

The radio-frequency spectrum as an asset

Olivier Corolleur,
Direction Générale des Entreprises (DGE)

Abstract:

The many aspects of assigning a “value” to the radio-frequency spectrum are discussed along with the studies that calculate this value. Like other environmental assets, the spectrum serves not just one but many, simultaneous needs. The competition between commercial and noncommercial uses, the scope (sometimes worldwide) of the decisions made about how to manage this asset, the necessity to reckon with not just the spectrum’s current use value but also its “conservation value” (which would make allowance for future uses or for the demand to limit the exposure to electromagnetic waves)... so many challenges for the organizations that regulate this commons.

What is the radio-frequency spectrum worth? This question is of interest to French authorities, since the spectrum is an immaterial asset in the public domain. A fair assessment of its value would be useful when the government has to make decisions about managing it, setting the technical conditions for its uses, optimizing the assignment of frequency bands, policing the radio waves, etc.¹

The introduction of auctions as a means for assigning use rights to the spectrum has, in recent years, drawn attention to the market price of licenses. For instance, the assignment via an auction in 2015 of the 700 MHz bandwidth (703-733 Mhz and 758-788 MHz) brought in €2,798.976,324, an amount that but partly reflects the spectrum’s value for the state.

Herein, a few examples will, in reference to the various studies made on this topic, shed light on the many dimensions of the radio-frequency spectrum’s value.

Assessing the spectrum’s value with respect to current and future uses.

Radio frequencies are indispensable in many fields:

- weather forecasts, which rely on observations from radar and satellites;
- scientific research, in particular radio astronomy and communications with probes, trackers, space engines, etc.;
- transportation (by sea, air, rail, road, etc.), especially for geolocation services via satellite (GPS, Galileo, etc.) and emergency communications and;
- telecommunications, in particular mobile phone services for the general public and professionals.

¹ This article, including quotations from French sources, has been translated from French by Noal Mellott (Omaha Beach, France). The translation into English has, with the editor’s approval, completed a few bibliographical references. All websites were consulted in October 2020.

The importance of the services for which radio frequencies are used varies widely over time depending on the field. For instance, terrestrial broadcasting was, for decades, the principal means for delivering television programs... until new means came into competition (satellite, cable, Internet). Yet another example: the automobile industry increasingly relies on radio frequencies for emergency communications (the e-call system), sensors (used for backing up a car), connected vehicles (for exchanging information with other vehicles or with the traffic infrastructure), and so forth.

Planning for different uses and services

Planning allows for the cohabitation of various services, uses and technologies on bands in the spectrum. It comes out of the work done:

- at the international level: in particular, the adoption of Radio Regulations (RR) under the treaty negotiated within the International Telecommunication Union (ITU);
- at the European level: the technical implementary measures in conformity with the EU's "Radio Spectrum Decision" for harmonizing conditions for using the spectrum,² or with the schedules of coordination for assigning frequencies set by the European Code of Electronic Communications; and
- at the national level, in particular the national table of frequency allocations: in France, the TNRBF approved by the prime minister.

The state devotes a considerable budget to this planning, for the necessary studies and the participation of experts in the national and international negotiations that shape this sector.

Planning is intended to respond as best possible to demands for various uses while preserving the capacity to respond to future needs, thus by avoiding restrictions that will hamper technological innovation or changes in uses. The goals are to avoid harmful interference in radio-frequency bands and make it easier to manufacture radio equipment and see to its interoperability.

Planning increases the spectrum's value. For instance, a band harmonized worldwide for a certain service is extraordinarily valuable for this use, since harmonization guarantees that receiving stations and network equipment will be available and interoperable at a price that benefits from economies of scale on the world market. In contrast, since these advantages will be missing for other uses, the band will be of little value for them.

The "digital dividend" (2008)

One of the spectrum issues that has been widely debated in recent years is the first so-called "digital dividend". It illustrates the problems faced by governments as they try to optimize the spectrum's value. The "digital dividend" refers to the previously assigned radio frequencies that the digitization of analog television freed in the UHF range.

The preparatory work on the bands thus released drew up several scenarios for allocating them to new audiovisual services (digital or mobile TV, etc., or some of them to mobile telephone services). Studies were carried out to evaluate each scenario's social utility. I might mention the studies on this dividend made for the European Commission in 2009 and for ARCEP, the French regulatory authority of electronic communications (ANALYSIS... 2008). For businesses, the social utility of each scenario for allocating the digital dividend was estimated through a micro-economic analysis that summed up:

- the surplus (additional profit) for the firms that use the spectrum;

² Decision 676/2002/CE of 7 March 2002, available at <https://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX:32002D0676>.

- the surplus for consumers, *i.e.*, the value they draw from the services provided (estimated to be the difference between their propensity to pay for the service and the price actually paid); and
- eventual externalities.

Upon reading these studies, we come to realize that estimates of the social utility reported for the various scenarios turn out to be fastidious — even in relatively simple cases, such as a choice between two types of commercial services in the same geographical zone. In effect, it is hard to estimate the consumer surplus and externalities, even though they might be decisive given digital technology's impact on the economy as a whole. To cite a recent example debated during the world radiocommunication conference (WRC) in October 2019, the decision about the technical conditions for the rollout of 5G on the 28 GHz band in the United States entailed weighing the conditions for this deployment with the risk of negative effects on weather services, a cause of concern worldwide.³

For decisions on sensitive questions, the ITU provides a multilateral discussion forum. This is necessary to keep the radio-frequency spectrum from turning into a tragedy of the commons.

Assigning use rights

Depending on the technology or service, the state may directly assign frequency bands (*e.g.*, the time signal on 162 kHz, radar for air traffic or the military) or authorize private economic agents to use them. A distinction is made between:

- the frequencies that may be freely used (*e.g.*, Wi-Fi, wireless phones or radar for cars);
- the frequencies subject to authorization, when a license is necessary for an efficient management of the spectrum. This authorization amounts to paying the state a fee for using the public domain. Setting this fee means taking account of the advantages for the license-holder.

For some services (in particular, mobile telephones and digital television), it has turned out to be necessary to limit the number of licenses for using frequencies, since the bands available on the spectrum are not on par with demands from all interested economic agents. On account of the scarcity of this resource, these use rights come to have a much higher market value; and the government will try to reap this added value for the general interest. It may set requirements for using a frequency band that correspond to public policy goals in matters of territorial development, innovation, the national budget, etc. For instance, the government invoked the following objectives for allocating the 3.5 GHz band to 5G: *"It is in your authority to propose to the government the conditions for assigning authorizations to use the frequencies in question. For this proposal to best fit into the state's policy about uses of the radio-frequency spectrum and about investment in providing services of high-speed mobile electronic communications throughout the country, the government intends to state the objectives that you will have to pursue when drafting the list of specifications: the level of revenue expected by the state, the equilibrium in terms of competition, innovation and the emergence of new services in [...] the economy, and, a final point, the national territory's digital development."*⁴ As we see, the spectrum's value for the state is assessed as a function of the realization of objectives and not just of the amount of fees to be paid for use rights.

³ Cf. The World Meteorological Organization's news of 27 November 2019 at <https://public.wmo.int/en/media/news/wmo-expresses-concern-about-radio-frequency-decision>.

⁴ Excerpt from a letter of 2 May 2019 by Jacqueline Gourault and Agnès Pannier-Runacher to the president of ARCEP. See the press release at https://www.entreprises.gouv.fr/files/files/directions_services/numerique/CP-lettre-de-cadrage-orientations-5G.pdf.

The debate about how to weight the objectives related to the general interest as the procedure for assigning frequencies plays out is often confused with the question about choosing a method (by lot, auction, etc.) for selecting license-holders. Several authors have dwelled on this topic since Coase's article in 1959 on broadcasting licenses. Minervini *et. al* (2008) have reviewed the literature on "*market-based methods of spectrum management*". These studies have, since 1992, led to an increasing number of auctions for commercial uses of the spectrum.

Nonetheless, the adoption of auctions as a licensing method has not led governments to give up on objectives of general interest other than the financial value of use rights. In mobile telephony for example, this increase in auctions has a parallel, since it has come along with stronger obligations about geographical coverage. This is evidence that several governments have another priority: digital developing the national territory.

Whatever the licensing method, the government often has to estimate the value of the licenses to be granted for given frequencies in order to set a reserve price for auctions or even annual licensing fees. There are two types of methods for doing this:

- BENCHMARKING relies on the market prices observed for previously made assignments and then tries to predict as best possible the value of the frequency to be assigned. Given the limited number of such observations however, the prices thus calculated might not be very relevant. After all, this calculation depends not only on identifying comparable frequencies but also on evaluating the main properties of the bandwidth to be assigned: the population receiving coverage, competition, etc.
- ESTIMATING THE NET PRESENT VALUE entails estimating, over the full licensing period, the extra profit for the license-holder. To do this, an operating statement (comprising all accounts of income and expenses) is made for a generic entity and then discounted at a rate corresponding to this type of investment.

Whatever method is used, the results are highly uncertain, since they are very sensitive to parameters that are hard to set. Like Alain Bernard (1979), we can, when making such calculations, recall Paul Valéry: "*What is simple is always false. What is not simple cannot be used.*"⁵

Covering the national territory

The obligations set about radio coverage when authorizations to use a band or bandwidth are issued provide major leverage for the state to foster the digital development of the national territory.

The issue of improving mobile network coverage in rural areas soon cropped up once the general public massively adopted mobile phones. Since 2003, especially under the program "White zones/town centers", public authorities have assumed the costs of installing transmission towers on condition that mobile operators install their equipment on the towers. Thanks to this program, more than three thousand downtown areas have received coverage. However, mobile network coverage in France still fell short of satisfying users' high expectations. According to the European Commission's Digital Economy and Society Index in 2017, France ranked 24th out of the 28 EU members states for 4G coverage: 69% of households were covered (the average of the four operators in the country) compared with an average of 84% in Europe.

⁵ Paul Valéry (1942) *Mauvaises pensées et autres*.

In this context, the government wanted to assign ARCEP the task of negotiating both the conditions for renewing licenses (which will expire between 2021 and 2024 for the 900 MHz, 1800 MHz and 2.1 GHz bandwidths used by mobile telephone operators) and the means necessary for rapidly improving mobile coverage in the country. These negotiations led in January 2018 to mobile telephone operators making commitments to invest €3-5 billion, according to ARCEP's estimates. ARCEP has set up a dashboard to monitor execution of this "Mobile New Deal".⁶ To make these commitments enforceable, they were incorporated in the contracts for current licenses in July 2018.

Furthermore, ARCEP adopted on 15 November 2018 decisions about assignments (as of 2021) on the 900 MHz, 1800 MHz and 2.1 GHz bands. The state has made fees stable (by forbearing from organizing auctions for license renewals) and foreseen exemptions in the 2019 budget act that target the IFER network flat tax.

Registering frequencies and policing the spectrum

The use rights on the spectrum that operators acquire are valuable only if the frequencies assigned to their transmitting/receiving stations (*i.e.*, the precise licensed uses of their frequencies) are registered and protected against interference by unauthorized uses. The state thus has to legally guarantee these authorized services lest the spectrum have no value for operators.

Beyond licensing, the value of frequency bands depends on their being registered and policed. For these notarial and policing activities, the state has to muster substantial resources to: develop and update databases, manage procedures of national and international coordination of assignments (so as to avoid interference), and activate fixed and mobile means for controlling the spectrum.

Conclusion

While the introduction of auctions for assigning use rights to the spectrum has, in recent years, raised the market price in certain cases, auctions do not spare public authorities the task of fine-tuning their decisions in order to optimize the spectrum's value. Like other environmental assets, the spectrum does not respond to a single goal but to many, simultaneous needs. Competing uses, whether commercial or not, the scope (sometimes worldwide) of decisions about spectrum management, and the need to take into account not just the current value but the "conservation value" (in prospect of future uses or demands for limiting as much as possible the exposure to radio waves) are issues that the authorities who take part in regulating this commons have to address.

⁶ For these commitments, see: ARCEP & DGE (2018) "Description des engagements des opérateurs sur la généralisation d'une couverture mobile de qualité pour l'ensemble des Français", 27 January, 7p., available via https://www.entreprises.gouv.fr/files/files/directions_services/numerique/description-du-dispositif-couverture-mobile-22janvier2018.pdf. The dashboard is on: <https://www.arcep.fr/cartes-et-donnees/new-deal-mobile.html>

References

ANALYSIS CONSULTING & HOGAN & HARTSON (2008) *Étude sur la valorisation du dividende numérique* (Paris: Autorité de Régulation des Communications Électroniques et des Postes), 135p., available via https://archives.arcep.fr/uploads/tx_gspublication/etude-dividende-numerique-mai2008.pdf.

BERNARD A. (1979) "Le Prix du hertz", *Journal des Télécommunications*, 46, September.

COASE R. (1959) "The Federal Communications Commission", *Journal of Law and Economics*, 2(1), pp. 1-40.

MINERVINI, L.F., CAVE M., & MFUH W. (2008) "Review of the literature on market-based methods of spectrum management", report to the ITU, June, 77p., available via https://www.itu.int/net4/ITU-D/CDS/bdtint/pri/pri_document_open.asp?pri=3GLO07059&doc=945.