBILE (OR)	
9 040-9 400	FIXED	
9 400-9 500	BROADCASTING 5.134 5.146	
9 500-9 900	BROADCASTING 5.147	
9 900-9 995	FIXED	
9 995-10 003	STANDARD FREQUENCY AND TIME SIGNAL (10 000 kHz) 5.111	
10 003-10 005	STANDARD FREQUENCY AND TIME SIGNAL Space research 5.111	
10 005-10 100	AERONAUTICAL MOBILE (R) 5.111	
10 100-10 150	FIXED Amateur	
10 150-11 175	FIXED Mobile except aeronautical mobile (R)	
11 175-11 275	AERONAUTICAL MOBILE (OR)	
11 275-11 400	AERONAUTICAL MOBILE (R)	
11 400-11 600	FIXED	
11 600-11 650	BROADCASTING 5.134 5.146	
11 650-12 050	BROADCASTING 5.147	
12 050-12 100	BROADCASTING 5.134 5.146	
12 100-12 230	FIXED	
12 230-13 200	MARITIME MOBILE 5.109 5.110 5.132 5.145	
13 200-13 260	AERONAUTICAL MOBILE (OR)	
13 260-13 360	AERONAUTICAL MOBILE (R)	

5.144 In Region 3, the stations of those services to which the band 7 995-8 005 kHz is allocated may transmit standard frequency and time signals.

5.145 The conditions for the use of the carrier frequencies 8 291 kHz, 12 290 kHz and 16 420 kHz are prescribed in Articles **31** and **52** and in Appendix **13**.

5.146 The bands 9 400-9 500 kHz, 11 600-11 650 kHz, 12 050-12 100 kHz, 15 600-15 800 kHz, 17 480-17 550 kHz and 18 900-19 020 kHz are allocated to the fixed service on a primary basis until 1 April 2007, subject to application of the procedure referred to in Resolution **21 (Rev.WRC-95)**. After 1 April 2007, frequencies in these bands may be used by stations in the fixed service, communicating only within the boundary of the country in which they are located, on condition that harmful interference is not caused to the broadcasting service. When using frequencies in the fixed service, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations.

5.147 On condition that harmful interference is not caused to the broadcasting service, frequencies in the bands 9 775-9 900 kHz, 11 650-11 700 kHz and 11 975-12 050 kHz may be used by stations in the fixed service communicating only within the boundary of the country in which they are located, each station using a total radiated power not exceeding 24 dBW.

5.148 (SUP - WRC-97)

13 360-18 030 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
13 360-13 410	FIXED RADIO ASTRONOMY 5.149	
13 410-13 570	FIXED Mobile except aeronautical mobile (R) 5.150	
13 570-13 600	BROADCASTING 5.134 5.151	
13 600-13 800	BROADCASTING	
13 800-13 870	BROADCASTING 5.134 5.151	
13 870-14 000	FIXED Mobile except aeronautical mobile (R)	
14 000-14 250	AMATEUR AMATEUR-SATELLITE	
14 250-14 350	AMATEUR 5.152	
14 350-14 990	FIXED Mobile except aeronautical mobile (R)	
14 990-15 005	STANDARD FREQUENCY AND TIME SIGNAL (15 000 kHz) 5.111	
15 005-15 010	STANDARD FREQUENCY AND TIME SIGNAL Space research	
15 010-15 100	AERONAUTICAL MOBILE (OR)	
15 100-15 600	BROADCASTING	
15 600-15 800	BROADCASTING 5.134 5.146	
15 800-16 360	FIXED 5.153	
16 360-17 410	MARITIME MOBILE 5.109 5.110 5.132 5.145	
17 410-17 480	FIXED	
17 480-17 550	BROADCASTING 5.134 5.146	
17 550-17 900	BROADCASTING	
17 900-17 970	AERONAUTICAL MOBILE (R)	
17 970-18 030	AERONAUTICAL MOBILE (OR)	

5.149 In making assignments to stations of other services to which the bands:

13 360-13 410 kHz,	4 990-5 000 MHz,	94.1-100 GHz,
25 550-25 670 kHz,	6 650-6 675.2 MHz,	102-109.5 GHz,
37.5-38.25 MHz,	10.6-10.68 GHz,	111.8-114.25 GHz,
73-74.6 MHz in Regions 1 and 3,	14.47-14.5 GHz,	128.33-128.59 GHz,
150.05-153 MHz in Region 1,	22.01-22.21 GHz,	129.23-129.49 GHz,
322-328.6 MHz,	22.21-22.5 GHz,	130-134 GHz,
406.1-410 MHz,	22.81-22.86 GHz,	136-148.5 GHz,
608-614 MHz in Regions 1 and 3,	23.07-23.12 GHz,	151.5-158.5 GHz,
1 330-1 400 MHz,	31.2-31.3 GHz,	168.59-168.93 GHz,
1 610.6-1 613.8 MHz,	31.5-31.8 GHz in Regions 1 and 3,	171.11-171.45 GHz,
1 660-1 670 MHz,	36.43-36.5 GHz,	172.31-172.65 GHz,
1 718.8-1 722.2 MHz,	42.5-43.5 GHz,	173.52-173.85 GHz,
2 655-2 690 MHz,	42.77-42.87 GHz,	195.75-196.15 GHz,
3 260-3 267 MHz,	43.07-43.17 GHz,	209-226 GHz,
3 332-3 339 MHz,	43.37-43.47 GHz,	241-250 GHz,
3 345.8-3 352.5 MHz,	48.94-49.04 GHz,	252-275 GHz
4 825-4 835 MHz,	76-86 GHz,	
4 950-4 990 MHz,	92-94 GHz,	

are allocated, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service (see Nos. **4.5** and **4.6** and Article **29**). (WRC-2000)

5.150 The following bands:

13 553-13 567 kHz	(centre frequency 13 560 kHz),
26 957-27 283 kHz	(centre frequency 27 120 kHz),
40.66-40.70 MHz	(centre frequency 40.68 MHz),
902-928 MHz	in Region 2 (centre frequency 915 MHz),
2 400-2 500 MHz	(centre frequency 2 450 MHz),
5 725-5 875 MHz	(centre frequency 5 800 MHz), and
24-24.25 GHz	(centre frequency 24.125 GHz)

are also designated for industrial, scientific and medical (ISM) applications. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. **15.13**.

5.151 The bands 13 570-13 600 kHz and 13 800-13 870 kHz are allocated, until 1 April 2007, to the fixed service on a primary basis and to the mobile except aeronautical mobile (R) service on a secondary basis, subject to application of the procedure referred to in Resolution **21 (Rev.WRC-95)**. After 1 April 2007, frequencies in these bands may be used by stations in the above-mentioned services, communicating only within the boundary of the country in which they are located, on the condition that harmful interference is not caused to the broadcasting service. When using frequencies in these services, administrations are urged to use the minimum power required and to take account of the seasonal use of frequencies by the broadcasting service published in accordance with the Radio Regulations.

5.152 *Additional allocation:* in Armenia, Azerbaijan, China, Côte d'Ivoire, Georgia, Iran (Islamic Republic of), Kazakstan, Moldova, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 14 250-14 350 kHz is also allocated to the fixed service on a primary basis. Stations of the fixed service shall not use a radiated power exceeding 24 dBW. (WRC-2000)

5.153 In Region 3, the stations of those services to which the band 15 995-16 005 kHz is allocated may transmit standard frequency and time signals.

18 030-23 350 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
18 030-18 052	FIXED	
18 052-18 068	FIXED Space research	
18 068-18 168	AMATEUR AMATEUR-SATELLITE 5.154	
18 168-18 780	FIXED Mobile except aeronautical mobile	
18 780-18 900	MARITIME MOBILE	
18 900-19 020	BROADCASTING 5.134 5.146	
19 020-19 680	FIXED	
19 680-19 800	MARITIME MOBILE 5.132	
19 800-19 990	FIXED	
19 990-19 995	STANDARD FREQUENCY AND TIME SIGNAL Space research 5.111	
19 995-20 010	STANDARD FREQUENCY AND TIME SIGNAL (20 000 kHz) 5.111	
20 010-21 000	FIXED Mobile	
21 000-21 450	AMATEUR AMATEUR-SATELLITE	
21 450-21 850	BROADCASTING	
21 850-21 870	FIXED 5.155A 5.155	
21 870-21 924	FIXED 5.155B	
21 924-22 000	AERONAUTICAL MOBILE (R)	
22 000-22 855	MARITIME MOBILE 5.132 5.156	
22 855-23 000	FIXED 5.156	
23 000-23 200	FIXED Mobile except aeronautical mobile (R) 5.156	
23 200-23 350	FIXED 5.156A AERONAUTICAL MOBILE (OR)	

5.154 *Additional allocation:* in Armenia, Azerbaijan, Georgia, Kazakstan, Moldova, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 18 068-18 168 kHz is also allocated to the fixed service on a primary basis for use within their boundaries, with a peak envelope power not exceeding 1 kW. (WRC-2000)

5.155 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Hungary, Kazakstan, Moldova, Mongolia, Uzbekistan, Kyrgyzstan, Slovakia, the Czech Rep., Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 21 850-21 870 kHz is also allocated to the aeronautical mobile (R) services on a primary basis.

5.155A In Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Kazakstan, Moldova, Mongolia, Uzbekistan, Kyrgyzstan, Slovakia, the Czech Rep., the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the use of the band 21 850-21 870 kHz by the fixed service is limited to provision of services related to aircraft flight safety. (WRC-2000)

5.155B The band 21 870-21 924 kHz is used by the fixed service for provision of services related to aircraft flight safety.

5.156 *Additional allocation:* in Nigeria, the band 22 720-23 200 kHz is also allocated to the meteorological aids service (radiosondes) on a primary basis.

5.156A The use of the band 23 200-23 350 kHz by the fixed service is limited to provision of services related to aircraft flight safety.

23 350-27 500 kHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
23 350-24 000	FIXED MOBILE except aeronautical mobile 5.157	
24 000-24 890	FIXED LAND MOBILE	
24 890-24 990	AMATEUR AMATEUR-SATELLITE	
24 990-25 005	STANDARD FREQUENCY AND TIME SIGNAL (25 000 kHz)	
25 005-25 010	STANDARD FREQUENCY AND TIME SIGNAL Space research	
25 010-25 070	FIXED MOBILE except aeronautical mobile	
25 070-25 210	MARITIME MOBILE	
25 210-25 550	FIXED MOBILE except aeronautical mobile	
25 550-25 670	RADIO ASTRONOMY 5.149	
25 670-26 100	BROADCASTING	
26 100-26 175	MARITIME MOBILE 5.132	
26 175-27 500	FIXED MOBILE except aeronautical mobile 5.150	

5.157 The use of the band 23 350-24 000 kHz by the maritime mobile service is limited to inter-ship radiotelegraphy.

5.158 and **5.159** Not used.

27.5-47 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
27.5-28	METEOROLOGICAL AIDS FIXED MOBILE	
28-29.7	AMATEUR AMATEUR-SATELLITE	
29.7-30.005	FIXED MOBILE	
30.005-30.01	SPACE OPERATION (satellite identification) FIXED MOBILE SPACE RESEARCH	
30.01-37.5	FIXED MOBILE	
37.5-38.25	FIXED MOBILE Radio astronomy 5.149	
38.25-39.986	FIXED MOBILE	
39.986-40.02	FIXED MOBILE Space research	
40.02-40.98	FIXED MOBILE 5.150	
40.98-41.015	FIXED MOBILE Space research 5.160 5.161	
41.015-44	FIXED MOBILE 5.160 5.161	
44-47	FIXED MOBILE 5.162 5.162A	

5.160 *Additional allocation:* in Botswana, Burundi, Lesotho, Malawi, Dem. Rep. of the Congo, Rwanda and Swaziland, the band 41-44 MHz is also allocated to the aeronautical radionavigation service on a primary basis. (WRC-2000)

5.161 *Additional allocation:* in Iran (Islamic Republic of) and Japan, the band 41-44 MHz is also allocated to the radiolocation service on a secondary basis.

5.162 *Additional allocation:* in Australia and New Zealand, the band 44-47 MHz is also allocated to the broadcasting service on a primary basis.

5.162A *Additional allocation:* in Germany, Austria, Belgium, Bosnia and Herzegovina, China, Vatican, Denmark, Spain, Estonia, Finland, France, Ireland, Iceland, Italy, Latvia, The Former Yugoslav Republic of Macedonia, Liechtenstein, Lithuania, Luxembourg, Moldova, Monaco, Norway, the Netherlands, Poland, Portugal, Slovakia, the Czech Rep., the United Kingdom, the Russian Federation, Sweden and Switzerland the band 46-68 MHz is also allocated to the radiolocation service on a secondary basis. This use is limited to the operation of wind profiler radars in accordance with Resolution **217 (WRC-97)**. (WRC-2000)

47-75.2 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="4">47-68
BROADCASTING

5.162A 5.163 5.164 5.165
5.169 5.171</td><td>47-50
FIXED
MOBILE</td><td>47-50
FIXED
MOBILE
BROADCASTING
5.162A</td></tr>
<tr><td colspan="2">50-54
AMATEUR
5.162A 5.166 5.167 5.168 5.170</td></tr>
<tr><td>54-68
BROADCASTING
Fixed
Mobile

5.172</td><td>54-68
FIXED
MOBILE
BROADCASTING

5.162A</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td rowspan="5">68-74.8
FIXED
MOBILE except aeronautical mobile

5.149 5.174 5.175 5.177
5.179</td><td>68-72
BROADCASTING
Fixed
Mobile
5.173</td><td rowspan="5">68-74.8
FIXED
MOBILE

5.149 5.176 5.179</td></tr>
<tr><td>72-73
FIXED
MOBILE</td></tr>
<tr><td>73-74.6
RADIO ASTRONOMY
5.178</td></tr>
<tr><td>74.6-74.8
FIXED
MOBILE</td></tr>
<tr><td></td></tr>
<tr><td>74.8-75.2</td><td colspan="2">AERONAUTICAL RADIONAVIGATION
5.180 5.181</td></tr>
</table>

5.163 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Estonia, Georgia, Hungary, Kazakstan, Latvia, Lithuania, Moldova, Mongolia, Uzbekistan, Kyrgyzstan, Slovakia, the Czech Rep., Russian Federation, Tajikistan, Turkmenistan and Ukraine, the bands 47-48.5 MHz and 56.5-58 MHz are also allocated to the fixed and land mobile services on a secondary basis.

5.164 *Additional allocation:* in Albania, Germany, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Côte d'Ivoire, Denmark, Spain, Finland, France, Gabon, Greece, Ireland, Israel, Italy, Jordan, Lebanon, Libya, Liechtenstein, Luxembourg, Madagascar, Mali, Malta, Morocco, Mauritania, Monaco, Nigeria, Norway, the Netherlands, Poland, Syria, the United Kingdom, Senegal, Slovenia, Sweden, Switzerland, Swaziland, Togo, Tunisia, Turkey and Yugoslavia the band 47-68 MHz, in Romania the band 47-58 MHz and in the Czech Rep. the band 66-68 MHz, are also allocated to the land mobile service on a primary basis. However, stations of the land mobile service in the countries mentioned in connection with each band referred to in this footnote shall not cause harmful interference to, or claim protection from, existing or planned broadcasting stations of countries other than those mentioned in connection with the band. (WRC-97)

5.165 *Additional allocation:* in Angola, Cameroon, the Congo, Madagascar, Mozambique, Somalia, Sudan, Tanzania and Chad, the band 47-68 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis.

5.166 *Alternative allocation:* in New Zealand, the band 50-51 MHz is allocated to the fixed, mobile and broadcasting services on a primary basis; the band 53-54 MHz is allocated to the fixed and mobile services on a primary basis.

5.167 *Alternative allocation:* in Bangladesh, Brunei Darussalam, India, Indonesia, Iran (Islamic Republic of), Malaysia, Pakistan, Singapore and Thailand, the band 50-54 MHz is allocated to the fixed, mobile and broadcasting services on a primary basis.

5.168 *Additional allocation:* in Australia, China and the Dem. People's Rep. of Korea, the band 50-54 MHz is also allocated to the broadcasting service on a primary basis.

5.169 *Alternative allocation:* in Botswana, Burundi, Lesotho, Malawi, Namibia, Dem. Rep. of the Congo, Rwanda, South Africa, Swaziland, Zambia and Zimbabwe, the band 50-54 MHz is allocated to the amateur service on a primary basis.

5.170 *Additional allocation:* in New Zealand, the band 51-53 MHz is also allocated to the fixed and mobile services on a primary basis.

5.171 *Additional allocation:* in Botswana, Burundi, Lesotho, Malawi, Mali, Namibia, Dem. Rep. of the Congo, Rwanda, South Africa, Swaziland and Zimbabwe, the band 54-68 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis.

5.172 *Different category of service:* in the French Overseas Departments in Region 2, Guyana, Jamaica and Mexico, the allocation of the band 54-68 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**).

5.173 *Different category of service:* in the French Overseas Departments in Region 2, Guyana, Jamaica and Mexico, the allocation of the band 68-72 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**).

5.174 *Alternative allocation:* in Bulgaria, Hungary, Poland and Romania, the band 68-73 MHz is allocated to the broadcasting service on a primary basis and used in accordance with the decisions in the Final Acts of the Special Regional Conference (Geneva, 1960). (WRC-97)

5.175 *Alternative allocation:* in Armenia, Azerbaijan, Belarus, Georgia, Kazakstan, Latvia, Lithuania, Moldova, Mongolia, Uzbekistan, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the bands 68-73 MHz and 76-87.5 MHz are allocated to the broadcasting service on a primary basis. The services to which these bands are allocated in other countries and the broadcasting service in the countries listed above are subject to agreements with the neighbouring countries concerned. (WRC-2000)

5.176 *Additional allocation:* in Australia, China, Korea (Rep. of), Estonia (subject to agreement obtained under No. **9.21**), the Philippines, the Dem. People's Rep. of Korea and Samoa, the band 68-74 MHz is also allocated to the broadcasting service on a primary basis. (WRC-2000)

5.177 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Kazakstan, Latvia, Moldova, Uzbekistan, Poland, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 73-74 MHz is also allocated to the broadcasting service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-2000)

5.178 *Additional allocation:* in Colombia, Costa Rica, Cuba, El Salvador, Guatemala, Guyana, Honduras and Nicaragua, the band 73-74.6 MHz is also allocated to the fixed and mobile services on a secondary basis.

5.179 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Bulgaria, China, Georgia, Kazakstan, Latvia, Lithuania, Moldova, Mongolia, Kyrgyzstan, Slovakia, the Czech Rep., Russian Federation, Tajikistan, Turkmenistan and Ukraine, the bands 74.6-74.8 MHz and 75.2-75.4 MHz are also allocated to the aeronautical radionavigation service, on a primary basis, for ground-based transmitters only.

5.180 The frequency 75 MHz is assigned to marker beacons. Administrations shall refrain from assigning frequencies close to the limits of the guardband to stations of other services which, because of their power or geographical position, might cause harmful interference or otherwise place a constraint on marker beacons.

Every effort should be made to improve further the characteristics of airborne receivers and to limit the power of transmitting stations close to the limits 74.8 MHz and 75.2 MHz.

5.181 *Additional allocation:* in Egypt, Israel, Japan, and Syria, the band 74.8-75.2 MHz is also allocated to the mobile service on a secondary basis, subject to agreement obtained under No. **9.21**. In order to ensure that harmful interference is not caused to stations of the aeronautical radionavigation service, stations of the mobile service shall not be introduced in the band until it is no longer required for the aeronautical radionavigation service by any administration which may be identified in the application of the procedure invoked under No. **9.21**. (WRC-2000)

75.2-137.175 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="4">75.2-87.5
FIXED
MOBILE except aeronautical mobile

5.175 5.179 5.184 5.187</td><td colspan="2">75.2-75.4
FIXED
MOBILE
5.179</td></tr>
<tr><td>75.4-76
FIXED
MOBILE</td><td>75.4-87
FIXED
MOBILE</td></tr>
<tr><td rowspan="2">76-88
BROADCASTING
Fixed
Mobile

5.185</td><td>5.182 5.183 5.188</td></tr>
<tr><td rowspan="2">87-100
FIXED
MOBILE
BROADCASTING</td></tr>
<tr><td>87.5-100
BROADCASTING

5.190</td><td>88-100
BROADCASTING</td></tr>
<tr><td>100-108</td><td colspan="2">BROADCASTING
5.192 5.194</td></tr>
<tr><td>108-117.975</td><td colspan="2">AERONAUTICAL RADIONAVIGATION
5.197</td></tr>
<tr><td>117.975-137</td><td colspan="2">AERONAUTICAL MOBILE (R)
5.111 5.198 5.199 5.200 5.201 5.202 5.203 5.203A 5.203B</td></tr>
<tr><td>137-137.025</td><td colspan="2">SPACE OPERATION (space-to-Earth)
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE-SATELLITE (space-to-Earth) 5.208A 5.209
SPACE RESEARCH (space-to-Earth)
Fixed
Mobile except aeronautical mobile (R)
5.204 5.205 5.206 5.207 5.208</td></tr>
<tr><td>137.025-137.175</td><td colspan="2">SPACE OPERATION (space-to-Earth)
METEOROLOGICAL-SATELLITE (space-to-Earth)
SPACE RESEARCH (space-to-Earth)
Fixed
Mobile-satellite (space-to-Earth) 5.208A 5.209
Mobile except aeronautical mobile (R)
5.204 5.205 5.206 5.207 5.208</td></tr>
</table>

5.182 *Additional allocation:* in Western Samoa, the band 75.4-87 MHz is also allocated to the broadcasting service on a primary basis.

5.183 *Additional allocation:* in China, Korea (Rep. of), Japan, the Philippines and the Dem. People's Rep. of Korea, the band 76-87 MHz is also allocated to the broadcasting service on a primary basis.

5.184 *Additional allocation:* in Bulgaria and Romania, the band 76-87.5 MHz is also allocated to the broadcasting service on a primary basis and used in accordance with the decisions contained in the Final Acts of the Special Regional Conference (Geneva, 1960). (WRC-97)

5.185 *Different category of service:* in the United States, the French Overseas Departments in Region 2, Guyana, Jamaica, Mexico and Paraguay, the allocation of the band 76-88 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**).

5.186 (SUP - WRC-97)

5.187 *Alternative allocation:* in Albania, the band 81-87.5 MHz is allocated to the broadcasting service on a primary basis and used in accordance with the decisions contained in the Final Acts of the Special Regional Conference (Geneva, 1960).

5.188 *Additional allocation:* in Australia, the band 85-87 MHz is also allocated to the broadcasting service on a primary basis. The introduction of the broadcasting service in Australia is subject to special agreements between the administrations concerned.

5.189 Not used.

5.190 *Additional allocation:* in Monaco, the band 87.5-88 MHz is also allocated to the land mobile service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-97)

5.191 Not used.

5.192 *Additional allocation:* in China and Korea (Rep. of), the band 100-108 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-97)

5.193 Not used.

5.194 *Additional allocation:* in Azerbaijan, Lebanon, Syria, Kyrgyzstan, Somalia and Turkmenistan, the band 104-108 MHz is also allocated to the mobile, except aeronautical mobile (R), service on a secondary basis. (WRC-97)

5.195 and **5.196** Not used.

5.197 *Additional allocation:* in Japan, Pakistan and Syria, the band 108-111.975 MHz is also allocated to the mobile service on a secondary basis, subject to agreement obtained under No. **9.21**. In order to ensure that harmful interference is not caused to stations of the aeronautical radionavigation service, stations of the mobile service shall not be introduced in the band until it is no longer required for the aeronautical radionavigation service by any administration which may be identified in the application of the procedures invoked under No. **9.21**. (WRC-2000)

5.198 *Additional allocation:* the band 117.975-136 MHz is also allocated to the aeronautical mobile-satellite (R) service on a secondary basis, subject to agreement obtained under No. **9.21**. (WRC-97)

5.199 The bands 121.45-121.55 MHz and 242.95-243.05 MHz are also allocated to the mobile-satellite service for the reception on board satellites of emissions from emergency position-indicating radiobeacons transmitting at 121.5 MHz and 243 MHz (see Appendix **13**).

5.200 In the band 117.975-136 MHz, the frequency 121.5 MHz is the aeronautical emergency frequency and, where required, the frequency 123.1 MHz is the aeronautical frequency auxiliary to 121.5 MHz. Mobile stations of the maritime mobile service may communicate on these frequencies under the conditions laid down in Article **31** and Appendix **13** for distress and safety purposes with stations of the aeronautical mobile service.

5.201 *Additional allocation:* in Angola, Armenia, Azerbaijan, Belarus, Bulgaria, Estonia, Georgia, Hungary, Iran (Islamic Republic of), Iraq, Japan, Kazakstan, Latvia, Moldova, Mongolia, Mozambique, Uzbekistan, Papua New Guinea, Poland, Kyrgyzstan, Slovakia, the Czech Rep., Romania, Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 132-136 MHz is also allocated to the aeronautical mobile (OR) service on a primary basis. In assigning frequencies to stations of the aeronautical mobile (OR) service, the administration shall take account of the frequencies assigned to stations in the aeronautical mobile (R) service. (WRC-97)

5.202 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Belarus, Bulgaria, the United Arab Emirates, Georgia, Iran (Islamic Republic of), Jordan, Latvia, Moldova, Oman, Uzbekistan, Poland, Syria, Kyrgyzstan, Slovakia, the Czech Rep., Romania, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 136-137 MHz is also allocated to the aeronautical mobile (OR) service on a primary basis. In assigning frequencies to stations of the aeronautical mobile (OR) service, the administration shall take account of the frequencies assigned to stations in the aeronautical mobile (R) service. (WRC-2000)

5.203 In the band 136-137 MHz, existing operational meteorological satellites may continue to operate, under the conditions defined in No. **4.4** with respect to the aeronautical mobile service, until 1 January 2002. Administrations shall not authorize new frequency assignments in this band to stations in the meteorological-satellite service. (WRC-97)

5.203A *Additional allocation:* in Israel, Mauritania, Qatar and Zimbabwe, the band 136-137 MHz is also allocated to the fixed and mobile, except aeronautical mobile (R), services on a secondary basis until 1 January 2005. (WRC-97)

5.203B *Additional allocation:* in Saudi Arabia, United Arab Emirates, Jordan, Oman and Syria, the band 136-137 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a secondary basis until 1 January 2005. (WRC-97)

5.204 *Different category of service:* in Afghanistan, Saudi Arabia, Bahrain, Bangladesh, Bosnia and Herzegovina, Brunei Darussalam, China, Cuba, the United Arab Emirates, India, Indonesia, Iran (Islamic Republic of), Iraq, Malaysia, Oman, Pakistan, Philippines, Qatar, Singapore, Sri Lanka, Thailand, Yemen and Yugoslavia, the band 137-138 MHz is allocated to the fixed and mobile, except aeronautical mobile (R), services on a primary basis (see No. **5.33**).

5.205 *Different category of service:* in Israel and Jordan, the allocation of the band 137-138 MHz to the fixed and mobile, except aeronautical mobile, services is on a primary basis (see No. **5.33**).

5.206 *Different category of service:* in Armenia, Azerbaijan, Belarus, Bulgaria, Egypt, Finland, France, Georgia, Greece, Kazakstan, Lebanon, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, Syria, Slovakia, the Czech Rep., Romania, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 137-138 MHz to the aeronautical mobile (OR) service is on a primary basis (see No. **5.33**). (WRC-2000)

5.207 *Additional allocation:* in Australia, the band 137-144 MHz is also allocated to the broadcasting service on a primary basis until that service can be accommodated within regional broadcasting allocations.

5.208 The use of the band 137-138 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-97)

5.208A In making assignments to space stations in the mobile-satellite service in the bands 137-138 MHz, 387-390 MHz and 400.15-401 MHz, administrations shall take all practicable steps to protect the radio astronomy service in the bands 150.05-153 MHz, 322-328.6 MHz, 406.1-410 MHz and 608-614 MHz from harmful interference from unwanted emissions. The threshold levels of interference detrimental to the radio astronomy service are shown in Table 1 of Recommendation ITU-R RA.769-1. (WRC-97)

5.209 The use of the bands 137-138 MHz, 148-150.05 MHz, 399.9-400.05 MHz, 400.15-401 MHz, 454-456 MHz and 459-460 MHz by the mobile-satellite service is limited to non-geostationary-satellite systems. (WRC-97)

137.175-148 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
137.175-137.825 SPACE OPERATION (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208A 5.209 SPACE RESEARCH (space-to-Earth) Fixed Mobile except aeronautical mobile (R) 5.204 5.205 5.206 5.207 5.208		
137.825-138 SPACE OPERATION (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) SPACE RESEARCH (space-to-Earth) Fixed Mobile-satellite (space-to-Earth) 5.208A 5.209 Mobile except aeronautical mobile (R) 5.204 5.205 5.206 5.207 5.208		
138-143.6 AERONAUTICAL MOBILE (OR) 5.210 5.211 5.212 5.214	**138-143.6** FIXED MOBILE RADIOLOCATION Space research (space-to-Earth)	**138-143.6** FIXED MOBILE Space research (space-to-Earth) 5.207 5.213
143.6-143.65 AERONAUTICAL MOBILE (OR) SPACE RESEARCH (space-to-Earth) 5.211 5.212 5.214	**143.6-143.65** FIXED MOBILE RADIOLOCATION SPACE RESEARCH (space-to-Earth)	**143.6-143.65** FIXED MOBILE SPACE RESEARCH (space-to-Earth) 5.207 5.213
143.65-144 AERONAUTICAL MOBILE (OR) 5.210 5.211 5.212 5.214	**143.65-144** FIXED MOBILE RADIOLOCATION Space research (space-to-Earth)	**143.65-144** FIXED MOBILE Space research (space-to-Earth) 5.207 5.213
144-146 AMATEUR AMATEUR-SATELLITE 5.216		
146-148 FIXED MOBILE except aeronautical mobile (R)	**146-148** AMATEUR 5.217	**146-148** AMATEUR FIXED MOBILE 5.217

5.210 *Additional allocation:* in France, Italy, Liechtenstein, Slovakia, the Czech Rep., the United Kingdom and Switzerland, the bands 138-143.6 MHz and 143.65-144 MHz are also allocated to the space research service (space-to-Earth) on a secondary basis. (WRC-2000)

5.211 *Additional allocation:* in Germany, Saudi Arabia, Austria, Bahrain, Belgium, Bosnia and Herzegovina, Denmark, the United Arab Emirates, Spain, Finland, Greece, Ireland, Israel, Kenya, Kuwait, The Former Yugoslav Republic of Macedonia, Liechtenstein, Luxembourg, Mali, Malta, Norway, the Netherlands, Qatar, the United Kingdom, Somalia, Sweden, Switzerland, Tanzania, Tunisia, Turkey and Yugoslavia, the band 138-144 MHz is also allocated to the maritime mobile and land mobile services on a primary basis. (WRC-2000)

5.212 *Alternative allocation:* in Angola, Botswana, Burundi, Cameroon, the Central African Rep., the Congo, Gabon, Gambia, Ghana, Guinea, Iraq, Jordan, Lesotho, Liberia, Libya, Malawi, Mozambique, Namibia, Nigeria, Oman, Dem. Rep. of the Congo, Rwanda, Sierra Leone, South Africa, Swaziland, Chad, Togo, Zambia and Zimbabwe, the band 138-144 MHz is allocated to the fixed and mobile services on a primary basis. (WRC-2000)

5.213 *Additional allocation:* in China, the band 138-144 MHz is also allocated to the radiolocation service on a primary basis.

5.214 *Additional allocation:* in Bosnia and Herzegovina, Croatia, Eritrea, Ethiopia, Kenya, The Former Yugoslav Republic of Macedonia, Malta, Somalia, Sudan, Tanzania and Yugoslavia, the band 138-144 MHz is also allocated to the fixed service on a primary basis. (WRC-2000)

5.215 Not used.

5.216 *Additional allocation:* in China, the band 144-146 MHz is also allocated to the aeronautical mobile (OR) service on a secondary basis.

5.217 *Alternative allocation:* in Afghanistan, Bangladesh, Cuba, Guyana and India, the band 146-148 MHz is allocated to the fixed and mobile services on a primary basis.

148-223 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>148-149.9
FIXED
MOBILE except aeronautical mobile (R)
MOBILE-SATELLITE (Earth-to-space) 5.209
5.218 5.219 5.221</td><td colspan="2">148-149.9
FIXED
MOBILE
MOBILE-SATELLITE (Earth-to-space) 5.209
5.218 5.219 5.221</td></tr>
<tr><td>149.9-150.05</td><td colspan="2">MOBILE-SATELLITE (Earth-to-space) 5.209 5.224A
RADIONAVIGATION-SATELLITE 5.224B
5.220 5.222 5.223</td></tr>
<tr><td>150.05-153
FIXED
MOBILE except aeronautical mobile
RADIO ASTRONOMY
5.149</td><td colspan="2" rowspan="3">150.05-156.7625
FIXED
MOBILE
5.225 5.226 5.227</td></tr>
<tr><td>153-154
FIXED
MOBILE except aeronautical mobile (R)
Meteorological Aids</td></tr>
<tr><td>154-156.7625
FIXED
MOBILE except aeronautical mobile (R)
5.226 5.227</td></tr>
<tr><td>156.7625-156.8375</td><td colspan="2">MARITIME MOBILE (distress and calling)
5.111 5.226</td></tr>
<tr><td>156.8375-174
FIXED
MOBILE except aeronautical mobile
5.226 5.229</td><td colspan="2">156.8375-174
FIXED
MOBILE
5.226 5.230 5.231 5.232</td></tr>
<tr><td rowspan="3">174-223
BROADCASTING
5.235 5.237 5.243</td><td>174-216
BROADCASTING
Fixed
Mobile
5.234</td><td rowspan="3">174-223
FIXED
MOBILE
BROADCASTING
5.233 5.238 5.240 5.245</td></tr>
<tr><td>216-220
FIXED
MARITIME MOBILE
Radiolocation 5.241
5.242</td></tr>
<tr><td></td></tr>
</table>

5.218 *Additional allocation:* the band 148-149.9 MHz is also allocated to the space operation service (Earth-to-space) on a primary basis, subject to agreement obtained under No. **9.21**. The bandwidth of any individual transmission shall not exceed ± 25 kHz.

5.219 The use of the band 148-149.9 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. The mobile-satellite service shall not constrain the development and use of the fixed, mobile and space operation services in the band 148-149.9 MHz.

5.220 The use of the bands 149.9-150.05 MHz and 399.9-400.05 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. The mobile-satellite service shall not constrain the development and use of the radionavigation-satellite service in the bands 149.9-150.05 MHz and 399.9-400.05 MHz. (WRC-97)

5.221 Stations of the mobile-satellite service in the band 148-149.9 MHz shall not cause harmful interference to, or claim protection from, stations of the fixed or mobile services operating in accordance with the Table of Frequency Allocations in the following countries: Albania, Algeria, Germany, Saudi Arabia, Australia, Austria, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Benin, Bosnia and Herzegovina, Brunei Darussalam, Bulgaria, Cameroon, China, Cyprus, Congo, Korea (Rep. of), Croatia, Cuba, Denmark, Egypt, the United Arab Emirates, Eritrea, Spain, Estonia, Ethiopia, Finland, France, Gabon, Ghana, Greece, Guinea, Guinea Bissau, Hungary, India, Iran (Islamic Republic of), Ireland, Iceland, Israel, Italy, Jamaica, Japan, Jordan, Kazakstan, Kenya, Kuwait, Latvia, The Former Yugoslav Republic of Macedonia, Lebanon, Libya, Liechtenstein, Lithuania, Luxembourg, Malaysia, Mali, Malta, Mauritania, Moldova, Mongolia, Mozambique, Namibia, Norway, New Zealand, Oman, Uganda, Uzbekistan, Pakistan, Panama, Papua New Guinea, Paraguay, the Netherlands, the Philippines, Poland, Portugal, Qatar, Syria, Kyrgyzstan, Slovakia, Romania, the United Kingdom, the Russian Federation, Senegal, Sierra Leone, Singapore, Slovenia, Sri Lanka, South Africa, Sweden, Switzerland, Swaziland, Tanzania, Chad, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Ukraine, Viet Nam, Yemen, Yugoslavia, Zambia, and Zimbabwe. (WRC-2000)

5.222 Emissions of the radionavigation-satellite service in the bands 149.9-150.05 MHz and 399.9-400.05 MHz may also be used by receiving earth stations of the space research service.

5.223 Recognizing that the use of the band 149.9-150.05 MHz by the fixed and mobile services may cause harmful interference to the radionavigation-satellite service, administrations are urged not to authorize such use in application of No. **4.4**.

5.224 (SUP - WRC-97)

5.224A The use of the bands 149.9-150.05 MHz and 399.9-400.05 MHz by the mobile-satellite service (Earth-to-space) is limited to the land mobile-satellite service (Earth-to-space) until 1 January 2015. (WRC-97)

5.224B The allocation of the bands 149.9-150.05 MHz and 399.9-400.05 MHz to the radionavigation-satellite service shall be effective until 1 January 2015. (WRC-97)

5.225 *Additional allocation:* in Australia and India, the band 150.05-153 MHz is also allocated to the radio astronomy service on a primary basis.

5.226 The frequency 156.8 MHz is the international distress, safety and calling frequency for the maritime mobile VHF radiotelephone service. The conditions for the use of this frequency are contained in Article **31** and Appendix **13**.

In the bands 156-156.7625 MHz, 156.8375-157.45 MHz, 160.6-160.975 MHz and 161.475-162.05 MHz, each administration shall give priority to the maritime mobile service on only such frequencies as are assigned to stations of the maritime mobile service by the administration (see Articles **31** and **52**, and Appendix **13**).

Any use of frequencies in these bands by stations of other services to which they are allocated should be avoided in areas where such use might cause harmful interference to the maritime mobile VHF radiocommunication service.

However, the frequency 156.8 MHz and the frequency bands in which priority is given to the maritime mobile service may be used for radiocommunications on inland waterways subject to agreement between interested and affected administrations and taking into account current frequency usage and existing agreements.

5.227 In the maritime mobile VHF service the frequency 156.525 MHz is to be used exclusively for digital selective calling for distress, safety and calling. The conditions for the use of this frequency are prescribed in Articles **31** and **52**, and Appendices **13** and **18**.

5.228 Not used.

5.229 *Alternative allocation:* in Morocco, the band 162-174 MHz is allocated to the broadcasting service on a primary basis. The use of this band shall be subject to agreement with administrations having services, operating or planned, in accordance with the Table which are likely to be affected. Stations in existence on 1 January 1981, with their technical characteristics as of that date, are not affected by such agreement.

5.230 *Additional allocation:* in China, the band 163-167 MHz is also allocated to the space operation service (space-to-Earth) on a primary basis, subject to agreement obtained under No. **9.21**.

5.231 *Additional allocation:* in Afghanistan, China and Pakistan, the band 167-174 MHz is also allocated to the broadcasting service on a primary basis. The introduction of the broadcasting service into this band shall be subject to agreement with the neighbouring countries in Region 3 whose services are likely to be affected.

5.232 *Additional allocation:* in Japan, the band 170-174 MHz is also allocated to the broadcasting service on a primary basis.

5.233 *Additional allocation:* in China, the band 174-184 MHz is also allocated to the space research (space-to-Earth) and the space operation (space-to-Earth) services on a primary basis, subject to agreement obtained under No. **9.21**. These services shall not cause harmful interference to, or claim protection from, existing or planned broadcasting stations.

5.234 *Different category of service:* in Mexico, the allocation of the band 174-216 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**).

5.235 *Additional allocation:* in Germany, Austria, Belgium, Denmark, Spain, Finland, France, Israel, Italy, Liechtenstein, Malta, Monaco, Norway, the Netherlands, the United Kingdom, Sweden and Switzerland, the band 174-223 MHz is also allocated to the land mobile service on a primary basis. However, the stations of the land mobile service shall not cause harmful interference to, or claim protection from, broadcasting stations, existing or planned, in countries other than those listed in this footnote.

5.236 Not used.

5.237 *Additional allocation:* in the Congo, Eritrea, Ethiopia, Gambia, Guinea, Libya, Malawi, Mali, Senegal, Sierra Leone, Somalia, Tanzania and Zimbabwe, the band 174-223 MHz is also allocated to the fixed and mobile services on a secondary basis. (WRC-97)

5.238 *Additional allocation:* in Bangladesh, India, Pakistan and the Philippines, the band 200-216 MHz is also allocated to the aeronautical radionavigation service on a primary basis.

5.239 Not used.

5.240 *Additional allocation:* in China and India, the band 216-223 MHz is also allocated to the aeronautical radionavigation service on a primary basis and to the radiolocation service on a secondary basis.

5.241 In Region 2, no new stations in the radiolocation service may be authorized in the band 216-225 MHz. Stations authorized prior to 1 January 1990 may continue to operate on a secondary basis.

5.242 *Additional allocation:* in Canada, the band 216-220 MHz is also allocated to the land mobile service on a primary basis.

5.243 *Additional allocation:* in Somalia, the band 216-225 MHz is also allocated to the aeronautical radionavigation service on a primary basis, subject to not causing harmful interference to existing or planned broadcasting services in other countries.

5.244 (SUP - WRC-97)

5.245 *Additional allocation:* in Japan, the band 222-223 MHz is also allocated to the aeronautical radionavigation service on a primary basis and to the radiolocation service on a secondary basis.

220-335.4 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td></td><td>220-225
AMATEUR
FIXED
MOBILE
Radiolocation 5.241</td><td></td></tr>
<tr><td>223-230
BROADCASTING
Fixed
Mobile

5.243 5.246 5.247</td><td>225-235
FIXED
MOBILE</td><td>223-230
FIXED
MOBILE
BROADCASTING
AERONAUTICAL
RADIONAVIGATION
Radiolocation
5.250</td></tr>
<tr><td>230-235
FIXED
MOBILE

5.247 5.251 5.252</td><td></td><td>230-235
FIXED
MOBILE
AERONAUTICAL
RADIONAVIGATION
5.250</td></tr>
<tr><td>235-267</td><td colspan="2">FIXED
MOBILE
5.111 5.199 5.252 5.254 5.256</td></tr>
<tr><td>267-272</td><td colspan="2">FIXED
MOBILE
Space operation (space-to-Earth)
5.254 5.257</td></tr>
<tr><td>272-273</td><td colspan="2">SPACE OPERATION (space-to-Earth)
FIXED
MOBILE
5.254</td></tr>
<tr><td>273-312</td><td colspan="2">FIXED
MOBILE
5.254</td></tr>
<tr><td>312-315</td><td colspan="2">FIXED
MOBILE
Mobile-satellite (Earth-to-space) 5.254 5.255</td></tr>
<tr><td>315-322</td><td colspan="2">FIXED
MOBILE
5.254</td></tr>
<tr><td>322-328.6</td><td colspan="2">FIXED
MOBILE
RADIO ASTRONOMY
5.149</td></tr>
<tr><td>328.6-335.4</td><td colspan="2">AERONAUTICAL RADIONAVIGATION
5.258 5.259</td></tr>
</table>

5.246 *Alternative allocation:* in Spain, France, Israel and Monaco, the band 223-230 MHz is allocated to the broadcasting and land mobile services on a primary basis (see No. **5.33**) on the basis that, in the preparation of frequency plans, the broadcasting service shall have prior choice of frequencies; and allocated to the fixed and mobile, except land mobile, services on a secondary basis. However, the stations of the land mobile service shall not cause harmful interference to, or claim protection from, existing or planned broadcasting stations in Morocco and Algeria.

5.247 *Additional allocation:* in Saudi Arabia, Bahrain, the United Arab Emirates, Jordan, Oman, Qatar and Syria, the band 223-235 MHz is also allocated to the aeronautical radionavigation service on a primary basis.

5.248 and **5.249** Not used.

5.250 *Additional allocation*: in China, the band 225-235 MHz is also allocated to the radio astronomy service on a secondary basis.

5.251 *Additional allocation:* in Nigeria, the band 230-235 MHz is also allocated to the aeronautical radionavigation service on a primary basis, subject to agreement obtained under No. **9.21**.

5.252 *Alternative allocation:* in Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe, the bands 230-238 MHz and 246-254 MHz are allocated to the broadcasting service on a primary basis, subject to agreement obtained under No. **9.21**.

5.253 Not used.

5.254 The bands 235-322 MHz and 335.4-399.9 MHz may be used by the mobile-satellite service, subject to agreement obtained under No. **9.21**, on condition that stations in this service do not cause harmful interference to those of other services operating or planned to be operated in accordance with the Table of Frequency Allocations.

5.255 The bands 312-315 MHz (Earth-to-space) and 387-390 MHz (space-to-Earth) in the mobile-satellite service may also be used by non-geostationary-satellite systems. Such use is subject to coordination under No. **9.11A**.

5.256 The frequency 243 MHz is the frequency in this band for use by survival craft stations and equipment used for survival purposes (see Appendix **13**).

5.257 The band 267-272 MHz may be used by administrations for space telemetry in their countries on a primary basis, subject to agreement obtained under No. **9.21**.

5.258 The use of the band 328.6-335.4 MHz by the aeronautical radionavigation service is limited to Instrument Landing Systems (glide path).

5.259 *Additional allocation:* in Egypt, Israel, Japan, and Syria, the band 328.6-335.4 MHz is also allocated to the mobile service on a secondary basis, subject to agreement obtained under No. **9.21**. In order to ensure that harmful interference is not caused to stations of the aeronautical radionavigation service, stations of the mobile service shall not be introduced in the band until it is no longer required for the aeronautical radionavigation service by any administration which may be identified in the application of the procedure invoked under No. **9.21**. (WRC-2000)

335.4-410 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
335.4-387	FIXED MOBILE 5.254	
387-390	FIXED MOBILE Mobile-satellite (space-to-Earth) 5.208A 5.254 5.255	
390-399.9	FIXED MOBILE 5.254	
399.9-400.05	MOBILE-SATELLITE (Earth-to-space) 5.209 5.224A RADIONAVIGATION-SATELLITE 5.222 5.224B 5.260 5.220	
400.05-400.15	STANDARD FREQUENCY AND TIME SIGNAL-SATELLITE (400.1 MHz) 5.261 5.262	
400.15-401	METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208A 5.209 SPACE RESEARCH (space-to-Earth) 5.263 Space operation (space-to-Earth) 5.262 5.264	
401-402	METEOROLOGICAL AIDS SPACE OPERATION (space-to-Earth) EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) Fixed Mobile except aeronautical mobile	
402-403	METEOROLOGICAL AIDS EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) Fixed Mobile except aeronautical mobile	
403-406	METEOROLOGICAL AIDS Fixed Mobile except aeronautical mobile	
406-406.1	MOBILE-SATELLITE (Earth-to-space) 5.266 5.267	
406.1-410	FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY 5.149	

5.260 Recognizing that the use of the band 399.9-400.05 MHz by the fixed and mobile services may cause harmful interference to the radionavigation satellite service, administrations are urged not to authorize such use in application of No. **4.4**.

5.261 Emissions shall be confined in a band of ± 25 kHz about the standard frequency 400.1 MHz.

5.262 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Bosnia and Herzegovina, Bulgaria, Colombia, Costa Rica, Cuba, Egypt, the United Arab Emirates, Ecuador, Georgia, Hungary, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kazakstan, Kuwait, Liberia, Malaysia, Moldova, Nigeria, Uzbekistan, Pakistan, the Philippines, Qatar, Syria, Kyrgyzstan, Slovakia, Romania, the Russian Federation, Singapore, Somalia, Tajikistan, Turkmenistan, Ukraine and Yugoslavia, the band 400.05-401 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-2000)

5.263 The band 400.15-401 MHz is also allocated to the space research service in the space-to-space direction for communications with manned space vehicles. In this application, the space research service will not be regarded as a safety service.

5.264 The use of the band 400.15-401 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. The power flux-density limit indicated in Annex 1 of Appendix **5** shall apply until such time as a competent world radiocommunication conference revises it.

5.265 Not used.

5.266 The use of the band 406-406.1 MHz by the mobile-satellite service is limited to low power satellite emergency position-indicating radiobeacons (see also Article **31** and Appendix **13**).

5.267 Any emission capable of causing harmful interference to the authorized uses of the band 406-406.1 MHz is prohibited.

410-470 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
410-420	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-space) 5.268	
420-430	FIXED MOBILE except aeronautical mobile Radiolocation 5.269 5.270 5.271	
430-440 AMATEUR RADIOLOCATION 5.138 5.271 5.272 5.273 5.274 5.275 5.276 5.277 5.280 5.281 5.282 5.283	**430-440** RADIOLOCATION Amateur 5.271 5.276 5.277 5.278 5.279 5.281 5.282	
440-450	FIXED MOBILE except aeronautical mobile Radiolocation 5.269 5.270 5.271 5.284 5.285 5.286	
450-455	FIXED MOBILE 5.209 5.271 5.286 5.286A 5.286B 5.286C 5.286D 5.286E	
455-456 FIXED MOBILE 5.209 5.271 5.286A 5.286B 5.286C 5.286E	**455-456** FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.286A 5.286B 5.286C 5.209	**455-456** FIXED MOBILE 5.209 5.271 5.286A 5.286B 5.286C 5.286E
456-459	FIXED MOBILE 5.271 5.287 5.288	
459-460 FIXED MOBILE 5.209 5.271 5.286A 5.286B 5.286C 5.286E	**459-460** FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.286A 5.286B 5.286C 5.209	**459-460** FIXED MOBILE 5.209 5.271 5.286A 5.286B 5.286C 5.286E
460-470	FIXED MOBILE Meteorological-Satellite (space-to-Earth) 5.287 5.288 5.289 5.290	

5.268 Use of the band 410-420 MHz by the space research service is limited to communications within 5 km of an orbiting, manned space vehicle. The power flux-density at the surface of the Earth produced by emissions from extra-vehicular activities shall not exceed –153 dB(W/m^2) for $0° \le \delta \le 5°$, $-153 + 0.077\ (\delta - 5)$ dB(W/m^2) for $5° \le \delta \le 70°$ and –148 dB(W/m^2) for $70° \le \delta \le 90^o$, where δ is the angle of arrival of the radio-frequency wave and the reference bandwidth is 4 kHz. No. **4.10** does not apply to extra-vehicular activities. In this frequency band the space research (space-to-space) service shall not claim protection from, nor constrain the use and development of, stations of the fixed and mobile services. (WRC-97)

5.269 *Different category of service:* in Australia, the United States, India, Japan and the United Kingdom, the allocation of the bands 420-430 MHz and 440-450 MHz to the radiolocation service is on a primary basis (see No. **5.33**).

5.270 *Additional allocation:* in Australia, the United States, Jamaica and the Philippines, the bands 420-430 MHz and 440-450 MHz are also allocated to the amateur service on a secondary basis.

5.271 *Additional allocation:* in Azerbaijan, Belarus, China, Estonia, India, Latvia, Lithuania, Kyrgyzstan and Turkmenistan, the band 420-460 MHz is also allocated to the aeronautical radionavigation service (radio altimeters) on a secondary basis. (WRC-2000)

5.272 *Different category of service:* in France, the allocation of the band 430-434 MHz to the amateur service is on a secondary basis (see No. **5.32**).

5.273 *Different category of service:* in Denmark, Libya and Norway, the allocation of the bands 430-432 MHz and 438-440 MHz to the radiolocation service is on a secondary basis (see No. **5.32**).

5.274 *Alternative allocation:* in Denmark, Norway and Sweden, the bands 430-432 MHz and 438-440 MHz are allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis.

5.275 *Additional allocation:* in Bosnia and Herzegovina, Croatia, Estonia, Finland, Latvia, The Former Yugoslav Republic of Macedonia, Libya, Slovenia and Yugoslavia, the bands 430-432 MHz and 438-440 MHz are also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-97)

5.276 *Additional allocation:* in Afghanistan, Algeria, Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Burkina Faso, Burundi, Egypt, the United Arab Emirates, Ecuador, Eritrea, Ethiopia, Greece, Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Italy, Jordan, Kenya, Kuwait, Lebanon, Libya, Liechtenstein, Malaysia, Malta, Nigeria, Oman, Pakistan, the Philippines, Qatar, Syria, the Dem. People's Rep. of Korea, Singapore, Somalia, Switzerland, Tanzania, Thailand, Togo, Turkey and Yemen, the band 430-440 MHz is also allocated to the fixed service on a primary basis and the bands 430-435 MHz and 438-

440 MHz are also allocated to the mobile, except aeronautical mobile, service on a primary basis. (WRC-97)

5.277 *Additional allocation:* in Angola, Armenia, Azerbaijan, Belarus, Cameroon, Congo, Djibouti, Georgia, Hungary, Israel, Kazakstan, Latvia, Mali, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, Slovakia, the Czech Rep., Romania, the Russian Federation, Rwanda, Tajikistan, Chad, Turkmenistan and Ukraine, the band 430-440 MHz is also allocated to the fixed service on a primary basis. (WRC-2000)

5.278 *Different category of service:* in Argentina, Colombia, Costa Rica, Cuba, Guyana, Honduras, Panama and Venezuela, the allocation of the band 430-440 MHz to the amateur service is on a primary basis (see No. **5.33**).

5.279 *Additional allocation:* in Mexico, the bands 430-435 MHz and 438-440 MHz are also allocated on a primary basis to the land mobile service, subject to agreement obtained under No. **9.21**.

5.280 In Germany, Austria, Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Liechtenstein, Portugal, Slovenia, Switzerland and Yugoslavia, the band 433.05-434.79 MHz (centre frequency 433.92 MHz) is designated for industrial, scientific and medical (ISM) applications. Radiocommunication services of these countries operating within this band must accept harmful interference which may be caused by these applications. ISM equipment operating in this band is subject to the provisions of No. **15.13**.

5.281 *Additional allocation:* in the French Overseas Departments in Region 2 and India, the band 433.75-434.25 MHz is also allocated to the space operation service (Earth-to-space) on a primary basis. In France and in Brazil, the band is allocated to the same service on a secondary basis.

5.282 In the bands 435-438 MHz, 1 260-1 270 MHz, 2 400-2 450 MHz, 3 400-3 410 MHz (in Regions 2 and 3 only) and 5 650-5 670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. **5.43**). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. **25.11**. The use of the bands 1 260-1 270 MHz and 5 650-5 670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.

5.283 *Additional allocation:* in Austria, the band 438-440 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis.

5.284 *Additional allocation:* in Canada, the band 440-450 MHz is also allocated to the amateur service on a secondary basis.

5.285 *Different category of service:* in Canada, the allocation of the band 440-450 MHz to the radiolocation service is on a primary basis (see No. **5.33**).

5.286 The band 449.75-450.25 MHz may be used for the space operation service (Earth-to-space) and the space research service (Earth-to-space), subject to agreement obtained under No. **9.21**.

5.286A The use of the bands 454-456 MHz and 459-460 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-97)

5.286B The use of the band 454-455 MHz in the countries listed in No. **5.286D**, 455-456 MHz and 459-460 MHz in Region 2, and 454-456 MHz and 459-460 MHz in the countries listed in No. **5.286E**, by stations in the mobile-satellite service, shall not cause harmful interference to, or claim protection from, stations of the fixed or mobile services operating in accordance with the Table of Frequency Allocations. (WRC-97)

5.286C The use of the band 454-455 MHz in the countries listed in No. **5.286D**, 455-456 MHz and 459-460 MHz in Region 2, and 454-456 MHz and 459-460 MHz in the countries listed in No. **5.286E**, by stations in the mobile-satellite service, shall not constrain the development and use of the fixed and mobile services operating in accordance with the Table of Frequency Allocations. (WRC-97)

5.286D *Additional allocation:* in Canada, the United States, Mexico and Panama, the band 454-455 MHz is also allocated to the mobile-satellite service (Earth-to-space) on a primary basis. (WRC-97)

5.286E *Additional allocation:* in Cape Verde, Indonesia, Nepal, Nigeria and Papua New Guinea, the bands 454-456 MHz and 459-460 MHz are also allocated to the mobile-satellite (Earth-to-space) service on a primary basis. (WRC-97)

5.287 In the maritime mobile service, the frequencies 457.525 MHz, 457.550 MHz, 457.575 MHz, 467.525 MHz, 467.550 MHz and 467.575 MHz may be used by on-board communication stations. Where needed, equipment designed for 12.5 kHz channel spacing using also the additional frequencies 457.5375 MHz, 457.5625 MHz, 467.5375 MHz and 467.5625 MHz may be introduced for on-board communications. The use of these frequencies in territorial waters may be subject to the national regulations of the administration concerned. The characteristics of the equipment used shall conform to those specified in Recommendation ITU-R M.1174 (see Resolution **341 (WRC-97)**). (WRC-97)

5.288 In the territorial waters of the United States and the Philippines, the preferred frequencies for use by on-board communication stations shall be 457.525 MHz, 457.550 MHz, 457.575 MHz and 457.600 MHz paired, respectively, with 467.750 MHz, 467.775 MHz, 467.800 MHz and 467.825 MHz. The characteristics of the equipment used shall conform to those specified in Recommendation ITU-R M.1174.

5.289 Earth exploration-satellite service applications, other than the meteorological-satellite service, may also be used in the bands 460-470 MHz and 1 690-1 710 MHz for space-to-Earth transmissions subject to not causing harmful interference to stations operating in accordance with the Table.

5.290 *Different category of service:* in Afghanistan, Azerbaijan, Belarus, China, Japan, Mongolia, Uzbekistan, Kyrgyzstan, Slovakia, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 460-470 MHz to the meteorological-satellite service (space-to-Earth) is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. (WRC-2000)

470-890 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="6">470-790
BROADCASTING

5.149 5.291A 5.294 5.296
5.300 5.302 5.304 5.306
5.311 5.312</td><td>470-512
BROADCASTING
Fixed
Mobile
5.292 5.293</td><td rowspan="2">470-585
FIXED
MOBILE
BROADCASTING

5.291 5.298</td></tr>
<tr><td rowspan="2">512-608
BROADCASTING
5.297</td></tr>
<tr><td rowspan="2">585-610
FIXED
MOBILE
BROADCASTING
RADIONAVIGATION
5.149 5.305 5.306 5.307</td></tr>
<tr><td rowspan="2">608-614
RADIO ASTRONOMY
Mobile-satellite except aeronautical mobile-satellite (Earth-to-space)</td></tr>
<tr><td rowspan="5">610-890
FIXED
MOBILE 5.317A
BROADCASTING

5.149 5.305 5.306 5.307
5.311 5.320</td></tr>
<tr><td rowspan="2">614-806
BROADCASTING
Fixed
Mobile

5.293 5.309 5.311</td></tr>
<tr><td rowspan="2">790-862
FIXED
BROADCASTING
5.312 5.314 5.315 5.316
5.319 5.321</td></tr>
<tr><td rowspan="2">806-890
FIXED
MOBILE 5.317A
BROADCASTING

5.317 5.318</td></tr>
<tr><td>862-890
FIXED
MOBILE except aeronautical mobile 5.317A
BROADCASTING 5.322

5.319 5.323</td></tr>
</table>

5.291 *Additional allocation:* in China, the band 470-485 MHz is also allocated to the space research (space-to-Earth) and the space operation (space-to-Earth) services on a primary basis subject to agreement obtained under No. **9.21** and subject to not causing harmful interference to existing and planned broadcasting stations.

5.291A *Additional allocation:* in Germany, Austria, Denmark, Estonia, Finland, Liechtenstein, Norway, Netherlands, the Czech Rep. and Switzerland, the band 470-494 MHz is also allocated to the radiolocation service on a secondary basis. This use is limited to the operation of wind profiler radars in accordance with Resolution **217 (WRC-97)**. (WRC-97)

5.292 *Different category of service:* in Mexico and Venezuela, the allocation of the band 470-512 MHz to the fixed and mobile services, and in Argentina and Uruguay to the mobile service, is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**.

5.293 *Different category of service:* in Canada, Chile, Colombia, Cuba, the United States, Guyana, Honduras, Jamaica, Mexico, Panama and Peru, the allocation of the bands 470-512 MHz and 614-806 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. In Argentina and Ecuador, the allocation of the band 470-512 MHz to the fixed and mobile services is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**. (WRC-2000)

5.294 *Additional allocation:* in Burundi, Cameroon, the Congo, Ethiopia, Israel, Kenya, Lebanon, Libya, Malawi, Senegal, Sudan, Syria, and Yemen, the band 470-582 MHz is also allocated to the fixed service on a secondary basis.

5.295 Not used.

5.296 *Additional allocation:* in Germany, Austria, Belgium, Cyprus, Denmark, Spain, Finland, France, Ireland, Israel, Italy, Libya, Lithuania, Malta, Morocco, Monaco, Norway, the Netherlands, Portugal, Syria, the United Kingdom, Sweden, Switzerland, Swaziland and Tunisia, the band 470-790 MHz is also allocated on a secondary basis to the land mobile service, intended for applications ancillary to broadcasting. Stations of the land mobile service in the countries listed in this footnote shall not cause harmful interference to existing or planned stations operating in accordance with the Table in countries other than those listed in this footnote. (WRC-2000)

5.297 *Additional allocation:* in Costa Rica, Cuba, El Salvador, the United States, Guatemala, Guyana, Honduras, Jamaica and Mexico, the band 512-608 MHz is also allocated to the fixed and mobile services on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-2000)

5.298 *Additional allocation:* in India, the band 549.75-550.25 MHz is also allocated to the space operation service (space-to-Earth) on a secondary basis.

5.299 Not used.

5.300 *Additional allocation:* in Israel, Libya, Syria and Sudan, the band 582-790 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a secondary basis.

5.301 Not used.

5.302 *Additional allocation:* in the United Kingdom, the band 590-598 MHz is also allocated to the aeronautical radionavigation service on a primary basis. All new assignments to stations in the aeronautical radionavigation service, including those transferred from the adjacent bands, shall be subject to coordination with the Administrations of the following countries: Germany, Belgium, Denmark, Spain, France, Ireland, Luxembourg, Morocco, Norway and the Netherlands.

5.303 Not used.

5.304 *Additional allocation:* in the African Broadcasting Area (see Nos. **5.10** to **5.13**), the band 606-614 MHz is also allocated to the radio astronomy service on a primary basis.

5.305 *Additional allocation:* in China, the band 606-614 MHz is also allocated to the radio astronomy service on a primary basis.

5.306 *Additional allocation:* in Region 1, except in the African Broadcasting Area (see Nos. **5.10** to **5.13**), and in Region 3, the band 608-614 MHz is also allocated to the radio astronomy service on a secondary basis.

5.307 *Additional allocation:* in India, the band 608-614 MHz is also allocated to the radio astronomy service on a primary basis.

5.308 Not used.

5.309 *Different category of service*: in Costa Rica, El Salvador and Honduras, the allocation of the band 614-806 MHz to the fixed service is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**.

5.310 (SUP - WRC-97)

5.311 Within the frequency band 620-790 MHz, assignments may be made to television stations using frequency modulation in the broadcasting-satellite service subject to agreement between the administrations concerned and those having services, operating in accordance with the Table, which may be affected (see Resolutions **33 (Rev.WRC-97)** and **507**). Such stations shall not produce a power flux-density in excess of the value –129 dB(W/m^2) for angles of arrival less than 20° (see Recommendation **705**) within the territories of other countries without the consent of the administrations of those countries.

5.312 *Additional allocation*: in Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Hungary, Kazakstan, Latvia, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, Slovakia, the Czech Rep., Romania, Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 645-862 MHz is also allocated to the aeronautical radionavigation service on a primary basis. (WRC-97)

5.313 (SUP - WRC-97)

5.314 *Additional allocation*: in Austria, Italy, Moldova, Uzbekistan, the United Kingdom and Swaziland, the band 790-862 MHz is also allocated to the land mobile service on a secondary basis. (WRC-2000)

5.315 *Alternative allocation*: in Greece, Italy and Tunisia, the band 790-838 MHz is allocated to the broadcasting service on a primary basis. (WRC-2000)

5.316 *Additional allocation*: in Germany, Saudi Arabia, Bosnia and Herzegovina, Burkina Faso, Cameroon, Côte d'Ivoire, Croatia, Denmark, Egypt, Finland, Israel, Kenya, The Former Yugoslav Republic of Macedonia, Libya, Liechtenstein, Monaco, Norway, the Netherlands, Portugal, Syria, Sweden, Switzerland and Yugoslavia, the band 790-830 MHz, and in these same countries and in Spain, France, Gabon and Malta, the band 830-862 MHz, are also allocated to the mobile, except aeronautical mobile, service on a primary basis. However, stations of the mobile service in the countries mentioned in connection with each band referred to in this footnote shall not cause harmful interference to, or claim protection from, stations of services operating in accordance with the Table in countries other than those mentioned in connection with the band. (WRC-2000)

5.317 *Additional allocation*: in Region 2 (except Brazil and the United States), the band 806-890 MHz is also allocated to the mobile-satellite service on a primary basis, subject to agreement obtained under No. **9.21**. The use of this service is intended for operation within national boundaries.

5.317A Administrations wishing to implement International Mobile Telecommunications-2000 (IMT-2000) may use those parts of the band 806-960 MHz which are allocated to the mobile service on a primary basis and are used or planned to be used for mobile systems (see Resolution **224 (WRC-2000)**). This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-2000)

5.318 *Additional allocation*: in Canada, the United States and Mexico, the bands 849-851 MHz and 894-896 MHz are also allocated to the aeronautical mobile service on a primary basis, for public correspondence with aircraft. The use of the band 849-851 MHz is limited to transmissions from aeronautical stations and the use of the band 894-896 MHz is limited to transmissions from aircraft stations.

5.319 *Additional allocation*: in Belarus, Russian Federation and Ukraine, the bands 806-840 MHz (Earth-to-space) and 856-890 MHz (space-to-Earth) are also allocated to the mobile-satellite, except aeronautical mobile-satellite (R), service. The use of these bands by this service shall not cause harmful interference to, or claim protection from, services in other countries operating in accordance with the Table of Frequency Allocations and is subject to special agreements between the administrations concerned.

5.320 *Additional allocation*: in Region 3, the bands 806-890 MHz and 942-960 MHz are also allocated to the mobile-satellite, except aeronautical mobile-satellite (R), service on a primary basis, subject to agreement obtained under No. **9.21**. The use of this service is limited

to operation within national boundaries. In seeking such agreement, appropriate protection shall be afforded to services operating in accordance with the Table, to ensure that no harmful interference is caused to such services.

5.321 *Alternative allocation*: in Italy, the band 838-854 MHz is allocated to the broadcasting service on a primary basis as from 1 January 1995.

5.322 In Region 1, in the band 862-960 MHz, stations of the broadcasting service shall be operated only in the African Broadcasting Area (see Nos. **5.10** to **5.13**) excluding Algeria, Egypt, Spain, Libya, Morocco, Namibia, Nigeria, South Africa, Tanzania, Zimbabwe and Zambia, subject to agreement obtained under No. **9.21**. (WRC-2000)

5.323 *Additional allocation*: in Armenia, Azerbaijan, Belarus, Bulgaria, Hungary, Kazakstan, Latvia, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, Slovakia, the Czech Rep., Romania, Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 862-960 MHz is also allocated to the aeronautical radionavigation service on a primary basis. Such use is subject to agreement obtained under No. **9.21** with administrations concerned and limited to ground-based radiobeacons in operation on 27 October 1997 until the end of their lifetime. (WRC-97)

890-1 260 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
890-942 FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-902** FIXED MOBILE except aeronautical mobile 5.317A Radiolocation 5.318 5.325 **902-928** FIXED Amateur Mobile except aeronautical mobile 5.325A Radiolocation 5.150 5.325 5.326 **928-942** FIXED MOBILE except aeronautical mobile 5.317A Radiolocation 5.325	**890-942** FIXED MOBILE 5.317A BROADCASTING Radiolocation 5.327
942-960 FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.323	**942-960** FIXED MOBILE 5.317A	**942-960** FIXED MOBILE 5.317A BROADCASTING 5.320
960-1 215	AERONAUTICAL RADIONAVIGATION 5.328 5.328A	
1 215-1 240	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.329 5.329A SPACE RESEARCH (active) 5.330 5.331 5.332	
1 240-1 260	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.329 5.329A SPACE RESEARCH (active) Amateur 5.330 5.331 5.332 5.334 5.335	

5.324 Not used.

5.325 *Different category of service*: in the United States, the allocation of the band 890-942 MHz to the radiolocation service is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21**.

5.325A *Different category of service:* in Cuba, the allocation of the band 902-915 MHz to the land mobile service is on a primary basis. (WRC-2000)

5.326 *Different category of service*: in Chile, the band 903-905 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis, subject to agreement obtained under No. **9.21**.

5.327 *Different category of service*: in Australia, the allocation of the band 915-928 MHz to the radiolocation service is on a primary basis (see No. **5.33**).

5.328 The use of the band 960-1 215 MHz by the aeronautical radionavigation service is reserved on a worldwide basis for the operation and development of airborne electronic aids to air navigation and any directly associated ground-based facilities. (WRC-2000)

5.328A *Additional allocation:* the band 1 164-1 215 MHz is also allocated to the radionavigation-satellite service (space-to-Earth) (space-to-space) on a primary basis. The aggregate power flux-density produced by all the space stations of all radionavigation-satellite systems at the Earth's surface shall not exceed the provisional value of –115 dB(W/m^2) in any 1 MHz band for all angles of arrival. Stations in the radionavigation-satellite service shall not cause harmful interference to, nor claim protection from, stations of the aeronautical-radionavigation service. The provisions of Resolution **605 (WRC-2000)** apply. (WRC-2000)

5.329 Use of the radionavigation-satellite service in the band 1 215-1 300 MHz shall be subject to the condition that no harmful interference is caused to, and no protection is claimed from, the radionavigation service authorized under No. **5.331**. See also Resolution **606 (WRC-2000)**. (WRC-2000)

5.329A Use of systems in the radionavigation-satellite service (space-to-space) operating in the bands 1 215-1 300 MHz and 1 559-1 610 MHz is not intended to provide safety service applications, and shall not impose any additional constraints on other systems or services operating in accordance with the Table. (WRC-2000)

5.330 *Additional allocation:* in Angola, Saudi Arabia, Bahrain, Bangladesh, Cameroon, China, the United Arab Emirates, Eritrea, Ethiopia, Guyana, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Lebanon, Libya, Morocco, Mozambique, Nepal, Nigeria, Pakistan, the Philippines, Qatar, Syria, Somalia, Sudan, Sri Lanka, Chad, Togo and Yemen, the band 1 215-1 300 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-97)

5.331 *Additional allocation:* in Algeria, Germany, Austria, Bahrain, Belgium, Benin, Bosnia and Herzegovina, Burundi, Cameroon, China, Croatia, Denmark, the United Arab Emirates, France, Greece, India, Iran (Islamic Republic of), Iraq, Kenya, The Former Yugoslav Republic of Macedonia, Liechtenstein, Luxembourg, Mali, Mauritania, Norway, Oman, the Netherlands, Portugal, Qatar, Senegal, Slovenia, Somalia, Sudan, Sri Lanka, Sweden, Switzerland, Turkey and Yugoslavia, the band 1 215-1 300 MHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.332 In the band 1 215-1 260 MHz, active spaceborne sensors in the Earth exploration-satellite and space research services shall not cause harmful interference to, claim protection from, or otherwise impose constraints on operation or development of the radiolocation service, the radionavigation-satellite service and other services allocated on a primary basis. (WRC-2000)

5.333 (SUP - WRC-97)

5.334 *Additional allocation:* in Canada and the United States, the bands 1 240-1 300 MHz and 1 350-1 370 MHz are also allocated to the aeronautical radionavigation service on a primary basis.

5.335 In Canada and the United States in the band 1 240-1 300 MHz, active spaceborne sensors in the earth exploration-satellite and space research services shall not cause interference to, claim protection from, or otherwise impose constraints on operation or development of the aeronautical radionavigation service. (WRC-97)

1 260-1 350 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 260-1 300	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.329 5.329A SPACE RESEARCH (active) Amateur 5.282 5.330 5.331 5.334 5.335 5.335A	
1 300-1 350	AERONAUTICAL RADIONAVIGATION 5.337 RADIOLOCATION RADIONAVIGATION SATELLITE (Earth-to-space) 5.149 5.337A	

5.335A In the band 1 260-1 300 MHz, active spaceborne sensors in the Earth exploration-satellite and space research services shall not cause harmful interference to, claim protection from, or otherwise impose constraints on operation or development of the radiolocation service and other services allocated by footnotes on a primary basis. (WRC-2000)

5.336 Not used.

5.337 The use of the bands 1 300-1 350 MHz, 2 700-2 900 MHz and 9 000-9 200 MHz by the aeronautical radionavigation service is restricted to ground-based radars and to associated airborne transponders which transmit only on frequencies in these bands and only when actuated by radars operating in the same band.

5.337A The use of the band 1 300-1 350 MHz by earth stations in the radionavigation-satellite service and by stations in the radiolocation service shall not cause harmful interference to, nor constrain the operation and development of, the aeronautical-radionavigation service. (WRC-2000)

1 350-1 525 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 350-1 400 FIXED MOBILE RADIOLOCATION 5.149 5.338 5.339	**1 350-1 400** RADIOLOCATION 5.149 5.334 5.339	
1 400-1 427	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	
1 427-1 429	SPACE OPERATION (Earth-to-space) FIXED MOBILE except aeronautical mobile 5.341	
1 429-1 452 FIXED MOBILE except aeronautical mobile 5.341 5.342	**1 429-1 452** FIXED MOBILE 5.343 5.341	
1 452-1 492 FIXED MOBILE except aeronautical mobile BROADCASTING 5.345 5.347 BROADCASTING-SATELLITE 5.345 5.347 5.341 5.342	**1 452-1 492** FIXED MOBILE 5.343 BROADCASTING 5.345 5.347 BROADCASTING-SATELLITE 5.345 5.347 5.341 5.344	
1 492-1 525 FIXED MOBILE except aeronautical mobile 5.341 5.342	**1 492-1 525** FIXED MOBILE 5.343 MOBILE-SATELLITE (space-to-Earth) 5.348A 5.341 5.344 5.348	**1 492-1 525** FIXED MOBILE 5.341 5.348A

5.338 In Azerbaijan, Bulgaria, Mongolia, Kyrgyzstan, Slovakia, the Czech Rep., Romania and Turkmenistan, existing installations of the radionavigation service may continue to operate in the band 1 350-1 400 MHz. (WRC-2000)

5.339 The bands 1 370-1 400 MHz, 2 640-2 655 MHz, 4 950-4 990 MHz and 15.20-15.35 GHz are also allocated to the space research (passive) and earth exploration-satellite (passive) services on a secondary basis.

5.340 All emissions are prohibited in the following bands:

1 400-1 427 MHz,	
2 690-2 700 MHz,	except those provided for by Nos. **5.421** and **5.422**,
10.68-10.7 GHz,	except those provided for by No. **5.483**,
15.35-15.4 GHz,	except those provided for by No. **5.511**,
23.6-24 GHz,	
31.3-31.5 GHz,	
31.5-31.8 GHz,	in Region 2,
48.94-49.04 GHz,	from airborne stations,
50.2-50.4 GHz[2],	except those provided for by No. **5.555A**,
52.6-54.25 GHz,	
86-92 GHz,	
100-102 GHz,	
109.5-111.8 GHz,	
114.25-116 GHz,	
148.5-151.5 GHz,	
164-167 GHz,	
182-185 GHz,	except those provided for by No. **5.563**,
190-191.8 GHz,	
200-209 GHz,	
226-231.5 GHz,	
250-252 GHz.	(WRC-2000)

5.341 In the bands 1 400-1 727 MHz, 101-120 GHz and 197-220 GHz, passive research is being conducted by some countries in a programme for the search for intentional emissions of extraterrestrial origin.

5.342 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Bulgaria, Uzbekistan, Kyrgystan, the Russian Federation and Ukraine, the band 1 429-1 535 MHz is also allocated to the aeronautical mobile service on a primary basis exclusively for the purposes of aeronautical telemetry within the national territory. As of 1 April 2007, the use of the band 1 452-1 492 MHz is subject to agreement between the administrations concerned. (WRC-2000)

5.343 In Region 2, the use of the band 1 435-1 535 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service.

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[2] **5.340.1** The allocation to the earth exploration-satellite service (passive) and the space research service (passive) in the band 50.2-50.4 GHz should not impose undue constraints on the use of the adjacent bands by the primary allocated services in those bands. (WRC-97)

5.344 *Alternative allocation:* in the United States, the band 1 452-1 525 MHz is allocated to the fixed and mobile services on a primary basis (see also No. **5.343**).

5.345 Use of the band 1 452-1 492 MHz by the broadcasting-satellite service, and by the broadcasting service, is limited to digital audio broadcasting and is subject to the provisions of Resolution **528 (WARC-92)**.

5.346 Not used.

5.347 *Different category of service:* in Bangladesh, Bosnia and Herzegovina, Botswana, Bulgaria, Burkina Faso, Cuba, Denmark, Egypt, Greece, Ireland, Italy, Kenya, Mozambique, Portugal, Sri Lanka, Swaziland, Yemen, Yugoslavia and Zimbabwe, the allocation of the band 1 452-1 492 MHz to the broadcasting-satellite service and the broadcasting service is on a secondary basis until 1 April 2007. (WRC-2000)

5.348 The use of the band 1 492-1 525 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. However, no coordination threshold in Article **21** for space stations of the mobile-satellite service with respect to terrestrial services shall apply to the situation referred to in No. **5.343**. With respect to the situation referred to in No. **5.343**, the requirement for coordination in the band 1 492-1 525 MHz will be determined by band overlap.

5.348A In the band 1 492-1 525 MHz, the coordination threshold in terms of the power flux-density levels at the surface of the Earth in application of No. **9.11A** for space stations in the mobile-satellite (space-to-Earth) service, with respect to the land mobile service use for specialized mobile radios or used in conjunction with public switched telecommunication networks (PSTN) operating within the territory of Japan, shall be –150 dB(W/m^2) in any 4 kHz band for all angles of arrival, instead of those given in Table 5-2 of Appendix **5.** The above threshold level of the power flux-density shall apply until it is changed by a competent world radiocommunication conference.

1 525-1 610 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 525-1 530 SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.351A Earth exploration-satellite Mobile except aeronautical mobile 5.349 5.341 5.342 5.350 5.351 5.352A 5.354	**1 525-1 530** SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.351A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	**1 525-1 530** SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.351A Earth exploration-satellite Mobile 5.349 5.341 5.351 5.352A 5.354
1 530-1 535 SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.351A 5.353A Earth exploration-satellite Fixed Mobile except aeronautical mobile 5.341 5.342 5.351 5.354	**1 530-1 535** SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.351A 5.353A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	
1 535-1 559	MOBILE-SATELLITE (space-to-Earth) 5.351A 5.341 5.351 5.353A 5.354 5.355 5.356 5.357 5.357A 5.359 5.362A	
1 559-1 610	AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.329A 5.341 5.362B 5.362C 5.363	

5.349 *Different category of service:* in Saudi Arabia, Azerbaijan, Bahrain, Bosnia and Herzegovina, Cameroon, Egypt, France, Iran (Islamic Republic of), Iraq, Israel, Kazakstan, Kuwait, The Former Yugoslav Republic of Macedonia, Lebanon, Morocco, Qatar, Syria, Kyrgyzstan, Romania, Turkmenistan, Yemen and Yugoslavia, the allocation of the band 1 525-1 530 MHz to the mobile, except aeronautical mobile, service is on a primary basis (see No. **5.33**). (WRC-2000)

5.350 *Additional allocation:* in Azerbaijan, Kyrgyzstan and Turkmenistan, the band 1 525-1 530 MHz is also allocated to the aeronautical mobile service on a primary basis. (WRC-2000)

5.351 The bands 1 525-1 544 MHz, 1 545-1 559 MHz, 1 626.5-1 645.5 MHz and 1 646.5-1 660.5 MHz shall not be used for feeder links of any service. In exceptional circumstances,

however, an earth station at a specified fixed point in any of the mobile-satellite services may be authorized by an administration to communicate via space stations using these bands.

5.351A For the use of the bands 1 525-1 544 MHz, 1 545-1 559 MHz, 1 610-1 626.5 MHz, 1 626.5-1 645.5 MHz, 1 646.5-1 660.5 MHz, 1 980-2 010 MHz, 2 170-2 200 MHz, 2 483.5-2 500 MHz, 2 500-2 520 MHz and 2 670-2 690 MHz by the mobile-satellite service, see Resolutions **212 (Rev.WRC-97)** and **225 (WRC-2000)**. (WRC-2000)

5.352 (SUP - WRC-97)

5.352A In the band 1 525-1 530 MHz, stations in the mobile-satellite service, except stations in the maritime mobile-satellite service, shall not cause harmful interference to, or claim protection from, stations of the fixed service in France and French overseas territories in Region 3, Algeria, Saudi Arabia, Egypt, Guinea, India, Israel, Italy, Jordan, Kuwait, Mali, Malta, Morocco, Mauritania, Nigeria, Oman, Pakistan, Philippines, Qatar, Syria, Tanzania, Viet Nam and Yemen notified prior to 1 April 1998. (WRC-97)

5.353 (SUP - WRC-97)

5.353A In applying the procedures of Section II of Article **9** to the mobile-satellite service in the bands 1 530-1 544 MHz and 1 626.5-1 645.5 MHz, priority shall be given to accommodating the spectrum requirements for distress, urgency and safety communications of the Global Maritime Distress and Safety System (GMDSS). Maritime mobile-satellite distress, urgency and safety communications shall have priority access and immediate availability over all other mobile satellite communications operating within a network. Mobile-satellite systems shall not cause unacceptable interference to, or claim protection from, distress, urgency and safety communications of the GMDSS. Account shall be taken of the priority of safety-related communications in the other mobile-satellite services. (The provisions of Resolution **222 (WRC-2000)** shall apply.) (WRC-2000)

5.354 The use of the bands 1 525-1 559 MHz and 1 626.5-1 660.5 MHz by the mobile-satellite services is subject to coordination under No. **9.11A**.

5.355 *Additional allocation:* in Bahrain, Bangladesh, Congo, Egypt, Eritrea, Iraq, Israel, Jordan, Kuwait, Lebanon, Malta, Morocco, Qatar, Syria, Somalia, Sudan, Chad, Togo and Yemen, the bands 1 540-1 559 MHz, 1 610-1 645.5 MHz and 1 646.5-1 660 MHz are also allocated to the fixed service on a secondary basis. (WRC-2000)

5.356 The use of the band 1 544-1 545 MHz by the mobile-satellite service (space-to-Earth) is limited to distress and safety communications (see Article **31**).

5.357 Transmissions in the band 1 545-1 555 MHz from terrestrial aeronautical stations directly to aircraft stations, or between aircraft stations, in the aeronautical mobile (R) service are also authorized when such transmissions are used to extend or supplement the satellite-to-aircraft links.

5.357A In applying the procedures of Section II of Article **9** to the mobile-satellite service in the bands 1 545-1 555 MHz and 1 646.5-1 656.5 MHz, priority shall be given to accommodating the spectrum requirements of the aeronautical mobile-satellite (R) service providing transmission of messages with priority 1 to 6 in Article **44**. Aeronautical mobile-satellite (R) service communications with priority 1 to 6 in Article **44** shall have priority access and immediate availability, by pre-emption if necessary, over all other mobile-satellite communications operating within a network. Mobile-satellite systems shall not cause unacceptable interference to, or claim protection from, aeronautical mobile-satellite (R) service communications with priority 1 to 6 in Article **44**. Account shall be taken of the priority of safety-related communications in the other mobile-satellite services. (The provisions of Resolution **222 (WRC-2000)** shall apply.) (WRC-2000)

5.358 (SUP - WRC-97)

5.359 *Additional allocation:* in Germany, Saudi Arabia, Armenia, Austria, Azerbaijan, Belarus, Benin, Bosnia and Herzegovina, Bulgaria, Cameroon, Spain, France, Gabon, Georgia, Greece, Guinea, Guinea-Bissau, Hungary, Jordan, Kazakstan, Kuwait, Latvia, Lebanon, Libya, Lithuania, Mali, Morocco, Mauritania, Moldova, Mongolia, Nigeria, Uganda, Uzbekistan, Pakistan, Poland, Syria, Kyrgyzstan, the Dem. People's Rep. of Korea, Romania, the Russian Federation, Senegal, Swaziland, Tajikistan, Tanzania, Tunisia, Turkmenistan and Ukraine, the bands 1 550-1 559 MHz, 1 610-1 645.5 MHz and 1 646.5-1 660 MHz are also allocated to the fixed service on a primary basis. Administrations are urged to make all practicable efforts to avoid the implementation of new fixed-service stations in these bands. (WRC-2000)

5.360 to **5.362** (SUP - WRC-97)

5.362A In the United States, in the bands 1 555-1 559 MHz and 1 656.5-1 660.5 MHz, the aeronautical mobile-satellite (R) service shall have priority access and immediate availability, by pre-emption if necessary, over all other mobile-satellite communications operating within a network. Mobile-satellite systems shall not cause unacceptable interference to, or claim protection from, aeronautical mobile-satellite (R) service communications with priority 1 to 6 in Article **44**. Account shall be taken of the priority of safety-related communications in the other mobile-satellite services. (WRC-97)

5.362B *Additional allocation:* The band 1 559-1 610 MHz is also allocated to the fixed service on a primary basis until 1 January 2005 in Germany, Armenia, Azerbaijan, Belarus, Benin, Bosnia and Herzegovina, Bulgaria, Spain, France, Gabon, Georgia, Greece, Guinea, Guinea-Bissau, Hungary, Kazakstan, Latvia, Lithuania, Moldova, Mongolia, Nigeria, Uganda, Uzbekistan, Pakistan, Poland, Kyrgyzstan, the Dem. People's Rep. of Korea, Romania, the Russian Federation, Senegal, Swaziland, Tajikistan, Tanzania, Turkmenistan and Ukraine, and until 1 January 2010 in Saudi Arabia, Cameroon, Jordan, Kuwait, Lebanon, Libya, Mali, Morocco, Mauritania, Syria and Tunisia. After these dates, the fixed service may continue to operate on a secondary basis until 1 January 2015, at which time this allocation shall no longer be valid. Administrations are urged to take all practicable steps to protect the radionavigation-

satellite service and the aeronautical radionavigation service and not authorize new frequency assignments to fixed-service systems in this band. (WRC-2000)

5.362C *Additional allocation:* in Bahrain, Bangladesh, Congo, Egypt, Eritrea, Iraq, Israel, Jordan, Kuwait, Lebanon, Malta, Morocco, Qatar, Syria, Somalia, Sudan, Chad, Togo and Yemen, the band 1 559-1 610 MHz is also allocated to the fixed service on a secondary basis until 1 January 2015, at which time this allocation shall no longer be valid. Administrations are urged to take all practicable steps to protect the radionavigation-satellite service and not authorize new frequency assignments to fixed-service systems in this band. (WRC-2000)

5.363 *Alternative allocation:* in Sweden, the band 1 590-1 626.5 MHz is allocated to the aeronautical radionavigation service on a primary basis.

1 610-1 660 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 610-1 610.6 MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION 5.341 5.355 5.359 5.363 5.364 5.366 5.367 5.368 5.369 5.371 5.372	**1 610-1 610.6** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) 5.341 5.364 5.366 5.367 5.368 5.370 5.372	**1 610-1 610.6** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Radiodetermination-satellite (Earth-to-space) 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.372
1 610.6-1 613.8 MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION 5.149 5.341 5.355 5.359 5.363 5.364 5.366 5.367 5.368 5.369 5.371 5.372	**1 610.6-1 613.8** MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) 5.149 5.341 5.364 5.366 5.367 5.368 5.370 5.372	**1 610.6-1 613.8** MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION Radiodetermination-satellite (Earth-to-space) 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.372
1 613.8-1 626.5 MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) 5.341 5.355 5.359 5.363 5.364 5.365 5.366 5.367 5.368 5.369 5.371 5.372	**1 613.8-1 626.5** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) Mobile-satellite (space-to-Earth) 5.341 5.364 5.365 5.366 5.367 5.368 5.370 5.372	**1 613.8-1 626.5** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) Radiodetermination-satellite (Earth-to-space) 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.369 5.372
1 626.5-1 660	MOBILE-SATELLITE (Earth-to-space) 5.351A 5.341 5.351 5.353A 5.354 5.355 5.357A 5.359 5.362A 5.374 5.375 5.376	

5.364 The use of the band 1 610-1 626.5 MHz by the mobile-satellite service (Earth-to-space) and by the radiodetermination-satellite service (Earth-to-space) is subject to coordination under No. **9.11A**. A mobile earth station operating in either of the services in this band shall not produce a peak e.i.r.p. density in excess of –15 dB(W/4 kHz) in the part of the band used by systems operating in accordance with the provisions of No. **5.366** (to which No. **4.10** applies), unless otherwise agreed by the affected administrations. In the part of the band

where such systems are not operating, the mean e.i.r.p. density of a mobile earth station shall not exceed –3 dB(W/4 kHz). Stations of the mobile-satellite service shall not claim protection from stations in the aeronautical radionavigation service, stations operating in accordance with the provisions of No. **5.366** and stations in the fixed service operating in accordance with the provisions of No. **5.359**. Administrations responsible for the coordination of mobile-satellite networks shall make all practicable efforts to ensure protection of stations operating in accordance with the provisions of No. **5.366**.

5.365 The use of the band 1 613.8-1 626.5 MHz by the mobile-satellite service (space-to-Earth) is subject to coordination under No. **9.11A**.

5.366 The band 1 610-1 626.5 MHz is reserved on a worldwide basis for the use and development of airborne electronic aids to air navigation and any directly associated ground-based or satellite-borne facilities. Such satellite use is subject to agreement obtained under No. **9.21**.

5.367 *Additional allocation*: The bands 1 610-1 626.5 MHz and 5 000-5 150 MHz are also allocated to the aeronautical mobile-satellite (R) service on a primary basis, subject to agreement obtained under No. **9.21**.

5.368 With respect to the radiodetermination-satellite and mobile-satellite services the provisions of No. **4.10** do not apply in the band 1 610-1 626.5 MHz, with the exception of the aeronautical radionavigation-satellite service.

5.369 *Different category of service:* in Angola, Australia, Burundi, China, Côte d'Ivoire, Eritrea, Ethiopia, India, Iran (Islamic Republic of), Israel, Jordan, Lebanon, Liberia, Libya, Madagascar, Mali, Pakistan, Papua New Guinea, Dem. Rep.of the Congo, Syria, Senegal, Sudan, Swaziland, Togo and Zambia, the allocation of the band 1 610-1 626.5 MHz to the radiodetermination-satellite service (Earth-to-space) is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21** from countries not listed in this provision. (WRC-97)

5.370 *Different category of service:* in Venezuela, the allocation to the radiodetermination-satellite service in the band 1 610-1 626.5 MHz (Earth-to-space) is on a secondary basis.

5.371 *Additional allocation:* in Region 1, the bands 1 610-1 626.5 MHz (Earth-to-space) and 2 483.5-2 500 MHz (space-to-Earth) are also allocated to the radiodetermination-satellite service on a secondary basis, subject to agreement obtained under No. **9.21**.

5.372 Harmful interference shall not be caused to stations of the radio astronomy service using the band 1 610.6-1 613.8 MHz by stations of the radiodetermination-satellite and mobile-satellite services (No. **29.13** applies).

5.373 Not used.

5.373A (SUP - WRC-97)

5.374 Mobile earth stations in the mobile-satellite service operating in the bands 1 631.5-1 634.5 MHz and 1 656.5-1 660 MHz shall not cause harmful interference to stations in the fixed service operating in the countries listed in No. **5.359**. (WRC-97)

5.375 The use of the band 1 645.5-1 646.5 MHz by the mobile-satellite service (Earth-to-space) and for inter-satellite links is limited to distress and safety communications (see Article **31**).

5.376 Transmissions in the band 1 646.5-1 656.5 MHz from aircraft stations in the aeronautical mobile (R) service directly to terrestrial aeronautical stations, or between aircraft stations, are also authorized when such transmissions are used to extend or supplement the aircraft-to-satellite links.

1 660-1 710 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 660-1 660.5	MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY 5.149 5.341 5.351 5.354 5.362A 5.376A	
1 660.5-1 668.4	RADIO ASTRONOMY SPACE RESEARCH (passive) Fixed Mobile except aeronautical mobile 5.149 5.341 5.379 5.379A	
1 668.4-1 670	METEOROLOGICAL AIDS FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY 5.149 5.341	
1 670-1 675	METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE 5.380 5.341	
1 675-1 690 METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.341	**1 675-1 690** METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MOBILE-SATELLITE (Earth-to-space) 5.341 5.377	**1 675-1 690** METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.341
1 690-1 700 METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) Fixed Mobile except aeronautical mobile 5.289 5.341 5.382	**1 690-1 700** METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE-SATELLITE (Earth-to-space) 5.289 5.341 5.377 5.381	**1 690-1 700** METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) 5.289 5.341 5.381
1 700-1 710 FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341	**1 700-1 710** FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MOBILE-SATELLITE (Earth-to-space) 5.289 5.341 5.377	**1 700-1 710** FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341 5.384

5.376A Mobile earth stations operating in the band 1 660-1 660.5 MHz shall not cause harmful interference to stations in the radio astronomy service. (WRC-97)

5.377 In the band 1 675-1 710 MHz, stations in the mobile-satellite service shall not cause harmful interference to, nor constrain the development of, the meteorological-satellite and meteorological aids services (see Resolution **213 (Rev.WRC-95)**[*]) and the use of this band shall be subject to coordination under No. **9.11A**.

5.378 Not used.

5.379 *Additional allocation:* in Bangladesh, India, Indonesia, Nigeria and Pakistan, the band 1 660.5-1 668.4 MHz is also allocated to the meteorological aids service on a secondary basis.

5.379A Administrations are urged to give all practicable protection in the band 1 660.5-1 668.4 MHz for future research in radio astronomy, particularly by eliminating air-to-ground transmissions in the meteorological aids service in the band 1 664.4-1 668.4 MHz as soon as practicable.

5.380 The bands 1 670-1 675 MHz and 1 800-1 805 MHz are intended for use, on a worldwide basis, by administrations wishing to implement aeronautical public correspondence. The use of the band 1 670-1 675 MHz by stations in the systems for public correspondence with aircraft is limited to transmissions from aeronautical stations and the use of the band 1 800-1 805 MHz is limited to transmissions from aircraft stations.

5.381 *Additional allocation:* in Afghanistan, Costa Rica, Cuba, India, Iran (Islamic Republic of), Malaysia, Pakistan and Sri Lanka, the band 1 690-1 700 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-97)

5.382 *Different category of service:* in Saudi Arabia, Armenia, Austria, Azerbaijan, Bahrain, Belarus, Bosnia and Herzegovina, Bulgaria, the Congo, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Guinea, Hungary, Iraq, Israel, Jordan, Kazakstan, Kuwait, the Former Yugoslav Republic of Macedonia, Lebanon, Mauritania, Moldova, Mongolia, Oman, Uzbekistan, Poland, Qatar, Syria, Kyrgyzstan, Romania, Russian Federation, Somalia, Tajikistan, Tanzania, Turkmenistan, Ukraine, Yemen and Yugoslavia, the allocation of the band 1 690-1 700 MHz to the fixed and mobile, except aeronautical mobile, services is on a primary basis (see No. **5.33**), and in the Dem. People's Rep. of Korea, the allocation of the band 1 690-1 700 MHz to the fixed service is on a primary basis (see No. **5.33**) and to the mobile, except aeronautical mobile, service on a secondary basis. (WRC-97)

5.383 Not used.

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[*] *Note by the Secretariat:* This Resolution was abrogated by WRC-2000.

5.384 *Additional allocation:* in India, Indonesia and Japan, the band 1 700-1 710 MHz is also allocated to the space research service (space-to-Earth) on a primary basis. (WRC-97)

1 710-2 170 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 710-1 930	FIXED MOBILE 5.380 5.384A 5.388A 5.149 5.341 5.385 5.386 5.387 5.388	
1 930-1 970 FIXED MOBILE 5.388A 5.388	**1 930-1 970** FIXED MOBILE 5.388A Mobile-satellite (Earth-to-space) 5.388	**1 930-1 970** FIXED MOBILE 5.388A 5.388
1 970-1 980	FIXED MOBILE 5.388A 5.388	
1 980-2 010	FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.351A 5.388 5.389A 5.389B 5.389F	
2 010-2 025 FIXED MOBILE 5.388A 5.388	**2 010-2 025** FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.388 5.389C 5.389D 5.389E 5.390	**2 010-2 025** FIXED MOBILE 5.388A 5.388
2 025-2 110	SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION-SATELLITE (Earth-to-space) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (Earth-to-space) (space-to-space) 5.392	
2 110-2 120	FIXED MOBILE 5.388A SPACE RESEARCH (deep space) (Earth-to-space) 5.388	
2 120-2 160 FIXED MOBILE 5.388A 5.388	**2 120-2 160** FIXED MOBILE 5.388A Mobile-satellite (space-to-Earth) 5.388	**2 120-2 160** FIXED MOBILE 5.388A 5.388
2 160-2 170 FIXED MOBILE 5.388A 5.388 5.392A	**2 160-2 170** FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.388 5.389C 5.389D 5.389E 5.390	**2 160-2 170** FIXED MOBILE 5.388A 5.388

5.384A The bands, or portions of the bands, 1 710-1 885 MHz and 2 500-2 690 MHz, are identified for use by administrations wishing to implement International Mobile Telecommunications-2000 (IMT-2000) in accordance with Resolution **223 (WRC-2000)**. This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations (WRC-2000).

5.385 *Additional allocation:* the band 1 718.8-1 722.2 MHz is also allocated to the radio astronomy service on a secondary basis for spectral line observations. (WRC-2000)

5.386 *Additional allocation:* the band 1 750-1 850 MHz is also allocated to the space operation (Earth-to-space) and space research (Earth-to-space) services in Region 2, in Australia, India, Indonesia and Japan on a primary basis, subject to agreement obtained under No. **9.21**, having particular regard to troposcatter systems.

5.387 *Additional allocation:* in Azerbaijan, Belarus, Georgia, Kazakstan, Mali, Mongolia, Kyrgyzstan, Slovakia, Romania, Tajikistan and Turkmenistan, the band 1 770-1 790 MHz is also allocated to the meteorological-satellite service on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-2000)

5.388 The bands 1 885-2 025 MHz and 2 110-2 200 MHz are intended for use, on a worldwide basis, by administrations wishing to implement International Mobile Telecommunications-2000 (IMT-2000). Such use does not preclude the use of these bands by other services to which they are allocated. The bands should be made available for IMT-2000 in accordance with Resolution **212 (Rev.WRC-97)**. (See also Resolution **223 (WRC-2000)**.) (WRC-2000)

5.388A In Regions 1 and 3, the bands 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz and, in Region 2, the bands 1 885-1 980 MHz and 2 110-2 160 MHz may be used by high altitude platform stations as base stations to provide International Mobile Telecommunications-2000 (IMT-2000), in accordance with Resolution **221 (WRC-2000)**. The use by IMT-2000 applications using high altitude platform stations as base stations does not preclude the use of these bands by any station in the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-2000)

5.389 Not used.

5.389A The use of the bands 1 980-2 010 MHz and 2 170-2 200 MHz by the mobile-satellite service is subject to coordination under No. **9.11A** and to the provisions of Resolution **716 (WRC-95)*** . The use of these bands shall not commence before 1 January 2000; however the use of the band 1 980-1 990 MHz in Region 2 shall not commence before 1 January 2005.

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* *Note by the Secretariat:* This Resolution was revised by WRC-2000.

5.389B The use of the band 1 980-1 990 MHz by the mobile-satellite service shall not cause harmful interference to or constrain the development of the fixed and mobile services in Argentina, Brazil, Canada, Chile, Ecuador, the United States, Honduras, Jamaica, Mexico, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela.

5.389C The use of the bands 2 010-2 025 MHz and 2 160-2 170 MHz in Region 2 by the mobile-satellite service shall not commence before 1 January 2002 and is subject to coordination under No. **9.11A** and to the provisions of Resolution **716 (WRC-95)***. (WRC-97)

5.389D In Canada and the United States the use of the bands 2 010-2 025 MHz and 2 160-2 170 MHz by the mobile-satellite service shall not commence before 1 January 2000.

5.389E The use of the bands 2 010-2 025 MHz and 2 160-2 170 MHz by the mobile-satellite service in Region 2 shall not cause harmful interference to or constrain the development of the fixed and mobile services in Regions 1 and 3.

5.389F In Algeria, Benin, Cape Verde, Egypt, Iran (Islamic Republic of), Mali, Syria and Tunisia, the use of the bands 1 980-2 010 MHz and 2 170-2 200 MHz by the mobile-satellite service shall neither cause harmful interference to the fixed and mobile services, nor hamper the development of those services prior to 1 January 2005, nor shall the former service request protection from the latter services. (WRC-2000)

5.390 In Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, Suriname and Uruguay, the use of the bands 2 010-2 025 MHz and 2 160-2 170 MHz by the mobile-satellite services shall not cause harmful interference to stations in the fixed and mobile services before 1 January 2005. After this date, the use of these bands is subject to coordination under No. **9.11A** and to the provisions of Resolution **716 (WRC-95)***. (WRC-2000)

5.391 In making assignments to the mobile service in the bands 2 025-2 110 MHz and 2 200-2 290 MHz, administrations shall not introduce high-density mobile systems, as described in Recommendation ITU-R SA.1154, and shall take that Recommendation into account for the introduction of any other type of mobile system. (WRC-97)

5.392 Administrations are urged to take all practicable measures to ensure that space-to-space transmissions between two or more non-geostationary satellites, in the space research, space operations and Earth exploration-satellite services in the bands 2 025-2 110 MHz and 2 200-2 290 MHz, shall not impose any constraints on Earth-to-space, space-to-Earth and other space-to-space transmissions of those services and in those bands between geostationary and non-geostationary satellites.

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* *Note by the Secretariat:* This Resolution was revised by WRC-2000.

5.392A *Additional allocation:* in Russian Federation, the band 2 160-2 200 MHz is also allocated to the space research service (space-to-Earth) on a primary basis until 1 January 2005. Stations in the space research service shall not cause harmful interference to, or claim protection from, stations in the fixed and mobile services operating in this frequency band.

2 170-2 520 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 170-2 200	FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A 5.388 5.389A 5.389F 5.392A	
2 200-2 290	SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION-SATELLITE (space-to-Earth) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392	
2 290-2 300	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)	
2 300-2 450 FIXED MOBILE Amateur Radiolocation 5.150 5.282 5.395	**2 300-2 450** FIXED MOBILE RADIOLOCATION Amateur 5.150 5.282 5.393 5.394 5.396	
2 450-2 483.5 FIXED MOBILE Radiolocation 5.150 5.397	**2 450-2 483.5** FIXED MOBILE RADIOLOCATION 5.150 5.394	
2 483.5-2 500 FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A Radiolocation 5.150 5.371 5.397 5.398 5.399 5.400 5.402	**2 483.5-2 500** FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A RADIOLOCATION RADIODETERMINATION-SATELLITE (space-to-Earth) 5.398 5.150 5.402	**2 483.5-2 500** FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A RADIOLOCATION Radiodetermination-satellite (space-to-Earth) 5.398 5.150 5.400 5.402
2 500-2 520 FIXED 5.409 5.410 5.411 MOBILE except aeronautical mobile 5.384A MOBILE-SATELLITE (space-to-Earth) 5.351A 5.403 5.405 5.407 5.412 5.414	**2 500-2 520** FIXED 5.409 5.411 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A MOBILE-SATELLITE (space-to-Earth) 5.351A 5.403 5.404 5.407 5.414 5.415A	

5.393 *Additional allocation:* in the United States, India and Mexico, the band 2 310-2 360 MHz is also allocated to the broadcasting-satellite service (sound) and complementary terrestrial sound broadcasting service on a primary basis. Such use is limited to digital audio broadcasting and is subject to the provisions of Resolution **528 (WARC-92)**, with the exception of *resolves* 3 in regard to the limitation on broadcasting-satellite systems in the upper 25 MHz. (WRC-2000)

5.394 In the United States, the use of the band 2 300-2 390 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. In Canada, the use of the band 2 300-2 483.5 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services.

5.395 In France, the use of the band 2 310-2 360 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service.

5.396 Space stations of the broadcasting-satellite service in the band 2 310-2 360 MHz operating in accordance with No. **5.393** that may affect the services to which this band is allocated in other countries shall be coordinated and notified in accordance with Resolution **33 (Rev.WRC-97)**. Complementary terrestrial broadcasting stations shall be subject to bilateral coordination with neighbouring countries prior to their bringing into use.

5.397 *Different category of service:* in France, the band 2 450-2 500 MHz is allocated on a primary basis to the radiolocation service (see No. **5.33**). Such use is subject to agreement with administrations having services operating or planned to operate in accordance with the Table of Frequency Allocations which may be affected.

5.398 In respect of the radiodetermination-satellite service in the band 2 483.5-2 500 MHz, the provisions of No. **4.10** do not apply.

5.399 In Region 1, in countries other than those listed in No. **5.400**, harmful interference shall not be caused to, or protection shall not be claimed from, stations of the radiolocation service by stations of the radiodetermination satellite service.

5.400 *Different category of service:* in Angola, Australia, Bangladesh, Burundi, China, Eritrea, Ethiopia, India, Iran (Islamic Republic of), Jordan, Lebanon, Liberia, Libya, Madagascar, Mali, Pakistan, Papua New Guinea, Dem. Rep. of the Congo, Syria, Sudan, Swaziland, Togo and Zambia, the allocation of the band 2 483.5-2 500 MHz to the radiodetermination-satellite service (space-to-Earth) is on a primary basis (see No. **5.33**), subject to agreement obtained under No. **9.21** from countries not listed in this provision. (WRC-97)

5.401 Not used.

5.402 The use of the band 2 483.5-2 500 MHz by the mobile-satellite and the radiodetermination-satellite services is subject to the coordination under No. **9.11A**. Administrations are urged to take all practicable steps to prevent harmful interference to the

radio astronomy service from emissions in the 2 483.5-2 500 MHz band, especially those caused by second-harmonic radiation that would fall into the 4 990-5 000 MHz band allocated to the radio astronomy service worldwide.

5.403 Subject to agreement obtained under No. **9.21**, the band 2 520-2 535 MHz (until 1 January 2005 the band 2 500-2 535 MHz) may also be used for the mobile-satellite (space-to-Earth), except aeronautical mobile-satellite, service for operation limited to within national boundaries. The provisions of No. **9.11A** apply.

5.404 *Additional allocation:* in India and Iran (Islamic Republic of), the band 2 500-2 516.5 MHz may also be used for the radiodetermination-satellite service (space-to-Earth) for operation limited to within national boundaries, subject to agreement obtained under No. **9.21**.

5.405 *Additional allocation:* in France, the band 2 500-2 550 MHz is also allocated to the radiolocation service on a primary basis. Such use is subject to agreement with the administrations having services operating or planned to operate in accordance with the Table which may be affected.

5.406 Not used.

5.407 In the band 2 500-2 520 MHz, the power flux-density at the surface of the Earth from space stations operating in the mobile-satellite (space-to-Earth) service shall not exceed –152 dB(W/(m^2 · 4 kHz)) in Argentina, unless otherwise agreed by the administrations concerned.

5.408 (SUP - WRC-2000)

5.409 Administrations shall make all practicable efforts to avoid developing new tropospheric scatter systems in the band 2 500-2 690 MHz.

5.410 The band 2 500-2 690 MHz may be used for tropospheric scatter systems in Region 1, subject to agreement obtained under No. **9.21**.

5.411 When planning new tropospheric scatter radio-relay links in the band 2 500-2 690 MHz, all possible measures shall be taken to avoid directing the antennae of these links towards the geostationary-satellite orbit.

5.412 *Alternative allocation:* in Azerbaijan, Bulgaria, Kyrgyzstan and Turkmenistan, the band 2 500-2 690 MHz is allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-2000)

5.413 In the design of systems in the broadcasting-satellite service in the bands between 2 500 MHz and 2 690 MHz, administrations are urged to take all necessary steps to protect the radio astronomy service in the band 2 690-2 700 MHz.

5.414 The allocation of the frequency band 2 500-2 520 MHz to the mobile-satellite service (space-to-Earth) shall be effective on 1 January 2005 and is subject to coordination under No. **9.11A**.

5.415 The use of the bands 2 500-2 690 MHz in Region 2 and 2 500-2 535 MHz and 2 655-2 690 MHz in Region 3 by the fixed-satellite service is limited to national and regional systems, subject to agreement obtained under No. **9.21**, giving particular attention to the broadcasting-satellite service in Region 1. In the direction space-to-Earth, the power flux-density at the Earth's surface shall not exceed the values given in Article **21**, Table **21-4**.

5.415A *Additional allocation*: in India and Japan, subject to agreement obtained under No. **9.21**, the band 2 515-2 535 MHz may also be used for the aeronautical mobile-satellite service (space-to-Earth) for operation limited to within their national boundaries. (WRC-2000)

2 520-2 700 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 520-2 655 FIXED 5.409 5.410 5.411 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.403 5.405 5.412 5.418 5.418B 5.418C	**2 520-2 655** FIXED 5.409 5.411 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.403 5.418B 5.418C	**2 520-2 535** FIXED 5.409 5.411 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.403 5.415A
		2 535-2 655 FIXED 5.409 5.411 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.418 5.418A 5.418B 5.418C
2 655-2 670 FIXED 5.409 5.410 5.411 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412 5.420	**2 655-2 670** FIXED 5.409 5.411 FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.420	**2 655-2 670** FIXED 5.409 5.411 FIXED-SATELLITE (Earth-to-space) 5.415 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.420
2 670-2 690 FIXED 5.409 5.410 5.411 MOBILE except aeronautical mobile 5.384A MOBILE-SATELLITE (Earth-to-space) 5.351A Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412 5.419 5.420	**2 670-2 690** FIXED 5.409 5.411 FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A MOBILE-SATELLITE (Earth-to-space) 5.351A Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.419 5.420	**2 670-2 690** FIXED 5.409 5.411 FIXED-SATELLITE (Earth-to-space) 5.415 MOBILE except aeronautical mobile 5.384A MOBILE-SATELLITE (Earth-to-space) 5.351A Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.419 5.420 5.420A
2 690-2 700	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.421 5.422	

5.416 The use of the band 2 520-2 670 MHz by the broadcasting-satellite service is limited to national and regional systems for community reception, subject to agreement obtained under No. **9.21**. The power flux-density at the Earth's surface shall not exceed the values given in Article **21**, Table **21-4**.

5.417 (SUP - WRC-2000)

5.418 *Additional allocation:* in Bangladesh, Belarus, Korea (Rep. of), India, Japan, Pakistan, Singapore, Sri Lanka and Thailand, the band 2 535-2 655 MHz is also allocated to the broadcasting-satellite service (sound) and complementary terrestrial broadcasting service on a primary basis. Such use is limited to digital audio broadcasting and is subject to the provisions of Resolution **528 (WARC-92)**. The provisions of No. **5.416** and Table **21-4** of Article **21**, do not apply to this additional allocation. Use of non-geostationary-satellite systems in the broadcasting-satellite service (sound) is subject to Resolution **539 (WRC-2000)**. (WRC-2000)

5.418A In certain Region 3 countries listed in No. **5.418**, use of the band 2 630-2 655 MHz by non-geostationary-satellite systems in the broadcasting-satellite service (sound) for which complete Appendix **4** coordination information, or notification information, has been received after 2 June 2000, is subject to the application of the provisions of No. **9.12A**, in respect of geostationary-satellite networks for which complete Appendix **4** coordination information, or notification information, is considered to have been received after 2 June 2000, and No. **22.2** does not apply. No. **22.2** shall continue to apply with respect to geostationary-satellite networks for which complete Appendix **4** coordination information, or notification information, is considered to have been received before 3 June 2000. Use of the band by non-geostationary-satellite systems in the broadcasting-satellite service (sound) is subject to the provisions of Resolution **539 (WRC-2000)**, and such systems shall be in accordance with Resolution **528 (WARC-92)**. (WRC-2000)

5.418B Use of the band 2 630-2 655 MHz by non-geostationary-satellite systems for which complete Appendix **4** coordination information, or notification information, has been received after 2 June 2000, is subject to the application of the provisions of No. **9.12**. Resolution **539 (WRC-2000)** applies. (WRC-2000)

5.418C Use of the band 2 630-2 655 MHz by geostationary-satellite networks for which complete Appendix **4** coordination information, or notification information, has been received after 2 June 2000 is subject to the application of the provisions of No. **9.13** with respect to non-geostationary-satellite systems in the broadcasting-satellite service (sound), and No. **22.2** does not apply. Resolution **539 (WRC-2000)** applies. (WRC-2000)

5.419 The allocation of the frequency band 2 670-2 690 MHz to the mobile-satellite service shall be effective from 1 January 2005. When introducing systems of the mobile-satellite service in this band, administrations shall take all necessary steps to protect the satellite systems operating in this band prior to 3 March 1992. The coordination of mobile-satellite systems in the band shall be in accordance with No. **9.11A**.

5.420 The band 2 655-2 670 MHz (until 1 January 2005 the band 2 655-2 690 MHz) may also be used for the mobile-satellite (Earth-to-space), except aeronautical mobile-satellite, service for operation limited to within national boundaries, subject to agreement obtained under No. **9.21**. The coordination under No. **9.11A** applies.

5.420A *Additional allocation:* in India and Japan, subject to agreement obtained under No. **9.21**, the band 2 670-2 690 MHz may also be used for the aeronautical mobile-satellite service (Earth-to-space) for operation limited to within their national boundaries. (WRC-2000)

5.421 *Additional allocation:* in Germany and Austria, the band 2 690-2 695 MHz is also allocated to the fixed service on a primary basis. Such use is limited to equipment in operation by 1 January 1985.

5.422 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Bosnia and Herzegovina, Brunei Darussalam, Congo, Côte d'Ivoire, Cuba, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Gabon, Georgia, Guinea, Guinea-Bissau, Iran (Islamic Republic of), Iraq, Israel, Jordan, Lebanon, Malaysia, Mali, Mauritania, Moldova, Mongolia, Nigeria, Oman, Uzbekistan, Pakistan, the Philippines, Qatar, Syria, Kyrgyzstan, the Dem. Rep. of the Congo, Romania, the Russian Federation, Somalia, Tajikistan, Tunisia, Turkmenistan, Ukraine, Yemen and Yugoslavia, the band 2 690-2 700 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. Such use is limited to equipment in operation by 1 January 1985. (WRC-2000)

2 700-4 800 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 700-2 900	AERONAUTICAL RADIONAVIGATION 5.337 Radiolocation 5.423 5.424	
2 900-3 100	RADIONAVIGATION 5.426 Radiolocation 5.425 5.427	
3 100-3 300	RADIOLOCATION Earth exploration-satellite (active) Space research (active) 5.149 5.428	
3 300-3 400 RADIOLOCATION 5.149 5.429 5.430	**3 300-3 400** RADIOLOCATION Amateur Fixed Mobile 5.149 5.430	**3 300-3 400** RADIOLOCATION Amateur 5.149 5.429
3 400-3 600 FIXED FIXED-SATELLITE (space-to-Earth) Mobile Radiolocation 5.431	**3 400-3 500** FIXED FIXED-SATELLITE (space-to-Earth) Amateur Mobile Radiolocation 5.433 5.282 5.432	
3 600-4 200 FIXED FIXED-SATELLITE (space-to-Earth) Mobile	**3 500-3 700** FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile Radiolocation 5.433 5.435	
	3 700-4 200 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile	
4 200-4 400	AERONAUTICAL RADIONAVIGATION 5.438 5.439 5.440	
4 400-4 500	FIXED MOBILE	
4 500-4 800	FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE	

5.423 In the band 2 700-2 900 MHz, ground-based radars used for meteorological purposes are authorized to operate on a basis of equality with stations of the aeronautical radionavigation service.

5.424 *Additional allocation:* in Canada, the band 2 850-2 900 MHz is also allocated to the maritime radionavigation service, on a primary basis, for use by shore-based radars.

5.425 In the band 2 900-3 100 MHz, the use of the shipborne interrogator-transponder system (SIT) shall be confined to the sub-band 2 930 -2 950 MHz.

5.426 The use of the band 2 900-3 100 MHz by the aeronautical radionavigation service is limited to ground-based radars.

5.427 In the bands 2 900-3 100 MHz and 9 300-9 500 MHz, the response from radar transponders shall not be capable of being confused with the response from radar beacons (racons) and shall not cause interference to ship or aeronautical radars in the radionavigation service, having regard, however, to No. **4.9**.

5.428 *Additional allocation:* in Azerbaijan, Bulgaria, Cuba, Mongolia, Kyrgyzstan, Romania and Turkmenistan, the band 3 100-3 300 MHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.429 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, China, the Congo, Korea (Rep. of), the United Arab Emirates, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Lebanon, Libya, Malaysia, Oman, Pakistan, Qatar, Syria, Dem. People's Rep. of Korea and Yemen, the band 3 300-3 400 MHz is also allocated to the fixed and mobile services on a primary basis. The countries bordering the Mediterranean shall not claim protection for their fixed and mobile services from the radiolocation service. (WRC-97)

5.430 *Additional allocation:* in Azerbaijan, Bulgaria, Cuba, Mongolia, Kyrgyzstan, Romania and Turkmenistan, the band 3 300-3 400 MHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.431 *Additional allocation:* in Germany, Israel, Nigeria and the United Kingdom, the band 3 400-3 475 MHz is also allocated to the amateur service on a secondary basis.

5.432 *Different category of service:* in Korea (Rep. of), Japan and Pakistan, the allocation of the band 3 400-3 500 MHz to the mobile, except aeronautical mobile, service is on a primary basis (see No. **5.33**). (WRC-2000)

5.433 In Regions 2 and 3, in the band 3 400-3 600 MHz the radiolocation service is allocated on a primary basis. However, all administrations operating radiolocation systems in this band are urged to cease operations by 1985. Thereafter, administrations shall take all practicable steps to protect the fixed-satellite service and coordination requirements shall not be imposed on the fixed-satellite service.

5.434 (SUP - WRC-97)

5.435 In Japan, in the band 3 620-3 700 MHz, the radiolocation service is excluded.

5.436 Not used.

5.437 (SUP - WRC-2000)

5.438 Use of the band 4 200-4 400 MHz by the aeronautical radionavigation service is reserved exclusively for radio altimeters installed on board aircraft and for the associated transponders on the ground. However, passive sensing in the earth exploration-satellite and space research services may be authorized in this band on a secondary basis (no protection is provided by the radio altimeters).

5.439 *Additional allocation:* in Iran (Islamic Republic of) and Libya, the band 4 200-4 400 MHz is also allocated to the fixed service on a secondary basis. (WRC-2000)

5.440 The standard frequency and time signal-satellite service may be authorized to use the frequency 4 202 MHz for space-to-Earth transmissions and the frequency 6 427 MHz for Earth-to-space transmissions. Such transmissions shall be confined within the limits of ± 2 MHz of these frequencies, subject to agreement obtained under No. **9.21**.

5.441 The use of the bands 4 500-4 800 MHz (space-to-Earth), 6 725-7 025 MHz (Earth-to-space) by the fixed-satellite service shall be in accordance with the provisions of Appendix **30B**. The use of the bands 10.7-10.95 GHz (space-to-Earth), 11.2-11.45 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space) by geostationary-satellite systems in the fixed-satellite service shall be in accordance with the provisions of Appendix **30B**. The use of the bands 10.7-10.95 GHz (space-to Earth), 11.2-11.45 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space) by a non-geostationary-satellite system in the fixed-satellite service is subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-2000)

4 800-5 830 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
4 800-4 990	FIXED MOBILE 5.442 Radio astronomy 5.149 5.339 5.443	
4 990-5 000	FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY Space research (passive) 5.149	
5 000-5 150	AERONAUTICAL RADIONAVIGATION 5.367 5.443A 5.443B 5.444 5.444A	
5 150-5 250	AERONAUTICAL RADIONAVIGATION FIXED-SATELLITE (Earth-to-space) 5.447A 5.446 5.447 5.447B 5.447C	
5 250-5 255	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH 5.447D 5.448 5.448A	
5 255- 5 350	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.448 5.448A	
5 350-5 460	EARTH EXPLORATION-SATELLITE (active) 5.448B AERONAUTICAL RADIONAVIGATION 5.449 Radiolocation	
5 460-5 470	RADIONAVIGATION 5.449 Radiolocation	
5 470-5 650	MARITIME RADIONAVIGATION Radiolocation 5.450 5.451 5.452	
5 650-5 725	RADIOLOCATION Amateur Space research (deep space) 5.282 5.451 5.453 5.454 5.455	
5 725-5 830 FIXED-SATELLITE (Earth-to-space) RADIOLOCATION Amateur 5.150 5.451 5.453 5.455 5.456	**5 725-5 830** RADIOLOCATION Amateur 5.150 5.453 5.455	

5.442 In the bands 4 825-4 835 MHz and 4 950-4 990 MHz, the allocation to the mobile service is restricted to the mobile, except aeronautical mobile, service.

5.443 *Different category of service:* in Argentina, Australia and Canada, the allocation of the bands 4 825-4 835 MHz and 4 950-4 990 MHz to the radio astronomy service is on a primary basis (see No. **5.33**).

5.443A *Additional allocation:* The band 5 000-5 010 MHz is also allocated to the radionavigation-satellite service (Earth-to-space) on a primary basis. See Resolution **603 (WRC-2000)**. (WRC-2000)

5.443B *Additional allocation:* The band 5 010-5 030 MHz is also allocated to the radionavigation-satellite service (space-to-Earth) (space-to-space) on a primary basis. In order not to cause harmful interference to the microwave landing system operating above 5 030 MHz, the aggregate power flux-density produced at the Earth's surface in the band 5 030-5 150 MHz by all the space stations within any radionavigation-satellite service system (space-to-Earth) operating in the band 5 010-5 030 MHz shall not exceed –124.5 dB(W/m^2) in a 150 kHz band. In order not to cause harmful interference to the radio astronomy service in the band 4 990-5 000 MHz, the aggregate power flux-density produced in the 4 990-5 000 MHz band by all the space stations within any radionavigation-satellite service (space-to-Earth) system operating in the 5 010-5 030 MHz band shall not exceed the provisional value of –171 dB(W/m^2) in a 10 MHz band at any radio astronomy observatory site for more than 2% of the time. For the use of this band, Resolution **604 (WRC-2000)** applies. (WRC-2000)

5.444 The band 5 030-5 150 MHz is to be used for the operation of the international standard system (microwave landing system) for precision approach and landing. The requirements of this system shall take precedence over other uses of this band. For the use of this band, No. **5.444A** and Resolution **114 (WRC-95)** apply. (WRC-2000)

5.444A *Additional allocation:* the band 5 091-5 150 MHz is also allocated to the fixed-satellite service (Earth-to-space) on a primary basis. This allocation is limited to feeder links of non-geostationary mobile-satellite systems and is subject to coordination under No. **9.11A**.

In the band 5 091-5 150 MHz, the following conditions also apply:

– prior to 1 January 2010, the use of the band 5 091-5 150 MHz by feeder links of non-geostationary-satellite systems in the mobile-satellite service shall be made in accordance with Resolution **114 (WRC-95)**;

– prior to 1 January 2010, the requirements of existing and planned international standard systems for the aeronautical radionavigation service which cannot be met in the 5 000-5 091 MHz band, shall take precedence over other uses of this band;

– after 1 January 2008, no new assignments shall be made to stations providing feeder links of non-geostationary mobile-satellite systems;

– after 1 January 2010, the fixed-satellite service will become secondary to the aeronautical radionavigation service.

5.445 Not used.

5.446 *Additional allocation:* in the countries listed in Nos. **5.369** and **5.400**, the band 5 150-5 216 MHz is also allocated to the radiodetermination-satellite service (space-to-Earth) on a primary basis, subject to agreement obtained under No. **9.21**. In Region 2, the band is also allocated to the radiodetermination-satellite service (space-to-Earth) on a primary basis. In Regions 1 and 3, except those countries listed in Nos. **5.369** and **5.400**, the band is also allocated to the radiodetermination-satellite service (space-to-Earth) on a secondary basis. The use by the radiodetermination-satellite service is limited to feeder links in conjunction with the radiodetermination-satellite service operating in the bands 1 610-1 626.5 MHz and/or 2 483.5-2 500 MHz. The total power flux-density at the Earth's surface shall in no case exceed –159 dB(W/m^2) in any 4 kHz band for all angles of arrival.

5.447 *Additional allocation:* in Germany, Austria, Belgium, Denmark, Spain, Estonia, Finland, France, Greece, Israel, Italy, Japan, Jordan, Lebanon, Liechtenstein, Lithuania, Luxembourg, Malta, Norway, Pakistan, the Netherlands, Portugal, Syria, the United Kingdom, Sweden, Switzerland and Tunisia, the band 5 150-5 250 MHz is also allocated to the mobile service, on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-2000)

5.447A The allocation to the fixed-satellite service (Earth-to-space) is limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service and is subject to coordination under No. **9.11A**.

5.447B *Additional allocation*: the band 5 150-5 216 MHz is also allocated to the fixed-satellite service (space-to-Earth) on a primary basis. This allocation is limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service and is subject to provisions of No. **9.11A**. The power flux-density at the Earth's surface produced by space stations of the fixed-satellite service operating in the space-to-Earth direction in the band 5 150-5 216 MHz shall in no case exceed –164 dB(W/m^2) in any 4 kHz band for all angles of arrival.

5.447C Administrations responsible for fixed-satellite service networks in the band 5 150-5 250 MHz operated under Nos. **5.447A** and **5.447B** shall coordinate on an equal basis in accordance with No. **9.11A** with administrations responsible for non-geostationary-satellite networks operated under No. **5.446** and brought into use prior to 17 November 1995. Satellite networks operated under No. **5.446** brought into use after 17 November 1995 shall not claim protection from, and shall not cause harmful interference to, stations of the fixed-satellite service operated under Nos. **5.447A** and **5.447B**.

5.447D The allocation of the band 5 250-5 255 MHz to the space research service on a primary basis is limited to active spaceborne sensors. Other uses of the band by the space research service are on a secondary basis. (WRC-97)

5.448 *Additional allocation:* in Austria, Azerbaijan, Bulgaria, Libya, Mongolia, Kyrgyzstan, Slovakia, the Czech Rep., Romania and Turkmenistan, the band 5 250-5 350 MHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.448A The use of the frequency band 5 250-5 350 MHz by the earth exploration-satellite (active) and space research (active) services shall not constrain the future development and deployment of the radiolocation service. (WRC-97)

5.448B The earth exploration-satellite (active) service operating in the band 5 350-5 460 MHz shall not cause harmful interference to, or constrain the use and development of, the aeronautical radionavigation service. (WRC-97)

5.449 The use of the band 5 350-5 470 MHz by the aeronautical radionavigation service is limited to airborne radars and associated airborne beacons.

5.450 *Additional allocation:* in Austria, Azerbaijan, Bulgaria, Iran (Islamic Republic of), Mongolia, Kyrgyzstan, Slovakia, the Czech Rep., Romania, Turkmenistan and Ukraine, the band 5 470-5 650 MHz is also allocated to the aeronautical radionavigation service on a primary basis. (WRC-97)

5.451 *Additional allocation:* in the United Kingdom, the band 5 470-5 850 MHz is also allocated to the land mobile service on a secondary basis. The power limits specified in Nos. **21.2**, **21.3**, **21.4** and **21.5** shall apply in the band 5 725-5 850 MHz.

5.452 Between 5 600 MHz and 5 650 MHz, ground-based radars used for meteorological purposes are authorized to operate on a basis of equality with stations of the maritime radionavigation service.

5.453 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, China, Congo, Korea (Rep. of), Egypt, the United Arab Emirates, Gabon, Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Lebanon, Libya, Madagascar, Malaysia, Nigeria, Oman, Pakistan, the Philippines, Qatar, Syria, the Dem. People's Rep. of Korea, Singapore, Swaziland, Tanzania, Chad and Yemen, the band 5 650-5 850 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-2000)

5.454 *Different category of service:* in Azerbaijan, Belarus, Georgia, Mongolia, Uzbekistan, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 5 670-5 725 MHz to the space research service is on a primary basis (see No. **5.33**). (WRC-2000)

5.455 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Bulgaria, Cuba, Georgia, Hungary, Kazakstan, Latvia, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, Slovakia, Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 5 670-5 850 MHz is also allocated to the fixed service on a primary basis.

5.456 *Additional allocation:* in Germany and in Cameroon, the band 5 755-5 850 MHz is also allocated to the fixed service on a primary basis.

5 830-7 550 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
5 830-5 850 FIXED-SATELLITE (Earth-to-space) RADIOLOCATION Amateur Amateur-satellite (space-to-Earth) 5.150 5.451 5.453 5.455 5.456	**5 830-5 850** RADIOLOCATION Amateur Amateur-satellite (space-to-Earth) 5.150 5.453 5.455	
5 850-5 925 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.150	**5 850-5 925** FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Amateur Radiolocation 5.150	**5 850-5 925** FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Radiolocation 5.150
5 925-6 700	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.149 5.440 5.458	
6 700-7 075	FIXED FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.441 MOBILE 5.458 5.458A 5.458B 5.458C	
7 075-7 250	FIXED MOBILE 5.458 5.459 5.460	
7 250-7 300	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE 5.461	
7 300-7 450	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.461	
7 450-7 550	FIXED FIXED-SATELLITE (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.461A	

5.457 Not used.

5.458 In the band 6 425-7 075 MHz, passive microwave sensor measurements are carried out over the oceans. In the band 7 075-7 250 MHz, passive microwave sensor measurements are carried out. Administrations should bear in mind the needs of the Earth exploration-satellite (passive) and space research (passive) services in their future planning of the bands 6 425-7 025 MHz and 7 075-7 250 MHz.

5.458A In making assignments in the band 6 700-7 075 MHz to space stations of the fixed-satellite service, administrations are urged to take all practicable steps to protect spectral line observations of the radio astronomy service in the band 6 650-6 675.2 MHz from harmful interference from unwanted emissions.

5.458B The space-to-Earth allocation to the fixed-satellite service in the band 6 700-7 075 MHz is limited to feeder links for non-geostationary satellite systems of the mobile-satellite service and is subject to coordination under No. **9.11A**. The use of the band 6 700-7 075 MHz (space-to-Earth) by feeder links for non-geostationary satellite systems in the mobile-satellite service is not subject to No. **22.2**.

5.458C Administrations making submissions in the band 7 025-7 075 MHz (Earth-to-space) for geostationary-satellite systems in the fixed-satellite service after 17 November 1995 shall consult on the basis of relevant ITU-R Recommendations with the administrations that have notified and brought into use non-geostationary-satellite systems in this frequency band before 18 November 1995 upon request of the latter administrations. This consultation shall be with a view to facilitating shared operation of both geostationary-satellite systems in the fixed-satellite service and non-geostationary-satellite systems in this band.

5.459 *Additional allocation:* in Russian Federation, the frequency bands 7 100-7 155 MHz and 7 190-7 235 MHz are also allocated to the space operation service (Earth-to-space) on a primary basis, subject to agreement obtained under No. **9.21**. (WRC-97)

5.460 *Additional allocation:* the band 7 145-7 235 MHz is also allocated to the space research (Earth-to-space) service on a primary basis, subject to agreement obtained under No. **9.21**. The use of the band 7 145-7 190 MHz is restricted to deep space; no emissions to deep space shall be effected in the band 7 190-7 235 MHz.

5.461 *Additional allocation:* the bands 7 250-7 375 MHz (space-to-Earth) and 7 900-8 025 MHz (Earth-to-space) are also allocated to the mobile-satellite service on a primary basis, subject to agreement obtained under No. **9.21**.

5.461A The use of the band 7 450-7 550 MHz by the meteorological-satellite service (space-to-Earth) is limited to geostationary-satellite systems. Non-geostationary meteorological-satellite systems in this band notified before 30 November 1997 may continue to operate on a primary basis until the end of their lifetime. (WRC-97)

7 550-8 750 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
7 550-7 750	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile	
7 750-7 850	FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) 5.461B MOBILE except aeronautical mobile	
7 850-7 900	FIXED MOBILE except aeronautical mobile	
7 900-8 025	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.461	
8 025-8 175	EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A	
8 175-8 215	EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A	
8 215-8 400	EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A	
8 400-8 500	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-Earth) 5.465 5.466 5.467	
8 500-8 550	RADIOLOCATION 5.468 5.469	
8 550-8 650	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.468 5.469 5.469A	
8 650-8 750	RADIOLOCATION 5.468 5.469	

5.461B The use of the band 7 750-7 850 MHz by the meteorological-satellite service (space-to-Earth) is limited to non-geostationary satellite systems. (WRC-97)

5.462 (SUP - WRC-97)

5.462A In Regions 1 and 3 (except for Japan), in the band 8 025-8 400 MHz, the earth exploration-satellite service using geostationary satellites shall not produce a power flux-density in excess of the following provisional values for angles of arrival (θ), without the consent of the affected administration:

– 174 dB(W/m^2) in a 4 kHz band for $0° \leq \theta < 5°$

– $174 + 0.5 (\theta - 5)$ dB(W/m^2) in a 4 kHz band for $5° \leq \theta < 25°$

– 164 dB(W/m^2) in a 4 kHz band for $25° \leq \theta \leq 90°$

These values are subject to study under Resolution **124 (WRC-97)***. (WRC-97)

5.463 Aircraft stations are not permitted to transmit in the band 8 025-8 400 MHz. (WRC-97)

5.464 (SUP - WRC-97)

5.465 In the space research service, the use of the band 8 400-8 450 MHz is limited to deep space.

5.466 *Different category of service:* in Israel, Malaysia, Singapore and Sri Lanka, the allocation of the band 8 400-8 500 MHz to the space research service is on a secondary basis (see No. **5.32**). (WRC-97)

5.467 *Alternative allocation:* in the United Kingdom, the band 8 400-8 500 MHz is allocated to the radiolocation and space research services on a primary basis.

5.468 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Burundi, Cameroon, China, the Congo, Costa Rica, Egypt, the United Arab Emirates, Gabon, Guyana, Indonesia, Iran (Islamic Republic of), Iraq, Jamaica, Jordan, Kuwait, Lebanon, Libya, Malaysia, Mali, Morocco, Mauritania, Nepal, Nigeria, Oman, Pakistan, Qatar, Syria, Dem. People's Rep. of Korea, Senegal, Singapore, Somalia, Swaziland, Tanzania, Chad, Togo, Tunisia and Yemen, the band 8 500-8 750 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-97)

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* *Note by the Secretariat:* This Resolution was revised by WRC-2000.

5.469 *Additional allocation:* in Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Hungary, Lithuania, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, Slovakia, the Czech Rep., Romania, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the band 8 500-8 750 MHz is also allocated to the land mobile and radionavigation services on a primary basis. (WRC-2000)

5.469A In the band 8 550-8 650 MHz, stations in the earth exploration-satellite service (active) and space research service (active) shall not cause harmful interference to, or constrain the use and development of, stations of the radiolocation service. (WRC-97)

8 750-10 000 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
8 750-8 850	RADIOLOCATION AERONAUTICAL RADIONAVIGATION 5.470 5.471	
8 850-9 000	RADIOLOCATION MARITIME RADIONAVIGATION 5.472 5.473	
9 000-9 200	AERONAUTICAL RADIONAVIGATION 5.337 Radiolocation 5.471	
9 200-9 300	RADIOLOCATION MARITIME RADIONAVIGATION 5.472 5.473 5.474	
9 300-9 500	RADIONAVIGATION 5.476 Radiolocation 5.427 5.474 5.475	
9 500-9 800	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION SPACE RESEARCH (active) 5.476A	
9 800-10 000	RADIOLOCATION Fixed 5.477 5.478 5.479	

5.470 The use of the band 8 750-8 850 MHz by the aeronautical radionavigation service is limited to airborne Doppler navigation aids on a centre frequency of 8 800 MHz.

5.471 *Additional allocation:* in Algeria, Germany, Bahrain, Belgium, China, the United Arab Emirates, France, Greece, Indonesia, Iran (Islamic Republic of), Libya, the Netherlands, Qatar and Sudan, the bands 8 825-8 850 MHz and 9 000-9 200 MHz are also allocated to the maritime radionavigation service, on a primary basis, for use by shore-based radars only.

5.472 In the bands 8 850-9 000 MHz and 9 200-9 225 MHz, the maritime radionavigation service is limited to shore-based radars.

5.473 *Additional allocation:* in Armenia, Austria, Azerbaijan, Belarus, Bulgaria, Cuba, Georgia, Hungary, Moldova, Mongolia, Uzbekistan, Poland, Kyrgyzstan, Slovakia, the Czech Rep., Romania, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the bands 8 850-9 000 MHz and 9 200-9 300 MHz are also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.474 In the band 9 200-9 500 MHz, search and rescue transponders (SART) may be used, having due regard to the appropriate ITU-R Recommendation (see also Article **31**).

5.475 The use of the band 9 300-9 500 MHz by the aeronautical radionavigation service is limited to airborne weather radars and ground-based radars. In addition, ground-based radar beacons in the aeronautical radionavigation service are permitted in the band 9 300-9 320 MHz on condition that harmful interference is not caused to the maritime radionavigation service. In the band 9 300-9 500 MHz, ground-based radars, used for meteorological purposes ,have priority over other radiolocation devices.

5.476 In the band 9 300-9 320 MHz in the radionavigation service, the use of shipborne radars, other than those existing on 1 January 1976, is not permitted until 1 January 2001.

5.476A In the band 9 500-9 800 MHz, stations in the earth exploration-satellite service (active) and space research service (active) shall not cause harmful interference to, or constrain the use and development of, stations of the radionavigation and radiolocation services. (WRC-97)

5.477 *Different category of service:* in Algeria, Saudi Arabia, Austria, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Guyana, India, Indonesia, Iran (Islamic Republic of), Iraq, Jamaica, Japan, Jordan, Kuwait, Lebanon, Liberia, Malaysia, Nigeria, Oman, Pakistan, Qatar, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, Sweden, Trinidad, Tobago, and Yemen, the allocation of the band 9 800-10 000 MHz to the fixed service is on a primary basis (see No. **5.33**). (WRC-2000)

5.478 *Additional allocation:* in Azerbaijan, Bulgaria, Mongolia, Kyrgyzstan, Slovakia, the Czech Rep., Romania, Turkmenistan and Ukraine, the band 9 800-10 000 MHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.479 The band 9 975-10 025 MHz is also allocated to the meteorological-satellite service on a secondary basis for use by weather radars.

10-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.45 FIXED MOBILE RADIOLOCATION Amateur 5.479	**10-10.45** RADIOLOCATION Amateur 5.479 5.480	**10-10.45** FIXED MOBILE RADIOLOCATION Amateur 5.479
10.45-10.5	RADIOLOCATION Amateur Amateur-satellite 5.481	
10.5-10.55 FIXED MOBILE Radiolocation	**10.5-10.55** FIXED MOBILE RADIOLOCATION	
10.55-10.6	FIXED MOBILE except aeronautical mobile Radiolocation	
10.6-10.68	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) Radiolocation 5.149 5.482	
10.68-10.7	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.483	
10.7-11.7 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 5.484A (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**10.7-11.7** FIXED FIXED-SATELLITE (space-to-Earth) 5.441 5.484A MOBILE except aeronautical mobile	**10.7-11.7** FIXED FIXED-SATELLITE (space-to-Earth) 5.441 5.484A MOBILE except aeronautical mobile

5.480 *Additional allocation:* in Argentina, Brazil, Chile, Costa Rica, Cuba, El Salvador, Ecuador, Guatemala, Honduras, Mexico, Paraguay, Peru, Uruguay and Venezuela, the band 10-10.45 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-2000)

5.481 *Additional allocation:* in Germany, Angola, Brazil, China, Costa Rica, El Salvador, Ecuador, Spain, Guatemala, Japan, Morocco, Nigeria, Oman, Uzbekistan, Paraguay, Peru, the Dem. People's Rep. of Korea, Sweden, Tanzania, Thailand and Uruguay, the band 10.45-10.5 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-2000)

5.482 In the band 10.6-10.68 GHz, stations of the fixed and mobile, except aeronautical mobile, services shall be limited to a maximum equivalent isotropically radiated power of 40 dBW and the power delivered to the antenna shall not exceed –3 dBW. These limits may be exceeded subject to agreement obtained under No. **9.21**. However, in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, China, the United Arab Emirates, Georgia, India, Indonesia, Iran (Islamic Republic of), Iraq, Japan, Kazakstan, Kuwait, Latvia, Lebanon, Moldova, Nigeria, Uzbekistan, Pakistan, the Philippines, Qatar, Syria, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan and Ukraine, the restrictions on the fixed and mobile, except aeronautical mobile, services are not applicable.

5.483 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Bosnia and Herzegovina, China, Colombia, Korea (Rep. of), Costa Rica, Egypt, the United Arab Emirates, Georgia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kazakstan, Kuwait, Latvia, Lebanon, Moldova, Mongolia, Uzbekistan, Qatar, Kyrgyzstan, the Dem. People's Rep. of Korea, Romania, the Russian Federation, Tajikistan, Turkmenistan, Ukraine, Yemen and Yugoslavia, the band 10.68-10.7 GHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. Such use is limited to equipment in operation by 1 January 1985. (WRC-2000)

5.484 In Region 1, the use of the band 10.7-11.7 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting-satellite service.

5.484A The use of the bands 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) in Region 2, 12.2-12.75 GHz (space-to-Earth) in Region 3, 12.5-12.75 GHz (space-to-Earth) in Region 1, 13.75-14.5 GHz (Earth-to-space), 17.8-18.6 GHz (space-to-Earth), 19.7-20.2 GHz (space-to-Earth), 27.5-28.6 GHz (Earth-to-space), 29.5-30 GHz (Earth-to-space) by a non-geostationary-satellite system in the fixed-satellite service is subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands

shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-2000)

11.7-14.25 GHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="3">11.7-12.5
FIXED
BROADCASTING
BROADCASTING-SATELLITE
MOBILE except aeronautical mobile

5.487 5.487A 5.492</td><td>11.7-12.1
FIXED 5.486
FIXED-SATELLITE (space-to-Earth) 5.484A
Mobile except aeronautical mobile
5.485 5.488</td><td rowspan="2">11.7-12.2
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE

5.487 5.487A 5.492</td></tr>
<tr><td>12.1-12.2
FIXED-SATELLITE (space-to-Earth) 5.484A
5.485 5.488 5.489</td></tr>
<tr><td>12.2-12.7
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE
5.487A 5.488 5.490 5.492</td><td>12.2-12.5
FIXED
MOBILE except aeronautical mobile
BROADCASTING
5.484A 5.487 5.491</td></tr>
<tr><td>12.5-12.75
FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space)

5.494 5.495 5.496</td><td>12.7-12.75
FIXED
FIXED-SATELLITE (Earth-to-space)
MOBILE except aeronautical mobile</td><td>12.5-12.75
FIXED
FIXED-SATELLITE (space-to-Earth) 5.484A
MOBILE except aeronautical mobile
BROADCASTING-SATELLITE 5.493</td></tr>
<tr><td>12.75-13.25</td><td colspan="2">FIXED
FIXED-SATELLITE (Earth-to-space) 5.441
MOBILE
Space research (deep space) (space-to-Earth)</td></tr>
<tr><td>13.25-13.4 EARTH EXPLORATION-SATELLITE (active)</td><td colspan="2">AERONAUTICAL RADIONAVIGATION 5.497
SPACE RESEARCH (active)
5.498A 5.499</td></tr>
<tr><td>13.4-13.75 EARTH EXPLORATION-SATELLITE (active)</td><td colspan="2">RADIOLOCATION
SPACE RESEARCH 5.501A
Standard frequency and time signal-satellite (Earth-to-space)
5.499 5.500 5.501 5.501B</td></tr>
<tr><td>13.75-14</td><td colspan="2">FIXED-SATELLITE (Earth-to-space) 5.484A
RADIOLOCATION
Standard frequency and time signal-satellite (Earth-to-space)
Space research
5.499 5.500 5.501 5.502 5.503 5.503A</td></tr>
<tr><td>14-14.25</td><td colspan="2">FIXED-SATELLITE (Earth-to-space) 5.484A 5.506
RADIONAVIGATION 5.504
Mobile-satellite (Earth-to-space) except aeronautical mobile-satellite
Space research
5.505</td></tr>
</table>

5.485 In Region 2, in the band 11.7-12.2 GHz, transponders on space stations in the fixed-satellite service may be used additionally for transmissions in the broadcasting-satellite service, provided that such transmissions do not have a maximum e.i.r.p. greater than 53 dBW per television channel and do not cause greater interference or require more protection from interference than the coordinated fixed-satellite service frequency assignments. With respect to the space services, this band shall be used principally for the fixed-satellite service.

5.486 *Different category of service:* in Mexico and the United States, the allocation of the band 11.7-12.1 GHz to the fixed service is on a secondary basis (see No. **5.32**).

5.487 In the band 11.7-12.5 GHz in Regions 1 and 3, the fixed, fixed-satellite, mobile, except aeronautical mobile, and broadcasting services, in accordance with their respective allocations, shall not cause harmful interference to, or claim protection from, broadcasting-satellite stations operating in accordance with the provisions of the Regions 1 and 3 Plan in Appendix **30**. (WRC-2000)

5.487A *Additional allocation:* in Region 1, the band 11.7-12.5 GHz, in Region 2, the band 12.2-12.7 GHz and, in Region 3, the band 11.7-12.2 GHz, are also allocated to the fixed-satellite service (space-to-Earth) on a primary basis, limited to non-geostationary systems and subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the broadcasting-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geosationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-2000)

5.488 The use of the band 11.7-12.2 GHz by geostationary-satellite networks in the fixed-satellite service in Region 2 is subject to the provisions of Resolution **77 (WRC-2000)**. For the use of the band 12.2-12.7 GHz by the broadcasting-satellite service in Region 2, see Appendix **30**. (WRC-2000)

5.489 *Additional allocation:* in Peru, the band 12.1-12.2 GHz is also allocated to the fixed service on a primary basis.

5.490 In Region 2, in the band 12.2-12.7 GHz, existing and future terrestrial radiocommunication services shall not cause harmful interference to the space services operating in conformity with the broadcasting-satellite Plan for Region 2 contained in Appendix **30**.

5.491 *Additional allocation:* in Region 3, the band 12.2-12.5 GHz is also allocated to the fixed-satellite service (space-to-Earth) on a primary basis. The power flux-density limits in

Table **21-4** of Article **21** shall apply to this frequency band. The introduction of the service in relation to the broadcasting-satellite service in Region 1 shall follow the procedures specified in Article 7 of Appendix **30**, with the applicable frequency band extended to cover 12.2-12.5 GHz. (WRC-2000)

5.492 Assignments to stations of the broadcasting-satellite service which are in conformity with the appropriate regional Plan or included in the Regions 1 and 3 List in Appendix **30** may also be used for transmissions in the fixed-satellite service (space-to-Earth), provided that such transmissions do not cause more interference, or require more protection from interference, than the broadcasting-satellite service transmissions operating in conformity with the Plan or the List, as appropriate. (WRC-2000)

5.493 The broadcasting-satellite service in the band 12.5-12.75 GHz in Region 3 is limited to a power flux-density not exceeding –111 dB(W/(m^2 · 27 MHz)) for all conditions and for all methods of modulation at the edge of the service area. (WRC-97)

5.494 *Additional allocation:* in Algeria, Angola, Saudi Arabia, Bahrain, Cameroon, the Central African Rep., the Congo, Côte d'Ivoire, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Madagascar, Mali, Morocco, Mongolia, Nigeria, Qatar, Dem. Rep. of the Congo, Syria, Senegal, Somalia, Sudan, Chad, Togo and Yemen, the band 12.5-12.75 GHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-97)

5.495 *Additional allocation:* in Bosnia and Herzegovina, Croatia, Denmark, France, Greece, Liechtenstein, Monaco, Uganda, Portugal, Romania, Slovenia, Switzerland, Tanzania, Tunisia and Yugoslavia, the band 12.5-12.75 GHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a secondary basis. (WRC-2000)

5.496 *Additional allocation:* in Austria, Azerbaijan, Kyrgyzstan and Turkmenistan, the band 12.5-12.75 GHz is also allocated to the fixed service and the mobile, except aeronautical mobile, service on a primary basis. However, stations in these services shall not cause harmful interference to fixed-satellite service earth stations of countries in Region 1 other than those listed in this footnote. Coordination of these earth stations is not required with stations of the fixed and mobile services of the countries listed in this footnote. The power flux-density limit at the Earth's surface given in Table **21-4** of Article **21**, for the fixed-satellite service shall apply on the territory of the countries listed in this footnote. (WRC-2000)

5.497 The use of the band 13.25-13.4 GHz by the aeronautical radionavigation service is limited to Doppler navigation aids.

5.498 (SUP - WRC-97)

5.498A The Earth exploration-satellite (active) and space research (active) services operating in the band 13.25-13.4 GHz shall not cause harmful interference to, or constrain the use and development of, the aeronautical radionavigation service. (WRC-97)

5.499 *Additional allocation:* in Bangladesh, India and Pakistan, the band 13.25-14 GHz is also allocated to the fixed service on a primary basis.

5.500 *Additional allocation:* in Algeria, Angola, Saudi Arabia, Bahrain, Brunei Darussalam, Cameroon, Egypt, the United Arab Emirates, Gabon, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Madagascar, Malaysia, Mali, Malta, Morocco, Mauritania, Nigeria, Pakistan, Qatar, Syria, Senegal, Singapore, Sudan, Chad and Tunisia, the band 13.4-14 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-2000)

5.501 *Additional allocation:* in Austria, Azerbaijan, Hungary, Japan, Mongolia, Kyrgyzstan, Romania, the United Kingdom and Turkmenistan, the band 13.4-14 GHz is also allocated to the radionavigation service on a primary basis. (WRC-2000)

5.501A The allocation of the band 13.4-13.75 GHz to the space research service on a primary basis is limited to active spaceborne sensors. Other uses of the band by the space research service are on a secondary basis. (WRC-97)

5.501B In the band 13.4-13.75 GHz, the Earth exploration-satellite (active) and space research (active) services shall not cause harmful interference to, or constrain the use and development of, the radiolocation service. (WRC-97)

5.502 In the band 13.75-14 GHz, an earth station in the fixed-satellite service shall have a minimum antenna diameter of 4.5 m and the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW. In addition the e.i.r.p., averaged over one second, radiated by a station in the radiolocation or radionavigation services shall not exceed 59 dBW. The protection of assignments to receiving space stations in the fixed-satellite service operating with earth stations that individually have an e.i.r.p. of less than 68 dBW shall not impose constraints on the operation of the radiolocation and radionavigation stations operating in accordance with the Radio Regulations. No. **5.43A** does not apply. See Resolution **733 (WRC-2000)**. (WRC-2000)

5.503 In the band 13.75-14 GHz, geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 shall operate on an equal basis with stations in the fixed-satellite service; after that date, new geostationary space stations in the space research service will operate on a secondary basis. Until those geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 cease to operate in this band:

– the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in geostationary-satellite orbit shall not exceed 71 dBW in the 6 MHz band from 13.772 to 13.778 GHz;

– the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in non-geostationary-satellite orbit shall not exceed 51 dBW in the 6 MHz band from 13.772 to 13.778 GHz.

Automatic power control may be used to increase the e.i.r.p. density in the 6 MHz band in this frequency range to compensate for rain attenuation, to the extent that the power flux-density at the fixed-satellite service space station does not exceed the value resulting from use by an earth station of an e.i.r.p. of 71 dBW or 51 dBW, as appropriate, in the 6 MHz band in clear-sky conditions. (WRC-2000)

5.503A Until 1 January 2000, stations in the fixed-satellite service shall not cause harmful interference to non-geostationary space stations in the space research and Earth exploration-satellite services. After that date, these non-geostationary space stations will operate on a secondary basis in relation to the fixed-satellite service. Additionally, when planning earth stations in the fixed-satellite service to be brought into service between 1 January 2000 and 1 January 2001, in order to accommodate the needs of spaceborne precipitation radars operating in the band 13.793-13.805 GHz, advantage should be taken of the consultation process and the information given in Recommendation ITU-R SA.1071.

5.504 The use of the band 14-14.3 GHz by the radionavigation service shall be such as to provide sufficient protection to space stations of the fixed-satellite service.

5.505 *Additional allocation:* in Algeria, Angola, Saudi Arabia, Bahrain, Bangladesh, Botswana, Brunei Darussalam, Cameroon, China, Congo, Korea (Rep. of), Egypt, the United Arab Emirates, Gabon, Guatemala, Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Lesotho, Lebanon, Malaysia, Mali, Morocco, Mauritania, Oman, Pakistan, the Philippines, Qatar, Syria, the Dem. People's Rep. of Korea, Senegal, Singapore, Somalia, Sudan, Swaziland, Tanzania, Chad and Yemen, the band 14-14.3 GHz is also allocated to the fixed service on a primary basis. (WRC-2000)

5.506 The band 14-14.5 GHz may be used, within the fixed-satellite service (Earth-to-space), for feeder links for the broadcasting-satellite service, subject to coordination with other networks in the fixed-satellite service. Such use of feeder links is reserved for countries outside Europe.

14.25-15.63 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14.25-14.3	FIXED-SATELLITE (Earth-to-space) 5.484A 5.506 RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) except aeronautical mobile-satellite Space research 5.505 5.508 5.509	
14.3-14.4 FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.506 MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) except aeronautical mobile-satellite Radionavigation-satellite	**14.3-14.4** FIXED-SATELLITE (Earth-to-space) 5.484A 5.506 Mobile-satellite (Earth-to-space) except aeronautical mobile-satellite Radionavigation-satellite	**14.3-14.4** FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.506 MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) except aeronautical mobile-satellite Radionavigation-satellite
14.4-14.47	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.506 MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) except aeronautical mobile-satellite Space research (space-to-Earth)	
14.47-14.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.506 MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) except aeronautical mobile-satellite Radio astronomy 5.149	
14.5-14.8	FIXED FIXED-SATELLITE (Earth-to-space) 5.510 MOBILE Space research	
14.8-15.35	FIXED MOBILE Space research 5.339	
15.35-15.4	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.511	
15.4-15.43	AERONAUTICAL RADIONAVIGATION 5.511D	
15.43-15.63	FIXED-SATELLITE (Earth-to-space) 5.511A AERONAUTICAL RADIONAVIGATION 5.511C	

5.507 Not used.

5.508 *Additional allocation:* in Germany, Bosnia and Herzegovina, France, Greece, Ireland, Iceland, Italy, The Former Yugoslav Republic of Macedonia, Libya, Liechtenstein, Portugal, the United Kingdom, Slovenia, Switzerland and Yugoslavia, the band 14.25-14.3 GHz is also allocated to the fixed service on a primary basis. (WRC-2000)

5.509 *Additional allocation:* in Japan the band 14.25-14.3 GHz is also allocated to the mobile, except aeronautical mobile, service on a primary basis. (WRC-2000)

5.510 The use of the band 14.5-14.8 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting-satellite service. This use is reserved for countries outside Europe.

5.511 *Additional allocation:* in Saudi Arabia, Bahrain, Bosnia and Herzegovina, Cameroon, Egypt, the United Arab Emirates, Guinea, Iran (Islamic Republic of), Iraq, Israel, Kuwait, Lebanon, Libya, Pakistan, Qatar, Syria, Slovenia, Somalia and Yugoslavia, the band 15.35-15.4 GHz is also allocated to the fixed and mobile services on a secondary basis. (WRC-97)

5.511A The band 15.43-15.63 GHz is also allocated to the fixed-satellite service (space-to-Earth) on a primary basis. Use of the band 15.43-15.63 GHz by the fixed-satellite service (space-to-Earth and Earth-to-space) is limited to feeder links of non-geostationary systems in the mobile-satellite service, subject to coordination under No. **9.11A**. The use of the frequency band 15.43-15.63 GHz by the fixed-satellite service (space-to-Earth) is limited to feeder links of non-geostationary systems in the mobile-satellite service for which advance publication information has been received by the Bureau prior to 2 June 2000. In the space-to-Earth direction, the minimum earth station elevation angle above and gain towards the local horizontal plane and the minimum coordination distances to protect an earth station from harmful interference shall be in accordance with Recommendation ITU-R S.1341. In order to protect the radio astronomy service in the band 15.35-15.4 GHz, the aggregate power flux-density radiated in the 15.35-15.4 GHz band by all the space stations within any feeder-link of a non-geostationary system in the mobile-satellite service (space-to-Earth) operating in the 15.43-15.63 GHz band shall not exceed the level of –156 dB(W/m^2) in a 50 MHz bandwidth, into any radio astronomy observatory site for more than 2% of the time. (WRC-2000)

5.511B (SUP - WRC-97)

5.511C Stations operating in the aeronautical radionavigation service shall limit the effective e.i.r.p. in accordance with Recommendation ITU-R S.1340. The minimum coordination distance required to protect the aeronautical radionavigation stations (No. **4.10** applies) from harmful interference from feeder-link earth stations and the maximum e.i.r.p. transmitted towards the local horizontal plane by a feeder-link earth station shall be in accordance with Recommendation ITU-R S.1340. (WRC-97)

5.511D Fixed-satellite service systems for which complete information for advance publication has been received by the Bureau by 21 November 1997 may operate in the bands 15.4-15.43 GHz and 15.63-15.7 GHz in the space-to-Earth direction and 15.63-15.65 GHz in the Earth-to-space direction. In the bands 15.4-15.43 GHz and 15.65-15.7 GHz, emissions from a non-geostationary space station shall not exceed the power flux-density limits at the Earth's surface of –146 dB(W/(m^2 · MHz)) for any angle of arrival. In the band 15.63-15.65 GHz, where an administration plans emissions from a non-geostationary space station that exceed –146 dB(W/(m^2 · MHz)) for any angle of arrival, it shall coordinate under No. **9.11A** with the affected administrations. Stations in the fixed-satellite service operating in the band 15.63-15.65 GHz in the Earth-to-space direction shall not cause harmful interference to stations in the aeronautical radionavigation service (No. **4.10** applies). (WRC-97)

15.63-18.6 GHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>15.63-15.7</td><td colspan="2">AERONAUTICAL RADIONAVIGATION
5.511D</td></tr>
<tr><td>15.7-16.6</td><td colspan="2">RADIOLOCATION
5.512 5.513</td></tr>
<tr><td>16.6-17.1</td><td colspan="2">RADIOLOCATION
Space research (deep space) (Earth-to-space)
5.512 5.513</td></tr>
<tr><td>17.1-17.2</td><td colspan="2">RADIOLOCATION
5.512 5.513</td></tr>
<tr><td>17.2-17.3</td><td colspan="2">EARTH EXPLORATION-SATELLITE (active)
RADIOLOCATION
SPACE RESEARCH (active)
5.512 5.513 5.513A</td></tr>
<tr><td>17.3-17.7
FIXED-SATELLITE
(Earth-to-space) 5.516
Radiolocation

5.514</td><td>17.3-17.7
FIXED-SATELLITE
(Earth-to-space) 5.516
BROADCASTING-SATELLITE
Radiolocation
5.514 5.515 5.517</td><td>17.3-17.7
FIXED-SATELLITE
(Earth-to-space) 5.516
Radiolocation

5.514</td></tr>
<tr><td rowspan="2">17.7-18.1
FIXED
FIXED-SATELLITE
(space-to-Earth) 5.484A
(Earth-to-space) 5.516
MOBILE</td><td>17.7-17.8
FIXED
FIXED-SATELLITE
(space-to-Earth)
(Earth-to-space) 5.516
BROADCASTING-SATELLITE
Mobile 5.518
5.515 5.517</td><td rowspan="2">17.7-18.1
FIXED
FIXED-SATELLITE
(space-to-Earth) 5.484A
(Earth-to-space) 5.516
MOBILE</td></tr>
<tr><td>17.8-18.1
FIXED
FIXED-SATELLITE
(space-to-Earth) 5.484A
(Earth-to-space) 5.516
MOBILE</td></tr>
<tr><td>18.1-18.4</td><td colspan="2">FIXED
FIXED-SATELLITE (space-to-Earth) 5.484A
(Earth-to-space) 5.520
MOBILE
5.519 5.521</td></tr>
<tr><td>18.4-18.6</td><td colspan="2">FIXED
FIXED-SATELLITE (space-to-Earth) 5.484A
MOBILE</td></tr>
</table>

5.512 *Additional allocation:* in Algeria, Angola, Saudi Arabia, Austria, Bahrain, Bangladesh, Bosnia and Herzegovina, Brunei Darussalam, Cameroon, the Congo, Costa Rica, Egypt, El Salvador, the United Arab Emirates, Finland, Guatemala, India, Indonesia, Iran (Islamic Republic of), Jordan, Kuwait, Libya, Malaysia, Morocco, Mozambique, Nepal, Nicaragua, Oman, Pakistan, Qatar, Singapore, Slovenia, Somalia, Sudan, Swaziland, Tanzania, Chad, Yemen and Yugoslavia, the band 15.7-17.3 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-97)

5.513 *Additional allocation:* in Israel, the band 15.7-17.3 GHz is also allocated to the fixed and mobile services on a primary basis. These services shall not claim protection from or cause harmful interference to services operating in accordance with the Table in countries other than those included in No. **5.512**.

5.513A Spaceborne active sensors operating in the band 17.2-17.3 GHz shall not cause harmful interference to, or constrain the development of, the radiolocation and other services allocated on a primary basis. (WRC-97)

5.514 *Additional allocation:* in Algeria, Germany, Angola, Saudi Arabia, Austria, Bahrain, Bangladesh, Bosnia and Herzegovina, Cameroon, Costa Rica, El Salvador, the United Arab Emirates, Finland, Guatemala, Honduras, India, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Libya, Nepal, Nicaragua, Oman, Pakistan, Qatar, Slovenia, Sudan and Yugoslavia, the band 17.3-17.7 GHz is also allocated to the fixed and mobile services on a secondary basis. The power limits given in Nos. **21.3** and **21.5** shall apply. (WRC-2000)

5.515 In the band 17.3-17.8 GHz, sharing between the fixed-satellite service (Earth-to-space) and the broadcasting-satellite service shall also be in accordance with the provisions of § 1 of Annex 4 of Appendix **30A**.

5.516 The use of the band 17.3-18.1 GHz by geostationary-satellite systems in the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting-satellite service. The use of the band 17.3-17.8 GHz in Region 2 by systems in the fixed-satellite service (Earth-to-space) is limited to geostationary satellites. For the use of the band 17.3-17.8 GHz in Region 2 by feeder links for the broadcasting-satellite service in the band 12.2-12.7 GHz, see Article **11**. The use of the bands 17.3-18.1 GHz (Earth-to-space) in Regions 1 and 3 and 17.8-18.1 GHz (Earth-to-space) in Region 2 by non-geostationary-satellite systems in the fixed-satellite service is subject to application of the provisions of No. **9.12** for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. **5.43A** does not apply. Non-geostationary-satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-2000)

5.517 In Region 2, the allocation to the broadcasting-satellite service in the band 17.3-17.8 GHz shall come into effect on 1 April 2007. After that date, use of the fixed-satellite (space-to-Earth) service in the band 17.7-17.8 GHz shall not claim protection from and shall not cause harmful interference to operating systems in the broadcasting-satellite service.

5.518 *Different category of service:* in Region 2, the allocation of the band 17.7-17.8 GHz to the mobile service is on a primary basis until 31 March 2007.

5.519 *Additional allocation:* the band 18.1-18.3 GHz is also allocated to the meteorological-satellite service (space-to-Earth) on a primary basis. Its use is limited to geostationary satellites and shall be in accordance with the provisions of Article **21**, Table **21-4**.

5.520 The use of the band 18.1-18.4 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links of geostationary-satellite systems in the broadcasting-satellite service. (WRC-2000)

5.521 *Alternative allocation:* in Germany, Denmark, the United Arab Emirates, Greece and Slovakia, the band 18.1-18.4 GHz is allocated to the fixed, fixed-satellite (space-to-Earth) and mobile services on a primary basis (see No. **5.33**). The provisions of No. **5.519** also apply. (WRC-2000)

18.6-22.21 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
18.6-18.8 EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.522B MOBILE except aeronautical mobile Space research (passive) 5.522A 5.522C	**18.6-18.8** EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.522B MOBILE except aeronautical mobile SPACE RESEARCH (passive) 5.522A	**18.6-18.8** EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.522B MOBILE except aeronautical mobile Space research (passive) 5.522A
18.8-19.3	FIXED FIXED-SATELLITE (space-to-Earth) 5.523A MOBILE	
19.3-19.7	FIXED FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 5.523B 5.523C 5.523D 5.523E MOBILE	
19.7-20.1 FIXED-SATELLITE (space-to-Earth) 5.484A Mobile-satellite (space-to-Earth) 5.524	**19.7-20.1** FIXED-SATELLITE (space-to-Earth) 5.484A MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528 5.529	**19.7-20.1** FIXED-SATELLITE (space-to-Earth) 5.484A Mobile-satellite (space-to-Earth) 5.524
20.1-20.2	FIXED-SATELLITE (space-to-Earth) 5.484A MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528	
20.2-21.2	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) Standard frequency and time signal-satellite (space-to-Earth) 5.524	
21.2-21.4	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive)	
21.4-22 FIXED MOBILE BROADCASTING-SATELLITE 5.530	**21.4-22** FIXED MOBILE	**21.4-22** FIXED MOBILE BROADCASTING-SATELLITE 5.530 5.531
22-22.21	FIXED MOBILE except aeronautical mobile 5.149	

5.522 (SUP - WRC-2000)

5.522A The emissions of the fixed service and the fixed-satellite service in the band 18.6-18.8 GHz are limited to the values given in Nos. **21.5A** and **21.16.2**, respectively. (WRC-2000)

5.522B The use of the band 18.6-18.8 GHz by the fixed-satellite service is limited to geostationary systems and systems with an orbit of apogee greater than 20 000 km. (WRC-2000)

5.522C In the band 18.6-18.8 GHz, in Algeria, Saudi Arabia, Bahrain, Egypt, the United Arab Emirates, Jordan, Lebanon, Libya, Morocco, Oman, Qatar, Syria, Tunisia and Yemen, fixed-service systems in operation at the date of entry into force of the Final Acts of WRC-2000 are not subject to the limits of No. **21.5A**. (WRC-2000)

5.523 (SUP - WRC-2000)

5.523A The use of the bands 18.8-19.3 GHz (space-to-Earth) and 28.6-29.1 GHz (Earth-to-space) by geostationary and non-geostationary fixed-satellite service networks is subject to the application of the provisions of No. **9.11A** and No. **22.2** does not apply. Administrations having geostationary-satellite networks under coordination prior to 18 November 1995 shall cooperate to the maximum extent possible to coordinate pursuant to No. **9.11A** with non-geostationary-satellite networks for which notification information has been received by the Bureau prior to that date, with a view to reaching results acceptable to all the parties concerned. Non-geostationary-satellite networks shall not cause unacceptable interference to geostationary fixed-satellite service networks for which complete Appendix **4** notification information is considered as having been received by the Bureau prior to 18 November 1995. (WRC-97)

5.523B The use of the band 19.3-19.6 GHz (Earth-to-space) by the fixed-satellite service is limited to feeder links for non-geostationary-satellite systems in the mobile-satellite service. Such use is subject to the application of the provisions of No. **9.11A**, and No. **22.2** does not apply.

5.523C No. **22.2** shall continue to apply in the bands 19.3-19.6 GHz and 29.1-29.4 GHz, between feeder links of non-geostationary mobile-satellite service networks and those fixed-satellite service networks for which complete Appendix **4** coordination information, or notification information, is considered as having been received by the Bureau prior to 18 November 1995. (WRC-97)

5.523D The use of the band 19.3-19.7 GHz (space-to-Earth) by geostationary fixed-satellite service systems and by feeder links for non-geostationary-satellite systems in the mobile-satellite service is subject to the application of the provisions of No. **9.11A**, but not subject to the provisions of No. **22.2**. The use of this band for other non-geostationary fixed-satellite service systems, or for the cases indicated in Nos. **5.523C** and **5.523E**, is not subject to the

provisions of No. **9.11A** and shall continue to be subject to Articles **9** (except No. **9.11A**) and **11** procedures, and to the provisions of No. **22.2**. (WRC-97)

5.523E No. **22.2** shall continue to apply in the bands 19.6-19.7 GHz and 29.4-29.5 GHz, between feeder links of non-geostationary mobile-satellite service networks and those fixed-satellite service networks for which complete Appendix **4** coordination information, or notification information, is considered as having been received by the Bureau by 21 November 1997. (WRC-97)

5.524 *Additional allocation:* in Afghanistan, Algeria, Angola, Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, China, the Congo, Costa Rica, Egypt, the United Arab Emirates, Gabon, Guatemala, Guinea, India, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Kuwait, Lebanon, Malaysia, Mali, Morocco, Mauritania, Nepal, Nigeria, Oman, Pakistan, the Philippines, Qatar, the Dem. Rep. of the Congo, Syria, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, Tanzania, Chad, Togo and Tunisia, the band 19.7-21.2 GHz is also allocated to the fixed and mobile services on a primary basis. This additional use shall not impose any limitation on the power flux-density of space stations in the fixed-satellite service in the band 19.7-21.2 GHz and of space stations in the mobile-satellite service in the band 19.7-20.2 GHz where the allocation to the mobile-satellite service is on a primary basis in the latter band. (WRC-2000)

5.525 In order to facilitate interregional coordination between networks in the mobile-satellite and fixed-satellite services, carriers in the mobile-satellite service that are most susceptible to interference shall, to the extent practicable, be located in the higher parts of the bands 19.7-20.2 GHz and 29.5-30 GHz.

5.526 In the bands 19.7-20.2 GHz and 29.5-30 GHz in Region 2, and in the bands 20.1-20.2 GHz and 29.9-30 GHz in Regions 1 and 3, networks which are both in the fixed-satellite service and in the mobile-satellite service may include links between earth stations at specified or unspecified points or while in motion, through one or more satellites for point-to-point and point-to-multipoint communications.

5.527 In the bands 19.7-20.2 GHz and 29.5-30 GHz, the provisions of No. **4.10** do not apply with respect to the mobile-satellite service.

5.528 The allocation to the mobile-satellite service is intended for use by networks which use narrow spot-beam antennas and other advanced technology at the space stations. Administrations operating systems in the mobile-satellite service in the band 19.7-20.1 GHz in Region 2 and in the band 20.1-20.2 GHz shall take all practicable steps to ensure the continued availability of these bands for administrations operating fixed and mobile systems in accordance with the provisions of No. **5.524**.

5.529 The use of the bands 19.7-20.1 GHz and 29.5-29.9 GHz by the mobile-satellite service in Region 2 is limited to satellite networks which are both in the fixed-satellite service and in the mobile-satellite service as described in No. **5.526**.

5.530 In Regions 1 and 3, the allocation to the broadcasting-satellite service in the band 21.4-22 GHz shall come into effect on 1 April 2007. The use of this band by the broadcasting-satellite service after that date and on an interim basis prior to that date is subject to the provisions of Resolution **525 (WARC-92)**.

5.531 *Additional allocation:* in Japan, the band 21.4-22 GHz is also allocated to the broadcasting service on a primary basis.

22.21-24.75 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
22.21-22.5	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) 5.149 5.532	
22.5-22.55	FIXED MOBILE	
22.55-23.55	FIXED INTER-SATELLITE MOBILE 5.149	
23.55-23.6	FIXED MOBILE	
23.6-24	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
24-24.05	AMATEUR AMATEUR-SATELLITE 5.150	
24.05-24.25	RADIOLOCATION Amateur Earth exploration-satellite (active) 5.150	
24.25-24.45 FIXED	**24.25-24.45** RADIONAVIGATION	**24.25-24.45** RADIONAVIGATION FIXED MOBILE
24.45-24.65 FIXED INTER-SATELLITE	**24.45-24.65** INTER-SATELLITE RADIONAVIGATION 5.533	**24.45-24.65** FIXED INTER-SATELLITE MOBILE RADIONAVIGATION 5.533
24.65-24.75 FIXED INTER-SATELLITE	**24.65-24.75** INTER-SATELLITE RADIOLOCATION-SATELLITE (Earth-to-space)	**24.65-24.75** FIXED INTER-SATELLITE MOBILE 5.533 5.534

5.532 The use of the band 22.21-22.5 GHz by the Earth exploration-satellite (passive) and space research (passive) services shall not impose constraints upon the fixed and mobile, except aeronautical mobile, services.

5.533 The inter-satellite service shall not claim protection from harmful interference from airport surface detection equipment stations of the radionavigation service.

5.534 *Additional allocation:* in Japan, the band 24.65-25.25 GHz is also allocated to the radionavigation service on a primary basis until 2008.

24.75-29.9 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
24.75-25.25 FIXED	**24.75-25.25** FIXED-SATELLITE (Earth-to-space) 5.535	**24.75-25.25** FIXED FIXED-SATELLITE (Earth-to-space) 5.535 MOBILE 5.534
25.25-25.5	FIXED INTER-SATELLITE 5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)	
25.5-27	EARTH EXPLORATION-SATELLITE (space-to Earth) 5.536A 5.536B FIXED INTER-SATELLITE 5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)	
27-27.5 FIXED INTER-SATELLITE 5.536 MOBILE	**27-27.5** FIXED FIXED-SATELLITE (Earth-to-space) INTER-SATELLITE 5.536 5.537 MOBILE	
27.5-28.5	FIXED 5.537A FIXED-SATELLITE (Earth-to-space) 5.484A 5.539 MOBILE 5.538 5.540	
28.5-29.1	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.523A 5.539 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	
29.1-29.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.523C 5.523E 5.535A 5.539 5.541A MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	
29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.539 Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space) 5.540 5.542	**29.5-29.9** FIXED-SATELLITE (Earth-to-space) 5.484A 5.539 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.525 5.526 5.527 5.529 5.540 5.542	**29.5-29.9** FIXED-SATELLITE (Earth-to-space) 5.484A 5.539 Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space) 5.540 5.542

5.535 In the band 24.75-25.25 GHz, feeder links to stations of the broadcasting-satellite service shall have priority over other uses in the fixed-satellite service (Earth-to-space). Such other uses shall protect and shall not claim protection from existing and future operating feeder-link networks to such broadcasting satellite stations.

5.535A The use of the band 29.1-29.5 GHz (Earth-to-space) by the fixed-satellite service is limited to geostationary-satellite systems and feeder links to non-geostationary-satellite systems in the mobile-satellite service. Such use is subject to the application of the provisions of No. **9.11A**, but not subject to the provisions of No. **22.2**, except as indicated in Nos. **5.523C** and **5.523E** where such use is not subject to the provisions of No. **9.11A** and shall continue to be subject to Articles **9** (except No. **9.11A**) and **11** procedures, and to the provisions of No. **22.2**. (WRC-97)

5.536 Use of the 25.25-27.5 GHz band by the inter-satellite service is limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.

5.536A Administrations installing Earth exploration-satellite service earth stations cannot claim protection from stations in the fixed and mobile services operated by neighbouring administrations. In addition, earth stations operating in the Earth exploration-satellite service should take into account Recommendation ITU-R SA.1278. (WRC-2000)

5.536B In Germany, Saudi Arabia, Austria, Belgium, Brazil, Bulgaria, China, Korea (Rep. of), Denmark, Egypt, United Arab Emirates, Spain, Estonia, Finland, France, Hungary, India, Iran (Islamic Republic of), Ireland, Israel, Italy, Jordan, Kenya, Kuwait, Lebanon, Libya, Liechtenstein, Lithuania, Moldova, Norway, Oman, Uganda, Pakistan, the Philippines, Poland, Portugal, Syria, Slovakia, the Czech Rep., Romania, the United Kingdom, Singapore, Sweden, Switzerland, Tanzania, Turkey, Viet Nam and Zimbabwe, earth stations operating in the Earth exploration-satellite service in the band 25.5-27 GHz shall not claim protection from, or constrain the use and deployment of, stations of the fixed and mobile services. (WRC-97)

5.537 Space services using non-geostationary satellites operating in the inter-satellite service in the band 27-27.5 GHz are exempt from the provisions of No. **22.2**.

5.537A In Bhutan, Indonesia, Iran (Islamic Republic of), Japan, Maldives, Mongolia, Myanmar, Pakistan, the Dem. People's Rep. of Korea, Sri Lanka, Thailand and Viet Nam, the allocation to the fixed service in the band 27.5-28.35 GHz may also be used by high altitude platform stations (HAPS). The use of the band 27.5-28.35 GHz by HAPS is limited to operation in the HAPS-to-ground direction and shall not cause harmful interference to, nor claim protection from, other types of fixed-service systems or other co-primary services. (WRC-2000)

5.538 *Additional allocation:* the bands 27.500-27.501 GHz and 29.999-30.000 GHz are also allocated to the fixed-satellite service (space-to-Earth) on a primary basis for the beacon transmissions intended for up-link power control. Such space-to-Earth transmissions shall not

exceed an equivalent isotropically radiated power (e.i.r.p.) of +10 dBW in the direction of adjacent satellites on the geostationary-satellite orbit. In the band 27.500-27.501 GHz, such space-to-Earth transmissions shall not produce a power flux-density in excess of the values specified in Article **21**, Table **21-4** on the Earth's surface.

5.539 The band 27.5-30 GHz may be used by the fixed-satellite service (Earth-to-space) for the provision of feeder links for the broadcasting-satellite service.

5.540 *Additional allocation:* the band 27.501-29.999 GHz is also allocated to the fixed-satellite service (space-to-Earth) on a secondary basis for beacon transmissions intended for up-link power control.

5.541 In the band 28.5-30 GHz, the earth exploration-satellite service is limited to the transfer of data between stations and not to the primary collection of information by means of active or passive sensors.

5.541A Feeder links of non-geostationary networks in the mobile-satellite service and geostationary networks in the fixed-satellite service operating in the band 29.1-29.5 GHz (Earth-to-space) shall employ uplink adaptive power control or other methods of fade compensation, such that the earth station transmissions shall be conducted at the power level required to meet the desired link performance while reducing the level of mutual interference between both networks. These methods shall apply to networks for which Appendix **4** coordination information is considered as having been received by the Bureau after 17 May 1996 and until they are changed by a future competent world radiocommunication conference. Administrations submitting Appendix **4** information for coordination before this date are encouraged to utilize these techniques to the extent practicable. (WRC-2000)

5.542 *Additional allocation:* in Algeria, Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, China, Congo, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Guinea, India, Iran (Islamic Republic of), Iraq, Japan, Jordan, Kuwait, Lebanon, Malaysia, Mali, Morocco, Mauritania, Nepal, Pakistan, the Philippines, Qatar, Syria, the Dem. People's Rep. of Korea, Somalia, Sudan, Sri Lanka and Chad, the band 29.5-31 GHz is also allocated to the fixed and mobile services on a secondary basis. The power limits specified in Nos. **21.3** and **21.5** shall apply. (WRC-2000)

29.9-34.2 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
29.9-30	FIXED-SATELLITE (Earth-to-space) 5.484A 5.539 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.543 5.525 5.526 5.527 5.538 5.540 5.542	
30-31	FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space) Standard frequency and time signal-satellite (space-to-Earth) 5.542	
31-31.3	FIXED 5.543A MOBILE Standard frequency and time signal-satellite (space-to-Earth) Space research 5.544 5.545 5.149	
31.3-31.5	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
31.5-31.8 EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) Fixed Mobile except aeronautical mobile 5.149 5.546	**31.5-31.8** EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	**31.5-31.8** EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) Fixed Mobile except aeronautical mobile 5.149
31.8-32	FIXED 5.547A RADIONAVIGATION SPACE RESEARCH (deep space) (space-to-Earth) 5.547 5.547B 5.548	
32-32.3	FIXED 5.547A INTER-SATELLITE RADIONAVIGATION SPACE RESEARCH (deep space) (space-to-Earth) 5.547 5.547C 5.548	
32.3-33	FIXED 5.547A INTER-SATELLITE RADIONAVIGATION 5.547 5.547D 5.548	
33-33.4	FIXED 5.547A RADIONAVIGATION 5.547 5.547E	
33.4-34.2	RADIOLOCATION 5.549	

5.543 The band 29.95-30 GHz may be used for space-to-space links in the Earth exploration-satellite service for telemetry, tracking, and control purposes, on a secondary basis.

5.543A In Bhutan, Indonesia, Iran (Islamic Republic of), Japan, Maldives, Mongolia, Myanmar, Pakistan, the Dem. People's Rep. of Korea, Sri Lanka, Thailand and Viet Nam, the allocation to the fixed service in the band 31-31.3 GHz may also be used by high altitude platform stations (HAPS) in the ground-to-HAPS direction. The use of the band 31-31.3 GHz by systems using HAPS shall not cause harmful interference to, nor claim protection from, other types of fixed-service systems or other co-primary services, taking into account No. **5.545**. The use of HAPS in the band 31-31.3 GHz shall not cause harmful interference to the passive services having a primary allocation in the band 31.3-31.8 GHz, taking into account the interference criteria given in Recommendations ITU-R SA.1029 and ITU-R RA.769. The administrations of the countries listed above are urged to limit the deployment of HAPS in the band 31-31.3 GHz to the lower half of this band (31-31.15 GHz) until WRC-03. (WRC-2000)

5.544 In the band 31-31.3 GHz the power flux-density limits specified in Article **21**, Table **21-4** shall apply to the space research service.

5.545 *Different category of service:* in Armenia, Azerbaijan, Belarus, Georgia, Mongolia, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 31-31.3 GHz to the space research service is on a primary basis (see No. **5.33**). (WRC-2000)

5.546 *Different category of service:* in Saudi Arabia, Armenia, Azerbaijan, Belarus, Egypt, the United Arab Emirates, Spain, Estonia, Finland, Georgia, Hungary, Iran (Islamic Republic of), Israel, Jordan, Latvia, Lebanon, Moldova, Mongolia, Uzbekistan, Poland, Syria, Kyrgyzstan, Romania, the United Kingdom, the Russian Federation, Tajikistan, Turkmenistan, Turkey and Ukraine, the allocation of the band 31.5-31.8 GHz to the fixed and mobile, except aeronautical mobile, services is on a primary basis (see No. **5.33**). (WRC-2000)

5.547 The bands 31.8-33.4 GHz, 37-40 GHz, 40.5-43.5 GHz, 51.4-52.6 GHz, 55.78-59 GHz and 64-66 GHz are available for high-density applications in the fixed service (see Resolutions **75 (WRC-2000)** and **79 (WRC-2000)**). Administrations should take this into account when considering regulatory provisions in relation to these bands. Because of the potential deployment of high-density applications in the fixed-satellite service in the bands 39.5-40 GHz and 40.5-42 GHz, administrations should further take into account potential constraints to high-density applications in the fixed service, as appropriate (see Resolution **84 (WRC-2000)**). (WRC-2000)

5.547A Administrations should take practical measures to minimize the potential interference between stations in the fixed service and airborne stations in the radionavigation service in the 31.8-33.4 GHz band, taking into account the operational needs of the airborne radar systems. (WRC-2000)

5.547B *Alternative allocation*: in the United States, the band 31.8-32 GHz is allocated to the radionavigation and space research (deep space) (space-to-Earth) services on a primary basis. (WRC-97)

5.547C *Alternative allocation*: in the United States, the band 32-32.3 GHz is allocated to the inter-satellite, radionavigation and space research (deep space) (space-to-Earth) services on a primary basis. (WRC-97)

5.547D *Alternative allocation*: in the United States, the band 32.3-33 GHz is allocated to the inter-satellite and radionavigation services on a primary basis. (WRC-97)

5.547E *Alternative allocation*: in the United States, the band 33-33.4 GHz is allocated to the radionavigation service on a primary basis. (WRC-97)

5.548 In designing systems for the inter-satellite and radionavigation services in the band 32-33 GHz, and for the space research service (deep space) in the band 31.8-32.3 GHz, administrations shall take all necessary measures to prevent harmful interference between these services, bearing in mind the safety aspects of the radionavigation service (see Recommendation **707**).

5.549 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Egypt, the United Arab Emirates, Gabon, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malaysia, Mali, Malta, Morocco, Mauritania, Nepal, Nigeria, Oman, Pakistan, the Philippines, Qatar, Dem. Rep. of the Congo, Syria, Senegal, Singapore, Somalia, Sudan, Sri Lanka, Togo, Tunisia and Yemen, the band 33.4-36 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-97)

34.2-40 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
34.2-34.7	RADIOLOCATION SPACE RESEARCH (deep space) (Earth-to-space) 5.549	
34.7-35.2	RADIOLOCATION Space research 5.550 5.549	
35.2-35.5	METEOROLOGICAL AIDS RADIOLOCATION 5.549	
35.5-36	METEOROLOGICAL AIDS EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.549 5.551A	
36-37	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive) 5.149	
37-37.5	FIXED MOBILE SPACE RESEARCH (space-to-Earth) 5.547	
37.5-38	FIXED FIXED-SATELLITE (space-to-Earth) 5.551AA MOBILE SPACE RESEARCH (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547	
38-39.5	FIXED FIXED-SATELLITE (space-to-Earth) 5.551AA MOBILE Earth exploration-satellite (space-to-Earth) 5.547	
39.5-40	FIXED FIXED-SATELLITE (space-to-Earth) 5.551AA MOBILE MOBILE-SATELLITE (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547	

40-40.5 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
40-40.5	EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth) SPACE RESEARCH (Earth-to-space) Earth exploration-satellite (space-to-Earth)	

5.550 *Different category of service:* in Armenia, Azerbaijan, Belarus, Georgia, Mongolia, Uzbekistan, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Ukraine, the allocation of the band 34.7-35.2 GHz to the space research service is on a primary basis (see No. **5.33**). (WRC-2000)

5.551 (SUP - WRC-97)

5.551A In the band 35.5-36.0 GHz, active spaceborne sensors in the earth exploration-satellite and space research services shall not cause harmful interference to, claim protection from, or otherwise impose constraints on operation or development of the radiolocation service, the meteorological aids service and other services allocated on a primary basis. (WRC-97)

5.551AA In the bands 37.5-40 GHz and 42-42.5 GHz, non-geostationary-satellite systems in the fixed-satellite service should employ power control or other methods of downlink fade compensation of the order of 10 dB, such that the satellite transmissions are at power levels required to meet the desired link performance while reducing the level of interference to the fixed service. The use of downlink fade compensation methods are under study by the ITU-R (see Resolution **84 (WRC-2000)**). (WRC-2000)

40.5-51.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
40.5-41 FIXED FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE Mobile 5.547	**40.5-41** FIXED FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE Mobile Mobile-satellite (space-to-Earth) 5.547	**40.5-41** FIXED FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE Mobile 5.547
41-42.5	FIXED FIXED-SATELLITE (space-to-Earth) 5.551AA BROADCASTING BROADCASTING-SATELLITE Mobile 5.547 5.551F 5.551G	
42.5-43.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.552 MOBILE except aeronautical mobile RADIO ASTRONOMY 5.149 5.547	
43.5-47	MOBILE 5.553 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.554	
47-47.2	AMATEUR AMATEUR-SATELLITE	
47.2-50.2	FIXED FIXED-SATELLITE (Earth-to-space) 5.552 MOBILE 5.149 5.340 5.552A 5.555	
50.2-50.4	EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) 5.340 5.555A	
50.4-51.4	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Mobile-satellite (Earth-to-space)	

5.551B (SUP - WRC-2000)

5.551C (SUP - WRC-2000)

5.551D (SUP - WRC-2000)

5.551E (SUP - WRC-2000)

5.551F *Different category of service*: in Japan, the allocation of the band 41.5-42.5 GHz to the mobile service is on a primary basis (see No. **5.33**). (WRC-97)

5.551G In order to protect the radio astronomy service in the band 42.5-43.5 GHz, the aggregate power flux-density in the 42.5-43.5 GHz band produced by all the space stations in any non-geostationary-satellite system in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) system operating in the 41.5-42.5 GHz band shall not exceed –167 dB(W/m^2) in any 1 MHz band at the site of a radio astronomy station for more that 2% of the time. The power flux-density in the band 42.5-43.5 GHz produced by any geostationary station in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) operating in the band 42-42.5 GHz shall not exceed –167 dB(W/m^2) in any 1 MHz band at the site of a radio astronomy station. These limits are provisional and will be reviewed in accordance with Resolution **128 (Rev.WRC-2000)**. (WRC-2000)

5.552 The allocation of the spectrum for the fixed-satellite service in the bands 42.5-43.5 GHz and 47.2-50.2 GHz for Earth-to-space transmission is greater than that in the band 37.5-39.5 GHz for space-to-Earth transmission in order to accommodate feeder links to broadcasting satellites. Administrations are urged to take all practicable steps to reserve the band 47.2-49.2 GHz for feeder links for the broadcasting-satellite service operating in the band 40.5-42.5 GHz.

5.552A The allocation to the fixed service in the bands 47.2-47.5 GHz and 47.9-48.2 GHz is designated for use by high altitude platform stations. The use of the bands 47.2-47.5 GHz and 47.9-48.2 GHz is subject to the provisions of Resolution **122 (WRC-97)***. (WRC-97)

5.553 In the bands 43.5-47 GHz and 66-71 GHz, stations in the land mobile service may be operated subject to not causing harmful interference to the space radiocommunication services to which these bands are allocated (see No. **5.43**). (WRC-2000)

5.554 In the bands 43.5-47 GHz, 66-71 GHz, 95-100 GHz, 123-130 GHz, 191.8-200 GHz and 252-265 GHz, satellite links connecting land stations at specified fixed points are also authorized when used in conjunction with the mobile-satellite service or the radionavigation-satellite service. (WRC-2000)

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* *Note by the Secretariat:* This Resolution was revised by WRC-2000.

5.555 *Additional allocation:* the band 48.94-49.04 GHz is also allocated to the radio astronomy service on a primary basis. (WRC-2000)

5.555A The band 50.2-50.4 GHz is also allocated, on a primary basis, to the fixed and mobile services until 1 July 2000. (WRC-97)

51.4-55.78 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
51.4-52.6	FIXED MOBILE 5.547 5.556	
52.6-54.25	EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) 5.340 5.556	
54.25-55.78	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.556A SPACE RESEARCH (passive) 5.556B	

5.556 In the bands 51.4-54.25 GHz, 58.2-59 GHz and 64-65 GHz, radio astronomy observations may be carried out under national arrangements. (WRC-2000)

5.556A Use of the bands 54.25-56.9 GHz, 57-58.2 GHz and 59-59.3 GHz by the inter-satellite service is limited to satellites in the geostationary-satellite orbit. The single-entry power flux-density at all altitudes from 0 km to 1 000 km above the Earth's surface produced by a station in the inter-satellite service, for all conditions and for all methods of modulation, shall not exceed –147 dB(W/(m^2 · 100 MHz)) for all angles of arrival. (WRC-97)

5.556B *Additional allocation:* in Japan, the band 54.25-55.78 GHz is also allocated to the mobile service on a primary basis for low-density use. (WRC-97)

55.78-66 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
55.78-56.9	EARTH EXPLORATION-SATELLITE (passive) FIXED 5.557A INTER-SATELLITE 5.556A MOBILE 5.558 SPACE RESEARCH (passive) 5.547 5.557	
56.9-57	EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.558A MOBILE 5.558 SPACE RESEARCH (passive) 5.547 5.557	
57-58.2	EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.556A MOBILE 5.558 SPACE RESEARCH (passive) 5.547 5.557	
58.2-59	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive) 5.547 5.556	
59-59.3	EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.556A MOBILE 5.558 RADIOLOCATION 5.559 SPACE RESEARCH (passive)	
59.3-64	FIXED INTER-SATELLITE MOBILE 5.558 RADIOLOCATION 5.559 5.138	
64-65	FIXED INTER-SATELLITE MOBILE except aeronautical mobile 5.547 5.556	
65-66	EARTH EXPLORATION-SATELLITE FIXED INTER-SATELLITE MOBILE except aeronautical mobile SPACE RESEARCH 5.547	

5.557 *Additional allocation:* in Japan, the band 55.78-58.2 GHz is also allocated to the radiolocation service on a primary basis. (WRC-97)

5.557A In the band 55.78-56.26 GHz, in order to protect stations in the Earth exploration-satellite service (passive), the maximum power density delivered by a transmitter to the antenna of a fixed service station is limited to –26 dB(W/MHz). (WRC-2000)

5.558 In the bands 55.78-58.2 GHz, 59-64 GHz, 66-71 GHz, 122.25-123 GHz, 130-134 GHz, 167-174.8 GHz and 191.8-200 GHz, stations in the aeronautical mobile service may be operated subject to not causing harmful interference to the inter-satellite service (see No. **5.43**). (WRC-2000)

5.558A Use of the band 56.9-57 GHz by inter-satellite systems is limited to links between satellites in geostationary-satellite orbit and to transmissions from non-geostationary satellites in high-Earth orbit to those in low-Earth orbit. For links between satellites in the geostationary-satellite orbit, the single entry power flux-density at all altitudes from 0 km to 1 000 km above the Earth's surface, for all conditions and for all methods of modulation, shall not exceed –147 dB(W/($m^2 \cdot$ 100 MHz)) for all angles of arrival. (WRC-97)

5.559 In the band 59-64 GHz, airborne radars in the radiolocation service may be operated subject to not causing harmful interference to the inter-satellite service (see No. **5.43**). (WRC-2000)

66-81 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
66-71	INTER-SATELLITE MOBILE 5.553 5.558 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.554	
71-74	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth)	
74-76	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE BROADCASTING BROADCASTING-SATELLITE Space research (space-to-Earth) 5.559A 5.561	
76-77.5	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite Space research (space-to-Earth) 5.149	
77.5-78	AMATEUR AMATEUR-SATELLITE Radio astronomy Space research (space-to-Earth) 5.149	
78-79	RADIOLOCATION Amateur Amateur-satellite Radio astronomy Space research (space-to-Earth) 5.149 5.560	
79-81	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite Space research (space-to-Earth) 5.149	

5.559A The band 75.5-76 GHz is also allocated to the amateur and amateur-satellite services on a primary basis until the year 2006. (WRC-2000)

5.560 In the band 78-79 GHz radars located on space stations may be operated on a primary basis in the Earth exploration-satellite service and in the space research service.

5.561 In the band 74-76 GHz, stations in the fixed, mobile and broadcasting services shall not cause harmful interference to stations of the fixed-satellite service or stations of the broadcasting-satellite service operating in accordance with the decisions of the appropriate frequency assignment planning conference for the broadcasting-satellite service. (WRC-2000)

81-86 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
81-84	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE MOBILE-SATELLITE (Earth-to-space) RADIO ASTRONOMY Space research (space-to-Earth) 5.149 5.561A	
84-86	FIXED FIXED-SATELLITE (Earth-to-space) 5.561B MOBILE RADIO ASTRONOMY 5.149	

5.561A The 81-81.5 GHz band is also allocated to the amateur and amateur-satellite services on a secondary basis. (WRC-2000)

5.561B In Japan, use of the band 84-86 GHz, by the fixed-satellite service (Earth-to-space) is limited to feeder links in the broadcasting-satellite service using the geostationary-satellite orbit. (WRC-2000)

86-111.8 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
86-92	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
92-94	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
94-94.1	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) Radio astronomy 5.562 5.562A	
94.1-95	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
95-100	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.149 5.554	
100-102	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	
102-105	FIXED MOBILE RADIO ASTRONOMY 5.149 5.341	
105-109.5	FIXED MOBILE RADIO ASTRONOMY SPACE RESEARCH (passive) 5.562B 5.149 5.341	
109.5-111.8	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	

5.562 The use of the band 94-94.1 GHz by the Earth exploration-satellite (active) and space research (active) services is limited to spaceborne cloud radars. (WRC-97)

5.562A In the bands 94-94.1 GHz and 130-134 GHz, transmissions from space stations of the Earth exploration-satellite service (active) that are directed into the main beam of a radio astronomy antenna have the potential to damage some radio astronomy receivers. Space agencies operating the transmitters and the radio astronomy stations concerned should mutually plan their operations so as to avoid such occurrences to the maximum extent possible. (WRC-2000)

5.562B In the bands 105-109.5 GHz, 111.8-114.25 GHz, 155.5-158.5 GHz and 217-226 GHz, the use of this allocation is limited to space-based radio astronomy only. (WRC-2000)

111.8-119.98 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
111.8-114.25	FIXED MOBILE RADIO ASTRONOMY SPACE RESEARCH (passive) 5.562B 5.149 5.341	
114.25-11 6	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	
116-119.98	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562C SPACE RESEARCH (passive) 5.341	

5.562C Use of the band 116-122.25 GHz by the inter-satellite service is limited to satellites in the geostationary-satellite orbit. The single-entry power flux-density produced by a station in the inter-satellite service, for all conditions and for all methods of modulation, at all altitudes from 0 km to 1 000 km above the Earth's surface and in the vicinity of all geostationary orbital positions occupied by passive sensors, shall not exceed –148 dB(W/(m^2 · MHz)) for all angles of arrival. (WRC-2000)

119.98-151.5 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
119.98-122.25	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562C SPACE RESEARCH (passive) 5.138 5.341	
122.25-123	FIXED INTER-SATELLITE MOBILE 5.558 Amateur 5.138	
123-130	FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) RADIONAVIGATION RADIONAVIGATION-SATELLITE Radio astronomy 5.562D 5.149 5.554	
130-134	EARTH EXPLORATION-SATELLITE (active) 5.562E FIXED INTER-SATELLITE MOBILE 5.558 RADIO ASTRONOMY 5.149 5.562A	
134-136	AMATEUR AMATEUR-SATELLITE Radio astronomy	
136-141	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite 5.149	
141-148.5	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
148.5-151.5	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	

5.562D *Additional allocation*: In Korea (Rep. of), the bands 128-130 GHz, 171-171.6 GHz, 172.2-172.8 GHz and 173.3-174 GHz are also allocated to the radio astronomy service on a primary basis until 2015. (WRC-2000)

5.562E The allocation to the Earth exploration-satellite service (active) is limited to the band 133.5-134 GHz. (WRC-2000)

151.5-158.5 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
151.5-155.5	FIXED MOBILE RADIO ASTRONOMY RADIOLOCATION 5.149	
155.5-158.5	EARTH EXPLORATION-SATELLITE (passive) 5.562F FIXED MOBILE RADIO ASTRONOMY SPACE RESEARCH (passive) 5.562B 5.149 5.562G	

5.562F In the band 155.5-158.5 GHz, the allocation to the Earth exploration-satellite (passive) and space research (passive) services shall terminate on 1 January 2018. (WRC-2000)

5.562G The date of entry into force of the allocation to the fixed and mobile services in the band 155.5-158.5 GHz shall be 1 January 2018. (WRC-2000)

158.5-202 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
158.5-164	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth)	
164-167	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
167-174.5	FIXED FIXED-SATELLITE (space-to-Earth) INTER-SATELLITE MOBILE 5.558 5.149 5.562D	
174.5-174.8	FIXED INTER-SATELLITE MOBILE 5.558	
174.8-182	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562H SPACE RESEARCH (passive)	
182-185	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.563	
185-190	EARTH EXPLORATION-SATELLITE (passive) INTER-SATELLITE 5.562H SPACE RESEARCH (passive)	
190-191.8	EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) 5.340	
191.8-200	FIXED INTER-SATELLITE MOBILE 5.558 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.149 5.341 5.554	
200-202	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341 5.563A	

5.562H Use of the bands 174.8-182 GHz and 185-190 GHz by the inter-satellite service is limited to satellites in the geostationary-satellite orbit. The single-entry power flux-density produced by a station in the inter-satellite service, for all conditions and for all methods of modulation, at all altitudes from 0 to 1 000 km above the Earth's surface and in the vicinity of all geostationary orbital positions occupied by passive sensors, shall not exceed -144 dB(W/(m^2 · MHz)) for all angles of arrival. (WRC-2000)

5.563 *Additional allocation:* in the United Kingdom, the band 182-185 GHz is also allocated to the fixed and mobile services on a primary basis.

5.563A In the bands 200-209 GHz, 235-238 GHz, 250-252 GHz and 265-275 GHz, ground-based passive atmospheric sensing is carried out to monitor atmospheric constituents. (WRC-2000)

202-248 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
202-20	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341 5.563A	
209-217	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY 5.149 5.341	
217-226	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY SPACE RESEARCH (passive) 5.562B 5.149 5.341	
226-231.5	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	
231.5-232	FIXED MOBILE Radiolocation	
232-235	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE Radiolocation	
235-238	EARTH EXPLORATION-SATELLITE (passive) FIXED-SATELLITE (space-to-Earth) SPACE RESEARCH (passive) 5.563A 5.563B	
238-240	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE RADIOLOCATION RADIONAVIGATION RADIONAVIGATION-SATELLITE	
240-241	FIXED MOBILE RADIOLOCATION	
241-248	RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite 5.138 5.149	

5.563B The band 237.9-238 GHz is also allocated to the Earth exploration-satellite service (active) and the space research service (active) for spaceborne cloud radars only. (WRC-2000)

248-1 000 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
248-250	AMATEUR AMATEUR-SATELLITE Radio astronomy 5.149	
250-252	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.563A	
252-265	FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) RADIO ASTRONOMY RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.149 5.554	
265-275	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY 5.149 5.563A	
275-1 000	(Not allocated) 5.565	

5.564 (SUP - WRC-2000)

5.565 The frequency band 275-1 000 GHz may be used by administrations for experimentation with, and development of, various active and passive services. In this band a need has been identified for the following spectral line measurements for passive services:

– radio astronomy service: 275-323 GHz, 327-371 GHz, 388-424 GHz, 426-442 GHz, 453-510 GHz, 623-711 GHz, 795-909 GHz and 926-945 GHz;

– Earth exploration-satellite service (passive) and space research service (passive): 275-277 GHz, 294-306 GHz, 316-334 GHz, 342-349 GHz, 363-365 GHz, 371-389 GHz, 416-434 GHz, 442-444 GHz, 496-506 GHz, 546-568 GHz, 624-629 GHz, 634-654 GHz, 659-661 GHz, 684-692 GHz, 730-732 GHz, 851-853 GHz and 951-956 GHz.

Future research in this largely unexplored spectral region may yield additional spectral lines and continuum bands of interest to the passive services. Administrations are urged to take all practicable steps to protect these passive services from harmful interference

until the date when the allocation Table is established in the above-mentioned frequency band. (WRC-2000)