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Diagnostic of the current situation of 5G technology: South America

Diagnóstico de la situación actual de la tecnología 5G: Suramérica

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ABSTRACT

This paper presents an analysis of the current state of 5G technology deployment in South American countries. The research is carried out employing an informal survey of the current regulations in mobile technologies, to later carry out a general overview of the most relevant aspects in the 13 South American countries and French Guiana. The commercial launches of 5G in the countries of Uruguay, Surinam, and Brazil are highlighted. The 3.5 GHz and 28 GHz spectrum bands are identified as potential for 5G development, used in a total of 26 tests distributed in 9 countries, except for Guiana, Paraguay, Venezuela, and French Guiana. Likewise, the countries with the highest spectrum release rate are Brazil with 609 MHz and Peru with 554.4 MHz, while Ecuador and Bolivia are the last ones in this aspect with 290 MHz and 284 MHz respectively, except for Argentina, the telecommunications sector in South America is decentralized, which means that there are several regulatory bodies. This study was conducted to review the current state of mobile technology in South America and obtain an overview of the actions carried out in the region for the implementation of 5G technology.

RESUMEN

Este trabajo presenta un análisis del estado actual del despliegue de tecnología 5G de los países de Suramérica. La investigación se realiza por medio de un levantamiento de información de la normativa vigente en tecnologías móviles para posteriormente realizar una visión general de los aspectos más relevantes en Suramérica. Se destacan los lanzamientos comerciales del 5G de los países de Uruguay, Surinam y Brasil. Se identifican las bandas del espectro de 3,5 GHz y 28 GHz como potenciales para el desarrollo 5G, utilizadas en un total de 26 pruebas distribuidas en 9 países, exceptuando a la Guyana, Paraguay, Venezuela y la Guyana Francesa, así mismo, los países que cuentan con un mayor índice de liberación de espectro son Brasil con 609 MHz y Perú con 554,4 MHz mientras que Ecuador y Bolivia son los últimos en este aspecto con 290 MHz y 284 MHz respectivamente, a excepción de Argentina el sector de las telecomunicaciones en Suramérica es descentralizado esto quiere decir que existen varios organismos reguladores. Este estudio fue realizado con la finalidad de revisar el estado actual de la tecnología móvil en Suramérica y obtener una visión general de las acciones llevadas a cabo en la región para la implementación de la tecnología 5G.

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1. Introduction

The technology sector maintains a tendency to evolve and achieve optimal environments for the end-user, smartphones, televisions, virtual assistants, smart homes and other digital devices generate more and more data creating a much more difficult environment to manage in terms of coverage and quality of service, as a result, mobile networks must be able to offer such availability and generate adequate support. In technical matters, 5G will provide facilities to increase the number of mobile connections with a figure that will reach 1100 million accesses, increase the download rate to 10 Gbps and reduce the delay with latency values below 1ms [1].

As a consequence of this, 5G technology has positioned itself as the best solution for wireless data transmission, besides having great benefits in connectivity and connection speed, this new generation of the mobile network brings many economic benefits, in [2] it is stated that the implementation of 5G technology will represent a contribution to the GDP of the entire American continent of 290 billion dollars, meaning a growth of 2.3% and a generation of 6.8 billion in taxes, the above budgeted for 2024.

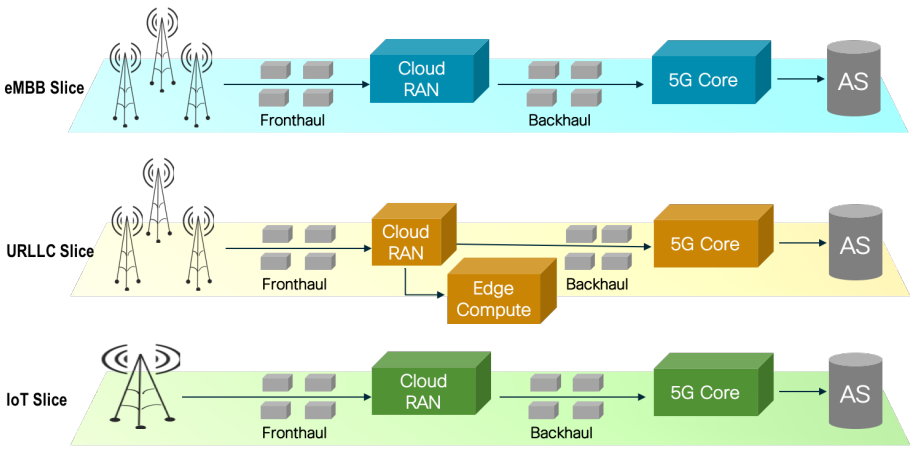
In the specific case of South America, there are similar social, economic, and cultural characteristics, but with certain differences in terms of regulatory policies and actions taken for the adoption of technology in South American countries. In terms of connectivity, the 5G Americas report [3] shows that by June 2019 in the Latin American region there were 701 million telephone accesses, 84% of which had the mobile broadband capacity, and this figure represents mobile penetration levels close to 100%. According to [4], by 2019 there was a 17% presence of 2G technology, 35% in 3G, and 47% for 4G technology; by 2025 it is expected an increase in 4G penetration with 67% and the presence of 5G technology with 7%, while 2G and 3G technologies will decrease by 5% and 21% respectively.

The present research has a data collection until October 1, 2020. From that moment on, we proceeded to analyze, compare, and write the article. This study was conducted to review the current state of mobile technology in South America, considering aspects such as the amount of bandwidth allocated for mobile technologies, infrastructure deployment capacity, and current regulations. This article presents a regulatory diagnosis, progress, and current situation in each South American country regarding fifth-generation technology. Section 2 presents a description of 5G operation and its main regulations and standards, section 3 presents a diagnosis of the frequency bands identified as potential for 5G implementation, section 4 shows the main 5G pilot tests conducted to date and analysis of results, section 5 presents a compilation of the most important aspects of the 13 countries politically constituted in South America and the dependence of French Guiana. Finally, the conclusions obtained are presented.

2. 5G technology standards

Initially, 5G technology specifications were suitable for communications with wired fiber-optic connections with download speeds like 300 Mbps in high-density areas and 1 Gbps in areas of good availability. Figure 1 shows the application forms of the 5G network in eMBB (enhanced mobile broadband), URLLC (ultra-reliable low latency communication), and IoT (Internet of Things) which can be supported independently in a single infrastructure.

Figure 1. 5G network architecture [5]



In this context, several specifications have been promulgated, one of them by the 3GPP that competes for a collaboration of groups of associations in the telecommunications sector to promulgate technological documents to the different versions, such as the 3GPP GSM05.05 standard characterized largely by having the predominant GMSK modulation and by the specification of acceptable power levels for mobile stations [6]. At the end of 2017, the first standard based on 5G called 'Non-Stand-Alone' (NSA) was delivered, here, the support that the 4G infrastructure has for the implementation of 5G is highlighted, for this very reason many of the pilot tests at the beginning based their development on this standard [7].

Subsequently, since the management of 3GPP, developments were maintained in a standard whose specifications did not depend on LTE networks. Consequently, by 2019 the scope of Release 15 is presented which meets the specification of being an independent standard for 5G, defining a new radio system complemented with a next-generation core network [8]. In July 2020 with 5G NR Release 16, being the second 5G technology standard an enhancement in Multi-User MIMO (MU-MIMO) is presented to support higher ranges, support multiple transmits, and receive points (multi-TRP), and better management to improve link reliability. For all MIMO-enabled devices, 5G NR Release 16 also supports a maximum power uplink to improve coverage at the cell edge, on the other hand, it addresses the concept of eURLLC (enhanced, ultra-reliable, low latency communication) which aims to offer improved link reliability (up to 99.9999%) [9].

3. Potential bands in 5G development

Governments around the world are working on the development of new policies to face this new technological revolution in the best way and contribute to its economic development. According to the ITU, with the arrival of 5G, an expansion of the spectrum is expected due to the allocation that must be made to achieve the launches [10], this depends largely on the authorized bodies in each country, whose main role is to identify barriers in this regard and establish potential bands for the deployment of 5G technology.

Table 1. Regulatory agencies.

Country	Regulatory agencies	Ministry Responsible	Regulatory Authority	Spectrum Management
Argentina	ENACOM - National Communications Entity	x	x	x
Bolivia	Ministry of Public Works, Services and Housing	x		
	ATT - Authority of Fiscalization and Social Control in Telecommunications and Transportation		x	x
Brazil	MCTI - Ministry of Science, Technology, and Innovation	x		
	ANATEL - National Telecommunications Agency		x	x
Chile	Ministry of Transportation and Telecommunications	x		
	SUBTEL - Undersecretariat of Telecommunications		x	x
Colombia	MINTIC - Ministry of Information and Communications Technologies	x		
	CRC - Communications Regulation Communication		x	
	ANE - National Spectrum Agency			x
Ecuador	MINTEL - Ministry of Telecommunications and the Information Society	x		
	ARCOTEL - Telecommunication Regulation and Control Agency		x	x
Guiana	Public Ministry of Telecommunications	x		
	PUC - Public Utilities Commission		x	
	NFMU - National Frequency Management Unit			x
Paraguay	Ministry of Public Works and Communications	x		
	MITIC - Ministry of Information and Communication Technology	x		
	CONATEL - National Telecommunications Commission		x	x
Perú	MTC - Ministry of Transportation and Communications	x		
	OSIPTEL - Supervisory Organism of Private Investment in Telecommunications		x	x
Suriname	Ministry of Public Works, Transportation and Communications	x		
	TAS - Telecommunications Authority of Suriname		x	x
Uruguay	DINATEL - National Telecommunications Directorate	x		
	URSEC - Communications Services Regulatory Unit		x	
	ANTEL - National Telecommunications Administration			x
Venezuela	MINCI - People's Ministry of Communication and Information	x		
	CONATEL - National Telecommunications Commission		x	x
French Guiana	ARCEP - Regulatory Authority for Electronic Communications and Posts		x	
	ANFR - National Frequency Agency			x

Source: own.

The role of international organizations is usually very important in terms of creating standards whose operation allows a guide for the deployment of the technology, in this sense, the role of international organizations in terms of regulations and specifications for 5G technology is highlighted. Under this line is the position of the ITU as the main body that with the IMT-2020 (International Mobile Telecommunications-2020) presents the requirements issued by the ITU-R (ITU Radiocommunication Sector) for 5G networks, devices, and services. This organization divides the world into three regions, with South America positioned in region 2 called Americas, in addition to the ITU there is the Inter-American Telecommunications Commission known by its acronym CITEL. In addition, the role played by the regulatory bodies in each country is highlighted, since these bodies will provide the regulatory aspect in the deployment of mobile infrastructure. Table 1 shows the regulatory bodies in the ICT sector in each country.

With the advent of 5G, these agencies oversee allocating a significant amount of spectrum. According to a GSMA study, the main regulators must allocate between 80 to 100 MHz of contiguous spectrum per operator. For 5G, the 3.5 GHZ (3.3 - 3.8 GHz) and 24 GHz (24 - 86 GHz) spectrum bands have been identified as the main 5G bands. Similarly, there are other frequency ranges for 5G with 700 MHz - 1 GHz and 1 GHz - 6 GHz [11]. Table 2 shows the spectral allocations in South America. The boxes shaded in pink specify the technologies used in that band. The yellow boxes represent an allocation but are used for other systems; they are in reordering, refarming, or reorganization for IMT use.

In the case of Brazil, 5G deployment is already in place, but under the DSS concept, which consists of redistributing 4G frequencies to 5G; for this reason, 5G for Brazil is not specified in Table 1. In the Americas, CITEL at the 2015 World Radiocommunication Conference (WRC-15) proposed to allocate the 1435-1518 MHz and 3400-3600 MHz bands for 5G technology, while it recommended disregarding the 2700-2900 MHz, 3600-4200 MHz, and 4500-4800 MHz frequency bands [13].

Table 2. Assigned spectral bands [12].

País	700 MHz	800 MHz	850 MHz	900 MHz	AWS	1,8 GHz	1,9 GHz	2,1 GHz	2,5 GHz	3,5 GHz	26 GHz	28 GHz
Argentina	4G	2G/3G	2G/3G	4G	4G		2G/3G/4G		4G			
Bolivia	4G		3G		4G		2G/3G/4G					
Brazil	4G		2G/3G	2G		3G/4G	3G	3G	4G			
Chile	4G		2G/3G	2G	3G/4G		3G		4G			
Colombia	4G	2G	2G/3G		4G		2G/3G	4G	4G			
Ecuador	4G		2G/3G		4G		2G/3G/4G					
Guiana	4G		2G/3G	2G/3G								
Paraguay	4G		2G/3G	2G/3G	4G		2G/3G/4G					
Perú	4G		2G/3G	3G/4G	4G		2G/3G	2G	4G			
Suriname	4G	2G		2G/3G		4G	2G			5G		
Uruguay	4G		2G/3G	2G	4G	2G	2G/3G/4G	3G				5G
Venezuela			3G	2G/3G	4G	4G	3G		4G			
French Guiana		2G		2G/3G/4G		2G		4G	4G			

Source: own.

Therefore, national agencies base the identification of potential frequency bands on the positions provided by entities such as CITEL, under this line, operators base their developments in the identified bands which are temporary allocation field for the development of experimental tests. According to data from the 5G Americas report for May 2020, the spectrum allocated for mobile services in Latin America averaged 392.1 MHz, which represents 30.2% of the ITU's suggestion for 2015 [12].

Tables 3, 4, and 5 present a compilation of MNOs (mobile network operators) that through the provisions taken in the regulations of each country with infrastructure sharing lease their equipment to MVNOs (mobile virtual network operators). To make it easier to understand the data, the presentation is divided into Table 3, which contains the countries with commercial deployments of 5G technology, Table 4 contains the countries with a spectrum allocation higher than the 5GAmericas average, and Table 5 presents the countries below this figure.

Table 3 highlights the high level of competition in the Brazilian market, which between MNOs and MVNOs totals thirteen companies. This is reflected in the fact that Brazil has three operators that provide 5G services under the Dynamic Sharing Spectrum (DSS) concept, whose operation is based on redistributing the frequencies already available by dynamically sharing the spectrum according to traffic demands [11]. On the other hand, Brazil is the country that allocates the most spectrum in South America to mobile telephony.

Table 3. Potential 5G bands in the countries with deployment. Band used for deployment [12].

Country	Operators (OMR)	Potential 5G Band	Spectrum Awarded	Virtual Operators (OMV)
Brazil	Claro	3,5 GHz, DSS*	609 MHz	Correios Celular Surf Telecom Brisanet Fluke Geek Cel
	Oi	3,5 GHz		
	Vivo	3,5 GHz, DSS*		
	Tim	3,5 GHz, DSS*		
	Algar	3,5 GHz		
	Sercomtel	-		
Uruguay	Antel	28 GHz*	515 MHz	Does not have
	Claro	28 GHz		
	Movistar	28 GHz 3,5 GHz		
Suriname	Digicel	Does not report	Does not report	Does not have
	Telesur	3,5 GHz*		

Source: own.

As for Uruguay and Suriname, there is an important trend to mention; the operators that already have 5G deployment are state-owned. In the Uruguayan case, the 28 GHz frequency band predominates in the deployment, its precursor is ANTEL (National Telecommunications Administration), which through Law No. 14235 [14] seeks to create a decentralized public service owned by the state, which includes functions such as providing urban and long-distance telecommunications services.

For the case of Suriname, Telesur is the telecommunications service provider fully owned by the Surinamese government. In its deployment, the 3.5 GHz frequency band was used; by means of Law No. 151 of 2004 [15], this state-owned company loses its participation in regulatory aspects but remains as a telecommunications operator in the country.

Table 4 shows the potential bands defined for 5G deployment, it is highlighted that the country with more spectrum awarded for mobile broadband technologies is Peru with 554.4 MHz followed by Colombia with 492.5 MHz and French Guiana with 428.8 MHz. In the case of the overseas department of French Guiana, although there are no 5G technology activities, it has a good infrastructure and a good percentage of 4G technology coverage, where the best positioned in this regard is the operator SFR with a total of 96% coverage, followed by Orange with 81% and Digicel with 76% [16]. Finally, Chile has good competitiveness in the market with ten active operators, as well as Peru with the same number, followed by Colombia with 9 participants.

Table 4. Potential 5G bands in the countries with the largest spectrum allotments [12]

Country	Operators (OMR)	Potential 5G Band	Spectrum Awarded	Virtual Operators (OMV)
Perú	Bitel	3,5 GHz	554,4 MHz	Incacel Dolphin Mobile Famagusta Guinea Mobile Flash Servicios Intermax
		3,5 GHz		
	Claro	3,5 GHz		
	Entel	3,5 GHz		
	Movistar	3,5 GHz		
Colombia	Partners + Avantel	-	492,5 MHz	Móvil Exito Virgin Mobile Flash Mobile HV Móvil
	Claro	28 GHz 3,5 GHz		
	ETB	28 GHz 3,5 GHz		
	Movistar	28 GHz 3,5 GHz		
	Tigo Une	28 GHz 3,5 GHz		
French Guiana	Digicel	3,5 GHz	428,8 MHz	-
	Orange	3,5 GHz		
	Outremer Telecom	3,5 GHz		
Chile	Claro	28 GHz	470 MHz	Telsur Netline Simple Virgin Mobile VTR Mundo Móvil
	Movistar	28 GHz		
	Entel	28 GHz		
	Wom	3,5 GHz		

Source: own.

Table 5 shows the countries with a spectrum allocation index lower than the average described above, specifically for mobile telephony. In this regard, there is a similarity in the number of operators in the market and the spectrum allocated, since in addition to being the countries with the lowest index in this aspect, they are also the countries with the lowest market share.

Table 5. Potential 5G bands in countries with lower spectrum allocations - Not available [12]

Country	Operators (OMR)	Potential 5G Band	Spectrum Awarded	Virtual Operators (OMV)
Argentina	Personal	28 GHz	390 MHz	CATEL
	Claro	28 GHz		
	Movistar	28 GHz		
Paraguay	Claro	-	350 MHz	-
	Personal	-		
	Tigo	-		
	Vox	-		
Venezuela	Movilnet	-	324 MHz	-
	Digitel	-		
	Movistar	-		
Ecuador	Claro	3,5 GHz	290 MHz	Virgin Mobile
	CNT	3,5 GHz		
	Movistar	3,5 GHz		
Bolivia	Entel	3,5 GHz	284 MHz	Mio
	Tigo	3,5 GHz		
	Viva	3,5 GHz		
Guiana	GTT +	-	Does not report	-
	Digicel	-		

Source: own.

4. 5G pilot tests in South America

The implementation of new technology requires planning and testing of infrastructure and deployment; as part of the entry of 5G in the region, certain pilot tests have been developed, these actions mark a pre-emphasis on the final deployment of the technology in each country and serve to determine the degree of impact that this technology can generate on the existing infrastructure.

By way of clarification, a 5G test is conducted in a laboratory environment, while 5G demonstrations often use the operators' network and are open to the public for measurement purposes. Table 6 summarizes some of the main 5G deployment characteristics. Uruguay with the 28 GHz band in 2019, Argentina with evidence of tests for this spectrum band at the beginning of 2017, in the cases of Bolivia and Ecuador there is evidence of 5G technology tests but no background with the bands used was found.

Table 6. 5G pilot tests in 28 GHZ.

Country	Frequency Band	Speed Obtained	Operator	Technology Provider	Type	Date
Argentina	28 GHz	20 Gbps	Movistar	Ericsson	5G Test	November 2017
	28 GHz	10 Gbps	Personal	Nokia	5G Test	April 2018
	Does not report	700 Mbps	Personal	Huawei	Demo 5G	May 2019
Uruguay	28 GHz	Does not report	Antel	Nokia	5G Deployment	April 2019
Bolivia	Does not report	1,8 Gbps	Entel	Huawei	5G Demo	September 2019
Ecuador	Does not report	930 Mbps	CNT	Huawei	5G Test	July 2019
	Does not report	1,1 Gbps	Claro	Huawei	5G Test	September 2019

Source: own.

Table 7 shows the records for the countries that prioritized their developments in the 3.5 GHz band, however, there are some cases where this frequency range was not used. In that sense Brazil is awarded as the largest precursor in 5G tests in this band, a total of 6 tests were identified exclusively for mobile telephony without counting the test conducted in 2016 for what was called pre-5G. In Peru, 2019 predominates as the year of the greatest boom in 5G technology with three tests performed, finally, the 5G deployment of Suriname in 3.5 GHz and the Brazilian one with 5G DSS stand out. Finally, two case studies are presented where the two spectrum bands have been used for 5G tests, Table 8 summarizes this record.

Table 7. 5G pilot tests in 3,5 GHZ.

Country	Frequency Band	Speed Obtained	Operator	Technology Provider	Type	Date
Brazil	2,6 GHz 1,8 GHz	682 Mbps	Claro	Ericsson	Pre-5G Demo	September 2016
	3,5 GHz	Does not report	Vivo	Huawei	5G Test	July 2018
	3,5 GHz	338 Mbps	Oi	Huawei	Demo 5G	March 2019
	3,5 GHz	1 Gbps	Tim	Huawei	5G Test	May 2019
	3,5 GHz	Does not report	Tim	Nokia	5G Test	May 2019
	3,5 GHz	Does not report	Tim	Ericsson	5G Test	May 2019
	3,5 GHz	1,1 Gbps	Oi	Huawei	Demo 5G	September 2019
	DSS	416 Mbps	Claro	Ericsson	5G DSS Deployment	July 2020
	DSS	Does not report	Vivo	Huawei	5G DSS Deployment	July 2020
	DSS	Does not report	TIM	Huawei, Nokia, Ericsson	5G DSS Deployment	September 2020
Perú	AWS 5GHz	1 Gbps	Movistar	Ericsson	Pre-5G Test	December 2017
	3,5 GHz	Does not report	Entel	Huawei	5G Test	March 2019
	3,5 GHz	3 Gbps	Claro	Huawei	5G Test	May 2019
	3,5 GHz	3,3 Gbps	Claro	Huawei	5G Test	November 2019
Surinam	3,5 GHz	Does not report	Telesur	Huawei	5G Deployment	November 2019

Source: own.

Table 8 separates the cases of Chile and Colombia due to the presence of the two frequency bands identified by CITEL as the potential for use in 5G tests, additionally, they are the countries with the highest record in speeds achieved, punctually in Colombia, the measured speeds reached 27 Gbps in a test conducted in July 2018, while in the Chilean case a speed of 25.4 Gbps stands out which was measured in a test conducted in June 2018, these two precedents are followed by a test conducted in Argentina in 2017 with 20 Gbps. Finally, the countries of Guiana, Paraguay, Venezuela, and the French Guiana dependency do not have records in 5G tests.

Table 8. 5G pilot tests in 3,5 and 28 GHz.

Country	Frequency Band	Speed Obtained	Operator	Technology Provider	Type	Date
Chile	27 GHz	10 Gbps	Claro	Nokia	5G Test	December 2017
	28 GHz	Does not report	Movistar	Nokia	5G Test	January 2018
	28 GHz	25,4 Gbps	Entel	Ericsson	5G Test	June 2018
	3,5 GHZ	722 Mbps	Wom	Huawei	5G Test	March 2019
Colombia	Does not report	640 Mbps	Tigo-UNE	Huawei	5G Test	November 2017
	28 GHz	10 Gbps	Claro	Nokia	5G Test	January 2018
	28 GHz	27 Gbps	Movistar	Ericsson	5G Test	July 2018
	3,5 GHz	Does not report	Movistar	Huawei	5G pilot project	May 2020
	3,5 GHz	864Mbps	Claro	Does not report	5G Test	July 2020

Source: own.

5. Main characteristics of 5G deployment in South America

Specifically, in South America, there is promising progress in most of the countries in this area, with the help of policies and studies, correct planning of the implementation of the new 5G technology is being carried out. The following is a compilation of the most important aspects regarding 5G deployments and the most important aspects of regulation with the limitation of spectrum release.

5.1. 5G Deployment

In South America: Brazil, Suriname, and Uruguay are the South American countries that have demonstrated deployments of 5G technology.

- In July 2020, Claro will deploy 5G DSS (Dynamic Spectrum Sharing), which consists of redistributing the frequency bands already available and used in the 4G network, reaching speeds of 416.6 Mbps [17].
- In Suriname, the operator leading the 5G market is Telesur, the implementation was set in the 3.5 GHz frequency band due to its availability for operation. [18].
- In the Uruguayan case ANTEL used the 28 GHz frequency band in the deployment in April 2019 in the cities of La Barra in Maldonado and Nueva Palmira in Colonia; its use is focused on fixed wireless access (FWA) [19].

5.2. Regulatory characteristics in South American countries

In the regulatory aspect, some specific differences remain in the case studies, of which the following stand out:

- In Argentina in Article 17 of Law No. 27078 of 2014 [20] called "Mecanismos de coordinación para el despliegue de redes de telecomunicaciones" (Coordination mechanisms for the deployment of telecommunications networks) which imposes the federal character which means that each province has the power to regulate the deployment of telecommunications infrastructure and services, on the other hand, in the "Documento base sobre la identificación de desafíos y necesidades de espectro radioeléctrico en Argentina" (Base document on the identification of challenges and needs of radio spectrum in Argentina) [21] it is identified that the bidding scheme in the 4G bands has not been finalized, it is important to conclude with this scheme to move forward with 5G technology.

- In the Bolivian case, Article 24 of Law No. 164 of 2011 [22] stands out, which requires that all infrastructure projects that provide electric power, hydrocarbon, and transport services must include the installation of optical fiber. The implementation of 5G technology is problematic since in the Bolivian National Frequency Plan the frequency range of the 3.5 GHz band is occupied by the Tupac Katari satellite [23].

- Regarding the Brazilian territory, Article 144 in paragraph 3 of Law 13879/2019 [24] determines that the investment will prioritize the implementation of network infrastructure with high data communication capacity in areas without adequate competition. Brazil has had delays in the aspect of spectrum release with several budgeted dates, in February 2020 ANATEL approved bidding for the 700 MHz, 2.3 GHz, 3.5 GHz, and 26 GHz bands, and the inclusion of another 100 MHz in the 3.5 GHz band which is expected to take place in 2021 [25].

- Through the document in public consultation version called National 5G Plan for Chile [26] published on July 25, 2018, there, 3400 - 3800 MHz and 27.5 - 28.35 GHz are identified as priority bands for the development of 5G technology. Following this guideline, at the beginning of 2020, the radio spectrum bands of 700 MHz; AWS; 3.5 GHz, and 28 GHz were identified to start a public consultation forbidding competition [27].

- In Colombia, the 5G Plan published in December 2019 [28] with validity in 2022 where it is expected to have a deployment of the technology stands out. It presents a review of the current regulations in the ICT sector and the deployment of infrastructure, on the other hand, it presents the challenges of the technology and how the transition from 4G to 5G would be carried out and the roadmap of activities to achieve this deployment.

- In Ecuador, the consultation process for the 900 MHz and AWS bands took place at the end of September 2017 and the consultations for the 3.3-3.4 GHz and 3.4-,3.6 GHz ranges took place in April 2018 [29]. In the case of 3.4-3.6 GHz, frequencies already mentioned as potentially usable in the implementation of 5G technology, 50 MHz are assigned to the operator CNT at the national level and 21.5 MHz to the fixed telephony operator Etapa, so 128.5 MHz remain available.

- In the Guyanese case, the flexibility on the part of the Public Utilities Commission (PUC) in the deployment of infrastructure, in the General Telecommunications Act [30] highlights 'The demolition of streets, the removal of obstacles and access to land', there, it is determined that the operator will have rights on private or public property to deploy their networks, including the natural environment. Guiana is still in a backward process of delayed convergence since according to [31], the country has an approximately 2% adoption rate of 4G in the population.

- Paraguay does not have independent resolutions that regulate the infrastructure deployment section, however, Article 24 of the telecommunications law [32] provides that the state has the power to expropriate properties for network deployment. The country does not have active bidding processes for the frequencies set for the 5G network, since these frequencies are currently assigned for other services and with a duration of validity until 2024 [33].

- The 5G technology environment in Peru is lagging due to the poor network infrastructure in Peru. According to the OSIPTEL report [34] of April 2020, in terms of telecommunications infrastructure for mobile services, there are only 2,476 antennas, which are insufficient for preceding technologies.

- In the case of Suriname, Chapter 3 of Law No. 151 of 2004 [15] contains the regulations for the deployment of infrastructure, in this sense, the granting of a concession to the satisfaction of the president with requirements in terms of financial resources, technical knowledge, organizational capacity and sufficient experience in telecommunications is emphasized. However, to the implementation, the country has several drawbacks in terms of spectrum liberalization according to [35] is because the government has not allocated sufficient frequency range of radio spectrum for operators to be able to offer mobile broadband transmission services of higher speed and quality.

- In 2019, Uruguay was the point of installation of infrastructure and tests, in general, to ensure correct deployment of 5G, in turn, verified the radiation limits imposed by the WHO and by the same Uruguayan regulations where the result, in general, was satisfactory [19].

- For the deployment of infrastructure in Venezuela there is the regulation imposed in Title III of the Organic Law of Telecommunications [36], the current state of 5G development evidences a delay, mostly due to the current penetration of 4G technology, according to [37] This figure is the same as the rest of the countries reached in 2016.

- Finally, French Guiana is presented, which with the Regulatory Authority for Communications and Posts (ARCEP) with 'The regulation of ARCEP at the service of connected territories' [38], reports the launch of a public consultation at the end of 2019, to gather the views of stakeholders on the allocation of frequencies in the 700 MHz band in the dependencies of Reunion and Mayotte and in the band 3.4 - 3.8 GHz on the island of Reunion (another overseas territory), in this sense French Guiana is left out of this process and is on hold.

6. Conclusions

Once the diagnosis was made, it was identified that most countries are moving towards the implementation of 5G technology, some to a greater extent than others, both the public and private sectors have maintained a line of actions to such an extent that there are already three countries in the region with formal deployments. Brazil, Uruguay, and Suriname already have 5G deployments, while Guiana, Paraguay, and Venezuela have not made much progress in the development of 5G, mainly in terms of infrastructure.

The importance of aspects such as spectrum allocation, 5G testing, and state policies affect the deployment in each country and define the pace of progress. In terms of spectrum allocation, Brazil, Uruguay, and Peru stand out above 550 MHz, while Colombia and Brazil are among the few countries to implement 5G-oriented policies with the 5G Plan: Colombia and the Brazilian Strategy for Fifth Generation Networks (5G). In terms of 5G deployment trials, Guiana, Paraguay, Venezuela, and French Guiana have not yet documented experimental trials.

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