

# Techniques for managing radio frequencies

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## **Abstract:**

The radio-frequency spectrum, now at the core of economic activities in modern digital societies, is related to major social, cultural and political issues. However this limited resource has to be shared out among all countries on the planet and for a wide range of uses and services. Managing the spectrum soon became indispensable at the supranational and national levels in order to guarantee the quality of radio-frequency assignments and to prevent interference. Procedures for backing up this guarantee are designed by the International Telecommunication Union (ITU) and adjusted at the national level. Implementing them means tapping capacities for processing and sharing data and adopting analytical methods, techniques and tools — which will have to evolve to cope with the problems that the proliferation of new services and forms of technology will force upon the management of the radio-frequency spectrum.

According to ConsoGlobe, 29 terabytes of data are published per second in the world. This stream of data irrigates and connects all zones of activity on our planet. Because radio frequencies are relatively easy to use and are natively suitable for mobility, they are a preferable medium for these data streams. They have thus become indispensable to several sectors: communications, audiovisual, transportation, energy, industry, security, defense....<sup>1</sup>

The radio-frequency spectrum is a natural resource, like water, energy or the soil. Unlike the latter however, it is present everywhere equal in quantity and quality; and using it neither wears it out nor uses it up. Once no longer used by a device in a zone, a given frequency can be instantaneously reused. Frequencies are like catalysts for many an activity. Nonetheless, they are a scarce resource, because the simultaneous, uncontrolled use of the same frequency band by several parties in a single area can generate interference between uses. It is also scarce because not all frequencies are of the same quality in terms of propagation or the capacity for transporting signals. Tapping the parts of the spectrum still available is, as a consequence, very often subject to the law of diminishing returns.

## **Tools for managing radio frequencies**

The unregulated use of frequencies can generate an interference that would jeopardize the operation of radiocommunication services and diminish the spectrum's use value.

A system of governance based on three institutional layers lays down the conditions for managing the spectrum and applying the adopted regulations: at the international level, the ITU-R (the sector of radiocommunications in the International Telecommunication Union); at the regional level in Europe the CEPT (European Conference of Postal and Telecommunications Administrations); and at the national level, the French government.

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<sup>1</sup> This article has been translated from French by Noal Mellott (Omaha Beach, France). All websites were consulted in November 2020.

In practical terms, four major categories of tools are used to manage radio frequencies:

- international, regional and national regulations and standards about, in particular, the table of allocations of frequency bands with mandatory specifications as well as recommendations for defining the good practices for radiocommunication services so as to avoid harmful interference;
- procedures of coordination and registration for deciding how to allot or assign use rights to the parties requesting them and how to protect these rights by registering them;
- official databases for registering these use rights; and
- technical tools for planning and managing assignments.

## **Tables of frequency allocations**

The general solution adopted for limiting the risks of interference involves restricting and harmonizing, as needs be, the uses of frequency bands. Restrictions are made at two levels.

At the international level, the ITU has divided the planet into three large geographical zones called “*regions*”. Its Radio Regulations (RR) allocate frequency bands to 39 radiocommunication “*services*” in each region, and contain the rules for using these allocated bands.

At the national level, the French government periodically makes decisions about assigning parts of the spectrum to a group of *affectataires*: nine public administrations and two independent authorities (the CSA and ARCEP). Out of this comes the national table of frequencies (TNRBF) managed by the ANFR (Agence Nationale des Fréquences) and signed by the prime minister.<sup>2</sup> For each frequency band, this table specifies the service(s) assigned in France and the parties, among these eleven, with access to them. It specifies the rights and obligations of these parties and the principal rules to be applied for coordinating and registering frequency assignments.

This table, the benchmark for national spectrum management, is grounded on the ITU’s Radio Regulations, the international agreements signed by France, certain CEPT recommendations or decisions, and nationwide agreements concluded with the parties assigned frequencies. It contains specifications about using frequencies in the country, with the modifications and addenda necessary for managing bands at the national level, and with appendices that follow up on, or provide details about, certain general regulations about allocated frequencies (in particular the bands shared by more than one assignee).

## **Coordination and registration of use rights**

International recognition of the use rights stemming from the allotment of a channel or assignment of a frequency is indispensable for their legal protection. For terrestrial services, this recognition takes the form of registering assignments in the Master International Frequency Register (MIFR) or modifying agreed-upon service plans. For this purpose, the competent administration addresses the request for each station or group of stations and notifies the ITU-R’s Radiocommunications Bureau (RB) (in accordance with the formalities foreseen in Appendix 4 of the RR). These notifications, grouped by service, frequency bands and regions are addressed via a secure website, WISFAT: Web Interface for Submission of Frequency Assignments/Allotments for Terrestrial Services. Software made available by the ITU (TerRaNotices, TerRaNV) can be used to generate notification forms and then to control whether they have been completely filled in prior to submission. Every two weeks, the RB publishes a circular letter of information (*BRIFIC*) on terrestrial service frequencies that contains notifications of the allotments and assignments submitted by

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<sup>2</sup> The TNRBF is available at <https://www.anfr.fr/gestion-des-frequences-sites/tnrbf/>.

the competent administrations. After controlling their conformity with the ITU's Table of Frequency Allocations and in the absence of objections from competent national authorities, the RB registers these modifications in the MIFR or in worldwide or regional plans; and *BRIFIC* publishes this information every fortnight.<sup>3</sup> Its circulars may be consulted directly, without installing any specific software, on DVD-ROM (available from the RB).

For national recognition and legal protection of use rights to a frequency (under the specified conditions), the frequency has to be assigned, and this assignment has to be registered in the TNRBF. Prior to this however, the party requesting a frequency assignment has to obtain formal authorization from all competent authorities with a stake on the band in question. All requests for such assignments and their registration have to follow a national procedure of coordination ("CAF") — except for requests for authorizations to use a frequency band that are delivered by the competent authorities with exclusive or priority status on the band (since these authorities benefit from a *de facto* right to register the request). If the transmitting station using the requested frequency exceeds a certain threshold (5W at the time of writing), the eventual user will also have to obtain the ANFR's approval or, in some cases, its opinion before installing or modifying the station that will be using the frequency. Only then may it claim an effective use right on the frequency. This approval is delivered following another procedure of coordination ("COMSIS") for an optimal utilization.

The ANFR manages the national coordination and registration of frequency assignments in the TNRBF. The practical means used is the FNF (national frequency file) application on the web interface. Applications for assignments or allotments of radiocommunication services — namely, terrestrial services (including broadcasting), space services (ground stations) and radioastronomy — are filed in the specified format (XML, SGML, etc.) and then validated by the authorities competent in the matter. The requests are published once they have passed controls for checking whether they are complete, eligible and, above all, in conformity with the TNRBF.

The competent authorities (who may access these requests using the software's consultation, extraction and printing features) have a period of two months for formulating observations. Every month, the requests for assignments left without comment for two months following publication are deemed "approved". The FNF software then registers the assignments in the national frequency file. This software can also be used to produce notifications (in the format specified by the RB) for requesting registration in the MIFR of the assignments validated at the national level and, as needs be, subject to coordination in accordance with the international agreements signed by France.

No radio station with power above 5W may be put into operation in France before reception of an agreement with, or opinion from, the ANFR. To obtain an agreement on the location of stations, authorities and operators file their requests on line via STATIONS, a software associated with a database managed by the ANFR. These requests are controlled and published weekly in a circular that can be consulted via STATIONS. They are examined for up to four weeks by the competent authorities and operators concerned so as to verify that the new transmitting stations will not disturb the operation of stations already installed. The ANFR analyzes the thus formulated opinions before making a decision. It also verifies the station's conformity with regulations about the exposure of the public to electromagnetic waves.

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<sup>3</sup> <https://www.itu.int/en/ITU-R/terrestrial/brific/Pages/default.aspx>

## **Notarial databases**

At the supranational level, administrative and technical data about the assignments enjoying a right to protection are registered in the Master International Frequency Register (MIFR) managed by the ITU-R. Queries of this register may be made in its associated database by using the e-MIFR software, on condition that an account (TIES) has been opened with the RB. These data can also be accessed via *BRIFIC*'s database (using TerRaQ for queries) or an online web portal.

In France, two “notarial” databases contain most of the information about the frequencies granted to authorities and end users in the country: the FNF and the STATIONS database.

The ANFR manages an Oracle database that receives information from the FNF software as part of the CAF procedure. It recapitulates all information about frequencies assigned by the competent authorities: nearly 450,000 assignments at the end of 2019. Once registered in the FNF, assignments have a national status and “grandfather” rights to protection against harmful interference from any assignment made at a later date. Access to this national frequency file is reserved for competent authorities (who may use the FNF software’s query feature).

The STATIONS database recapitulates all administrative and technical information on radio stations that has been communicated to the ANFR as part of the COMSIS procedure. Developed as an Oracle database, it is updated via a like-named application, which manages requests for approval or an opinion as well as the declarations of plans for setting up radio installations. Extranet access to the STATIONS database involves a procedure for logging in with a password. Afterwards, the following information may be consulted: plans for installations (weekly circulars), declared installations (stations with power below 5W) and installations (more than 5W) that have obtained approval or a favorable opinion from the ANFR — nearly 80,000 radio stations at the end of 2019.

## **Planning and assigning frequencies**

The tools needed by users of the spectrum and by the competent authorities guide their decisions about the architecture of their systems and orient their search for solutions that take into account both regulatory requirements and the objectives assigned to systems already in operation. Developed in house or through a customization of enterprise application software, these tools have several modules: databases, interfaces for visualization, SIG, modules for computing, interfaces for exchanges with standard applications and the *BRIFIC*, FNF and STATIONS databases. They are used to follow up on the licensing cycle, calculate licensing fees (with an interface to the billing system), conduct technical analyses (coverage, CEM, etc.), search for “free” frequencies (in plans for a given frequency band), “preplan” stations and networks, etc.

## **Conclusion**

To prevent interference on the airwaves, radio-frequency management has, at both the supranational and national levels, adopted tools for storing and sharing information on the use rights granted, identifying the resources still available, and coordinating the allocation of these resources to radio services. Given the proliferation of new services and the growing demand for certain frequency bands, more dynamic forms of management will probably have to be developed; and new tools, designed and put to use. Artificial intelligence, adaptive databases, open data, crowdsourcing and blockchains are forms of technology that will probably soon offer technical solutions to the challenges stemming from a dynamic management of radio frequencies.