

The national management of radio frequencies

Gilles Brégant,
ANFR

Abstract:

The radio-frequency spectrum, a vulnerable resource, requires an attentive management, which, in France, is done through the Agence Nationale des Fréquences (ANFR) and its consultations with stakeholders. By taking account both of international negotiations on changes in the uses of bandwidths and of the needs of national actors, the ANFR grants bandwidths to eleven “assignees”. The table listing assigned bandwidths is regularly updated and approved by the prime minister. These “assignees” then collect projects from “emitters”, which the ANFR, after having authorized them following consultations, will record in a digital registry. Permits for emissions are subject to coordination near the borders. This system of control settles problems of interference and regularly assesses the compliance of equipment in terminals. This work is steadily becoming increasingly technical with more sharing of the spectrum, as higher frequencies are put to use and the number of emitters rises. This requires continually updating ANFR’s skills, qualifications and tools.

The radio frequency spectrum has become essential to the operation of many services in the nation, whether of defense or economic development. This resource is inherently vulnerable however. Anyone who has transmitting and receiving equipment can, unannounced, stake out a position on a bandwidth and immediately generate interference in surrounding areas. Problems also crop up if uses of bandwidths are too diverse. If devices transmit strong, very different signals on the same frequency, the strongest source will deafen sensitive receivers. To draw benefits from it and increase the density of its use, the spectrum must, therefore, be managed.¹

Managing the spectrum of radio frequencies, which are an immaterial property of the state, might seem like an awesome, virtual task. It has many points in common with the management of more familiar goods, namely real estate. To develop a new “space”, a city has to define a zoning plan and then make the new lots viable with basic amenities. For this, it has to deliver building permits that allow third parties (private persons, public services, promoters or firms) to proceed with construction work. Finally, once the new neighborhood has been built, the public administration will have to see to law and order there, and verify whether the buildings remain in compliance with the permits. This triptych for the managers of real estate — design, implementation, control — also holds for management of the spectrum, which, in France, is the responsibility of a public administrative unit: the National Frequency Agency (ANFR: Agence Nationale des Fréquences).

¹ This article has been translated from French by Noal Mellott (Omaha Beach, France).

Design: A “zoning plan” for the spectrum

A zoning plan for land use normally takes account of: actual land conditions, existing easements and restrictions (existing highways, for example), and, too, expectations for the new neighborhood. In like manner, a “spectrum zoning plan” implies taking account of the needs of the new services planned for the spectrum and depends on several conditions.

Among these conditions are the restrictions on using a frequency band that have been established, at the highest level, by international agreements. France, by belonging to the ITU, has bound itself to abide by this organization’s Radio Regulations (RR), which set the conditions for the services allocated to frequency bands. France thus has commitments with regard to other ITU member states: the use of a bandwidth may be exonerated of the RR’s specifications on condition that doing so does not generate observable disturbances at the country’s borders. Upholding the RR is the basis for reaping certain advantages, among them the organization of international air traffic above the country or the use of standardized, less expensive terminals (television sets, car radios, mobile telephones).

These regulations are constantly evolving at the global level of the ITU and its continental partners: the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Union. Influence has to be exercised when regulations are drafted so that they suit our country’s interests. All countries do as much. Paradoxically, changes in the use of national frequencies are largely worked out around a table of international negotiations, where the ANFR’s international team is active. This team is made up of genuine diplomats of the spectrum who continually interact with their counterparts elsewhere during the process of drafting new articles for the RR or the CEPT’s decisions. Literal “directions for use” thus emerge out of a consensus about the services imagined for the future. They stipulate, for example, the specifications for transmitting stations or the maximal intensity of parasitical emissions in adjacent bands.

To be sure that the orientations adopted will be in conformity with national interests, meetings have to be regularly organized with French authorities who oversee the spectrum — in the first place with the principal French public administrations and authorities who use radio frequencies. Eleven of these *affectataires* sit on the ANFR’s governing board: the High Audiovisual Council (CSA), the Regulatory Authority of Electronic Communications and the Post Office (ARCEP), the ministries in charge of Defense, the Interior, Research and Maritime Affairs, along with the high commissioners of Overseas France, the Directorate General for Civil Aviation (DGAC), the National Center of Spatial Studies, and Météo France (the weather service).

ANFR committees also bring together representatives from most of the firms, public or private, that use radio frequencies: the operators of satellites and mobile telephone networks as well as firms in the audiovisual and transportation (by air, sea or rail) industries. Besides these representatives who are used to attending these meetings, there are newcomers: firms in highway transportation (in prospect of driverless vehicles) or startups in wireless services. These discussions always take place in view of the rollout within the next five to ten years of a new use. So, there is a natural synergy between management of the spectrum and R&D in industry. When points of divergence appear between the two, the ANFR usually manages to propose compromises that satisfy both. If disagreement persists, the prime minister takes up the matter.

The results drawn from these international conditions and the aspirations of these national stakeholders are periodically written down in the national table of frequency allocations (in France, the TNRBF). This table, approved by the prime minister, lists the services authorized on each band everywhere in France. It is binding on all assignees of frequency bands. A particularity of France is that its national frequency table is divided into three sections corresponding to three ITU “regions”: European France and the islands of Réunion and Mayotte (Region 1: Europe/NearEast/Africa); the Antilles and French Guiana (Region 2: the Americas); and French Polynesia and New Caledonia (Region 3: Asia-Oceania). France thus plans its frequencies in three different ways in line with the relevant regions, where the same terrestrial services are not assigned to the same radio frequencies.

Finally, the “spectrum zoning plan” — the TNRBF — has to foresee concrete possibilities, and this calls for work on the “viability” of the bands to be used for new services. The spectrum is a finite, resource that is dwindling as it is ever more intensely put to use. While a few bands (at, in particular, very high and very low frequencies) are still seldom used, demand is concentrated on the bandwidths that are easier to use but that have been previously assigned to other services. A prerequisite is, therefore, to expropriate these users so as to allow the new services to be deployed.

Under the procedure of “reviewing frequency assignments”, a new bandwidth usually has to be found for the service that is forced to move. However this review procedure might cause losses to the expropriated operator, who will have to replace his transmitting and receiving equipment. To limit this impact, the ANFR may temporarily cover these extra costs and then obtain reimbursement of the funds advanced from the new occupants on the band. In several countries, funding the eviction of preexisting services is often an obstacle to benefitting from the new possibilities offered by a modification of the RR. Thanks to its “prefinancing” arrangement, France has overcome this obstacle.

Implementation: Licensing

Once a radio band is allocated to a new service, the question arises of assigning the band to actual users. Such decisions are made by the competent public administrations or authorities (*affectataires*) that have been allotted radio frequencies. Government entities like the Ministry of Defense or DGAC may use bands only for their own needs, whereas the CSA and ARCEP are independent administrative authorities endowed with the power to legally grant third parties use rights to frequencies. The CSA enters into agreements with audiovisual firms, such as radio or television companies, whereas ARCEP delivers licenses to entities of all sorts, whether big (like mobile networks or the Paris subway system, RATP), small or medium-sized companies or public administrations. Each competent administration or authority that has been allotted frequencies adopts procedures for the submission of plans for the local installation of transmitting stations: relay stations (television, mobile telephone), radar stations, networks of sensors for monitoring flooding, etc. Let us now examine these “building permits”.

The only literal “building permit” is the one that authorizes an operator to erect a building on which an antenna may be installed. This permit, in France, is not in the competence of spectrum management. It is a matter of urbanism: the mayor delivers building permits.

As for the figurative “building permits”, the ANFR examines requests for an authorization (license) to use certain frequencies. Each plan submitted is referred to consultations with all other competent administrations and authorities, who may, for four weeks, object to the plan. If opposition is voiced, the ANFR suspends the authorization procedure, and a process of conciliation is opened in order to define the restrictions necessary for inserting this plan for a new use of a frequency into the existing radio-frequency environment. When an authorization (license) is granted, it is registered in a national data base along with the specifications about the uses authorized. This registration opens the right to be protected from any transmitting stations that will be installed thereafter and against cross-border interference. The data base of civilian transmitting stations is on the ANFR’s website: www.cartoradio.fr.

To avoid interference, neighboring radio stations have to be compatible with the station to be installed. “Coordination” is the process of achieving a coherence between transmitting stations in a given geographical area. In France, coordination is usually conducted by the public authority with competence for the bandwidths concerned and, if need be, by the ANFR if the competent authority is not the same for all transmitting stations concerned — as is always the case in border zones, where French radio stations have to fit into an environment with signals from foreign stations.

For this reason, the ANFR along with the competent authorities negotiate crossborder agreements, in particular for audiovisual services since type use frequencies with a range of dozens of kilometers. Comprising several developed countries that are not big compared with the distances covered by certain frequencies, Europe has a very dense hertz environment. It is one of the most complex coordination regions in the world.

Control: Enforcing regulations

The third activity in spectrum management occurs downstream, after transmitting station has been installed. The task is to verify whether the station is operating in conformity with its license and frequency assignment plan. In cases of harmful interference, an inquiry will be made with the goal of putting an end to the interference and proposing a better set of operating parameters. Some of the competent public administrations or authorities have the power to undertake such an inquiry. The CSA has agents in the field who, equipped with devices for measuring interference, intervene when audiovisual broadcasts are causing problems. Likewise, the Ministry of Defense handles the major problems of interference and jamming in its zones of operation, whether in France or abroad. For most of the other competent authorities, this policing of the spectrum is done by the ANFR via its branch offices.

This control function means recurrent investments in the equipment (*e.g.*, spectrometers and goniometers) needed to enforce regulations and in regular training so that controllers are capable of detecting the new types of interference that crop up as services and uses evolve. For example, interference between two FM radio stations is much simpler to investigate than an intermittent disturbance of weather radar by a local network of video surveillance (CCTV) located eighty kilometers away... or a disturbance in airspace caused by mobile satellite navigation devices.

To apply the standing regulations based on the registry of frequencies in the ANFR's data base, the spectrum has to be managed in view of the transmission of big media or technological events, which require temporary, "ephemeral" frequency assignments. The 24 Hours of the Mans, for instance, relies on several radio-frequency networks to operate within a limited area; the uninterrupted delivery of radio services is critical to the race's success. These networks allow for real-time feedback of: parameters from all vehicles to racing teams' command centers; video streams from the cars toward receiving stations in the grandstands; broadcasts from a temporary FM station; the links of the media (visual or audio) covering the race; the steering of drones; connections with safety and security services; the alerts to be sent to organizers; communications with the police and other official services; and, too, a temporary reinforcement of mobile networks so that the persons in attendance not experience an outage. The ANFR supervises in real time many such big, complicated events, such as the Tour de France bicycle race and, eventually, the Olympic Games to be held in Paris in 2024.

A final point: controlling transmitting stations does not mean an absence of controls for receiving stations, *i.e.*, terminals (whether mobile telephones or the receiving stations for rescue operations at sea). As a member of the EU, France no longer requires approval prior to the placing of new radio-frequency terminals on the market. Access to the European market is open on condition that manufacturers can prove that they have complied with EU legal provisions. However the ANFR still has the power to verify whether the equipment for sell in France abides by these regulatory texts. It regularly exercises this power, in particular to control the level of emissions from portable telephones (as measured by their specific absorption rate, SAR). The results of these controls are released as open data and shared with ANSES (Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail). This agency oversees the safety of food, the environment and occupational health, notably the exposure to radio frequencies. ANSES proposes to the government orientations for seeing to public safety; and the ANFR oversees the application of the proposals adopted in actual practice.

Preparing for the future

The proliferation of wireless uses is causing the spectrum to be “densified”. In an effort to cope, technology is steadily becoming more complex. It has thus become possible to transmit more information on given bandwidths. This pressure naturally leads to changes in spectrum management, changes for making the methods used more efficient and for giving priority to prevention over the ever more expensive process of finding a solution in cases of interference. The major trends under way are:

- **SHARING OF THE SPECTRUM.** This allows for allocating a single band for several types of services. It involves testing algorithms for modulating signals as a function of space or time in the *ex ante* quest to limit interference. Spectrum management is thus shifting toward actions in real time.
- **UPCONVERSION OF FREQUENCIES.** This has been made necessary owing to both the congestion on lower frequencies and changes in the architecture. These changes allow for managing and coordinating several close relay stations (thus compensating for short ranges) and for techniques that recuperate the transmission errors created by physical obstacles (which used to be a problem in these channels). The millimeter waves that used to be reserved for space (satellites, radar) will soon be allocated for 5G in dense urban areas.
- **THE MULTIPLICATION OF SOURCES** is related to the two preceding trends. The number of transmitting stations to be registered is going to significantly increase; but these stations will have a much lower unit power. This can be observed in communications, both terrestrial (small urban antennas for 5G, sensors for smart cities, etc.) and spatial (megaconstellations of satellites in orbit). These ever more numerous sources might make interference more frequent, more intermittent and, thus, harder to solve.

Management of the spectrum in France is constantly adapting to maintain and consolidate order in wireless services, a condition necessary for their very existence. This ability to adapt is the keystone of the internationally recognized “French school of radio-frequency management”, which contributes to our sovereignty and opens opportunities for our businesses to develop, whether satellite manufacturers, startups or network operators.