Digital Radio in Brazil: Not left, nor right. Let's move forward

Radio Digital no Brasil: nem à esquerda, nem à direita. Vamos em frente

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RESUMO

Este artigo se volta para a iminente definição do Sistema Brasileiro de Rádio Digital (SBRD), tendo como objeto privilegiado de análise o *middleware* Ginga, desenvolvido para a TV Digital Interativa Brasileira. Aponta para a importância da pesquisa colaborativa e independente dos cidadãos envolvidos na defesa da Digital Radio Mondiale como padrão para o Rádio Digital Brasileiro e argumenta que o surgimento de uma nova gestão dinâmica do espectro torna obsoleto o seu uso exclusivo, regido historicamente por regimes de concessão. Por fim, observa criticamente a mercantilização do espectro como o principal obstáculo à transição do analógico para o digital e afirma a emergência de um novo paradigma do espectro, abundante, como bem comum tecnológico.

Palavras-chave: Televisão Digital; Rádio Digital; Middleware Ginga; Espectro; Paradigma.

ABSTRACT

The article focuses the imminent choice of the Brazilian Digital Radio System (SBRD), taking as a privileged object the analysis of the Ginga middleware, developed for the Interactive Brazilian Digital TV. Pointing to the importance of collaborative and independent research carried out by citizens engaged in defending the Digital Radio Mondiale standard for Brazilian Digital Radio, we argue for an emerging dynamic spectrum management that makes obsolete its historical and exclusive use governed by concessionary regimes. Finally, we observe the commodification of the spectrum as an obstacle affecting the transition from analogue to digital and affirm a new paradigm of the spectrum as abundant and a technological common good.

Keywords: Digital Television; Digital Radio; Ginga Middleware; Spectrum; Paradigm.

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INTRODUCTION

"The medium is the message"

Marshall McLuhan

Digital technologies are emerging in many devices and this is changing paradigms. Considering the evolution from analogical broadcast to the digital, this article reflects on the decision between two emergent technologies within the context of a "spectrum struggle" to compare migration processes in Brazil considering contributions from academia, civil society organizations, the private sector and government.

Interactive digital television is an effort of national development, combining industrial investments, academic knowledge and public policy vision. This article presents alternatives for the digital radio system which are being discussed by a small group of independent researchers and citizens who investigate new possibilities of spectrum allocation for an autonomous infrastructure that ensures digital global communication beyond surveillance and invisible control[1].

Digital broadcasting brings at least five crucial elements when compared to analogue services: 1) the optimization of the spectrum; 2) multiprogramming; 3) new services; 4) interactivity; and 5) reduction of energy consumption. These possibilities have guided the Brazilian preference for a standard begun with the nipo-brazilian digital television system over 10 years ago[2], when the Japanese ISDB-T was chosen. The government's directive has been almost entirely repeated in the Ministerial directive no.290, which guides the Brazilian Digital Radio System[3].

Although there is a technical evolution widely taking place, technical alienation (SIMONDON, 2017) hampers the development of new possibilities characteristic of technologies such as new multimedia communication platforms. The dominant trend is the possibility of receiving content with more lines and pixels. In the case of images, this is an invitation for people to buy new TV receivers with high definition plasma screens under the very controversial concept of "image quality"[4].

Digital radio is an opportunity to broadcast data and interactive services using shortwave frequencies, and introduces an alternative for both the government and civil society to communicate over large territories. The notion of "quality" is brought to the discussion by the proposed migration of Medium Waves to FM in Brazil, where it is argued that the digital signal has a better sound quality and is better than the ordinary analogue FM. Based on a critical analysis, we are oposing the extinction of

[1] See http://drm-brasil.org Access: 30 jan. 2017.

[2] See http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/decreto/d5820.htm Access 30 jan. 2017.

[3] See http://www2.mcti.gov.br/index.php/2016-11-29-21-49-46/legislacao/por-ano/2010/portaria-n-290-de-30-marco-de-2010 Access 30 jan. 2017.

[4] The human perception is not able to recognize the amount of different colors exhibited in these "definitions".

the AM band, as proposed by the federal government supported by an influential sector of the Brazilian academy. We argue that it would be advantageous to migrate to digital equipments and avoid double investments, needing only to buy digital transmiters, instead of buying FM and, later, digital ones.

Broadcasting digital radio in today's AM bands would allow governments to manage digital standards in a way that could improve transparency, and connect public services to remote communities. Combining old and new communicational tools, communities could produce their own information and make it available to other distant and/or isolated locations through lower energy consuming transmiters as well as amplifying the public audience.

The government and the private sector pretend to the general public that radio waves occupy the spectrum as a scarce resource. We will attempt to explain here that this is not true, and that this is a statement related to the market pricing for spectrum access, supported by the underlying ambition of promoting the spectrum on a supply and demand basis, which reinforces the notion of scarcity. This commercial strategy transforms what is a common good into a highly valuable and controlled resource. Furthermore, a price tag makes this resource more visible, and this is especially true when we deal with an invisible resource like the spectrum (WORMBS 2011, p. 92-93). If "*technology clearly affects both institutions and appropriation*", (op. cit., p. 104), how can a new spectrum management paradigm really emerge when it is faced not only with old technologies, but is decided in an illusive environment of scarcity which only serves self-benefitting government bodies and powerful commercial institutions?

DIGITAL RADIO TECHNOLOGY

Generally, digital radio systems are classified in two categories: those whose transmission is made through the same frequency channel using AM or FM stations, known as In-band on-channel (IBOC); and those that use a new channel for digital radio transmission, such as a channel in the FM band or shared UHF digital TV channel. There have been four digital systems technically approved since 2012 by the ITU[5]: DAB/DAB +, DRM, HD Radio and ISDB-T. To understand the importance of the decision of the new standard for digital radio for the different social actors involved in radio broadcasting, we propose to analyse what is now happening in Europe where the first digital radio transmission dates from more than twenty years ago.

According to a 2012 mapping made by the Community Media Forum Europe (CMFE)[6] there were 2.237 community radio stations identified in 29 countries (from the 47 European countries), compared with a world total estimate of 17.000 community radio stations. Almost all community radios are still broadcasting on analogue FM both in Europe and in other parts of the world, and a further analogue switch-off occurred only recently in Norway[7].

[5] See http://www.itu.int/en/Pages/default.aspx Access 30 jan. 2017.

[6] See https://www.epra.org/news_items/cmfe-publishes-first-mapping-of-community-media-in-europe Access: 11 Apr. 2017

[7] See https://www.theguardian.com/world/2017/jan/05/norway-first-to-start-switching-off-fm-radio Access: 30 jan. 2017.

Many institutions like AMARC Europe and CMFE strongly support maintaining analogue FM basically because they do not see "any urge for an imminent digital transition nor for a switch-off". Unlike Brazil, the large presence of internet services in these territories covers the demand for multimedia content circulation, where local and community radio transition could be "*detrimental to both the individuals and the organizations operating community radio stations as well as their listeners, as equipment has to be replaced on both ends*"[8]. But, as stated: for a future transition, it is considered that DRM+ is "*a transparent and low cost system*"[9] that should be available for community radios in Europe, compared to the more expensive and complex DAB+ system already adopted in some countries.

According to the CFME, the DRM+ system is slowly developing in Europe, but this is not due to technical difficulties: the main obstacle is the competitive impact of the DAB/DAB+ system. Created in 1985, the DAB system began its operation through the BBC in 1995, and has since been established as a major radio system in the UK. In spite of being in operation for almost 20 years, there are still very few DAB listeners in Europe compared to the FM networks which are still the largest listening platform for all European countries including the UK. In order to enhance the development of DAB, stakeholders are calling for an FM "switch-off", forcing audiences to migrate their equipments to digital and buy DAB. But the extinction of the FM band seems a very difficult mission against firm resistance. As confirmed by CFME, some governments have already stated that even if the major national radio networks should migrate to DAB, the FM band will persevere since the DAB technology is not suited for small-scale broadcasting.

According to the CFME study, analogue FM will be the dominant platform for almost all community radio stations in Europe for many years to come. This favorable scenario for FM operators highlights the possibilities for digital broadcasting to open additional channels on FM, with enhanced sound and energy-saving qualities. Also important is that digital radio is an innovative platform which opens scope for data transmission, interactivity and new services.

Our investigation aims to question established business models for managing analogue broadcasting, and it is no coincidence that these findings have been developed in collaboration between independent researchers and qualified investigative citizens, who have been consistently ignored by civil society organizations and government bodies. Even though the research produced has been made public, and members of our research collective have attended numerous public forums, seminars and hearings, those responsible for qualifying, defending and ensuring the access to and tools for our freedom of speech and our right to communication continue to overlook our contribution. We hope this paper will instigate this debate and propagate worldwide to form a coalition around simple concepts around the right of use of the spectrum, to help make informed decisions about the best option to invest in a collective spectrum use in our emergent digital era.

[8] See https://www.epra.org/attachments/portoroz-wg2-local-and-community-media-introduction Access: 11 Apr. 2017

[9] ibidem. Access: 11 Apr. 2017

THE GINGA MIDDLEWARE IN THE BRAZILIAN DIGITAL TV SYSTEM

Before we continue with our analysis of digital radio possibilities, and introduce what we're assuming as the basis of a new global autonomous digital communication system, we need to describe the importance of the Ginga Middleware to the Brazilian interactive Digital Television System.

In 2003, the debate around digital television in Brazil raised public attention towards a new system that would enable the development of a national industry, generate employment and democratize information. This last objective guided the development of one crucial part of the whole system which is called the middleware.

A total of 76 research institutions and universities have been involved in a national consortium responsible for analyzing, adapting and developing innovative solutions for the Brazilian Digital TV. This was one of the most important academic mobilizations ever made to establish a technological standard for the country, followed by many others in Latin America and Africa.

All standards are usually implemented by hardware through a receiving board that is inside the television, the radio, the tablet, the cellphone, etc. On these hardware infrastructures the applications run and are executed. If we want independence from the manufacturers there's a need to make these applications independent from the hardware and the operating systems, and a new layer has to be built into the system. A new standard is then embedded: the middleware. Its purpose is to support the development of applications and make them independent from the offered infrastructure. This leads us looking for a Domain Specific Language (DSL) for use on both TV and Radio, which is declarative. The NCL language, developed since 1991 at Telemedia Lab (PUC RJ), has been chosen for the middleware and is, in fact, the most innovative element of the Brazilian Digital TV system.

Ginga is a middleware for interactive applications[10]. A middleware that has the function of providing platform-independent application execution support. Ginga is basically the player of this language, its executor, and NCL allows synchronizing media very simply. Another important point is the language's ability to adapt content. On television, it is very important to allow content to be customized for each viewer, which we refer to as "personalized TV". In the case of the Digital TV and Digital Radio systems, content adaptation is significant, particularly in the way it is able to develop a single application to adapt to the receiving device: TV or Radio. This is undoubtedly another huge advantage of having Ginga in Digital Radio.

The ability to support multiple distribution networks is also an important language concern. In the case of Ginga, originally designed for Digital TV, it is possible to receive additional content through airwaves or any other network, such as the Internet. This is crucial in the case of digital radios because the radio band is too small to send audio applications, and therefore sending a video stream further to audio is something that would blow the band. With Ginga, additional content can be searched through complementary networks.

After the begining of digital television transmissions in 2007, public adoption of the new system was not as quick as expected. On one hand we have the broadcasters complaining about insufficient funding to implement a new infrastructure of

[10] See http://git.telemidia.puc-rio.br Access 30 jan. 2017.

transmitters and content production equipment, and on the other users are being forced to spend significant sums of cash on new plasma screens to receive the same content in high definition. Even with a change in public policy in 2010, when the support of DTV became mandatory in all TV sets sold in Brazil, the number of people equipped with DTVs were still restricted to those with higher incomes or access to credit whilst the poorer classes continued relying on analogue TV. It is important to say that the only nationally developed feature, the Ginga middleware, has been included as a mandatory feature in new DTV receivers since 2014, and to this date has been seldom used by commercial broadcasters[11].

Although Ginga is currently regarded as being of no importance to TV content production, we argue that this is crucially different for the digital radio system, because the radio itself will never be only a display device. For instance, radio programs could send both music and text information to receivers whilst other additional information could be searched and accessed through mobile devices with a distributed application system: the ability to have multiple devices connected is very significant for digital radio, perhaps even more so than for TV, because, as we have previously indicated, there are evident limitations of radio bandwidth for the transmission of digital data. This is another advantage of the NCL language: it easily allows for the development of applications for multiple devices.

BRAZILIAN DIGITAL RADIO SYSTEM

In response to the public call for tests of digital radio, published in the Official Journal of the Brazilian Union on June 13th of 2011, two systems presented themselves: the HD Radio and the DRM. From a technical point of view, coverage and audio quality, the systems were equivalent. This was a situation somewhat different from digital TV, where one of the systems had obvious technological advantages, at least for us researchers[12].

The HD Radio system, known as the standard IBOC, is a digital radio system that is designed to operate on the adjacent channels of the AM or FM analogue signal in the Medium Waves and VHF bands. Unlike the DRM system, the HD Radio specification is not entirely public, with the application definition and audio encoder being proprietary. To broadcast an HD Radio signal, broadcasters need a license that must be obtained from the company that owns the rights to the system, iBiquity Digital Corporation.

The development of the DRM system began in 1998, with the founding of the DRM Consortium. The DRM Consortium is a non-profit organization based in Switzerland, created with the initial objective of designing a digital radio system for the bands in

[11] The Ginga middleware was developed jointly (both standards and reference implementation) by two Brazilian universities: PUC-Rio (Pontifical Catholic University of Rio de Janeiro) and UFPB (Federal University of Paraíba). Also, the audio and video coders were upgraded, with support from the academy, from MPEG-2, used in Japan, to MPEG-4, providing better compression for the source media, allowing more audiovisual programs to be broadcasted in the same physical channel.

[12] Since 2009, a group of researchers from different backgrounds (Social Sciences, Computer Sciences, Law, Communication and Telecommunication) had established the platform drm-brasil.org which assembles news and available public research concerning digital radio in Brazil and around the world. Despite the emergent decision on the stardard for the Brazilian System, the academy, technical communities and non-governmental actors were still reticent on the best decision to make. Nélia Del Bianco wrote an article which expresses some of the reasons for this historical omission (BIANCO, 2011).

which AM (Amplitude Modulation) modulation is used. In 2005, the system was extended to operate also in VHF, where the FM (Frequency Modulation) stations are located.

DRM can operate with an AAC decoder that supports both variants used in ISDB-T, the standard of digital television adopted in Brazil, the DRM+ digital radio standard, and DRM30, covered by the same royalties of a decoder that supports only one variant. Therefore, it is possible to save costs in the manufacture of a compatible and interoperable receiver between digital TV and radio. With systems sharing the same encoder, Brazil would mark a position of innovation on a national scale and arouse interest on a global scale.

The Brazilian government is considering narrowband digital radio systems, HD Radio, and DRM, which use few kHz of spectral width. Interactivity in broadcasting is an element of great relevance for the future of communications in Brazil and Latin America. Without it, radio and TV tend to be disconnected from the technological advances of multimedia and hypermedia systems developed for the Internet.

In his 1999 article, the Brazilian researcher Kischinhevsky described the presentation of the DAB standard for digital radio at the Hannover Industrial Fair in Germany, and noted: "*Radio has been the subject of various experiments, (...) but the main research trend current is not the improvement of a specific existing media, but the fusion of several of them (radio, TV, internet) into a single apparatus*" (1999, p. 157). But how do we carry out this merger?

Ginga allows the convergence between radio, TV and other media. With Ginga, the advantages of broadcasting over other media, such as the possibility of full coverage of the Brazilian population, free access and the ubiquity of the receivers can be widely explored.

The first public demonstration involving the transmission and reception of a digital radio signal with Ginga occurred during the II International Conference - Spectrum, Society and Communication, which took place at PUC-Rio in November 2013[13].

LEFT, RIGHT OR MOVE FORWARD

Radio arrived in Brazil as a project of a group of intellectuals who wanted to "*raise the cultural level of the country*" (CALABRE 2002, p. 21). On the occasion of the centenary of the declaration of independence on September 7, 1922, the first transmission antenna was installed on the Corcovado hill, in the then capital city of Rio de Janeiro. The first stations soon followed in the so-called "pioneering cycle of the Brazilian radio", built between 1920 and 1930 near Rio Branco Avenue, in the center of the city, and in the port area. Radio Educadora was created in 1926, also in the city centre, and in 1936 the Ministry of Education and Health Radio, currently the well-known Radio MEC, with both a cultural and educational mission. In 1929, as Lia Calabre recorded, there were more than 60.000 receiving units in São Paulo, and the "*habit of listening to radio was consolidating*" (CALABRE 2002, p. 16). On the other hand, although almost half of the households in Rio de Janeiro owned radio receivers (46.23%) in 1940, this number was quite different from the national trend, which

[13] More information about Ginga for DRM can be seen at: http://www.telemidia.puc-rio.br/~rafaeldiniz/radio/ Access: 30 Jan. 2017.

reached only 5% of the 10 million or so households visited, reflecting an unequal distribution of both electricity and information.

In Brazil, according to the most recent data of the Ministry of Communications, from 2013, there are 9.024 radio stations, of which 4.888 are community radio stations, 3.773 commercial stations and 373 educational stations. There are also 66 stations operating in the Tropical Wave range (OT, bands between 2300kHz and 5060kHz) and 71 that operate in the Shortwave range (OC, bands between 5900kHz and 26100kHz). Signals transmitted in these frequency bands have the special quality of being reflected by layers E and F of the terrestrial ionosphere, which allows a range from hundreds to thousands of kilometers from the radiating point.

In 1976, the country had 977 radio stations, 802 of Medium Wave, 112 of Tropical Wave, 30 of Short Wave and 33 of Modulated Frequency, according to the yearbook of the Brazilian Institute of Geography and Statistics. That is a very different picture from what we see today with the explosion of FM broadcasters and a modest growth of AM broadcasters. According to Virgínia Moreira, the importance of AM broadcasters was to allocate "*most of their time to programs aimed at everyday problems of ordinary citizens*" (MOREIRA 1991, p. 41), with the participation of the listener via telephone, letter or even personally, and a style of programming that today continues to influence FM broadcasting.

If the original objective of radio as a medium was to bring education to a country of continental dimensions, with a then mostly illiterate population, Brazil can consider this mission to have failed since only a very small percentage of radio broadcasters are dedicated to education and culture. After the 1932 Law 21.111– which authorized the broadcasting of commercial advertisement – was decreed the commercial management by communication companies gained force in Brazil inspired by the American broadcasting model, and this new approach became responsible for the formation of oligopolies in the communication industry. The result: "*The regulation of Brazilian radio services was created almost entirely based in the commercial model, following the North American norm*" (REBOUÇAS and DIAS 2016, p. 45).

In Brazil, even if the Constitution foresees that no politician can ever be the owner of any communication vehicle (Federal Constitution, Art. 54), as noticed by Rebouças and Dias (2016, p. 48): "*The text is vague and provides an inconclusive interpretation of what administration, management and ownership actually are*". In fact, even if the law prohibits a person exercising a political mandate to have an administrative role in TV or radio, it does not prohibit partnership in a TV or radio station[14].

On July 5, 2011, the Special Subcommittee on Digital Radio was installed in the framework of the Commission for Science and Technology, Communication and Information - CCTCI of the Chamber of Deputies, with the objective of accompanying the discussion on the choice of the digital radio standard to be adopted in Brazil, to debate the differences between existing systems around the world. These findings would be used to analyze technical obstacles and inform on the possibilities of creating national technology based on one of these systems. This Subcommittee held a number of events, including working trips to the United States of America and

[14] According to the survey of Media Owners, 271 politicians are partners and directors of 324 communication companies in Brazil (REBOUÇAS and DIAS, 2016, p. 48).

Germany, with Sandro Alex as reporter, a well-known radio personality who had started his political career in a commercial radio station in the state of Paraná[15].

The first of these journeys was held between October 23 and 29, 2011 and was aimed at verifying the HD Radio system's ability to operate digital radio broadcast technology and to evaluate its potential to serve as a platform for the development of the Brazilian Digital Radio System. A congressional delegation went to the US cities of Baltimore, Columbia, Washington and New York. Between April 15 and 21, 2012, a new delegation from the Brazilian Chamber of Deputies went to the United States to participate in NAB 2012, the main event for world broadcasting which had as its main purpose to evaluate the progress of HD Radio as a model for the Brazilian Digital Radio System and promote international cooperation.

Lastly, between 10 and 16 July 2012, another delegation from the Chamber of Deputies went to Germany to evaluate the DRM system - Digital Radio Mondiale, with the aim of verifying its progress, and included an evaluation of the DRM30 and DRM+ technology formats, also being considered as a possibility for the adaptation of the Brazilian Digital Radio System.

Surprisingly, the conclusion of the Subcommittee's final report, dated September 2013, begins with the following consideration that proposes the migration of broadcasters from AM to FM:

> It should be remembered that the time that has elapsed since the beginning of the studies aimed at the implementation of digital technology has caused serious damages to the Brazilian population, since the Public authority has not preserved the spectrum destined to AM against noise and interference, turning unavoidable the need to migrate these broadcasters to the FM band.

Currently, it is a well-known fact that the digital signal in the AM range is free of noise and interference, giving the listener a better audio quality than analogue FM broadcast. However, according to the report, "*the unavoidable migration of AM broadcasters to the FM band cannot serve as a pretext to further delay the digitization of the radio, being certain, that the technology being used should contemplate exclusively the FM service*". This statement seems to us to be incomprehensible and inopportune: by proposing the migration "unavoidable" for AM broadcasters to FM, the result would be an even more congested FM spectrum, where non-profit broadcasters would no longer fit. Instead of revitalizing the AM band with digital transmissions with a higher quality than FM, the report supports that the best technological standard to be adapted for the Brazilian Digital Radio System is the HD Radio which specifically does not work on the AM band. Disregarding the ministerial order itself which enforces the digitalization of the Radio in various frequency ranges, the report records this contradiction:

[15] The debate around the Brazilian standard for digital radio has been polarized between commercial radios, interested in maintaining the same amount of broadcasters which guides the support of the HD Radio, and, on the other hand, the possibilities brought by DRM with possibilities of multiprogramming and a more efficient use of spectrum. More info about this debate and tests with DRM can be found at http://www.drm-brasil.org/node/5 and http://www.drm-brasil.org/sites/drm.sarava.org/files/TDF%20DRM%20tests%20Brazil.pdf. More information about Sandro Alex in portuguese can be found at: https://pt.wikipedia.org/wiki/Sandro_Alex Acess: 30 jan. 2017.

> The conclusion of the research leads us to defend the implementation of the HD Radio system in Brazil. However, it is not advisable for Brazilian broadcasters to be bound by a single business model or a single technology. In this way the broadcasters of medium, short and tropical could adopt another system that contemplates these bands.

The proposal of the report was therefore to adopt two standards of digital radio, focusing primarily on FM broadcasters, which considers as a "flexible" strategic technological plan the possibility of generating "multiple business models or technologies".

The decision of two standards would be reckless for two obvious reasons: in addition to making receivers more expensive, such a proposal would hamper negotiation with royalty holders and subsequently with manufacturing equipment. Perhaps because of its absurdity, the report was not even voted in the Subcommittee of the Chamber of Deputies.

In the northern region of Brazil, for example, there is already an installed receiver base operating on AM. The implementation of digital radio can combine both analogue and digital transmissions to receive and broadcast data and audio, with content produced by traditional communities and local governments. These transmissions include broadcasting interactive applications over DRM, which would be received by DRM radios with Ginga middleware installed.

So, if the main issue for data transmission through digital radio is how to best circumvent the bandwidth limitation for sending data, one of the options should consider the media types supported by the middleware to get as much compression as possible. The SVG and SSML media consume a low bitrate for the transmission of vectorial images and for speech synthesis. However, it is important that there are low bitrate options also for bitmap and audio based images (DINIZ 2015, p. 95). An important aspect of SVG could be its use in digital radio for visualizing data. For example, information related to traffic, weather, navigability conditions, or disease outbreaks in territories, are all perfectly suited for SVG with a low byte consumption. Dynamic SVG applications using NCLua script is also possible (DINIZ 2015, p. 94). Finally, NCL allows the application to run distribution across multiple devices that are accessible via different networks. Examples of devices include mobile handsets, tablets, personal computers, automotive or home media centers, connected TVs, or any other device that can establish a connection to a radio receiver.

It should be noted that shortwave and tropical radio receivers usually have a telescopic antenna or are used with an external antenna, as in automobiles, for better reception. This feature makes multi-device support important so that portable devices such as a mobile phone or a tablet can access information from the radio. Using Ginga on digital radio could make radio an excellent platform for broadcasting multimedia content.

DYNAMIC SPECTRUM MANAGEMENT

Spectrum has been a public and crucial resource to communication for the last one hundred years. Since the introduction of radio, the potential to amplify communication between people has been widely discussed. Worldwide spectrum is under-used, and in Brazil half of the cities are using half the allocated spectrum (NOVAES and AFONSO 2016). This is absurd in a contemporary context where new

technologies can provide more efficient and equitable use of the spectrum, leading us to a paradigm shift: the abundance of the spectrum (STAPLE and WERBACH 2004). Our main questions are quite simple: is the spectrum that is being used, being used efficiently? And what are the opportunities and challenges for the use of the spectrum, particularly in the transition from analogue to digital technologies?

While it has become commonly accepted that the electromagnetic spectrum is a scarce resource, the fact is that at least half of the spectrum is not being used most of the time and a new approach to the spectrum management is necessary to promote its dynamic and efficient use. This objective has been a theme of public audiences proposed by the National Telecommunication Agency (Anatel), of Brazil[16] for the last two years. At the same time, the Brazilian federal government is dedicated to distributing digital TV decoders in order to accelerate the analogical TV switch-off, freeing up 700MHz of the spectrum for new services development. In this global context of migration, can one still work on the possibility of national solutions for local and sustainable digital communication networks?

Some countries are investing in the use of TV "blank spaces" for broadband connection, such as in the United States and Canada, but the importance of analogue TV spectrum is quite diverse in Brazil: only 15% of North-Americans or Canadians receive analogue signal, when in Brazil this number would be closer to 80%. In Brazil, the digital dividend is very different in each region. In the north, both connectivity and computers are rare and none of the initiatives that have been implemented resulted in significant digital appropriation. Focused on an emergent market, the objective of "connecting the next billion" is being used by big corporations to offer different levels of access to the Internet, which in some cases violate national regulations. The quality and the effective demand of services in communities with abundant spectrum available has to be investigated with an accurate methodology: relating them to public policies, this process could lead to an innovative solutions for digital communication between governments and citizens. And beyond the Internet, which could be the next technical solutions to improve communication in this new emergent digital context?

Brazil has its own specificities and we can't really adopt one particular model, such as implemented in North America or Europe, where most of the homes either have cable TV or don't receive any air broadcasting. Whilst in some developing countries there is almost no fixed line infrastructure and very little broadcasting, especially outside of the major urban centers. When socio-technical environments are different we have to be careful when thinking about global strategies to move forward with spectrum management.

New radio software technologies, in contrast, open up relevant possibilities for a global development of communication through the spectrum, such as cognitive radio and software defined radio.

The new regulations that consider the effective use of the spectrum are proposing that beyond primary use of the radio frequency bands, there would be the possibility of allocating the same band with some protection for a secondary use. One way to demand secondary use is measuring effective use of the spectrum at local level, in order to evaluate options for regulatory policies that would improve and expand on

[16] Videos: 1st Seminar "Spectrum Managment – Visions for the Future" https://www.youtube.com/watch?v=q2Jcbnn2plQ. 2nd Seminar: https://www.youtube.com/watch?v=FrW1yz_v9PY Access: 30 Jan. 2017.

spectrum usage in developing digital municipalities. Low-cost technical resources exist today for communities to carry out this monitoring themselves.

There's also a need to change the mentality of regulators. Today it has become evident that what we thought we knew about the spectrum and spectrum policy turns out to be utterly and catastrophically wrong. There's no need to limit the number of people that use the public airwaves in order to prevent interference: now we have software that can do it better than regulators. We don't need to have auctions to allocate a resource that isn't scarce. But the appeal of the revenue involved is too powerful for regulators and national Governments to let go, thus restristing the spectrum in an environment where pricing determines the commercial relationship with this ample resource.

A fresh approach would be to move away from the idea of scarcity and shift to the notion of abundance. There is plenty of spectrum available, and digitalization is an excellent opportunity to develop new solutions that can be locally implemented and globally shared.

In our analysis of the way the spectrum management is currently being proposed we point to the importance of independent researchers in developing cutting-edge solutions for widely available devices, who primarily work with open and free software technologies, ensuring local communities and individuals can be empowered by the tools available to them. It is crucial to realize that open electronic devices, all around us today, can be improved through a decentralized and distributed collaborative process, and citizens, independent groups, and collectives can take ownership of the means of communication. We no longer need or want to depend upon large corporations to provide us with the tools or the space to exercise our civil and human right to inform each other.

As pointed out by Rebouças and Dias (2016, p. 52) "*if Brazil is not making progress around the media regulation theme*", the discussion around "the difficulties posed by cross-ownership" becomes an obsolete issue. Considering the new scenario of digital and dynamic spectrum management, it no longer matters who is the owner of the concessionary media, as the scarcity model has imposed for more then a century, limiting the debate around the type of content that should be transmitted. To express the plurality of society and guarantee the educational and cultural purpose that brought radio to Brazil, the 21st digital media debate should consider the abundance of digital content production by the people and the emergence of abundant of new flexible spectrum spaces for sharing this content in a dynamic, uncontrolled and diverse public sphere. A structural media reform can now be based on low-cost technological developments, to reframe the relationship between civil society, the State and private sectors, giving prominence to the general interests of the many, instead of the commercial demands of the few. The current transformation is not ideological. We are facing a paradigm shift inviting us to use an intelligent approach to available tools and resources, which can propel us towards a better future in a global democratic information society.

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