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STRATEGIC SPECTRUM PLAN

- public consultation -

ANACOM
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ANACOM AUTORIDADE NACIONAL DE COMUNICAÇÕES

Index

0 Executive Summary

Radio spectrum[1] is a public resource and its use is fundamental for the life of every citizen, for organisations, for the Portuguese State and for the visitors that are hosted in Portugal every year. Spectrum is one of the means by which people communicate with each other; receive and comment on news; watch television or listen to the radio and interact with public services. But spectrum is also playing an increasingly important role for the economy and for digital transformation, connecting machines, favouring the automation of production in various sectors of activity and enabling increasingly sophisticated means of working and productivity increases.

The growing importance of electronic communications services has been accompanied by a considerable increase in their use which has put pressure on the spectrum. On the one hand, it is increasingly used *intensively*: we have more and more people and more and more machines connected, using more and more services provided over the spectrum. On the other hand, spectrum has been used more and more *extensively*: also as a result of more intensive use and development of technology, more portions of the spectrum are now usable and utilised.

The increased use of spectrum makes it a more and more scarce and valued resource. Additionally, the spectrum and, more specifically, the assignment of Rights of Use of frequencies (RoU) enabling its use, as well as the conditions under which they are allocated and renewed, have a more structuring role in the competitive dynamics in the markets that use it. Thus, spectrum regulation is faced with complex choices, which are made particularly difficult by a context where, necessarily, the information available to the regulator is by nature asymmetric, incomplete and imperfect. Regulation requires knowledge about the uses and dynamics of spectrum for social and economic purposes, but this knowledge is often uncertain, fragmented and constantly on the verge of becoming outdated. In this context, the National Communications Authority (ANACOM) has been responding to this challenge using the modern means at its disposal, including, where appropriate, decentralised market means, to help ensure the great and ultimate goal of regulation: that the available spectrum is used efficiently and effectively, maximising the gains generated for citizens, for users in general and for the economy as a whole.

[1] The term "radio spectrum" means all frequencies associated with electromagnetic waves below 3000 GHz that propagate in space without an artificial guide.

ANACOM approved, in August 2016[2], the document containing the strategies in relation to the provision of frequencies for civilian radio services/applications, meeting the spectrum requirements and the specificities of each service/application. This document has been called the Strategic Spectrum Plan (SSP). The present version of the SSP stems from the provisions of the multi-annual activities[3].

The Strategic Spectrum Plan identifies strategic actions and new trends in spectrum management, namely taking into account the results of the last World Radiocommunication Conference (WRC-19) and the issues already on the agenda of the next Conference, WRC-23, as well as ongoing developments at European level. For a set of services considered most relevant, after considering the specificities of each service within the scope of its evolution, the Plan identifies the main strategic actions in order to satisfy the respective spectrum needs. The SSP also lists the main characteristics of the mechanisms for making the spectrum available, including when the assignment of RoU takes place.

The STRATEGIC SPECTRUM PLAN also identifies a number of aspects to be taken into account in the definition of the spectrum strategy to be implemented by ANACOM. Thus, recognising the relevance, among others, of:

- continuous follow-up to apply more modern means in spectrum regulation to ensure that the available spectrum is used efficiently and effectively, maximising gains for citizens, users in general and the economy as a whole;
- ensuring competitive conditions in electronic communications markets;
- regulatory predictability;
- compliance with the principle of technological neutrality;
- the continued search for innovative and increasingly efficient spectrum sharing techniques;
- international coordination as an essential element of the national Strategic Spectrum Plan, with committed involvement, alongside ANACOM, in relevant international activities being crucial,

ANACOM is expected to take decisions on a number of topics in the coming years, most notably:

[2] Available at https://www.anacom.pt/render.jsp?categoryId=387665.
[3] Available at https://www.anacom.pt/render.jsp?categoryId=290015.

- assess the need for spectrum in view of the continuity, or not, of the provision of the free-to-air television service via DTT;
- assess the spectrum needs for the shared use of the 3800-4200 MHz frequency band by terrestrial broadband wireless systems providing private local area network connectivity;
- consider the various interests in the upper part of the 6 GHz band (6425-7125 MHz) and decide on the future use of this spectrum in due course;
- monitor technological evolution, with a view to identifying new spectrum or sharing conditions for spectrum in use to foster the development of 5G/6G;
- further assess the economic and strategic benefits of shared use of spectrum under the LSA model, with a view to implementing it wherever and whenever possible;
- proceed with the preparation for the 2023 World Radiocommunication Conference, with a view to defining the positions that best defend national interests, both at CEPT and ITU level;
- assess the potential of the duplex gap (733-758 MHz) and guard bands (694-703 MHz and 788-790 MHz) in the 700 MHz band, with a view to deciding on their future use;
- assess and decide on the renewal, and under which conditions, of RoU whose validity expires in the coming years.

Finally, given its evolving and dynamic nature, it is considered that the SSP should be updated regularly and as events occur at national, regional and/or international level with an impact on spectrum management and the strategy presented, namely every 4 years.

1 Framework

The need to be connected anywhere and at any time and the expansion of possible uses of the spectrum is reflected in the growing use of radiocommunications services and applications, making a system that ensures effective and efficient management of the use of the radio spectrum more pressing and urgent.

Spectrum, which is a natural, public and scarce resource, can and should be used to improve the life and well-being of citizens and consumers, as well as the efficiency and competitiveness of the national economy, bearing in mind the urgency of environmental sustainability issues. In a growing trend, spectrum use has become more and more intensive as new services, applications and users emerge and existing uses intensify.

Considering the strategic nature of this scarce resource, as well as the variety of possible uses, spectrum management involves a delicate balance between different public policy objectives, which must be made compatible, such as for example the population's access to free-to-air television, which in the DTT modality implies the availability of frequencies that could be used for other applications, namely the mobile service, whose market is undergoing strong expansion.

Terrestrial and space radiocommunications are used in all sectors of economic and social activity, namely in broadcasting, national defence and public security, aeronautical and maritime communications (including those related to control, management and security), industrial production, mobile communications (personal and corporate), scientific research and environmental monitoring.

Together with the growing trend towards more *intensive* use of spectrum, there is a more *extensive* use of frequency bands, namely the higher frequency bands (e.g. millimetre waves), which allow greater bandwidths and higher data transmission rates, and which were not as widely used in the past as they are today as a result of technological evolution.

Additionally, the allocation and renewal of spectrum usage rights are an increasingly central instrument in determining competitive conditions in electronic communications markets and in promoting social welfare.

ANACOM's responsibilities include ensuring the effective and efficient management of the radio spectrum, in particular by ensuring that harmful interference does not occur, and promoting competition in the supply of networks and services, with the power to launch public consultation processes and expressions of interest[4].

It should also be noted that, within the scope of its powers, ANACOM is responsible for ensuring coordination between civil, military and paramilitary radiocommunications. The frequencies managed by the Armed Forces and security services are the result of negotiations between ANACOM and EMGFA (Estado-Maior-General das Forças Armadas) under the National Agreement for Sharing Frequencies in Times of Peace. Nevertheless, spectrum planning is upstream the responsibility of the regulator, who will also consider these frequencies, seeking, when appropriate and necessarily in continuous coordination with the EMGFA, to make viable the options that bring the greatest value to society.

For spectrum management leading to its effective and efficient use, it is necessary to take into account a number of variables, of which the most important are (i) political and legal factors of national and international order, (ii) the effect on society resulting from the use of the spectrum, (iii) the economic impact (job creation, business dynamics and sectorial structure, placement of equipment on the market, social and territorial cohesion, etc.), and, not less important, (iv) technological evolution and the technical particularities leading to an adequate use of the spectrum.

While, on the one hand, it is fundamental to take these variables into account so that spectrum management fits the relevant policies and takes into account the legal, social, economic and technical framework, they do not always prove to be objective or measurable, so it is necessary to take into account a set of administrative and technical procedures, to systematise, whenever possible, the complex task of managing the radio spectrum, taking into account the new challenges, which include the defence of national interests in international forums.

In particular, one of the great challenges facing the regulator in the pursuit of its mission is that it tends to work on the basis of asymmetric, incomplete and imperfect information. In this context, the adoption of more decentralised, market-based instruments that minimise the regulatory risk and help determine solutions that are closer to the social optimum may seem appropriate.

[4] Pursuant to Article 8(1)(a) and (e) and Article 9(2)(h) of its Statutes, approved by Decree-Law 39/2015 of 16 March, available at https://dre.pt/dre/detalhe/diario-republica/52-2015-66761445.

It is also important in this exercise to consider the role of spectrum in mitigating climate change. Indeed, the growing relevance of environmental sustainability should be taken into account within the scope of spectrum management, and the decisions to be adopted should aim to maximise the contribution of the spectrum to reducing the carbon and ecological footprint. Among other actions that can be taken to address the challenges of climate change, it is important to consider how wireless technologies can help other sectors to contribute to this overall goal by ensuring that spectrum is available for essential climate change applications, such as climate change monitoring, weather forecasting and other scientific applications. Of note in this context is the report and opinion of the Radio Spectrum Policy Group (RSPG)[5], both concerning the role of the spectrum in mitigating climate change, which also highlight the importance of using more environmentally friendly energy sources in the sector and encouraging research, for example at the European Union (EU) level, to develop standards and technologies that lead to lower energy consumption.

ANACOM's Multi-Year Plan 2022-2024 defines as a strategic goal: "Review the Strategic Spectrum Plan" in 2022. The revised version of the SSP presented here reflects the trends in spectrum management, namely taking into account the results of WRC-19 and the issues on the agenda of the next Conference, WRC-23, as well as the ongoing developments at European level (in the framework of the European Conference of Postal and Telecommunications Administrations [CEPT] and the EU). In particular, it is important in this European context to pay attention to the strategic lines identified in the RSPG Opinion on the review of the Radio Spectrum Policy Programme[6] and in the Strategic Plan 2020-2025[7] developed by the CEPT Electronic Communications Committee.

The SSP sets out strategic criteria and principles regarding radio spectrum (section 2). Based on these criteria and principles, the strategic objectives for spectrum in the national context are presented (section 3). For each of the radiocommunications services highlighted in this document, a brief framework is provided as well as a summary description of the current situation, identifying the main strategic actions in order to satisfy the respective spectrum needs, after considering the specificities

[5] RSPG Opinion on the role of radio spectrum policy to help combat climate change, available at https://rspg-spectrum.eu/wp-content/uploads/2021/11/RSPG21-041final-RSPG_Opinion_on_climate_change.pdf and RSPG Report on the role of radio spectrum policy to help combat climate change, available at https://rspg-spectrum.eu/wp-content/uploads/2021/06/RSPG21-026final_RSPG_Report_on_Climate_Change.pdf.
[6] Available at https://rspg-spectrum.eu/wp-content/uploads/2021/06/RSPG21-033final-RSPG_Opinion_on_RSPP.pdf.
[7] Available at https://cept.org/files/16100/ECC(20)093%20Annex%2012_ECC%20Strategic%20Plan%202020-2025.pdf.

of each service within the scope of its evolution (section 4). In section 5 the main characteristics of the mechanisms for assigning rights of use of frequencies are presented, indicating the advantages and disadvantages of each one.

Given the evolving and dynamic nature that we have been witnessing with regard to the use of the spectrum and its management, it is considered that the SSP should be updated regularly and as and when events occur at national, regional and/or international level with an impact on spectrum management and the strategy presented, for example considering the cycle of World Radiocommunications Conferences, which as a rule take place every four years.

In this context, the SSP is put up for public consultation under Article 9(2)(h) of ANACOM's Statutes, with a view to gathering the opinion of the various market players (manufacturers, operators, private and public entities, users and others) on it, particularly with regard to the strategic objectives outlined in this document.

Interested parties should send their contributions in writing, in Portuguese, preferably by e-mail to pee2022@anacom.pt.

Once the consultation is closed, ANACOM will prepare a final report analysing the contributions received and will publish the final version of the SSP accordingly.

In the publication of the results, the confidentiality of the elements duly identified and justified by the interested parties shall be guaranteed. In this sense, all interested parties are requested to clearly identify the elements that they consider confidential and to send a non-confidential version of their answers to be made available on the website of this Authority at the end of the consultation process. If there is no unequivocal identification of the confidentiality of the data, ANACOM will consider that there is no matter subject to confidentiality.

The results of this consultation are not binding and do not prejudge future decisions of ANACOM on the issues addressed herein.

2 Criteria and principles

The SSP aims to establish strategic guidelines in relation to the radio spectrum, highlighting in particular the global strategic vision and detailing the perspective of making frequencies available for civilian radio services/applications, in order to meet the spectrum requirements and the specificities of each service/application, with the aim of promoting a more efficient use of the spectrum and guaranteeing the satisfaction of current and future spectrum needs in Portugal. The availability of transparent information to the market allows the various players to adopt strategies with some degree of predictability, which is essential for the adequate economic development of the country.

The regulator's main objective with spectrum management and planning is to maximise the welfare of citizens and users of services provided on the basis of the spectrum, as well as the positive impact on society and the economy. At an instrumental level, ANACOM has several principles and criteria that seek to ensure the main objective.

These principles and criteria, some of which derive from Law 5/2004 of 10 February[8] (Electronic Communications Law), as amended, are as follows:

a) Transparency, non-discrimination and proportionality;
b) Availability of radio spectrum;
c) Ensuring effective competition conditions in the relevant markets;
d) Effective and efficient use of frequencies[9];
e) Weighing the interests of spectrum users;
f) Technology and service neutrality;
g) Maximising the value ofspectrum usage, taking into account the generality of radiocommunications services, applications and systems, given their interest for society in its various aspects;
h) Increasing the efficiency of the spectrum management process, with particular focus on simplifying it;

[8] Law 16/2022, published on 16 August, approves the new Electronic Communications Law (LCE), transposing Directives 98/84/EC, 2002/77/EC and (EU) 2018/1972, amending Laws 41/2004 of 18 August and 99/2009 of 4 September, and Decree-Laws 151-A/2000 of 20 July and 24/2014 of 14 February, and revoking Law 5/2004 of 10 February and Ministerial Order 791/98 of 22 September. This Law shall enter into force in general 90 days after its publication.
[9] The principle of the effective and efficient use of frequencies is fundamental with regard to the allocation of these resources and implies that the frequencies made available must be effectively and efficiently used in accordance with the conditions set out in the allocation act, respecting this principle.

i) Continuing to guarantee regulatory predictability, promoting a consistent regulatory approach over appropriate review periods, ensuring that decision-making is based on principles and criteria known to all and that decisions with an impact on the market are always preceded by consultative procedures that allow all stakeholders to actively participate in such decision-making at all stages of the spectrum management process;

j) Balancing the level of permissible interference with shared, and potentially more massive, use of the radio spectrum.

Additionally, it should be noted that the spectrum usage fees (set by order of the government member responsible for the communications area) consist of a mechanism that promotes the proper management of the resource in question, through discouraging the holding of more spectrum than necessary, thus penalising behaviours contrary to the proper functioning of the market, although without compromising the intensive use of the spectrum.

3 Strategic objectives

ANACOM provides the National Table of Frequency Allocations (NTFA) on its institutional website[10], which gathers, among other things, up-to-date information on the use, reservation and licensing of the radio spectrum in Portugal. In other words, the NTFA is an essential instrument in spectrum management that brings together fundamental elements for the proper fulfilment of frequency management and planning activities.

The SSP contains the programmatic lines of ANACOM's future intervention and, in this context, includes information which is relevant for market players, highlighting a set of strategic objectives:

a) *Make spectrum available for the various activities and users, taking into account its social, cultural and economic value.*

As a limited and scarce resource, and at the same time important for the national economy in the most varied sectors, spectrum allocations should meet the need for services / applications / users to correspond to those that maximise the value generated for society.

b) *Pursue social and cultural objectives as well as civil protection needs, disaster relief and climate change mitigation.*

The use of the spectrum has safety, health, public interest, cultural, educational, scientific, social, environmental and technical implications. There are several uses that support public services, such as public safety and security services, including civil protection and disaster relief, and scientific activities, such as meteorology, Earth observation, radio astronomy and space research, which need to be properly considered in the context of spectrum planning.

c) *Secure and preserve competitive markets.*

Access to spectrum has an important effect on competition in electronic communications markets. The assignment of frequencies, where applicable, shall contribute to the development of competition in the relevant markets, namely through the adoption of measures favouring the emergence of competitive dynamics capable of producing positive effects on the users of the services provided.

[10] Available at https://www.anacom.pt/render.jsp?categoryId=348130.

d) *Encourage a flexible use of the spectrum with a view to adapting it to market needs.*

Flexibility in management, access and use of the radio spectrum is notably achieved through the implementation of principles of technology and service neutrality and mechanisms, including decentralised mechanisms, for trade and leasing rights to use frequencies - the so-called secondary spectrum market. This flexibility in the use of the spectrum should be accompanied by the introduction of mechanisms, namely of intervention by ANACOM, aimed at ensuring that competition is not distorted (for example, measures or conditions which neutralise possible effects of this nature arising either from the flexible use of the spectrum or from the accumulation of rights of use of frequencies, resulting from trade or leases).

e) *Ensure efficient use of spectrum resources by monitoring and encouraging appropriate use by market players.*

In the context of the powers relating to the management of the radio spectrum, ANACOM must continue to ensure a permanent service of supervision, through monitoring and control of the spectrum, throughout the national territory, with the main objective of ensuring that any users and any radiocommunications networks and stations operate without harmful interference. In order to allow a more efficient and effective monitoring, it is fundamental to reinforce the automation of processes.

f) *Promote technological innovation leading to more efficient use of spectrum with a view to increasing benefits to users.*

It is ANACOM's concern to promote technological neutrality which provides conditions for the offer of solutions with increasing diversity and quality to consumers, in an environment of permanent innovation and technological evolution.

g) *Contribute to international harmonisation of the radio spectrum.*

An important component of ANACOM's activities is the participation in forums where international harmonisation of the radio spectrum is decided, thereby ensuring that national interests are taken into account in the harmonisation process. The first step towards harmonisation of spectrum uses is often taken by international organisations (CEPT and the International Telecommunications Union [ITU], for example), by identifying or replanning frequencies for new use cases.

h) *Review the regulatory framework for radiocommunications.*

The review of the regulatory texts on radiocommunications contributes to making spectrum management and use more efficient. It should occur in close cooperation, where applicable, with the entities that have spectrum management responsibilities in Portugal.

i) *Develop an integrated spectrum management platform.*

To streamline the whole spectrum management process, it is fundamental to promote continuous improvement in order to integrate and adapt the spectrum management application systems in their various components, and in particular the planning, assignment of frequencies and spectrum monitoring and control.

j) *Strengthen spectrum sharing.*

Considering that the growing and intense use of the spectrum in the various sectors of society conditions the identification of frequency bands for exclusive use for each of the radiocommunications services, systems and applications, the spectrum sharing should be reinforced[11], whenever possible and appropriate, thus allowing a more efficient, innovative and flexible management/use of this resource. In this context, both at international and national level, several initiatives have been developed and a number of innovative spectrum sharing techniques are under discussion (see section 4).

k) *Enhance radio literacy of radio spectrum users.*

By providing society with appropriate information (namely by giving visibility to the information published on ANACOM's website, promoting more thematic public interventions and complementing these with various clarifications that answer frequently asked questions), ANACOM aims to empower users to choose and make the best use of radiocommunications services.

l) *Promote public awareness of the possible health effects of exposure to electromagnetic fields from radio communications stations.*

[11] Spectrum sharing can be defined as the use of the same spectrum resources by more than one user, i) at the same time and in different geographical areas, ii) in the same geographical area and at different times, and iii) at the same time and in the same geographical area.

It is intended that this promotion of knowledge will contribute to increasing the levels of confidence of the population, through the dissemination of scientific research in this area, keeping citizens informed of the conclusions of studies carried out by credible entities in relation to this topic and in particular the setting of reference levels and basic restrictions in this area, as well as the continuous monitoring of compliance with the limits applicable to electromagnetic fields carried out by ANACOM as well as their respective publication.

4 Action plans

The fast technological development and the convergence of electronic communications have created a dynamic environment in which spectrum is an increasingly important resource. As such, it is in ANACOM's interest that spectrum management keeps pace with this evolution, facilitating access to it and allowing for more flexible and efficient management and use.

Communications are evolving fast and towards a completely heterogeneous wireless environment, and it is crucial that adequate and sufficient spectrum is made available to enable the implementation of evolving, different and more flexible scenarios that integrate technologies and services in a way that is unperceivable to the user. At the national level, it is considered essential to establish in a timely manner the appropriate conditions for the continuous evolution of the communications sector and, consequently, the strategic objectives set out in the previous section must be implemented.

Radio spectrum is indeed a limited and necessary (indispensable) resource for the provision of wireless electronic communications services such as mobile broadband, mobile telephony, radio and television broadcasting. However, access to spectrum is also needed for several other services that may be less known by the public but are also important for national society and economy, such as radio astronomy, sensor networks, radar or radiolocation services.

4.1 Technical trials

In the context of experimentation, ANACOM authorises, whenever possible, the use of the radio spectrum to carry out technical trials and scientific studies, under Article 5(3) of Decree-Law 151-A/2000 of 20 July, as amended, under the licensing exempt regime. This Authority has considered that this type of technical trials and studies have a great added value, as they allow researchers, manufacturers, operators and other interested parties to test various functionalities and capabilities of technologies, as well as to refine their theoretical models, before proceeding with the implementation of their business models, with the eventual provision of services to consumers.

The technical tests and scientific studies, promoted and supported by this Authority, are a relevant contribution to technological innovation and the development of the economy and, consequently, of the society on a global scale. The scientific trials and studies provide an opportunity for all involved to explore the potential of radio technologies, enhancing knowledge on their use, as well as adding value to the Authority, which sees this process as an additional mechanism to enable it to regulate/supervise the market in the future.

Also noteworthy, in the context of innovation, is ANACOM's involvement in Technological Free Zones, framed by Decree-Law 67/2021 of 30 July.

4.2 Regulatory approach to spectrum sharing

Licensed Shared Access (LSA), as defined by the RSPG, is a regulatory approach designed to facilitate the introduction of radio systems operated by a limited number of licence holders subject to an individual licensing regime in a frequency band already allocated to one or more incumbent users. In the context of LSA, additional users can use the spectrum (or part of) according to the sharing rules (which shape the sharing framework as explained in Figure 1) that are contained in their spectrum rights of use, whereby all authorised users, including incumbents, are allowed to offer a certain quality of service.

The main objective of LSA is to enable the allocation of rights of spectrum use to new operators on a shared basis, allowing them to make available electronic communications services with guarantees of a certain quality of service (QoS). However, it is necessary to ensure that certain flexibility requirements are met, so that incumbents and new operators are not failed the possibilities and expectations to develop their networks and/or technologies.

As an example, spectrum sharing based on the LSA concept could be based on geographical separation/differentiation. The area represented in blue in Figure 1[12] identifies the spectrum availability for LSA users. The sharing framework may also contemplate future needs of an incumbent, as illustrated by the stations represented in green in Figure 1.

[12] Based on ECC Report 205 - Licensed Shared Access (LSA), subsequently reflected in ITU-R Report SM.2404-0 - *Regulatory tools to support enhanced shared use of the spectrum*.

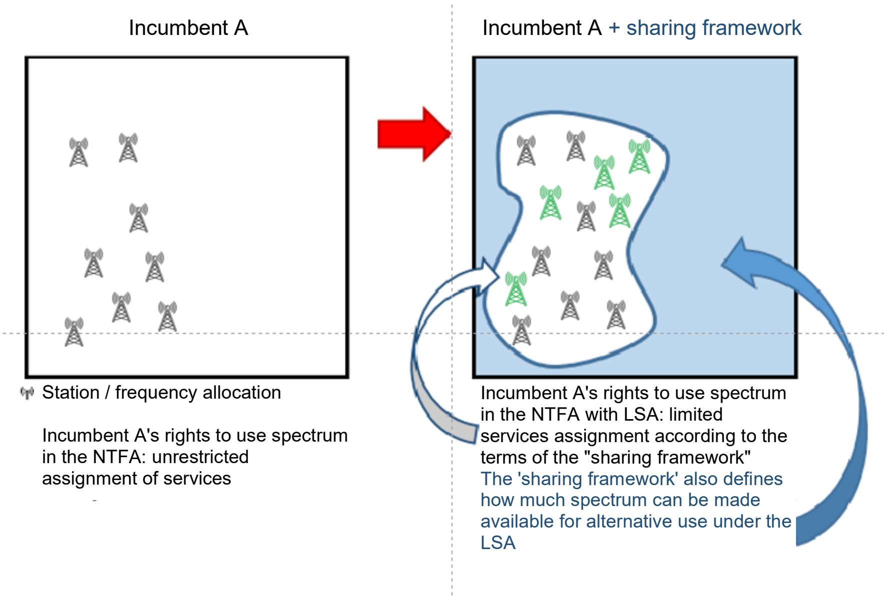


Figure 1- Sharing Framework

It should be noted that, in the context of LSA, sharing can take place in several dimensions, namely in time, frequency and space (geographical area).

CEPT has developed harmonised conditions for the use of the band 2300-2400 MHz for Mobile/Fixed Communications Networks (MFCN), in accordance with ECC Decision (14)02, "Harmonised technical and regulatory conditions for the use of the band 2300-2400 MHz for Mobile/Fixed Communications Networks (MFCN)", adopted on 27 June 2014. LSA pilot tests were carried out in Italy, France, Finland and the Netherlands to assess the feasibility of implementing LSA in a real-life scenario in the context and given the singularities of each of these countries. The Netherlands has implemented an LSA solution based on the specifications of the European Telecommunications Standards Institute (ETSI)[13].

In the specific case of Portugal, the incumbent services in the 2.3-2.4 GHz band are Services Ancillary to Programme Making / Services Ancillary to Broadcasting (SAP/SAB). In this context, radio licences are currently granted in the 2.3-2.39 GHz band, which confers the right to use the spectrum assigned to them at anytime and anywhere in the national territory, without having to provide any additional information on its use. For this reason, the implementation of LSA in this spectrum in Portugal raises

[13] Available at https://www.etsi.org/newsroom/news/1625-2019-07-etsi-specifications-on-licensed-shared-spectrum-successfully-implemented-in-the-netherlands-for-the-entertainment-industry.

additional technological challenges, in terms of the identification and detection (in space and time) of spectrum uses.

In this context ANACOM, together with various entities, carried out a "Study on the Licensed Shared Access (LSA) spectrum sharing model in Portugal"[14,15], whose report was published in September 2020.

From a technological point of view, and based on the pilot tests carried out in Portugal, it was possible to validate the LSA concept and make spectrum sharing viable in the 2.3-2.4 GHz band, without major constraints under the considered conditions. Despite the good results obtained, we can see on the horizon a potential for improvement in some relevant aspects to be considered should an implementation of the LSA model in the 2.3-2.4 GHz band be chosen in Portugal. In parallel, it will be important to evaluate the advantages from an economic and strategic point of view of the shared use of this spectrum by operators, in order to establish a technical, regulatory and legal framework that defines the bases for the introduction of the LSA model in Portugal.

The more comprehensive and global perspective presented above calls for a detailed analysis, with emphasis on the most relevant civilian radio services/applications for society.

4.3 Spectrum sharing techniques

The more intensive use of spectrum, in particular from 400 MHz to 6 GHz[16] by various socio-economic sectors, makes it more difficult to identify frequency bands for exclusive use by each of the radio services, systems and applications. As a consequence, within spectrum policy, the strategy will tend to consider approaches based on the shared use of spectrum.

[14] Available at https://www.anacom.pt/render.jsp?contentId=1563344.
[15] Available at https://www.etsi.org/newsroom/news/1571-etsi-licensed-shared-access-specifications-for-a-trial-in-portugal-to-support-5g-deployment.
[16] The identification of this part of the spectrum, which is more attractive to users and to the market, is the result of a combination of the need for more and more bandwidth and the existence of an economically and operationally viable technology. This led to the concentration and necessary sharing of spectrum by various radio systems and services in so-called sweet spots, which were characterised by the continuous and consistent rise of radio services and systems in the radio spectrum.

Spectrum sharing can be carried out along the following dimensions[17]:

- Frequency;
- Space;
- Time;
- Signal (code).

Note that in a given sharing context more than one dimension may be used and that this sharing may be static or dynamic (changing over a short period of time).

Building on the four dimensions set out above and from a regulatory perspective, the RSPG report entitled "Spectrum Sharing: The forward-looking survey" identifies two types of spectrum sharing:

- horizontal (non-hierarchical) sharing, in which radio systems have equal rights in terms of access to spectrum, with spectrum sharing between licensed stations of different services (inter-services) or between stations of the same service (intra-services), as well as radio licenced exempt applications (e.g. Wi-Fi);
- vertical (hierarchical) sharing, in which radio systems have distinct priorities for access to spectrum, including spectrum overlay (e.g. white spaces and RLAN at 5 GHz) and spectrum underlay (e.g. ultra wideband [UWB]).

Depending on the requirements of the scenario, including the specific quality objectives of each spectrum user/service, spectrum sharing can be exploited by using, inter alia:

- Spectrum detection/access mechanisms: some of these mechanisms are Detect And Avoid (DAA), Listen Before Talk (LBT) and Dynamic Frequency Selection (DFS). This category includes Short Range Devices (SRD) which use multiple spectrum access techniques to mitigate interference and allow coexistence between the various devices, on a non-protected and non-interference basis, without exclusive use of the spectrum and radio licenced exempt;
- Cognitive technology mechanisms: they allow a radio system to dynamically and autonomously adjust its operational parameters and protocols, based on the knowledge obtained from the operational environment or the results of the learning process, in order to achieve predefined objectives when sharing the spectrum. Note that some cognitive spectrum

[17] See Rec. ITU-R SM.1132-2 - General principles and methods for sharing between radiocommunication services or between radio stations - https://www.itu.int/rec/R-REC-SM.1132/en.

sharing technologies are based on the implementation of geolocation databases, which can provide to the equipment information to identify parts of the spectrum available for sharing so that existing services/applications are protected. Cognitive spectrum sharing technologies can also make use of equipment that detects the availability of frequency channels for autonomous transmissions, without the need for integration or connection to a database, through sensing.

Other techniques, such as beamforming, filtering, receiver performance, dynamic frequency assignment between technologies (e.g. Dynamic Spectrum Sharing [DSS]), interoperability at protocol level, can also foster spectrum sharing, and the most recent developments in spectrum management, in the context of sharing, are based on Artificial Intelligence (AI) and Blockchain, in particular cognitive access-based approaches.

ANACOM will continue to monitor the development of new spectrum sharing techniques and, with the underlying objective of maximising the efficient use of spectrum, will aim to implement them on a case-by-case basis in Portugal, taking into consideration their suitability for the bands and services in question, the market demand and the national context with regard to spectrum usage conditions.

4.4 Mobile Service

4.4.1 Networks for the provision of terrestrial electronic communications services

The networks for the provision of terrestrial electronic communications services include electromagnetic wave transmission systems, whether or not based on permanent infrastructure or centralised administration capability, which allow signals to be transmitted over terrestrial mobile networks regardless of the type of information transmitted.

4.4.1.1 Description of the current situation:

Digital mobile communications began in Portugal in 1991, with the allocation of the first licence for the provision of land mobile service (LMS), exclusively according to the Global System for Mobile Communications (GSM), in the 900 MHz and 1800 MHz frequency bands.

In 2001, licences were granted for the provision of LMS, exclusively according to the Universal Mobile Telecommunication System (UMTS), in the 2100 MHz frequency band.

In 2010, and as part of the so-called refarming, ANACOM authorised the use of the already assigned frequencies in the 900 MHz and 1800 MHz band also for the operation of the UMTS system.

In 2012, following the multi-band auction, mobile operators were also granted rights of use of frequencies in the 800 MHz and 2.6 GHz bands on a flexible usage basis, additional spectrum in the 900 MHz and 1800 MHz frequency bands, and authorised the Long Term Evolution (LTE) and Worldwide interoperability for Microwave Access (WiMAX) in the 900 MHz and 1800 MHz bands[18]. By the end of 2012, the 2100 MHz band could also be used on a technology-neutral basis, i.e. with technologies other than UMTS (e.g. LTE).

In 2021, and following a second multi-band auction, rights to use frequencies for the provision of terrestrial electronic communications services were granted in the 700 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2600 MHz and 3600 MHz bands, as shown in **Table 1**:

[18] Available at https://www.anacom.pt/render.jsp?contentId=1120054#.VoJrXV4isZV.

FREQUENCY RANGE	QUANTITY OF SPECTRUM PER OPERATOR (MHz)					
	DENSE AIR*	DIGI*	MEO*	NOS*	NOWO*	VODAFONE*
700 MHz (FDD)			10	20		20
800 MHz (FDD)			20	20		20
900 MHz (FDD)		10	20	20		20
1800 MHz (FDD)		10	40	40	20	40
2100 MHz (FDD)			40	40		40
2600 MHz (FDD)		10	40	40		40
2600 MHz (TDD)		25				25
3600 MHz (TDD)	100/55 (until 2025) 40 [19]	40	90	100	40	90
* DENSE AIR: Dense Air Portugal, Unipessoal, Lda. * DIGI: Digi Portugal, Sociedade Unipessoal, Lda. * MEO: MEO - Serviços de Comunicações e Multimédia, S.A. * NOS: NOS - Comunicações, S.A. * NOWO: NOWO Communications, S.A. * VODAFONE: Vodafone Portugal - Comunicações Pessoais, S.A.						

Table 1 - Frequency bands, authorised technologies and amount of spectrum per operator

In summary, there are currently six licences allocated corresponding to the rights of use of frequencies for the provision of terrestrial electronic communications services (TECS)[20], respectively in the 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2600 MHz and 3600 MHz frequency bands[21].

In addition to the 700 MHz spectrum that was made available in the multi-band auction finalised in 2021[22], there is still spectrum available in this band, namely the duplex gap and the 700 MHz guard bands, the use of which is being further considered. ANACOM intends to submit a public consultation

[19] Until 2025, DENSE AIR has spectrum of regional scope: 100 MHz in zones 1 and 2, and 55 MHz in zones 3 to 8. However, the company has acquired a RoU in the same band - 40 MHz nationally - that partially overlap with the regional spectrum over which it already held RoU.

[20] Available at http://www.anacom.pt/render.jsp?categoryId=345109.

[21] Several mobile virtual network operators (MVNOs) are also authorised to provide mobile telephony services: (i) Lycamobile, which is supported by VODAFONE's network, (ii) NOWO, which is supported by MEO's network and (iii) ONI, which is supported by MEO's network. These operators (with the exception of NOWO) do not hold rights of use of frequencies as they base their economic activity on radio media provided by network operators.

[22] According to the European Commission's Implementing Decision (EU) 2016/687 of 28 April on the harmonisation of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the EU.

on the future uses of the duplex gap and the 700 MHz guard bands that could eventually result in additional spectrum being made available for supplemental downlink (SDL), as well as PMSE and/or PPDR and/or M2M IoT, depending on market interest.

Importantly, WRC-19 identified a set of additional globally harmonised frequency bands for mobile "5G" (in ITU-R terminology: for the implementation of International Mobile Telecommunications (IMT), including IMT-2020), namely 24.25-27.5 GHz; 37-43.5 GHz and 66-71 GHz. The conditions attached to this additional spectrum assignment include power limits for the protection of the Earth exploration satellite service (EESS) - passive - in bands below the 24.25-27.5 GHz range (namely those provided by Copernicus, the European Union's Earth Observation Programme) and at 36-37 GHz. During WRC-19 further IMT bands were also identified, on a regional basis and do not cover Europe as a whole.

The 26 GHz band was the first band identified by Europe above 6 GHz for the development of 5G (with reduced geographical coverage, but high data transmission capacity) that is gradually being made available in Europe for terrestrial electronic communications services and was recently the subject of a public consultation in Portugal, whose report was published on 19 July 2022[23].

In the future, other bands could also contribute to the development of 5G/6G, namely the L-Band (1427-1517 MHz), the upper part of the 6 GHz band, the 40.5-43.5 GHz and 66-71 GHz bands.

As regards the L-band, Commission Implementing Decision (EU) 2018/661 of 26 April 2018[24] determines that the use by fixed service systems beyond 1 January 2023 is dependent on the market interest in using the band for TECS. In this context, successive consultations have been launched to listen the market and other stakeholders on the future use of the 1427-1517 MHz band, the latest in 2022[25].

The upper part of the 6 GHz band (6425-7125 MHz) is being disputed by the mobile community for terrestrial electronic communications services, being one of the bands that is part of WRC-23 agenda item 1.2 and is currently being studied in several international forums. It should be noted that the interest in keeping the band available for the fixed service should be studied, both for the type of current use (long distance and inter-island connections) and for use in connections with narrowband

[23] Available at https://www.anacom.pt/render.jsp?contentId=1725616.
[24] Available at https://eur-lex.europa.eu/legal-content/PT/TXT/?uri=CELEX%3A32018D0661.
[25] Available at https://www.anacom.pt/render.jsp?contentId=1724291.

channels (which may have to migrate to this band, following the possible need to make available the 1500 MHz band for to boost SDL). On the other hand, it should also be noted that CEPT is, since November 2021, analysing the possibility of making the upper part of the 6 GHz band available for Wireless Fidelity (Wi-Fi). Finally, it is worth mentioning that the licensing of a fixed satellite service (FSS) earth station in Madeira Island is foreseen to uplink data from the European Geostationary Navigation Overlay Service (EGNOS) Ranging Integrity Monitoring Stations (RIMS) to a Eutelsat satellite at 6725-7025 MHz.

Regarding 40.5-43.5 GHz, it should be noted that CEPT is preparing its response to the Commission's 3rd Mandate on 5G (least restrictive harmonised technical conditions for next generation (5G) terrestrial wireless systems for 40.5-43.5 GHz). At the moment, it is expected that no additional technical measures for MFCN or FSS are needed to allow compatibility at the lower end of the band (40.5 GHz). In parallel to the preparation of the CEPT Report in response to that Mandate, the Electronic Communications Committee (ECC) is also developing two Recommendations on 5G FSS and MFCN (in-band coexistence and in adjacent bands), as well as a new ECC Decision on MFCN in the 40.5-43.5 GHz band. In addition, it was also considered necessary to revise Decision ECC/DEC/(02)04 to update the regulatory framework for FSS coordinated earth stations in the 40.5-42.5 GHz band.

Regarding the 66-71 GHz range, it is noted that the band was also analysed in CEPT and it was considered that the technical conditions reflected in Commission Implementing Decision (EU) 2019/1345 of 2 August 2019[26] and ERC/REC Recommendation 70-03[27] already allow next generation (5G) wireless broadband electronic communications services.

Furthermore, the spectrum needs for the shared use of the 3800-4200 MHz frequency band by terrestrial wireless broadband systems providing private local area network connectivity are being assessed in CEPT, taking into account the protection of satellite receiving earth stations and other existing applications and services, both in the 3800-4200 MHz band and adjacent bands, in particular in 4200-4400 MHz, where radio altimeters (life safety and security equipment, installed in aircraft, used mainly for precision approach to runways, proximity to the ground, landing and collision avoidance) operate.

[26] Available at https://eur-lex.europa.eu/legal-content/PT/ALL/?uri=CELEX:32019D1345.
[27] Available at https://docdb.cept.org/document/845.

Taking into consideration the technology neutrality, there has been a trend at European level to switch off previous generations, such as 3G networks. Although there may be interest in using more efficient and technologically advanced networks, the immediate switch-off of 2G and 3G networks may rise constraints, namely in the provision of some functionalities and in the fulfilment of certain coverage obligations. ANACOM monitors international initiatives, both at the level of BEREC and RSPG, which aim to learn about existing migration plans in the European Union and anticipate the challenges that may arise.

4.4.1.2 Strategic actions:

In order to stimulate beneficial competition for the national market, while promoting an efficient use of spectrum resources by market players, a set of strategic actions have been identified, among which the following stand out:

1. Develop in a timely manner the appropriate regulatory framework for the deployment of mobile broadband networks, identifying additional spectrum for TECS (including for 5G/6G);
2. Foster the use of wireless broadband technologies that enable data transmission at higher speeds, as well as with lower latency and also ultra-reliability, allowing the development of diversified scenarios;
3. Monitor and, if necessary, impose conditions to improve the coverage and capacity of mobile networks throughout the country;
4. Develop frequency coordination actions at international level as necessary to avoid harmful interference;
5. Fostering application growth and innovation, namely M2M/IoT.

4.4.2 Private radio networks - Private land mobile service

Private land mobile service networks are non-publicly accessible mobile radio communications (PMR) networks that are intended to serve the communications needs of a wide variety of closed user groups. These groups include companies operating in the fields of civil construction and public works, transport, security, civil protection, surveillance, agricultural holdings, industry, leisure activities, energy and hospitals, among others.

PMR networks are based on two distinct strands, one dominant, with the use of analogue and narrowband digital technologies, with frequencies up to 470 MHz and almost all channelling at 12.5 kHz, and the other with the progressive use of digital technologies, at frequencies below 1 GHz and with channelling above 200 kHz.

4.4.2.1 Description of the current situation:

The vast majority of private networks[28] have analogue technology for voice calls with reduced call set-up times, which allows the availability, among others, of group calls, use of signalling through simple protection tones or selective calling.

However, with the advent of digital technology, frequency planes in the 160 MHz, 440 MHz and 450 MHz bands have been adapted to allow the gradual migration from analogue networks. The use of digital technology - which allows a generally more efficient use of spectrum - results in an increase in the above functionalities and an improvement in the quality of service of the networks, namely better voice quality, enhanced security through advanced encryption systems and the possibility to increase data transmission rates.

Overall, this type of network is served by, among others, Digital Private Mobile Radio (dPMR), Digital Mobile Radio (DMR), Terrestrial Trunked Radio (TETRA), GSM for railways (GSM-R) technologies.

There are currently more than 2,200 private networks licensed in Portugal, of which around 600 are digital networks, almost all operating in the ultra-high frequency (UHF) band.

Note that there has been a significant reduction in the number of private analogue networks of national/regional scope (with semi-duplex operation), concentrating the use of private networks in reduced and specific areas.

The expansion of digital systems has accelerated the migration from analogue to digital. However, analogue systems will probably continue to be used, at least in part, until the equipment on the market becomes obsolete (analogue equipment meets the technical needs of most companies).

Operating frequencies for private networks are assigned on a case-by-case basis and for a specific area, in full accessibility mode, on a first-come, first-served basis.

[28] See https://www.anacom.pt/render.jsp?categoryId=64310#.VnA2QOnnlCo.

With the development of new mobile generations, namely 5G, the paradigm of private networks as we know them today may change in the scope of their use. In fact, with these new technologies it is foreseeable that they will expand to different vertical businesses, i.e. businesses targeting specific market segments, beyond the traditional mobile broadband market, such as the automation of industry, public services, smart buildings, public safety and telemedicine.

4.4.2.2 Strategic actions:

Bearing in mind the national framework, as well as the need to ensure a more efficient use of spectrum resources by market players, the following strategic actions are identified:

1. Foster the transfer from analogue to digital technology in frequency bands which accommodate PMR, so as to maximise efficient use of the radio spectrum;

2. Explore the new scenarios for private local networks, taking into consideration the technological evolution, in frequency bands above 1 GHz;

3. Seek to make available, in a timely manner, adequate spectrum to accommodate the new scenarios that may be considered for private networks, always bearing in mind the underlying opportunity cost.

4.4.3 Private radio communications networks - Railway mobile communication systems systems

The radio communications system currently used for railway operations, GSM-R (Global System for Mobile communications - Railways), originated from GSM technology and is the result of years of collaboration between the various agents in the railway sector, with a view to using a single communications platform.

This system has become compulsory for use on interoperable lines and corridors as a communications system in its own right and to support the radio links involved in the railway signalling system.

Railway mobile communication systems support critical safety, traffic command and control and traffic management services and applications.

4.4.3.1 Description of the current situation:

The current GSM-R system is based on specifications defined in September 2000 and, due to its technological obsolescence, it is unlikely to be assured much after 2030. The future railway mobile communication system (FRMCS) will succeed GSM-R as one of the essencial elements of the European Railway Traffic Management System (ERTMS). This system will be the basis for digitalisation and innovation in railway services. GSM-R and its successor(s), including FRMCS, are designated as Railway Mobile Radio (RMR).

Compared to GSM-R, FRMCS is expected to offer a higher quality of service, use spectrum more efficiently and be more cost-effective. The system is also expected to offer more applications, such as Automatic Train Operation (ATO) or the Connected Driver Advisory System (C-DAS), and to enable technological developments over an extended period of time. FRMCS critical railway applications, such as monitoring and control of critical infrastructure, can be efficiently exploited using narrow band Internet of Things (NB-IoT).

In response to a Mandate from the European Commission (EC), the ECC adopted CEPT Reports Nos. 74 and 76 which assess the required amount of spectrum for RMR, identify frequency bands and harmonised technical conditions for FRMCS.

Refer E.P. (currently Infraestruturas de Portugal, S.A.), the company which ensures all the support and operation of the national railway network telecommunications, was authorised[29] to operate the GSM-R system in the 876-880 MHz and 921-925 MHz bands, which are currently the radio support of the GSM-R system mentioned in the European Commission Interoperability Directives.

4.4.3.2 Strategic actions:

In order to allow parallel operation of GSM-R and its successor during the transition phase from GSM-R to FRMCS, and to benefit from new critical railway applications during and beyond this phase, it is essential that RMRs have access to sufficient and harmonised spectrum. To this end, it is intended to:

1. Implement Commission Implementing Decision (EU) 2021/1730 of 28 September 2021 establishing, on a non-exclusive basis, the conditions of use of the paired frequency bands

[29] Available at https://www.anacom.pt/render.jsp?contentId=632310.

874.4-880.0 MHz, 919.4-925.0 MHz and 1900-1910 MHz for mobile railway radio communications;

2. Monitor the development of technical specifications and standards for FRMCS, with the first tests and subsequent implementation of FRMCS expected in 2025 at the international level;

3. Monitor spectrum use by RMR systems that are, or will be, deployed nationally, including any developments in spectrum management with a negative impact on interoperability.

4.4.4 Intelligent Systems used in Transport

Intelligent Transport Systems (ITS) aim at more efficient control and traffic management of the different land transport modes, environmentally sustainable, combining information, communication, positioning and automation technologies, allowing users to be better informed and to make a safer, more coordinated and "intelligent" use of transport.

ITS systems may or may not be safety-related such that their objectives and requirements differ.

Automotive short-range radar equipment, intended for vehicle collision avoidance, is also included in ITS.

Road ITS include cooperative systems based on real-time communications between the vehicle (including cars, trucks, bicycles, motorcycles, trams, construction equipment, agricultural equipment as well as pedestrian and cycling equipment) and its environment (other vehicles, infrastructure, etc.).

Urban rail ITS are intelligent systems applied to urban or suburban railway lines permanently guided by at least one control and management system, separated from road and pedestrian traffic.

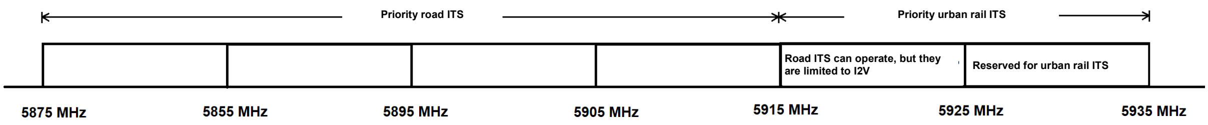
ITS are taking a central role in an integrated approach to road and rail safety, avoiding potentially dangerous traffic situations and reducing the number of accidents.

The European Commission, through its Implementing Decision (EU) 2019/1345 of 2 August 2019, has harmonised, inter alia, the operating conditions for non-safety-related ITS systems used in the fields of transport (road, rail, inland waterways, maritime or air transport, depending on the technical conditions), in particular in traffic management, navigation and mobility management. This type of application includes interfaces between different modes of transport, such as communications between vehicles (V2V), between vehicles and fixed installations (V2I) and communications by and for users.

4.4.4.1 Description of the current situation:

The 5875-5935 MHz frequency band is, under Commission Implementing Decision (EU) 2020/1426[30] of 7 October 2020, reserved in the NTFA for ITS as follows:

- The sub-band 5925-5935 MHz is reserved for urban rail ITS;
- Priority should be given to road ITS applications in the 5875-5915 MHz sub-band;
- Priority should be given to urban rail ITS applications in the 5915-5935 MHz sub-band;
- However, road ITS can operate in the 5915-5925 MHz sub-band, limited to applications involving infrastructure-to-vehicle (I2V) connectivity only, coordinated with urban rail ITS where appropriate;
- In the 5925-5935 MHz sub-band, urban rail ITS access should be allowed on a shared basis with the Fixed Service, subject to national circumstances.



Industry efforts have resulted in the development of two competing technologies for short-range communications between the vehicle and its environment, ITS-G5 (based on the IEEE 802.11/11p specifications) and LTE-V2X (based on 3GPP specifications), and ETSI is considering spectrum sharing solutions for these technologies in the 5855-5925 MHz band.

Finally, it should be mentioned that CEPT is currently carrying out compatibility studies between ITS systems operating in the 5875-5935 MHz band and very low power wireless local area networks (WAS/RLAN VLP) operating in the 5945-6425 MHz band, in order to reassess the conditions associated with the operation of WAS/RLAN[31].

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[30] Available at https://www.anacom.pt/render.jsp?contentId=1567067.

[31] See recital (13) of https://eur-lex.europa.eu/legal-content/PT/TXT/?qid=1602492451985&uri=CELEX:32020D1426.

4.4.4.2 Strategic actions:

1. Follow developments within CEPT on the review of technical conditions for wireless local area networks above 5935 MHz that safeguard the protection of safety-related applications in the urban rail ITS domain below 5935 MHz, as well as safety-related applications in the road ITS domain below 5925 MHz (e.g. out-of-band emission limit requirements);
2. Foster the use of the 5875-5935 MHz band by urban rail and road ITS, while respecting the applicable technical requirements.

4.4.5 Emergency and safety nets

Emergency and safety nets, also known as PPDR, are intended for the safety of the population and are also used in emergency situations such as floods, storms associated with adverse weather conditions, forest fires, droughts, earthquakes and volcanic eruptions.

4.4.5.1 Description of the current situation:

The emergency and security communications[32] are aimed at specific and restricted groups of users, such as security forces and armed forces, fire brigades, medical emergency and civil protection.

Portugal has implemented the Integrated System for Portugal's Security and Emergency Networks[33] (SIRESP), based on a shared national telecommunications infrastructure, using digital trunking technology (TETRA), which must serve the communications needs of the emergency and security forces and services, ensuring intercommunication and interoperability between the various forces and services and, if necessary, allow centralised command and coordination.

SIRESP uses the 380-383 MHz / 390-393 MHz frequency bands as well as, where necessary, the 383-385 MHz / 393-395 MHz extension bands and is used by a wide range of bodies[34].

The use of broadband services for emergency communications by the so-called Broadband Public Protection and Disaster Relief (BB-PPDR) systems implies making spectrum available for this purpose,

[32] Available at https://www.anacom.pt/render.jsp?categoryId=331608.
[33] Available at https://www.siresp.pt/.
[34] Available at https://www.siresp.pt/sobre-nos/utilizadores/.

with the 400 MHz and/or 700 MHz frequency bands being appropriate, in accordance with CEPT Decision ECC/DEC/(16)02[35] and pursuant to Implementing Decision 2016/687 of 28 April 2016[36].

4.4.5.2 Strategic actions:

Taking into account the relevance of matching existing resources to potential emergency situations, it is considered strategic:

1. To make spectrum available to meet the requirements/needs of broadband services for emergency and safety communications, depending on the future scenario[37] that may eventually be adopted in Portugal. In particular, ANACOM will carry out a public consultation on the future uses of the duplex gap and the 700 MHz guard bands, in the context of which the possibility of making additional spectrum available for these applications will be considered.

4.5 Fixed Service

4.5.1 Radiocommunications networks in the fixed service

The fixed service is characterised by establishing communications between stations at specific fixed locations, without recourse to physical connections, being suitable for use in areas where there is no cable/fibre (or in redundancy thereof), when there is a need to connect locations at a great distance (for example, connections between islands), or in the presence of physical obstacles (rivers or mountains).

Communications using fixed wireless systems (unidirectional or bidirectional) can be carried out using only two stations, thus establishing point-to-point links, or between central stations and several terminal stations, designating these systems as point-to-multipoint links.

In response to the different needs of various entities, are granted network licences for point-to-point and point-to-multipoint links and granted station licences for uses in frequency bands below 30 MHz.

[35] Available at https://docdb.cept.org/document/941.
[36] Available at https://eur-lex.europa.eu/legal-content/PT/TXT/?uri=CELEX%3A32016D0687.
[37] ECC Report 218 identifies three models for implementing BB-PPDR networks.

Licensing in the fixed service depends on the propagation analysis and on interference evaluation in order to mitigate possible problems in communications, also aiming to maximise the reuse of frequencies or their sharing. Based on criteria established in recommendations from international organizations (ITU-R and CEPT), it is possible to adapt the frequencies to be assigned to the operation of a given fixed service system, taking into account its technical characteristics (such as the required bandwidth, the desired transmission rate, the distance between stations).

4.5.1.1 Description of the current situation:

The NTFA[38] specifies the frequency bands available for the fixed service in Portugal. Additional information on frequency bands and plans can be found on ANACOM's website: Fixed Service[39].

It should be noted that there is a historical separation between fixed wireless links operating below and above 1 GHz, which is fundamentally based on the difference channel spacings (less than 25 kHz below 1 GHz, and from 500 kHz to 1500 MHz above 1 GHz) and in applicable fees.

Frequency bands below 1 GHz

In frequency bands below 1 GHz, namely in the more expressive 406-430 MHz band, around 100 networks are in operation, geographically distributed throughout the mainland and the Autonomous Regions of the Azores and Madeira (with a total of 275 point-to-point links). There are also 16 networks of point-to-multipoint links sharing the same frequency band, consisting of 50 central stations and 247 terminal stations.

In this context, it should be noted that, as mentioned in the section on private radio networks, part of the 410-430 MHz band could be made available in the future for land mobile systems, in accordance with ECC Decision ECC/DEC/(19)02, or for BB-PPDR systems, in accordance with ECC Decision ECC/DEC/(16)02.

The 158-163 MHz frequency band is used by warning systems for populations in the event of danger (3 networks) and the 34 MHz band is used by a data transmission system for buoys (ondographs).

[38] Available at https://www.anacom.pt/render.jsp?categoryId=302495.
[39] Available at https://anacom.pt/render.jsp?categoryId=336138.

Regarding stations operating on decametric waves (frequency bands below 30 MHz), there are currently 101 stations, totalling 1349 frequency assignments. The number of these stations has been decreasing over the last few years.

Frequency bands above 1 GHz

Over the last decades, there has been a continuous demand for the use of point-to-point links operating in frequency bands above 1 GHz (1500 MHz, 2, 6, 7, 8, 11, 13, 15, 18, 23, 38 and 80 GHz), mainly as a result of the need to interconnect the base stations of the networks of the SCET operators and as a result of the flexibility, robustness and economy that this transmission technology offers.

Currently, there are around 4800 licensed point-to-point links (9600 fixed stations), geographically distributed throughout the mainland and the Autonomous Regions of the Azores and Madeira.

As can be seen from Figure 2 below, since 2000 there has been a sustained increase in the number of point-to-point links used in the different frequency bands (with the exception of links in the 15 GHz and 38 GHz bands), highlighting the significant increase in links in the 18 GHz and 23 GHz bands, the preferred bands for SCET operators to interconnect their base stations.

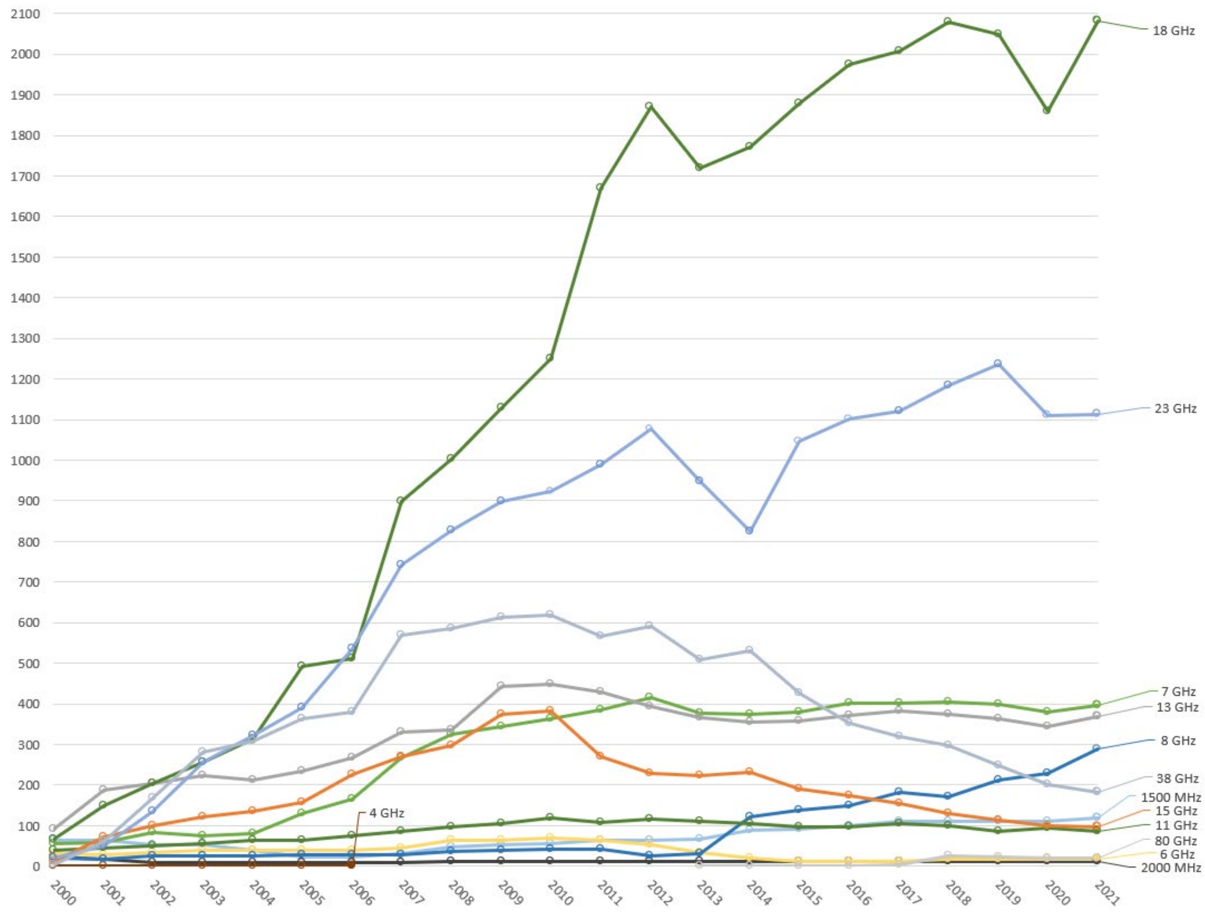

Figure 2- Evolution of the number of point-to-point links per frequency band.

In recent years, as a result of the increase in installed capacity at the aforementioned base stations, there has also been a need to increase the transmission rate of fixed wireless systems, observed both in the use of channels with greater bandwidth, or in the use of radio equipment with better spectral efficiency.

Figure 3 depicts the evolution of the number of point-to-point links as a function of the channels bandwidth, regardless of the frequency band used. This figure also shows a sustained increase in the number of links, regardless of the channel bandwidth used, which varies from 500 kHz to 1.5 GHz. However, there was a significant reduction of links with 7/7.5 MHz bandwidth (started in 2012), which were replaced with links using higher capacity: 13.75/14 MHz, 28/29.65 MHz and 56/59.6 MHz.

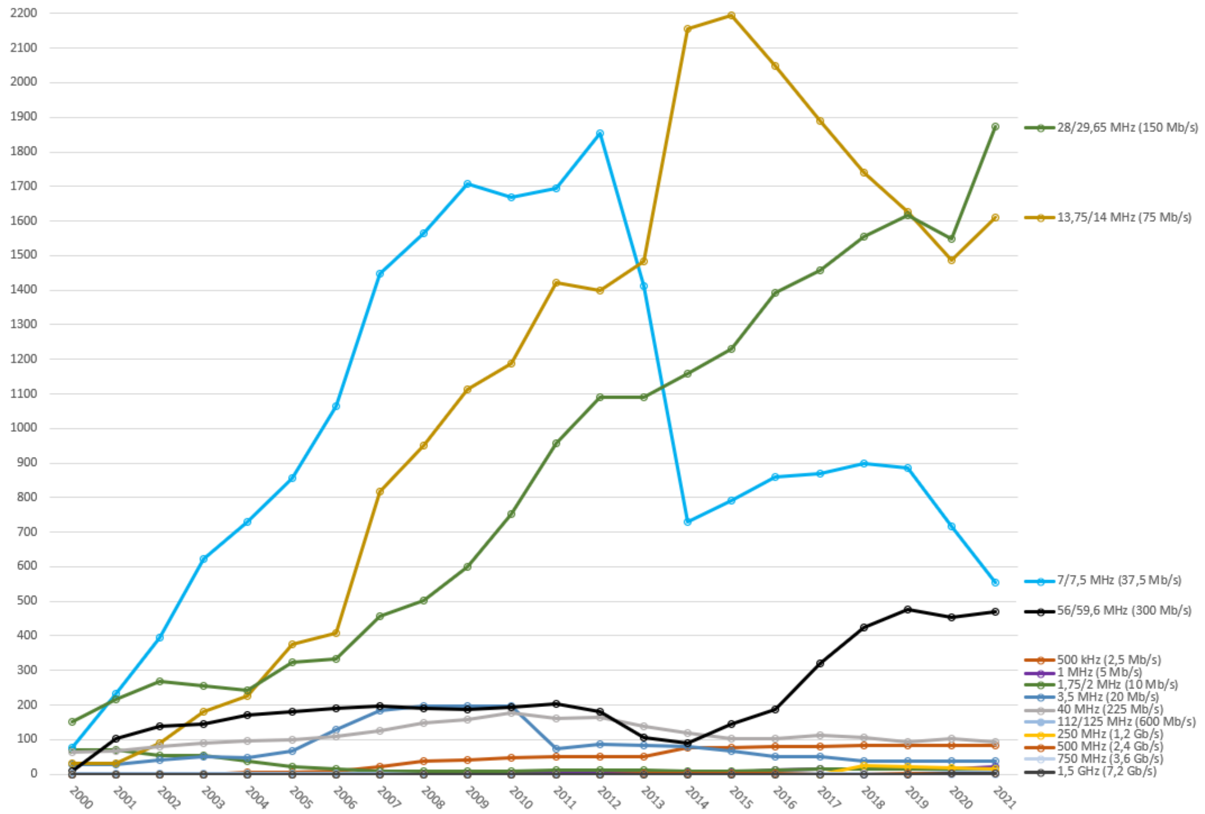

Figure 3- Evolution of the number of point-to-point links per channel bandwidth.

The technological evolution and the possibility of using modulations with a higher number of states, has allowed a significant increase in capacity.

It is considered that the frequency bands currently available for the fixed service adjust to the needs of the market for the coming years, even taking into account the implementation or increase of their own network infrastructure by the new SCET operators with 5G networks, being possible to accommodate these needs in the usual frequency bands (7, 8, 11, 13, 15, 18, 23, 38 and 80 GHz). If the increase in demand is more significant, consideration will be given to making more frequency bands available, in particular above 90 GHz.

It should be noted that, within the scope of the European Union (EU) strategy for the Digital Single Market, was approved and implemented the Decision (EU) 2018/661, of 26 April 2018, amending the Decision (EU) 2015/750, of 8 May 2015, on the harmonization of the frequency band 1452-1492 MHz for terrestrial systems capable of providing electronic communications services in the Union, with regard to its extension in the harmonised frequency bands 1427-1452 MHz and 1492-1517 MHz. As a result of this Decision, the continued use of the L-Band (1427-1517 MHz) by fixed wireless systems, beyond 1 January 2023, is dependent on national demand for SCET.

In this context, current licence holders have already been alerted to the possibility of not continuing to use the L-Band, namely the 1492-1517 MHz band, and ANACOM will provide alternatives to meet the eventual need to migrate these uses to other(s) frequency band(s).

4.5.1.2 Strategic actions:

Given the European guidelines and the increasing need for spectrum for the different communications services, it becomes relevant in the context of the fixed service:

1. The possible future availability of part(s) of the 410-430 MHz band, for private use of radiocommunications networks, will require a reassessment of its use by the fixed service;

2. Monitor technological development aimed at providing higher frequency bands, intended for establishing point-to-point and point-to-multipoint links;

3. Take the actions, related to the L-Band, deemed necessary depending on the results of future public consultations, including the possible implementation of new plans with reduced bandwidth, in an alternative frequency band, in order to respond to the possible need to migrate current uses of fixed wireless systems;

4. With a view to making the licensing of the fixed service more agile, consider the possibility of assigning exclusive frequency blocks at regional or national level, as well as promoting other simplified licensing solutions.

4.6 Broadcasting Service

4.6.1 Sound broadcasting

According to the current Radio Law, Law 54/2010 of 24 December, sound broadcasting activity is understood to be the organisation and provision, on a continuous basis, of sound programme services for broadcasting to the general public.

The sound broadcasting service in Portugal is currently provided exclusively through analogue technology, in 3 distinct frequency bands, commonly known as shortwave, medium wave and frequency modulation (FM), where shortwave - unlike medium wave or FM, in which potential listeners are in the area close to the transmitters - is intended to be received many hundreds or thousands of kilometres from the transmitter.

4.6.1.1 Description of the current situation:

As regards shortwave and medium wave, the situation remains practically identical to that referred to in the 2016 SSP, i.e. there is no licensed shortwave broadcasting station in the territory, and the number of medium wave stations in operation is very low, which leads us to conclude that the new digital technology available, Digital Radio Mondiale (DRM), continues not to elicit special interest from Portuguese broadcasting operators.

In view of the above and given that there has been no interest in the frequency bands where it operates for the implementation of other radiocommunications services, the short and medium wave radio broadcasting service is still not a matter of great importance that warrants special attention.

Also with regard to the FM band, the situation is currently very similar to that referred to in the 2016 SSP, continuing to be the privileged means for the sound broadcasting service, with six nationwide networks, two regional networks and more than three hundred local radio stations remaining in operation, totalling of more than seven hundred licensed transmitters and relay stations, with an increase of around ten licensed relay stations compared to 2016.

The FM band is saturated in many areas of the country, namely in the metropolitan areas of Lisbon and Porto, and it is only possible to license new local radio stations if the government decides to promote the respective public tenders in very specific municipalities and most of them with relatively low economic activity.

With regard to the other existing digital technology in the VHF band (174-223 MHz) - Digital Audio Broadcasting (DAB/DAB+) - ANACOM has been collecting information each year on its development in the various European countries. In some countries it has been evolving significantly, notably in the United Kingdom, Switzerland and Norway (where, as decided by the government, the “closure” of national FM networks has already been carried out), where the DAB/DAB+ audiences already exceed their FM counterparts. However, there are also countries that, similarly to Portugal, do not register any evolution in the adoption of this technology, as is the case of Ireland, where it was decided to close down DAB broadcasts throughout the country in 2021.

It should also be noted that the entry into force of Law 16/2022 of 16 August (Electronic Communications Law) represents a clear regulatory incentive, namely to car manufacturers and consumers, for a transition to digital radio, since it determines the incorporation of a digital receiver in all new category M vehicles placed on the market for sale or rental for the first time.

Analysing the data for the year 2021 in the European countries that have already transposed Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018, it is possible to see a very considerable increase in the number of new cars already incorporating receivers compatible with DAB/DAB+ technology, which will increase over the years.

4.6.1.2 Strategic actions:

1. As analogue FM receivers continue to be widespread in the national market, the current use of the band (87.5-108 MHz) is expected to be maintained in the medium/long term. In other words, no alternative strategic actions are foreseen in this area in the time horizon of this SSP;
2. With regard to DAB+, the development of the DAB+ at European level should continue to be assessed annually so that a decision can be taken in a timely manner as to whether to reintroduce it into Portugal. Should this occur, it may be necessary to reformulate the current assignments and allotments that Portugal holds under the Geneva Agreement 06 (GE06), so that it meets the needs of the market and is adapted to the scope of the tenders that may be defined and promoted by the government.

4.6.2 **Digital television broadcasting**

A digital terrestrial television broadcasting network consists of transmitter stations and/or relay stations using digital technology, operating in frequency bands allocated to the television broadcasting service, which broadcast different television programme services, which are received by the general public.

4.6.2.1 Description of the current situation:

In the context of Decision (EU) 2017/899 of the European Parliament and of the Council, of 17 May 2017, on the use of the band 470-790 MHz, which determined that, as of 30 June 2020, the band 694-790 MHz (700 MHz band) should be assigned to terrestrial systems capable of providing broadband wireless electronic communications services, the DTT network operating in Portugal, which was overwhelmingly made up of transmitters and relay stations broadcasting in the band 694-790 MHz, was migrated to sub-700 MHz, that is, 470-694 MHz. This process, which took place between February and December 2020, also led to the DTT network fundamentally changing from a single-frequency network (SFN) complemented by an overlay multi-frequency network (MFN) to an MFN network composed of SFN networks of reduced size, keeping the overlay network in operation.

Although the offer of programme services on the network has been increased with the inclusion of RTP3 and RTP Memória, as of December 2016, the penetration of the service has been gradually reducing, estimating that the population accessing the free-to-air television service exclusively through the DTT platform - by terrestrial and complementary means (satellite - Direct To Home [DTH]) - does not exceed about 5%[40].

On the other hand, the RoU allocated is valid until 9 December 2023, and it is not known whether its holder, MEO - Serviços de Comunicações e Multimédia, SA[41], will request its renewal. However, it will have to do so by the deadline of 9 December 2022.

One of the agenda items (agenda item 1.5) at WRC-23 is the re-examination of the use of the band 470-960 MHz, at issue being whether to change the allocation table in Region 1 to add mobile services already at WRC-23 or to defer this discussion to WRC-27. This issue will be discussed at European level in the RSPG under sub-group WRC-23 and in the ECC under the CPG PTD.

Regarding this issue, both the report to the European Commission of the High Level Group on the future use of the band 470-790 MHz (known as the "Lamy Report"), submitted in September 2014, and the RSPG 15-595 opinion of October 2015, recommend that the band 470-694 MHz should be available for DTT until at least 2030.

Still on this subject, the European Commission has referred in early 2022 a questionnaire to regulators on the current and future use of the 470-694 MHz band. This questionnaire will be part of the information to be collected by the European Commission as part of the project "Study on the use of the sub-700 MHz band (470-694 MHz)". This project provides the Commission with information on

[40] Available at https://www.anacom.pt/render.jsp?contentId=1728093.

[41] MEO has already publicly stated several times that it has not decided whether it will request the renewal of the RoU it holds.

technological developments related to digital terrestrial broadcasting, consumer trends, the role of public media services and developments in auxiliary broadcasting equipment.

4.6.2.2 Strategic actions:

Portugal's position at WRC-23 on the future of the 470-694 MHz band cannot be separated from the process of renewal, or not, of the RoU currently in force for DTT and the decision to be taken by the government. It is also important to highlight the possible relevance of this spectrum for other uses in the near future.

Indeed:

1. Should the government decide that the population's access to free-to-air television in Portugal will continue to be processed via DTT - whether MEO's ROU is renewed or a new tender is opened, ANACOM's action should focus on defending that there is no immediate change in the use of the 470-694 MHz band;

2. Should the government decide that free-to-air television in Portugal should be made available to the population by means that do not use the frequency band in question, for example through the fibre-optic network complemented by satellite broadcasting or exclusively through satellite broadcasting, then ANACOM's action should involve advocating a change in the use of the band so that it can be used by other services and thus promote alternative use of the band in Portugal.

4.6.3 *SAP/SAB applications (PMSE, ENG/OB, radio microphones)*

SAP/SAB applications, also known as PMSE applications, are the set of applications that use the radio spectrum to support programme making and production (audio and video). The use of SAP/SAB applications is typically associated with sports events, outdoor music events, theatre productions, television entertainment and news reporting, or film production support.

Although they can complement each other, SAP/SAB applications are divided into two types:

- audio links: the most commonly used audio SAP/SAB applications are wireless microphones (handheld and body worn) and in-ear monitoring aids (IEM[42]);
- video links: the most commonly used video SAP/SAB applications are wireless cameras and handheld and mobile video links, including in-vehicle video links.

SAP/SAB applications typically share spectrum with other radio applications/services, based on criteria established to ensure their compatibility, i.e., so that they do not suffer or cause harmful interference.

The demand for access to spectrum for SAP/SAB has been increasing in recent years due to the presence of new streaming content producers or new forms of content (e.g., higher resolution visualisations), among others. In this sense, to meet this demand, there is a continuous need for spectrum for users of SAP/SAB applications.

4.6.3.1 Description of the current situation:

There is a very intensive occupation of the spectrum in two of the various frequency bands currently available in Portugal for SAP/SAB applications: the 470-694 MHz band for audio applications and the 2200-2400 MHz band for video applications.

In the frequency band 470-694 MHz, audio SAP/SAB applications are exempt from licensing when the effective radiated power (e.r.p.) of equipment is less than 50 mW.

There have been no reports so far of interference caused by licence-exempt SAP/SAB applications in the 470-694 MHz band to other SAP/SAB applications belonging to licensed operators, i.e., with power above 50 mW, operating in this band simultaneously at the same location. However, the situation is likely to occur in the future, for example for temporary events generating extremely high demand for spectrum. In this sense, it is worth considering the study of a solution that allows the reorganisation of the different uses of SAP/SAB applications in the 470-694 MHz band in order to mitigate the occurrence of possible interference between these applications.

In the frequency band 2200-2400 MHz, there is currently a spectrum shortage, given the high demand for it by entities that produce and cover events, using temporary licences.

[42] *In-Ear Monitoring*.

In view of the above, as there are other bands identified in ERC Recommendation 25-10 for SAP/SAB applications (audio and video links), the possibility of making additional frequency bands available for these applications should be considered, either through temporary licensing or under a licensing exemption scheme.

In this context, it should also be noted that, pursuant to Commission Implementing Decision (EU) 2016/687 of 28 April 2016[43], part of the duplex gap bands (733-758 MHz) and/or the guard bands (694-703 MHz and 788-790 MHz) of the 700 MHz band may become, inter alia, available for audio SAP/SAB applications, and it is up to each Member State to decide on the use of this spectrum.

4.6.3.2 Strategic actions:

In light of the foregoing:

1. ANACOM will analyse possible solutions for reorganising the different uses of SAP/SAB applications in the 470-694 MHz band for licence-exempt applications and for applications subject to licensing in order to mitigate the occurrence of possible interference, without prejudice to the guidelines that the European Union will define for this band in the context of its positioning for WRC-23 (regarding agenda item 1.5).
2. ANACOM will carry out a public consultation on the future uses of the duplex gap and the 700 MHz guard bands that could eventually result in additional spectrum being made available for audio and video SAP/SAB applications.
3. ANACOM should also consider making available additional frequency bands for SAP/SAB applications (audio and video links) commonly used in several European countries, such as the 1350-1400 MHz and 7-8.5 GHz bands.

4.7 Satellite Services

GSO Satellites

The space sector as a whole, comprising satellite communications (satcom), satellite navigation (satnav) and Earth observation satellite (EESS), is crucial for electronic communications. This sector

[43] Available at https://eur-lex.europa.eu/legal-content/PT/TXT/?uri=CELEX%3A32016D0687.

has seen significant growth, reflected both by the sustained increase over the years in the number of licensed earth stations and by the gradual increase in frequency bands made available for various categories of stations that can operate under the licensing exemption regime.

Over the last five decades, the vast majority of satcom services have been provided via geostationary satellites (GSO), with around 350 currently in orbit.

The main advantage of GSOs - their ability to transmit information over large territorial areas - led to the development of satellites for the broadcasting business (broadcast satellite service [BSS]), and it is commonly accepted to have been the driver of the satcom sector for decades.

Perhaps the biggest change currently affecting satcom is related to the paradigm shift in the reception of sound and television broadcasting (linear) to non-linear television (which allows you to watch what you want, when you want).

This reality applies both to systems offering conventional FSS fitted with regional coverage beams, and to multiple spot beams High Throughput Satellites (HTS) systems.

NGSO Satellites

While satcom services suffer saturation from the supply of traditional satellite television broadcasting services, we are seeing an increase in the number of other vertical markets as potential revenue sources. The biggest opportunity for the space *downstream* sector lies in vertical sectors such as transport, energy, agriculture and healthcare.

It cannot be ignored that these sectors are changing at an unprecedented pace with increased automation, energy efficiency, reduction of environmental impact, simplification and digitalisation of processes and increased safety as key factors.

The advent of evolving and/or disruptive concepts and technologies, such as 5G and IoT or M2M services, will make the phenomenon more evident and the space sector will not survive if it remains niche or closed in on itself.

In this context, non-geostationary satellite constellations (NGSO) are playing a key role. In fact, over the past decade, several NGSO satellite constellations with distinct commercial offers have been launched, with narrow-bandwidth M2M/IoT services standing out.

But NGSO satellite constellations have also been launched to compete in the traditional GSO satellite market, such as Internet via satellite services (such as the SpaceX/Starlink or OneWeb constellations).

The pressure for coordination and spectrum occupation mechanisms that accommodate both types of satellites (GSO and NGSO) will increase in this context. Regulatory, technical and operational measures, harmonised at international level, will need to be developed to ensure coexistence between systems with different types of orbit, without creating potential situations of harmful interference to any of them.

Due to the specific characteristics of satellite communications, the promotion of these different services will also require the national implementation of spectrum harmonisation measures decided at international level, namely in the CEPT. As ANACOM has always done, all measures deemed feasible from a technical and regulatory perspective will be implemented nationally.

ESIM

One of the successful examples of the implementation of spectrum harmonisation measures has been the work developed in the CEPT in the scope of Earth Stations In Motion (ESIM), earth stations installed in vehicles, ships or aircraft that remain connected to the space station even when in motion.

The great advantage of these stations lies in the way they can establish reliable communications at high bandwidths for internet applications on the move.

The need for more spectrum for ESIM is growing due to increasing demand, mainly from maritime operators[44] (such as cruise lines) and aeronautical operators (airlines).

Since 2005, when the first spectrum harmonisation measures for ESV (Earth Station on Vessels) and AES (Aircraft Earth Stations) appeared, namely for the Ku-band (14/12 GHz), several stations operating in higher frequency bands, such as the Ka-band (30/20 GHz), or operating with NGSO systems have emerged in order to accommodate the growing interest in establishing higher speed internet connections on moving platforms (maritime and aeronautical).

[44] According to international literature, in 2014 more than 20,000 ships were connected via satellite. This number is estimated to reach 50,000 in the coming years.

Since 2015, the world radiocommunications conferences (WRC) have always had at least one agenda item dedicated to ESIM. ANACOM is monitoring developments in studies related to this item and will not fail to reflect in its regulatory framework all measures resulting from world conferences, boosting the development of this type of stations.

The fulfilment of users' needs in a specific sector such as satellite communications is heavily dependent on the regulatory environment.

4.7.1.1 Description of the current situation:

The supply of satellite radio communication services in Portugal is quite differentiated in terms of installed infrastructure and/or availability of the service.

At the end of 2021, there were a total of 105 radio licences for space radiocommunications services, consisting of 65 earth station licences (of which 19 from the FSS, 1 from the mobile satellite service [MSS][45], 41 from the space operations service and 4 from the EESS), 8 Very Small Aperture Terminal (VSAT) network licences, 30 Satellite News Gathering (SNG) earth station licences and 2 MSS network licences at 2 GHz that include Complementary Ground Component (CGC).

All these earth stations use about 6 GHz upstream and 10 GHz downstream of spectrum currently available for space-based radio services, which extends from 137 MHz to 50.2 GHz.

Although the terrestrial infrastructure for the supply of electronic communications in Europe and similarly in Portugal is quite dense, there has been continuous growth over the years in the supply of satellite services.

In this context, it is worth highlighting the significant increase in recent years in the number of earth stations in the space operations service intended for telemetry, telecommand and satellite tracking, functions involving space stations which, in turn, operate within the scope of different space radiocommunications services (FSS, MSS, BSS, EESS, etc.).

[45] Mobile Satellite Service.

This growth is mainly due to the development of national teleports[46] that have been able to attract foreign companies to install their gateway earth stations, used to connect the satellite network to the terrestrial network (to offer end users an internet or television service), and their telecommand and control earth stations, mainly of new NGSO constellations, in these same teleports.

It should also be noted that much of the spectrum available for space-based radio services - around 4 GHz upwards and 5 GHz downwards - can be used under the licence-exemption scheme.

In fact, there are several types of earth stations, such as ESIM, which can be used in Portugal without any radio licence, thanks to spectrum harmonisation measures established at international level which ANACOM has implemented nationally wherever appropriate, thus promoting the satellite communications market.

In this context, it will also be important to reconsider the regime of exemption of the licensing of exclusively receiving earth stations, resulting from the implementation in 2003 of Decision ERC/DEC/(99)26 (on exemption of individual licensing of Receive-Only Earth Stations), which is now considered too restrictive. In fact, the licence exemption only applies to receiving earth stations operating in the frequency bands 3.4-4.2 GHz, 10.7-12.75 GHz and 17.7-20.2 GHz. An amendment to the regulatory framework allowing for exemption from licensing of receiving earth stations operating, on a non-protected basis, in any frequency bands allocated to the service concerned, will promote the satellite communications market.

The growth in satellite service provision brings, as a consequence, the need for additional spectrum to adequately meet the demand for new applications (IoT, M2M, broadband, DTH and government uses), new technologies and industrial competitiveness.

The global satellite communications market, according to data provided by the Satellite Market and Research portal[47], will grow to 330 million installations by 2026. This market includes not only communications per se, but the entire value chain from satellite construction, launch and ground infrastructure. These figures indicate a growing need for European industry to position itself more competitively and closer to the American industry. A more complete overview of the financial

[46] Infrastructure with several Hubs and/or Gateways ground stations sharing the same physical space (Site).
[47] Available at http://www.satellitemarkets.com/market-trends/global-satellite-broadband-addressable-market-expected-grow-330-million-premises-2026.

amounts involved in the global space industry, however, can be found in Bryce Tech's report called "State of the Satellite Industry"[48].

Therefore, the development of new satellite systems and new applications is to be expected. The areas of user interest and need lie in the implementation of "always connected", "security", complete "terminal integration", high throughput rate coupled with high quality of service, access to cloud-stored data and low-cost solutions.

4.7.1.2 Strategic actions:

In order to enable the development of new satellite systems and new applications, it is important to:

1. Consider national interests, namely those of industry, operators, service providers and academia, with regard to the development of projects within the scope of new satellite radio communication technologies and systems, seeking to satisfy inherent spectral needs;

2. Establish the right regulatory framework and technical conditions to accommodate the use of higher frequency bands, notably in the Q/V bands (40/50 GHz);

3. Monitor the developments related to ESIM as well as other satellite terminals, making available at national level, where appropriate, harmonised frequency bands for such terminals;

4. Adapt the current regulatory framework in order to promote the satellite communications market, allowing the reception of these signals in any frequency bands allocated to the service in question, under the licensing exemption scheme (operating on a non-protected basis).

4.8 Scientific Services

The Space Science Services are the Radiocommunications Services involving the EESS and the Meteorological Satellite Service (MetSat) as a sub-element of the EESS, and the Space Research Service (SRS).

[48] Available at https://brycetech.com/reports/report-documents/SIA_SSIR_2021.pdf.

The EESS is a definition of the ITU, laid down in the Radio Regulations (RR). However, it is commonly referred to by scientific bodies (e.g., the European Space Agency [ESA] and the United States Space Agency [NASA]) as the Earth Observation (EO) service and refers to the use of remote sensing technologies to monitor the terrestrial, maritime (including rivers and lakes) and atmospheric environment.

This monitoring activity relies on the use of the radio spectrum, which serves the purpose of measuring and recording natural physical phenomena.

Within the EESS, scientific, environmental and meteorological measurements (e.g., rainfall, wind, soil moisture, ocean surface temperature) and the monitoring and warning of natural disasters (floods, earthquakes, fires, etc.) are carried out.

Usually Low Earth Orbit (LEO) satellite systems are used to obtain image-data on Earth's features. These images are then processed and analysed to extract different types of information that can serve a myriad of scientific and/or industrial applications. EESS technologies use two types of sensors:

- Optical or thermal (passive) sensors: operate in the frequency bands of visible light (infrared) although the base band signal is sent from the satellite to the Earth in the radio spectrum;
- Radar sensors (active): operate in the radio spectrum and because radar measures the energy sent to earth and the energy received back, which passes through cloud cover, it can be used at day, at night and in all weather conditions. They are called Synthetic Aperture Radar (SAR).

Meteorological satellite systems (MetSat) are used to help in weather forecasting, to diagnose and monitor adverse situations resulting from unfavourable weather conditions, to assist in the monitoring of cargo transportation by sea or air, and to monitor the climate and the environment.

Meteorological Auxiliary Systems (MetAids) aim to support meteorological systems; they use data collected (e.g. temperature, humidity, atmospheric pressure and wind speed) by a large number of ground stations, such as probes, weather radars and wind profiling radars.

SRS is a radiocommunications service that uses spacecraft for scientific or technical research, mainly for communications in near space (communications to and from the International Space Station [ISS]) and deep space.

Scientific services are limited to specific frequency bands and require a very particular environment, namely free from harmful interference. Thus, the protection of the frequencies used is of utmost importance so that the observations do not result in distorted data.

4.8.1.1 Description of the current situation:

Currently in Portugal, the user community for space scientific services is mainly governmental: meteorological satellite data reception and processing by the Portuguese Institute for the Sea and Atmosphere (IPMA) or EESS satellites by the Ministries of the Environment, Internal Administration and Defence.

As far as radio astronomy is concerned, it is worth mentioning that there was an important initiative in Portugal, which was the installation in the Alentejo (Moura) of a testing ground for the Square Kilometre Array (SKA) project in Africa and Australia. This project will make it possible to observe and map the first stars and galaxies after the Big Bang[49], to map violent phenomena in the universe (e.g., black holes) and to detect traces of precursor molecules of life in distant planetary systems and intelligent life in the universe.

4.8.1.2 Strategic actions:

With a view to meeting the spectrum requirements for current and future needs of scientific services, as well as considering the contribution of these services to combating climate change, it is important to ensure:

1. That radio stations operating in certain sensitive frequency bands for data collection operate without suffering harmful interference, so as to ensure the reliability of measurements made by satellite sensors and their transmission to receiving earth stations;
2. The best conditions for sharing frequency bands, so as not to cause situations of potential harmful interference to scientific space services;
3. That the frequency bands allocated to the Radio Astronomy service continue to be protected from potential interference situations.

[49] See https://portugal.skatelescope.org/ciencia/.

4.9 Maritime Services

4.9.1 Maritime Mobile Service and Maritime Satellite Mobile Service

The Maritime Mobile Service (MMS) is a radio communications service between coastal (land-based) stations and ship stations or between ship stations, or between associated shipboard communications stations.

The Maritime Mobile Satellite Service (MMSS) is a mobile satellite service in which the mobile earth stations are located on board ships.

4.9.1.1 Description of the current situation:

As stated in the 2016 SSP, the regime for the use of the radio spectrum by MMS and MMSS radio stations continues to be established by Decree-Law 179/97, of 24 July[50]. The use of coastal stations (MMS) and coastal earth stations (MMSS) requires authorisation and licensing by ANACOM. On the other hand, the use of ship stations requires authorisation and licensing by the Directorate-General of Natural Resources, Safety and Maritime Services (DGRM), as provided for in Article 4 of Decree-Law 179/97 of 24 July.

In Portugal, MMS communications are mainly based on the VHF band, and to this end a national plan of VHF frequencies (metric waves) was approved through Ministerial Order 630/2002 of 12th June[51], published in the Official Gazette, Series I-B, no. 134, of 12th June 2002, subsequently rectified by Rectification Declaration no. 26-D/2002[52], published in the Official Gazette, Series I-B, no. 175, of 31st July 2002.

This plan was the object of a review project prepared during 2015, which resulted from the activity of a working group involving various entities with competences in this area, although it has not yet been published in the Official Gazette.

[50] Available at https://www.anacom.pt/render.jsp?contentId=958411#.VnhAWbaLSUk.
[51] Available at https://dre.pt/dre/detalhe/diario-republica/134-2002-117835.
[52] Available at https://dre.pt/dre/detalhe/diario-republica/175-2002-118206.

The VHF MMS Frequency Plan, on the other hand, will soon have to be modified as a result of both CEPT (European Conference of Postal and Telecommunications Administrations) Decision ECC DEC (19)03 and WRC-19.

WRC-19 also contained a further agenda item calling for an assessment of the need for additional spectrum requirements and/or updating of regulatory provisions applicable to the global maritime distress and safety system (GMDSS). The decision taken by WRC-19 was to recognise the need to use the frequency band 1621.35-1626.5 MHz for use by GMDSS and further decided that this allocation would be in both directions of transmission (Earth-Space and Space-Earth). This decision also implies that the International Maritime Organisation (IMO) has accepted that, in addition to the INMARSAT system - which traditionally ensures this service - the GMDSS will now also be ensured by the IRIDIUM system.

Taking into account that the periodic changes to Appendix 18 of the RR, imply changes to the MMS Frequency Plan, ANACOM intends with respect to the other competent entities to consider the best way to speed up this process, avoiding the publication of successive orders.

It should also be mentioned that, although it is not significant in Portugal, there is currently congestion in the VHF MMS band in several CEPT countries, namely in the voice channels, due to the implementation of digital selective calling (DSC), automatic identification systems (AIS) and the VHF data exchange system (VDES), which reduced the number of available voice channels.

In this sense, studies are being developed at ITU, CEPT and IMO level on the possible expansion of the number of phonetic channels in the VHF MMS band based on the implementation of digital technology, using channels with spacing of 12.5 kHz and 6.25 kHz.

4.9.1.2 Strategic actions:

In view of the above, it becomes necessary to:

1. Draw up a procedure to speed up the process of updating the Maritime Mobile Service Frequency Plan;

2. Prepare, within the scope of MMS, a new national VHF frequency plan based on Appendix 18 of the RR and ECC Decisions;

3. Continue to monitor technological development as well as the reflection of the massive use of digital technology in this service, which, with a much greater dynamic than in the last decades, may imply new needs for change;

4. Consider the development of possible technical and regulatory measures necessary for the introduction of the IRIDIUM system within the GMDSS.

4.10 Aeronautical Services

The aeronautical mobile service (AMS) is a radio communications service between aeronautical stations and aircraft stations or between aircraft stations, in which survival craft stations and disaster location radio beacon stations may also participate on established distress and emergency frequencies.

The aeronautical mobile-satellite service (AMSS) is a service in which mobile earth stations are located on board aircraft. The survival craft stations and emergency position-indicating radiobeacon stations may also participate in this service.

4.10.1.1 Description of the current situation:

It is recalled that the application of European Union legislation, namely Regulation 677/2011/EU, and the publication, in 2015, of the statutes of the National Civil Aviation Authority (ANAC), introduced changes to the actors involved in the national management and coordination of these frequencies.

Currently, the management of frequencies is carried out in close coordination with NAV Portugal and ANAC. The licensing of stations operating on the ground is carried out by ANACOM, while the licensing of stations operating on board aircraft is the responsibility of ANAC.

Portuguese airspace is made up of two large areas: the Lisbon Flight Information Region (FIR) which includes mainland Portugal and the Autonomous Region of Madeira, and the Santa Maria FIR which includes the Autonomous Region of the Azores and most of the North Atlantic Ocean.

It follows from the application of the EU European Regulation 1079/2012 of 16 November 2012[53], which is only applicable to the Lisbon FIR, that there are distinct rules for Portuguese airspaces. In fact, this Regulation, which "*lays down requirements for voice channel spacing for the Single European Sky*", imposed a set of rules regarding the reduction of channel spacing from 25 kHz to 8.33 kHz, which led to the need to develop a process of migration of Lisbon FIR users to the new operating conditions, which was completed by 31.12.2020, as planned.

At international level, the debate on the Global Aviation Distress and Safety System (GADSS) should be highlighted. GADSS is a concept / system being developed by the International Civil Aviation Organization (ICAO) to ensure the timely identification and tracking of aircraft, in all phases of flight, comprising tracking in normal flight situations, as well as autonomous distress tracking (ADT) and flight data recovery (FDR) in anomalous situations. WRC-19 contained an agenda item calling for the assessment of the need for additional spectrum requirements and/or updating of regulatory provisions applicable to GADSS. The decision taken by WRC-19 was that there would be no need to make any change to these provisions of the Radio Regulations, so no substantial change to the conditions under which this system is based is envisaged in the near future.

With the conclusion of the migration process for users of the Lisbon FIR to use channels with 8.33 kHz separation, the management and use of the 117.975-137 MHz frequency band is currently stable.

4.10.1.2 Strategic actions:

Taking into account all the legislation currently in force, which focuses on the management of the spectrum allocated to aeronautical services, and as stated in the 2016 SSP, we reiterate the importance of:

1. Clarifying the competencies of each of the various actors.

Furthermore, the following are essential:

2. Closely monitor the issues being developed at international level, namely:
    - a possible additional spectrum allocation for the aeronautical mobile (route) service (AM(R)S) in the 117.95-137 MHz band and for AMS in the 15 GHz and 22 GHz bands;

[53] Available at https://eur-lex.europa.eu/legal-content/pt/TXT/?uri=CELEX%3A32012R1079.

- the use of FSS in Control and Non-Payload Communications (CNPC) of Unmanned Aircraft Systems (UAS);
- the possible revision of the AP. 27 of the RR (use of digital technologies in the safety of human life in commercial aviation);
- the development of possible spectrum requirements and technical and regulatory measures necessary for the introduction of GADSS (satellite and terrestrial components).

4.11 Amateur and Amateur Satellite Services

The amateur service is a radiocommunications service for the purpose of self-training, intercommunication and technical study carried out by amateurs, i.e. by duly authorised persons interested in radioelectricity (including propagation studies) on a purely personal basis and without pecuniary interest. The amateur satellite service is a radio communications service using space stations on earth satellites for the same purposes as the amateur service.

ANACOM is responsible for creating conditions for the development of amateur and amateur satellite services, particularly since it recognises the importance of these services for scientific and technological dissemination in the field of electronic communications in general and radiocommunications in particular.

Although there are no watertight demarcations, one can consider four fundamental activities in amateur radio: communication, experimentation and research, education and participation in civil protection activities, which are described below:

a) **Communication** - many years ago amateur radio was the only way to communicate to the whole world effectively (via the ionosphere, albeit with low bandwidth - first in telegraphy and then in telephony) and affordably. Today you can communicate with any part of the world quickly and efficiently with a high bandwidth, without resorting to amateur radio services. For this reason, the community of amateurs communicating over long distances is getting smaller and smaller. In shorter distance communications, amateur radio has seen "strong competition" from private systems - exempt from any licence or registration - examples of which are the personal radio service - citizen band (CB) and PMR446. This explains the progressive reduction in the number of amateurs and the progressive ageing of the amateur radio community.

b) **Experimentation and research** - this aspect is perhaps today the most important in the activity of amateurs and the most differentiating in terms of radiocommunications services. In fact, amateurs have over time been pioneers in experimentation in the world of radiocommunications, "inventing" solutions for their radiocommunications. It should be noted that, recognising the experimental nature of amateur radio activities in the search for new modes of communication, the current regulations have a provision that allows the granting of temporary authorisations for the operation of stations that do not comply in whole or in part with the technical provisions defined in the regulatory framework, having, however, to comply with what is set out in the NTFA.

c) **Education** - there have been increasing initiatives to bring radio science to schools by amateurs - usually by teachers or parents of pupils, and more generally to society. Some amateurs and amateur associations have also developed initiatives in this sense, namely promoting communications within the amateur satellite service between young non-amateurs and the International Space Station - which has an amateur station on board. Also worth mentioning is the important annual Jamboree On The Air (JOTA) initiative in which amateurs, their associations and in particular the amateur scouts, promote a taste for radiocommunications among younger people who are not (yet) amateurs. These and similar initiatives are possible via a regulatory provision that allows non-amateurs to use amateur stations, provided they are properly supervised.

d) **Participation in civil protection activities** - Amateurs may make an important contribution in tactical radiocommunications in support of civil protection, and it is desirable that the participation of amateurs in activities related to civil protection is coordinated by national, regional and local entities with responsibilities in this area. In other words, it will be up to these entities, if they deem it necessary, to call and frame amateurs and their associations.

4.11.1.1 Description of the current situation:

The operating rules for radiocommunication stations of the amateur and amateur satellite services, as well as the rights and obligations of amateurs operating in Portuguese territory are established in the specific legal framework, in force since 1 June 2009, constituted by Decree-Law 53/2009, of 2

March[54], by the "Procedures for the amateur service"[55], as well as by the applicable provisions of the NTFA and namely by the document "Use of frequencies by the amateur and amateur satellite services - NTFA"[56], which establishes access to frequency bands by the various amateur categories[57].

It should be noted that an adaptation of the regulatory framework is under development, aiming, among other things, at changing the status of category 3, allowing amateurs in this category to communicate autonomously from their stations.

The bands required for the operation of amateur and amateur satellite service stations in Region 1, as defined in the RR, have not changed much in recent years. However, the trend has been to enable stations of these services to access new bands, and the following worth noting:

a) the allocation at WRC-15 of the band 5351.5-5366.5 kHz to the amateur service with secondary status;
b) the allocation at WRC-19, for Region 1, of the 50-52 MHz band to the amateur service with secondary status which was already followed by Portugal before this decision was taken at international level.

Finally, it should be noted that:

a) in response to requests from amateurs, annual authorisations have been granted for the use of the 1850-2000 kHz band, after coordination, as it is a conditional band, an example of which is the "Use of the 1850-2000 kHz band by the amateur service in 2022"[58], available on ANACOM's website;
b) although the availability of the so-called 5 MHz band requires coordination at national level because it is a conditional band, it has been possible on an annual basis to find a solution allowing amateurs who so request, subject to case-by-case authorisations, to use the band 5351.5-5366.5 kHz, with the equivalent isotropically radiated power limited to 15 W and a

[54] Available at https://www.anacom.pt/render.jsp?contentId=956876.
[55] Available at https://www.anacom.pt/streaming/decisaoamador27052009.pdf?contentId=955142&field=ATTACHED_FILE.
[56] Available at https://www.anacom.pt/streaming/SAAS_setembro_2013.pdf?contentId=1188800&field=ATTACHED_FILE.
[57] Information on individual national amateur stations, as well as on stations in common use, can be consulted on the function to search for data on amateur and amateur satellite services on ANACOM's website (https://www.anacom.pt/saas/home-publica.do).
[58] Available at https://anacom.pt/render.jsp?contentId=1718969.

further set of frequencies in this part of the spectrum: 5288.5 kHz, 5371.5 kHz, 5380.5 kHz and 5403.5 kHz without such a limitation of transmission power.

4.11.1.2 Strategic actions:

In light of the foregoing, the following strategic actions regarding amateur and amateur satellite services are highlighted:

1. Complete the adaptation of the current regulatory framework to the new requirements for the management of amateur and amateur satellite services which will entail:
    - in a first phase, with the publication of the amendment to Decree-Law 53/2009, of 2 March[59], the fixing of frequency bands for the operation of category 3 amateurs:
        - ✓ 3700-3800 kHz, 7100-7200 kHz and 14250-14350 kHz, with a peak power of 10 W;
        - ✓ 28-29.7 MHz, with a peak power of 100 W;
        - ✓ 51-52 MHz, 144-145,806 MHz, 430-435 MHz and 438-440 MHz, with a peak power of 50 W.
    - at a later stage, following public consultation on the NTFA and in particular on the document "Frequency use by amateur and amateur satellite services - NTFA"[60], fix access to frequency bands for all amateur categories.
2. Consider permanent access, under conditions to be defined, for amateurs to the 1850-2000 kHz band, notably under footnote RR5.96, after the necessary national coordination;
3. Consider permanent access, after national coordination, given that it is a conditioned band, to the 5351.5-5366.5 kHz band, in accordance with the RR, and to a further set of frequencies in this part of the spectrum: 5288.5 kHz, 5371.5 kHz, 5380.5 kHz and 5403.5 kHz, with conditions to be defined;
4. Follow up the studies for WRC-23 involving the amateur and amateur satellite services and in particular their allocations in the band 1240-1300 MHz in order to ensure protection of the satellite radionavigation service (space-Earth) in this band.

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59 Available at https://www.anacom.pt/render.jsp?contentId=956876.

60 Available at https://www.anacom.pt/streaming/SAAS_setembro_2013.pdf?contentId=1188800&field=ATTACHED_FILE.

4.12 Short range devices

"Short-range devices", also called SRD, used in various applications and frequency bands, provide one-way or two-way communications over a short distance. These devices play an important role in the daily life of consumers, businesses and public organisations, supporting the development of a wide range of applications with very short range, including broadband data transmission or M2M connectivity.

They operate on a non-interference and non-protected basis and cannot cause harmful interference to any radio communications service duly authorised, nor claim protection from harmful interference caused by radiocommunications services. They operate on a non-exclusive and shared basis and cannot claim protection even from other short-range devices.

Short-range devices benefit from a particular regulatory regime and do not need a radio licence or rights of use of frequency to operate; however, this does not mean that they do not have to comply with certain conditions for spectrum usage as well as with the relevant ETSI standards and European placing-on-the-market legislation.

Some of the advantages of using SRD, from the consumer's point of view, are to decrease the installation of cabled networks to obtain certain services, to have the capacity to connect devices to fixed broadband networks, or to increase security through the installation of low-cost alarms, with no spectrum usage paid for. For manufacturers there are also several advantages, such as being able to develop niche markets with new applications or services at low cost under clear and well-defined regulatory and technical conditions.

There are, however, some disadvantages, such as the inability to provide QoS, as the frequency band is shared, as well as the fact that they have limited coverage, given the powers allowed for this type of device.

4.12.1.1 Description of the current situation:

The categories of equipment currently authorised, and using various frequency bands, are as follows:

- Non-specific short-range devices;
- Broadband data transmission equipment;

- Wireless Access Systems / Radio Local Area Networks (WAS/RLAN);
- Low power indoor WAS/RLAN (LPI) devices;
- Very Low Power (VLP) WAS/RLAN devices;
- Transport and traffic telematics (TTT);
- Intelligent transport systems;
- Radiodetermination devices;
- Low duty cycle/high reliability devices;
- Model control;
- Inductive devices;
- Radio microphone applications;
- Continuous transmission/high duty cycle devices;
- Assistive listening devices (ALD);
- Radio Frequency Identification (RFID) devices;
- Active medical implants;
- Medical data acquisition devices;
- Broadband fixed wireless access systems (BFWA);
- Citizens band (CB);
- Telecommand,, telemetry, telealarm and data transmission systems.

The frequency bands and respective conditions of use for SRD are set out in the NTFA, which is available on ANACOM's website.

4.12.1.2 Strategic actions:

Rapid changes in technology and societal demands will lead to new applications for short-range devices which will require constant assessment of spectrum harmonisation conditions, taking into account their economic benefits, and it is essential to monitor these developments.

The following strategic actions regarding the assessment and availability of spectrum for short-range devices should be highlighted:

1. Keeping abreast of developments in the SRD industry and preparing the regulatory framework in a timely manner so that new equipment, when placed on the market, can operate in Portugal, taking into account the growing importance of short-range equipment for the economy and the rapid changes at the level of technology and social needs; in this context, it should be noted that

CEPT is, since November 2021, analysing the possibility of making the upper part of the 6 GHz band available for Wi-Fi, although, as described above, the upper part of the 6 GHz band (6425-7125 MHz) is also being disputed by the mobile community for terrestrial electronic communications services;

2. Follow the developments in CEPT with regard to the European Commission's standing Mandate: "Annual update of the technical annex of the Commission Decision on the harmonisation of radio spectrum for use by short-range devices";

3. Promote the harmonisation of licence-exempt frequency bands and their technical conditions for use by SRDs at European and global level, so as to avoid harmful interference and ensure the greatest possible flexibility, while promoting reliable and efficient use of frequency bands by short-range devices as well as developing economies of scale;

4. Prospectively assess the impact that new spectrum needs (which remain unpredictable) for smart energy grids, smart metering, smart transport systems, M2M communications and IoT will have in the future, in order to ensure that the regulatory solutions to be implemented accommodate these developments appropriately.

5 Assignment methods of rights of use of frequencies

Under the terms of Article 30 of the Electronic Communications Law (LCE), Law 5/2004, of 10 February, in its current wording, the use of frequencies is dependent on the allocation of rights of use only when necessary for:

- Avoiding harmful interference;
- Ensuring the technical quality of the service;
- Safeguarding the efficient use of spectrum;
- Carrying out other objectives of general interest defined by law.

As previously mentioned, it should be noted that on 16 August a new Electronic Communications Law (LCE) was published, Law 16/2022, which will come into force 90 days after its publication. As provided for in Article 36 of the aforementioned lawregarding the use of the radio spectrum, the use of frequencies is dependent on the allocation of rights of use only when necessary to maximise their efficient use in accordance with demand. It is therefore up to the regulator to define this radio spectrum usage regime, taking into consideration the following criteria:

- The need to safeguard the efficient use of radio spectrum;
- The specific characteristics of the radio spectrum concerned;
- The need for protection against harmful interference, taking into account the technological solutions for managing it;
- The need to ensure the technical quality of the communications or service;
- The development of reliable conditions for sharing the use of radio spectrum, where appropriate;
- The achievement of other objectives of general interest defined by law.

The allocation of rights of use of frequencies shall be carried out through open, objective, transparent, proportionate and non-discriminatory procedures, which may take place under full accessibility or be subject to competitive or comparative selection procedures, namely auction or contest.

Over the years, ANACOM has awarded RoU through various methods:

- full accessibility in the case of fixed wireless access (FWA) (2006)[61];
- auction, in the case of the introduction of fourth- and fifth-generation mobile communications (4G[62] and 5G[63]);
- public tender, in the introduction of second- and third-generation mobile communications (2G and 3G[64]), in the award of licences for terrestrial digital radio broadcasting (T-DAB) (1998), FWA[65] (1999) and DTT[66] (2001 and 2008).

The following sections present the main characteristics of these allocation mechanisms and discuss the advantages and disadvantages of each one.

5.1 Selection methods

Where, on the basis of available information, including from previous public consultations or observation of market structure, it is foreseen that demand for spectrum is likely to exceed supply, a mechanism needs to be found to promote that spectrum is delivered to those best able to create value for citizens and users. In well-designed selection processes, and allowing for the market failures alluded to later, the entities able to generate the most value from spectrum use will tend to be those willing to pay the most for it.

5.1.1 Competitive methods / Auctions

In this selection procedure, in addition to the qualification conditions, the duration of the RoU, the obligations and payment conditions, which are also contemplated in other selection methods, the regulators define the rules of the bidding process, the maximum amount of spectrum to be assigned to each bidder and other rules (such as those dictating the auction model). The RoU is awarded to the

[61] Following the reconfiguration of FWA RoU, the 24.5-26.5 GHz band was subject to an additional RoU allocation process under the full accessibility regime. More information available at https://www.anacom.pt/render.jsp?contentId=449700.
[62] More information Available at https://www.anacom.pt/render.jsp?categoryId=340922.
[63] More information Available at https://www.anacom.pt/render.jsp?categoryId=415903.
[64] Additional information available at https://www.anacom.pt/render.jsp?categoryId=330915.
[65] Additional information available at https://www.anacom.pt/render.jsp?contentId=13065.
[66] Additional information available at https://www.anacom.pt/render.jsp?contentId=13515 and https://www.anacom.pt/render.jsp?contentId=958892.

bidders who place the highest value on the spectrum, and the amount due for the award RoUmay be paid in full immediately or in variable instalments over the term of the RoU.

In auctions, the amount of spectrum that will be assigned to each operator may be variable and only known in the last stages of the selection procedure, thus allowing operators to acquire the amount of spectrum appropriate to their business models. On the other hand, in the auction models - namely those implemented in the last decades - fixed coverage obligations were imposed, i.e. they did not allow a proportional valuation for offers whose business models were based on an expansion of service coverage. However, this type of valuation has recently been introduced in some auctions (such as in Denmark), where incentives are given for buying lots with specific associated obligations, which translates into hybrid schemes, as discussed in section 5.1.3.

Auctions, if applied with an appropriate design, are mechanisms that promote both *static* and *dynamic efficiency*. On the one hand, they tend to make spectrum available to operators who are best able to transform its use into the production of better services and at the most competitive prices (static efficiency). On the other hand, it may allow efficient entry of new operators and change in the market structure (dynamic efficiency).

In fact, experience with auctions in the United States of America (USA) at the end of the 20th century boosted the popularity of this type of mechanism for spectrum allocation RoU and promoting competition in the sector from 2000 onwards.

This trend has also been seen in Europe, as evidenced in the 2002 "Review of Radio Spectrum Management"[67], as well as in the 2005 European Commission's Communication "A market-based approach to spectrum management in the European Union" [68].

Another aspect that should be mentioned, and which contributed to the use of auctions as a selection procedure, was the use of electronic means for the submission of bids, which made it possible to overcome barriers imposed by using specific physical spaces for bidding, and which somewhat conditioned the auction model.

67 Available at http://web1.see.asso.fr/ICTSR1Newsletter/No004/RS%20Management%20-%202_title-42.pdf.
68 Available at https://www.anacom.pt/render.jsp?contentId=968493&languageId=0.

5.1.2 Comparative methods / Beauty context

Public tenders are selection procedures where regulators define a set of specifications with the qualification conditions, the amount of spectrum to be assigned to each operator, the duration of the RoU and obligations (e.g. minimum coverage, investments for the information society). The specifications also set out criteria for evaluating the candidates' proposals (investments, planning of coverage, services provided, etc.).

In public tenders, which were widely used in Europe until the end of the 20th century, the amounts of spectrum allocated to each operator are defined and known by the operators at the start of the selection procedure. In this type of selection procedures, proposals whose business models commit to expanding service coverage as well as investments for society may also be valued, i.e. proposals that explicitly incorporate the social value of the spectrum.

However, the application of the principles of technological and service neutrality, which became a rule in 2004 with the entry into force of Decree-Law 5/2004, of 10 February (LCE), restricts the definition of objective criteria for evaluating proposals in public tenders, limiting them to economic criteria (investments). For this reason, auctions have become more frequent in Europe over time. Indeed, public tenders present some disadvantages when compared to auctions, such as the risk of judicial challenge of the outcome and higher administrative costs. Moreover, the diversity of technological solutions (in the context of technological neutrality) makes it difficult to compare projects which, in addition, may have different characteristics and purposes. Moreover, the design of tenders is rarely as flexible as that of auctions, in terms of accommodating the needs signalled by the market.

However, there is a tendency for auctions to include conditions or rules normally associated with tenders. This has allowed the incorporation of broader economic and social objectives, underpinned by competitive dynamics to achieve the full potential of spectrum use resulting in economic and social progress. The investment burden in the development of the operator's network is no longer a by-product of the activity of the operator who wins the frequencies but is the mechanism at the operator's disposal to win the selection procedure.

5.1.3 Hybrid schemes

A hybrid approach generally merges certain elements of tenders with those of an auction, i.e. combining certain commitments to fulfil obligations with a bid. Potential advantages of this format include the acceptance of voluntary commitments by bidders, for example on coverage and/or competition obligations (access to mobile virtual network operators (MVNOs) and national roaming for new entrants). The way in which voluntary commitments are made by operators depends on the auction design: reduction of reserve prices, association of obligations to certain lots (predefined quantities of spectrum that may be subject to bidding) or through a bidding phase where operators present additional commitments in exchange for a price reduction of the final amount payable.

As an example, the 2018 Danish auction[69] solves the difficulty of combining bidding and coverage/investment obligations by allowing, at a later bidding stage, winners to bid on lots that have associated extra coverage obligations in exchange for a reduction in the final amount payable (previously established) for the award of their right of use. Additionally, in Austria's 2020 auction[70], operators purchased lots with obligations and at a later stage presented additional coverage commitments in exchange for a reduction in the final amount payable.

However, the relationship between the reduction in the final amounts payable (discount) and the cost associated with the additional obligations tends to be subjective, which makes it susceptible to litigation and criticism.

5.1.4 Full accessibility

RoU allocation under the full accessibility regime is normally done on a first-come, first-served basis, i.e. according to the order in which requests are received. This process is particularly suitable for frequency bands where no spectrum scarcity is expected.

This method has the advantage of being relatively fast and simple for both the regulator and the operators. In addition, it ensures that spectrum can be used for operations, even of low economic value, when these do not compete with other uses.

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[69] See https://ens.dk/sites/ens.dk/files/Tele/information_memorandum_-_updated_feb_2019.pdf.
[70] Further information at https://www.rtr.at/TKP/was_wir_tun/telekommunikation/spectrum/procedures/Multibandauktion_700-1500-2100MHz_2020/FRQ5G_2020_tender_document.en.html.

The faster access for consumers resulting from a simpler allocation process, and which allows spectrum to be used quickly, also contributes to maximising consumer benefits for market development and the implementation of new technological solutions.

On the other hand, the choice of full accessibility requires a high degree of confidence in (future) oversupply of spectrum, at the risk of exhausting the resource.

In short, the choice of this allocation procedure depends on the bands at stake and the assumption that the supply of frequencies will exceed demand, over a relevant period.

5.2 Obligations and remedies to correct market failures

The application of the various RoU allocation methods is generally accompanied by measures aimed at correcting market failures, thus promoting greater efficiency. Some of these measures, which may take the form of *ex-ante* obligations or *ex-post* corrective measures, are outlined below.

5.2.1 Favourable conditions for new entrants (e.g. set-aside mechanisms; network access obligations).

The regulator may seek to increase the efficiency and level of competition in the markets by creating favourable conditions for new entrants. This can be done by imposing spectrum caps and/or reserving spectrum for new entrants in the case of auctions.

On the other hand, where it is considered that it would be beneficial for competition in a specific market, the regulator may impose obligations on incumbents to grant access to their networks to new entrants for a certain period. In general, these obligations should expire when new entrants have already established their own networks.

5.2.2 Coverage obligations

The award of RoU is an important mechanism available to the regulator to promote the economic and social cohesion of the national territory. In this context, it is common to impose coverage obligations regardless of the allocation method adopted. The imposition of these obligations, which forces operators to complete a specific level of coverage, in terms of population and/or territory, by a certain date, is currently a standard procedure in most countries. ANACOM will continue to assess, in future procedures, the appropriateness of imposing this type of obligations, as well as the way in which they are imposed, particularly in terms of their geographical breakdown, bearing in mind the need to meet the expectations of the population, businesses and institutions in general, particularly when it is a question of providing services in areas and timeframes which would not otherwise be available, and which are relevant to the economic and social development of the country.

In addition to coverage, these obligations can be even more specific and include the capacity required for that coverage. For example, in the "5G Auction"[71] an obligation was imposed to cover a certain number of parishes, with a minimum speed of 100 Mbps, contemplating coverage in each of the parishes of at least 90% of the population. A similar obligation was imposed in the process of MEO's and Vodafone's 900 MHz and 1800 MHz spectrum renewal.RoU

In the context of the above, it is important to reconcile, in the case of RoU allocations by auction, the imposition of coverage obligations with the setting of reserve prices for spectrum in a way that is attractive and contributes to efficient operations.

5.2.3 "Use it or lose it"

"Use it or lose it" obligations can be used to discourage spectrum hoarding that prevents new competitors from entering. The RoU holder may be obliged to commence their activity by a certain date by using the spectrum and, if they fail to do so, may lose their licence (or have the conditions changed). In any case, the application of this principle necessarily involves previous assessment.

[71] Auction for the allocation of rights of use of frequencies in the 700 MHz, 900 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz and 3.6 GHz bands.

5.2.4 "Use it or share it" or "Use it or lease it"

Another alternative would be to impose "use it or share it" or "use it or lease it" obligations. If the operator does not use that spectrum allocated to it within a defined timeframe, then it must share it with, or sublease it to, other operators.

5.2.5 Durations

The duration of the RoU that are awarded, in accordance with the above principles, will be decided in accordance with the specific characteristics of each licence and each service, taking into account regulatory predictability.

In the specific case of wireless broadband electronic communications services, the RoU will be awarded for a minimum period of 15 years, with regulatory predictability of at least 20 years regarding the conditions for investment in the infrastructures which relies on the use of such radio spectrumRoU.

5.2.6 Secondary Spectrum Market

In situations of change, such as an increase in demand for spectrum for a particular service or the development of a technology with greater spectral efficiency, it is desirable to have mechanisms in place to allow the necessary adaptations to meet new and future market needs.

While there are already approaches to RoU allocation that are more flexible than an individually assigned licence (one that grants an entity the exclusive right to use frequencies in a designated geographical space, whether or not it is operating in that frequency and geography), such as the shared access (LSA) or simultaneous shared access (club licensing) models, none of these approaches is potentially as flexible as the possibility of spectrum trading in secondary markets (through exchange, swap or spectrum leasing) or through multilateral agreements (spectrum pooling). In effect, transactions on secondary markets allow a third party to use part of the spectrum for a specified duration and in a specified area, according to its needs.

It is following a set of actions developed at the international level[72], actions related to the introduction of a more flexible spectrum management and use, that the implementation of a Secondary Spectrum Trading (SSM) has been proposed.

Allowed in some countries, SSM allows the change of spectrum holder in its entirety, or only in part, upon compliance with specific obligations that may be identical or differ from those initially set when the spectrum was first assigned, Primary Spectrum Trading (PST), to the holding entity (operator, service provider, other). SSM aims at a more flexible, efficient and effective use of spectrum in an attempt to reduce spectrum scarcity and benefit end users. For example, SSM can promote the efficient use of spectrum by leasing and exchanging (understood as trading) underutilised spectrum to third parties.

Spectrum trading can provide additional flexibility by favouring the transfer of spectrum resources to agents willing to pay for access to them, providing higher value uses and subsequent potential increases in dynamic efficiency. There is also an addition benefit from greater liquidity of the assets, especially considering the long durations of licences, which allows operators acquiring spectrum in the primary market to take more risk in its implementation, fostering innovation.

Spectrum leasing is also relevant to satisfy temporary needs, as this secondary market tool allows third parties access to some part of a holder's spectrum under defined usage conditions, which establish the time period, frequency and geographical areas of use to be complied with by the lessee. There are different approaches to leasing with regard to responsibility for maintaining the original terms and conditions.

Some countries have actively tried to promote SSM in recent years, such as Italy which introduced obligations to lease unused spectrum to promote more efficient spectrum use. In particular, in the 3.6-3.8 GHz band, operators must lease unused spectrum in specified locations (areas not included in the coverage obligations list) to other operators that do not own frequencies in bands up to 3.8 GHz.

In addition to secondary market transactions, another option is through private spectrum sharing agreements, or spectrum pooling, which allows incumbents providing the same service, for example mobile operators, to share these resources. This practice should only be used in cases where the

[72] See, for example, Freitas et al. (2020),"Fundamentals for the design of a mechanism to foster the liquidity of the secondary spectrum market in Brazil". Journal of Law, State and Telecommunications, vol. 12, no. 1, pp. 187-204, Available at https://periodicos.unb.br/index.php/RDET/article/view/30005.

regulator concludes that competition is ensured and there is a clear social added value in pooling scarce resources, which can notably translate into increased network coverage and/or availability[73].

ANACOM continues to study other alternative mechanisms to manage the growing demand for spectrum beyond conventional forms of sharing, while recognising the challenges which often make their possible implementation in the medium term impossible. For example, the proposal of an "open market" for capacity[74], operated in a neutral wholesale infrastructure, where granular blocks of space/time/frequency are permanently traded (and in which capacity is traded for a given network only according to price, which is determined, in real time, by marginal demand) could possibly foster greater sharing of resources (and necessarily a more efficient use of them, whether spectrum or network infrastructures), more efficient exchanges and the reduction of barriers to entry for new operators and to the expansion of existing operators (which would gain open access to spectrum resources for short to long-term durations, and over areas of different dimensions), thus also promoting competition in the markets where it may be implemented.

5.2.7 RoU Renewal

The allocation principles for rights of use, described in the previous sections, should also apply to decisions on their renewal.

Regarding the term for renewal of the RoU, ANACOM will take into consideration the advantages of ensuring a simultaneous expiry of the RoU, as provided for in the LCE. When there are several operators in a given market with similar characteristics in terms of the technologies they use, the services they provide and their positioning in the market, and they are therefore direct competitors, the renewal of the respective RoU at different times and with different periods of validity presents several disadvantages.

[73] See, for example, https://rspg-spectrum.eu/wp-content/uploads/2021/02/RSPG21-016final_RSPG_Report_on_Spectrum_Sharing.pdf.

[74] See Cramton et al. (2020), "Open Access Markets for Capacity and the Inseparability of Spectrum and Infrastructure" in Gregory Taylor and Catherine Middleton (eds) "Frequencies: International Spectrum Policy," Chapter 10, McGill-Queen's University Press, 2020, available at https://www.cramton.umd.edu/papers2015-2019/doyle-cramton-forde-open-access-markets.pdf.

Firstly, it has the disadvantage of leading to the adoption of relatively piecemeal approaches at the time of expiry of the individual RoU, rather than allowing for more global approaches that consider the market as a whole. With the simultaneous renewal of RoU, more consistent and demanding obligations can be imposed, avoiding distortions of competition.

Secondly, the simultaneous termination of the RoU of several suppliers present in the market mitigates the disadvantages associated with simultaneous strategic behaviour by operators, allowing the reallocation of part or all of the RoU, and making it possible to increase contestability and increasing the level of competition.

Moreover, in terms of spectrum planning, this simultaneity also makes it possible to re-think the band in question and, if appropriate in the light of technological evolution and the harmonisation of conditions of use of that spectrum, to re-plan it.

In this context, in decisions on RoU renewalRoU, ANACOM will consider making the term of the RoU coincide, thus allowing for decisions that consider the market as a whole and allow for a holistic approach, while promoting competition in the markets. This approach was followed by ANACOM in its decision on the renewal of the RoU awarded to Vodafone and MEO in the 900 MHz and 1800 MHz bands for terrestrial electronic communications services[75].

[75] Available at https://www.anacom.pt/render.jsp?contentId=1623481.

6 Next actions

The efficient management of the use of the radio spectrum is one of ANACOM's main tasks. Given the multiplicity of actors involved and impacted by the activities inherent to spectrum management, it is fundamental that the strategy to be adopted is approached from a holistic perspective, namely by taking into account the various services/applications and spectrum bands. The national Strategic Plan for Spectrum contained in this document is developed bearing in mind the reality of its current/planned use at national level, and this (national) perspective cannot be dissociated from the international context. As such, international coordination is an essential element of the national Strategic Plan for Spectrum, and therefore the committed involvement of all entities, including ANACOM, in international activities, particularly CEPT/ITU, is considered crucial.

The present document has sought to provide a framework for activities at the international level, as they are of paramount importance in the field of spectrum coordination and harmonisation, strongly influencing the design of the strategic plan at the national level. The description of the radiocommunications services, the current use of the spectrum and the strategic actions foreseen in each of the areas were also drawn up in some detail. Given the increasingly intensive use of spectrum in different sectors, it is also important, within the scope of future use/strategy of the spectrum, to assess the potential of the increasingly shared use of the spectrum, and for this purpose it is essential to guarantee a technical/regulatory framework that responds to this challenge.

There has been, since the publication of the previous SSP in 2016, a significant increase in spectrum made available for TECS, as well as some increase in spectrum made available for stations exempt from licensing (SRD, satellite terminal stations, etc.), and a decrease in spectrum available for the television broadcasting service and SAP/SAB (audio) applications.

ANACOM is expected to take decisions on a number of topics in the coming years, most notably:

- Assess the need for spectrum in view of the continuity, or not, of the provision of the free-to-air television service via DTT;
- Assess the spectrum needs for the shared use of the 3800-4200 MHz frequency band by terrestrial broadband wireless systems providing private local area network connectivity;
- Consider the various interests in the upper part of the 6 GHz band (6425-7125 MHz) and decide on the future use of this spectrum in due course;

- Monitor technological evolution, with a view to identifying new spectrum or spectrum sharing conditions in use to foster the development of 5G/6G;
- Further assess the economic and strategic benefits of shared use of spectrum under the LSA model, with a view to implementing it wherever and whenever possible;
- Continue the preparation for the 2023 World Radiocommunication Conference, with a view to defining the positions that best defend national interests, both at CEPT and ITU level;
- Assess the potential of the duplex gap (733-758 MHz) and guard bands (694-703 MHz and 788-790 MHz) in the 700 MHz band, with a view to deciding on their future use;
- Assess and decide on the renewal, and under what conditions, of RoU whose validity expires in the coming years.

Given the dynamic character that has been witnessed in terms of the use of the spectrum and its strategic management, the SSP should be updated in a timeframe no longer than four years, considering the cycle of World Radiocommunications Conferences, in order to reflect regional and/or international evolution of the different services and applications, as well as their impact on the national economy.

Acronyms and abbreviations

2G	Second-Generation Mobile
3G	Third-Generation Mobile
4G	Fourth-Generation Mobile
5G	Fifth-Generation Mobile
6G	Sixth-Generation Mobile
ADT	Autonomous Distress Tracking
AES	Aircraft Earth Stations
AIS	Automatic Identification Systems
ALD	Assistive Listening Devices
AMS	Aeronautical Mobile Service
AM(R)S	Aeronautical Mobile (Route) Service
AMSS	Aeronautical Mobile-Satellite Service
ANAC	National Civil Aviation Authority
ANACOM	National Communications Authority
ATO	Automatic Train Operation
BB-PPDR	Broadband Public Protection and Disaster Relief
BFWA	Broadband Fixed Wireless Access
BSS	Broadcasting Satellite Service
C-DAS	Connected Driver Advisory System
CB	Citizens Band
EECC	European Electronic Communications Code
CEPT	European Conference of Postal and Telecommunications Administrations
CGC	Complementary Ground Component
CNPC	Control and Non-Payload Communications
PST	Primary Spectrum Trading
SSM	Secondary Spectrum Market
DAA	Detect And Avoid
DAB	Digital Audio Broadcasting
DFS	Dynamic Frequency Selection
DGRM	Directorate-General for Natural Resources, Security and Maritime Services

DMR	Digital Mobile Radio
dPMR	digital Private Mobile Radio
DRM	Digital Radio Mondiale
DSC	Digital Selective Calling
DSS	Dynamic Spectrum Sharing
DTH	Direct-to-Home
RoU	Right of Use of Frequencies
ECC	Electronic Communications Committee
EESS	Earth Exploration-Satellite Service
EGNOS	European Geostationary Navigation Overlay Service
EMGFA	General Staff of the Armed Forces
ENG/OB	Electronic News Gathering / Outside Broadcasting
EO	Earth Observation
ERTMS	European Rail Traffic Management System
ESA	European Space Agency
ESIM	Earth Stations In Motion
ESV	Earth Station on Vessels
ETSI	European Telecommunications Standards Institute
USA	United States of America
FDR	Flight Data Recorder
FIR	Flight Information Region
FM	Frequency Modulation
FRMCS	Future Railway Mobile Communication System
FSS	Fixed-Satellite Service
FWA	Fixed Wireless Access
GADSS	Global Aeronautical Distress and Safety System
GE06	Geneva Agreement 06
GMDSS	Global Maritime Distress and Safety System
GSM	Global System for Mobile communications
GSM-R	Global System for Mobile Communications - Railway
GSO	Geostationary Satellite Orbit
HTS	High Throughput Satellites
I2V	Infrastructure to Vehicle
ICAO	International Civil Aviation Organization

IMO	International Maritime Organization
IMT	International Mobile Telecommunications
IMT-2020	5G in ITU terminology
IoT	Internet of Things
IPMA	Portuguese Sea and Atmosphere Institute
IPTV	Method of transmitting television signals via IP networks
ISS	International Space Station
ITS	Intelligent Transport Systems
JOTA	Jamboree On The Air
LBT	Listen Before Talk
LCE	Electronic Communications Law
LEO	Low Earth Orbit
LPI	Low Power Indoor
LSA	Licensed Shared Access
LTE	Long-Term Evolution
M2M	Machine to Machine
MetAids	Meteorological Aids Service
MetSat	Meteorological Satellite
MFCN	Mobile/Fixed Communications Networks
MFN	Multi-Frequency Network
MMS	Maritime Mobile Service
MMSS	Maritime Mobile-Satellite Service
MSS	Mobile Satellite Service
MVNO	Mobile Virtual Network Operator
NASA	National Aeronautics and Space Administration
NAV Portugal	Navegação Aérea Portugal
NB-IoT	Narrowband Internet of Things
NGSO	Non-Geostationary Satellite Orbit
e.r.p.	Effective radiated power
SSP	Strategic Spectrum Plan
PMR	Professional (Private) Mobile Radio
PMR446	PMR on 446 MHz
PMSE	Programme Making and Special Events
PPDR	Public Protection and Disaster Relief

NTFA	National Table of Frequency Allocations
QoS	Quality of Service
RIMS	Ranging and Integrity Monitoring Stations
RMR	Railway Mobile Radio
RR	ITU Radio Regulations
RSPG	Radio Spectrum Policy Group
SAP/SAB	Services Ancillary to Programme Making / Services Ancillary to Broadcasting
SAR	Synthetic Aperture Radar
satcom	Satellite communications
satnav	Satellite navigation
TECS	Terrestrial Electronic Communications Services
SDL	Supplemental DownLink
SFN	Single-Frequency Network
SIRESP	Integrated System for Emergency and Safety Nets in Portugal
SKA	Square Kilometre Array
LMS	Land Mobile Service
SNG	Satellite News Gathering
SRD	Short Range Devices
SRS	Space Research Service
T-DAB	Terrestrial Digital Audio Broadcasting
DTT	Digital Terrestrial Television
TETRA	Terrestrial Trunked Radio Access
UAS	Unmanned Aircraft Systems
EU	European Union
UHF	Ultra High Frequency
ITU	International Telecommunications Union
ITU-R	ITU, Radiocommunications Sector
UMTS	Universal Mobile Telecommunication System
UWB	Ultra Wideband
V2V	Vehicle to Vehicle
V2X	Vehicle to everything
V2I	Vehicle to Infrastructure
VDES	VHF Data Exchange System

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VHF	Very High Frequency
VLP	Very Low Power
VSAT	Very Small Aperture Terminal
WAS/RLAN	Wireless Access Systems/Radio Local Area Networks
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide interoperability for Microwave Access
WRC-15	World Radiocommunication Conference 2015
WRC-19	World Radiocommunication Conference 2019
WRC-23	World Radiocommunication Conference 2023
WRC-27	World Radiocommunication Conference 2027

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