

PAVING THE WAY TOWARDS 6G: Andean Community Status

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ABSTRACT – The upcoming 6G era in the 2030s will face new challenges from the radio spectrum management and regulation point of view due to an increasing variety of spectrum bands involved in this technology. In addition, regulators in the 6G era must introduce a new set of spectrum management approaches that facilitate and encourage telecommunication operators the deployment of new cellular networks.

This paper aims to study the secondary market and sharing spectrum issues from a regulatory point of view in the countries of the Andean Community. The paper considers the sharing spectrum mechanisms and the secondary market definition described by the International Telecommunication Union (ITU) and discusses their implementation status in each country. This study provides a baseline about the current secondary market and sharing spectrum status in the region, that can be used for both scholars and policymakers, the former can use the results to conduct further research, while the latter could consider the outcomes into account to design, execute and evaluate new policies in the telecommunication sector.

Keywords: 6G, Telecommunication sector, Sharing Spectrum, Radio Spectrum management, regulation.

1. INTRODUCTION

In order to catch up the needs of an eager super-connected and globally data driven society, the wireless communication industry have kept an intensive and fast-growing evolution trend during the last 40 years. Consequently, this industry have evolved from the first generation (1G) of wireless communications to the current fifth generation (5G). However, 21th century society is becoming more and more data-centric, data-dependent, digitized, and automated. Moreover, new services and applications such as 3D gaming and extended reality plus the rapid development of data centers and automated processes will require a throughput on the order of Terabits per second (Tbps), that might surpass the 5G networks capabilities [1]. Therefore, researchers have devoted their efforts beyond-5G solutions, i.e., the sixth generation (6G) of wireless communications [2-4], aiming to meet the future demands of the 2030 era, thus the first 6G White Paper was launched in 2019 [5]. It is expected that 6G provides hyper-fast links with peak throughput exceeding the Tbps rate with ultra-high reliability and ultra-low latency [6]. In addition, 6G will not only require wider bandwidth which is available at sub-THz and THz bands but also it will use all the existing bands in lower frequencies [7]. Thus, this novel technology will face new challenges due to a vast range of radio spectrum bands with different propagation characteristics and fragmentation of spectrum management approaches. Because spectrum management will continue to play an important role in the deployment of 6G networks, this paper discuss the spectrum management regulatory strategies in the countries of the Andean community: Ecuador, Colombia, Peru, and Bolivia, focusing on sharing spectrum mechanisms and telecommunication secondary market based on the International Telecommunication Union (ITU) framework. This papers aims to encourage policy makers to realize in these acountries about modern mechanisms that allow new telecommunication operators to get ready for early adoption of the 6G technology. To run the analysis, the paper proceeds as

follows. Section II shows a general review of spectrum management strategies. Section III presents a brief overview of the Andean community countries in particular their telecommunication infrastructure status. The IV section presents the found results, while discussion and conclusion are listed in sections V and VI, respectively.

2. LITERATURE REVIEW

This chapter aims to explain spectrum sharing management strategies and telecommunication secondary market approaches, we also present spectrum management decisions in different countries. Due to scarceness nature of the radio spectrum , spectrum management decisions intent to maximize benefits towards society and the efficient utilization of this resource [8]. On the other hand, secondary frequency markets allow mobile networks operators (MNOs) to sell or exchange frequency bands without governmental perimissions or following some few restrictions.

The literature review stands out the evolution of spectral management approaches throughout the years from administrative allocation, to market-based models, and the unlicensed commons approach [9].

For the first generation of mobile celular networks the administrative allocation represented the major spectrum management approach. In this mechanism, the central government grants usage licenses within a primary market, the national regulators used to define rules and conditions for spectrum access rights, this method is also named command and control model because regulators have the unique decision power [10]. Due to growing criticism over the time, the regulators have opened the telecommunication sector to market-based mechanisms [11]. This second approach includes holding auctions, secondary markets and sharing models, that replaces the centralised model by endowing MNOs with higher flexibility. As a consequence, spectrum auctions have became a key tool [12] in the 3G and 4G era for regulators in several countries, being the most commom types single round or simple (open or closed) auctions; and multiple round (successive or simultaneous) auctions.

Regarding secondary spectrum trading, it treats the spectrum assignments in a similar way to property rights allowing parties i.e., MNOs to buy and sale equipment licenses or spectrum utilization. Thus, the original spectrum property rights obtained from the regulator can be traded or leased following geography or bandwidth parameters for a given period of time [13]. For instance, by 2010 according to ITU, 11 countries possessed a spectrum secondary market and another 12 countries were planning to implement it. In Latin America, countries like Chile, Mexico, and Uruguay allow spectrum trading among MNOs while in the European and North American side Spain, Finland, United Kingdom, Canada, and The United States are countries that possess secondary markets as well. The combination of spectrum from various licensed operators designed in New Zealand under the name of “licensed spectrum parks” [14] helps to boosts up the secondary market ecosystem, here the government assigns bands for cooperative use in restricted geographic areas encouraging small operators to join the cellular network ecosystem. Finally, another advanced mechanism in the spectrum sharing regulation is trough the use of small cell, where the primary licensee uses spectrum in remote areas, this spectrum can be reused by small cells in high-demand urban areas that are far away from the remote location in order to improve the spectral efficiency.

In regards the third major approach, unlicensed commons approach models assume full liberalization in the use of spectrum from the MNOs, only subjected to no interference principles [8]. By making the spectrum Access possible to any stakeholder the ecosystem becomes more

competitive and successful solutions as WiFi, Bluetooth, and ZigBee arise [15]. Although typically cellular mobile operators were not interested in these bands, the 5G networks consider sharing radio frequency bands with those of WiFi i.e., open access, and it is expected that 6G networks also take benefits from these unlicensed frequency bands to provide ultra-high-speed, ultra-high-reliability and, ultra-low-latency services and applications.

3. METHODS

This research aims to study current telecommunications policies in regards to Andean Community countries, listed as Ecuador, Colombia, Bolivia, and Peru. These neighboring countries not only face similar issues in economy, educational, and political areas but also share similar cultural facts. Thus the underlying goal of this intra-countries institution is to set up tight links seeking peaceful and equilibrated development among the members [16].

This paper takes into account findings regarding spectrum management from the 6G Wireless Summit held in 2019. Additionally, in order to explore the radio spectrum policies, this study uses definitions described by the ITU in its publication “Policy Guidelines and Economic Aspects” about secondary market, auctions mechanisms, and spectrum sharing mechanisms as combination of spectrum from various licensed operators, and spectrum-sharing model using small cells. The information collected and here shown follows an bibliographical review i.e., it comes from official public web sites and official documents from public institutions and regulators in each country.

It is to be said that this paper does not aim to evaluate the policies adopted by this countries rather to examine and highlight decisions made so far.

4. EXPECTED RESULTS

4.1. Ecuador

In Ecuador the ministry of telecommunications and information society is the major public institution in regards of ICT. Under it, the Telecommunications Regulation and Control Agency (Agencia de Regulacion y Control de las Telecomunicaciones - ARCOTEL) is the body responsible for managing the spectrum. Although the telecommunications laws have changed through the last 20 years, the Organic Law of Telecommunications (LOT) released in February 2015 is the one that rules the radiofrequency spectrum nowadays. The ARCOTEL grants operators with frequency bands through concessions of it (art. 37), additionally, article 44 prohibits to transfer, lease or alienate the spectrum bands by any means without the permission of the ARCOTEL. In regards of spectrum allocation mechanisms, the ARCOTEL states both direct administrative allocation and public contests (art. 50). Nonetheless, the last time the Ecuadorian government signed a spectrum contract was in 2015, giving the operators Movistar and Claro 50 MHz and 60 MHz respectively, following a direct allocation mechanism. This method was possible because the Ecuadorian regulations allow direct spectrum allocation in case the telecomm operator is established in the country already. In contrast, when the stated-own company CNT was granted with spectrum for LTE deployment by 2012, the central government gave them 30 MHz and 40 MHz in the 700 MHz and 2100 MHz bands respectively, by giving an *authorization* which is the official mechanism among public institutions. Finally, the regulatory body in Ecuador does not describes mechanisms as shared sprectum from various licensed operators nor spectrum-sharing model using small cells. Although, the article 51 states the direct allocation model for ‘band sharing’ it does not provide details about how to get shared access to that spectrum.

4.2. Colombia

The country divide the spectrum management according to the service provided, thus the *Autoridad Nacional de Television (ANTV)* oversees TV broadcasting and grants licenses related to that service. Meanwhile, the agency on charge of spectrum regulation management for mobile communications is the *Agencia Nacional del Espectro (ANE)* that also provides technical support to the Ministry of ICT (*MinTIC*, for its Spanish acronym). Regarding the secondary spectrum market, as part of the *Plan Vive Digital 2014 -2018* (Live Digital Plan 2014 - 2018), the ANE and MinTIC, each one within the framework of their competences, they engage to use the spectrum more efficiently through the implementation of secondary market, unlicensed use, and light licensing, in order to accelerate the development of the telecommunication sector. Thus, by 2014 ANE began a secondary spectrum market test in the 23 Ghz , and another test in the 18 GHz band by 2018. However, according to the *Spectrum Public Policy 2020-2024* report launched in June 2020, these mechanisms have been barely used due to a missing regulation so that stakeholders can easily adopt this strategy. In regards to the most recent awarded spectrum, there were public auctions in December 2019, in the 700 MHz and 2500 MHz frequency bands where *Tigo, Claro,* and UK-based partners were awarded 40 Mhz, 50 Mhz, and 50 MHz, respectively. Finally, the regulatory body in Colombia does not describe mechanisms for shared spectrum from various licensed operators and spectrum-sharing model using small cells. Table 1 shows a summary of spectrum management mechanisms status in Ecuador and Colombia.

Table 1. Summary of spectrum management mechanisms status in Ecuador and Colombia

Spectrum Management Mechanisms	Ecuador	Colombia
Spectrum assignment model used in the last contracts	Direct Allocation	Public Auctions
Spectrum Secondary Market	Prohibited without the regulator permission	Allowed by the regulator, barely used
Shared spectrum from various licensed operators	Not described	Not described
Spectrum-sharing model using small cells	Not described	Not described

Reference: author's elaboration

5. DISCUSSION

The goal of this essay is to highlight the importance and the key role of spectrum management in the 6G era from a regulatory point of view. This papers considers the ITU recommendations about shared spectrum machenisms in order to identify the current status of this regard in the selected countries. The Framework can be used as baseline to study the economic impact when late and not optimal decisions about spectrum management are taken and also to detect the gaps when compared with developed countries.

Additionally, for the best of author's knowledge, the ITU has no released and fixed the standards for 6G communications, thus as soon as these parameters are released, a more accurate spectrum management study can be carry on. Finally, this essay takes into account two out of four Andean community country, therefore it can be expanded in order to make a broader and meaningful analysis in the region.

6. CONCLUSION

Around 30 years back, countries, especially central government and decision makers have seen the radio spectrum as another mechanism to collect money simply. However over the past years, this approach has changed and radio spectrum management is well recognized as a key role specially in the deployment of wireless high-speed communications. In the case of Ecuador, its policies allow spectrum trading by operators however the ARCTEL takes the full control by allowing or rejecting the trade, as the bibliographical review indicates this mechanism leads to the absence of a spectrum secondary market in Ecuador. Moreover, the Ecuadorian LoT as well as the Colombian laws do not provide advanced mechanisms such as shared spectrum from various licensed operators and spectrum-sharing models using small cells, that aim to improve the coverage area in rural areas and improve spectral efficiency. Therefore, both countries must update their regulations so those advanced spectrum sharing models can boost the local telecommunication ecosystem by adding new operators that come around with high-end technologies. In regards to the secondary spectrum market in Colombia, the country had run several test beds during the last 10 years at different frequency bands. Nonetheless, the results are still poor and that market has not that much activity as desired. Lack of national evaluation systems and accurate data from official sources stand as a barrier in analyzing the impact of the policies taken in each country. A micro-level evaluation of the regulations is needed to better understand the positive and negative effects of the policies. Policy makers can use the findings to design, execute and assess the regulations applied so far.

AUTHOR CONTRIBUTIONS

Only one author who was in charge of the full paper elaboration.

ACKNOWLEDGEMENT

KAIST, Global ITTP program. Daejeon, South Korea.

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