

Analysis of ITU Spectrum Recommendations in Latin America

Understanding Spectrum
Allocations and Utilization
in Latin America



April 2016

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EXECUTIVE SUMMARY

At the end of 2015, the Western Hemisphere had over 1.144 billion wireless subscribers, a figure accounting for 15.7 percent of global subscriptions.¹ In the Americas, mobile markets in Latin America and the Caribbean share several characteristics.

A common trait in the region is mobile service penetration, which at the end of 2015 stood above 100 percent on a regional scale with five markets boasting penetration rates in excess of 130 percent, seven others in the range of 100 percent to 130 percent, and the remaining markets slightly below 100 percent. The region also shares low penetration of fixed broadband, while it has a growing base of subscribers using smartphones and mobile broadband services.

The need for allocating more spectrum to mobile service providers throughout the region is a key element in driving mobile broadband technology deployment. Meeting this need will enable continued technological evolution to keep up with society's growing demand.

North America, including Mexico, allocated capacity in the Advanced Wireless Services (AWS) 1.7/2.1 GHz band, also known as the AWS-3 band (1755-1780/2155-2180 MHz) and will be allocating the 600 MHz band, which has become available after the repacking of the broadcast television stations using that band. It is important for Latin America to work in concert towards a standardized spectrum plan. The region will profit from economies of scale and provide access to a full ecosystem of processors, terminals and infrastructure; as well as from the possibility of Long Term Evolution (LTE) broadband roaming.

At the end of 2015, the 850 Megahertz (MHz) band was the only common spectrum offered throughout Latin American markets. Likewise, by that date, fourteen markets had allocated AWS 1.7/2.1 GHz spectrum (1710-1755 MHz coupled with 2110-2155 MHz) and at least five markets had completed the 2.5 Gigahertz (GHz) range (2500 MHz at 2690 MHz) for mobile service provision.

¹ Ovum, WCIS+, December 2015

Table 1: Mobile Spectrum Allocations in Latin America.

Source: 5G Americas based on regulators' data²

	700	850	900	1700	1800	1900	1700/ 2100	2100	1900/ 2100	2300	2600
ARGENTINA											
BOLIVIA											
BRASIL											
CHILE											
COLOMBIA											
COSTA RICA											
ECUADOR											
EL SALVADOR											
GUATEMALA											
HONDURAS											
MÉXICO											
NICARAGUA											
PANAMÁ											
PARAGUAY											
PERÚ											
R. DOMINICANA											
URUGUAY											
VENEZUELA											

There are several drivers behind government initiatives to allocate spectrum, the main being the need to foster technology innovation through the development of new technologies. This will provide higher data throughputs, allowing users to access mobile broadband internet services and video centric applications. Another factor contributing to higher spectrum demand is the evolution of the Latin American mobile market, which increased from 60 million users in 2000 to 706 million in 2015³.

The International Telecommunication Union (ITU) 2078 Report on Mobile, Radiodetermination, Amateur and Related Satellite Services (ITU-R M. 2078) establishes suggestions for the allocation of sufficient radio spectrum to allow for appropriate International Mobile Telecommunication (IMT)-2000 and IMT-Advanced development.

The International Telecommunications Union (ITU) estimates that, by 2020, a range of 1340 to 1960 MHz of spectrum will have to be allocated to mobile service. Considering the estimate of 1300 MHz for 2015 made by the same body, in the first quarter of 2016, 330 MHz, i.e. 25.38 percent of this parameter, had been allocated throughout the region on average. The regional situation can be summed up as follows: five countries have allocated over 400 MHz; five are below 400 MHz, but above 300 MHz and the remaining countries range from 208 to 290 MHz

Using the ITU's reference for 2015 as a benchmark, only five markets exceed 30 percent of the target and 10 are above 20 percent. On the other hand, three countries are below 20 percent.

² In the table, 11 frequencies are shown in 10 countries in the region. The 700 MHz spectrum allocation in Bolivia and Puerto Rico corresponds to bands 12, 13, 14 and 18 of the Third Generation Partnership Project (3GPP). Ecuador and Nicaragua adopted the Asia Pacific Telecommunity channel plan (APT 700 MHz), corresponding to band 28 of the 3GPP. El Salvador has not defined its band plan.

³ Ovum, WCIS+, December 2015

Taking into account these allocations to operators for commercial service offerings, there is still a shortage of internationally harmonized wireless spectrum in the region. In this regard, regulators should take a step from 'showing interest' and having 'plans' to actually 'making more spectrum available' for mobile service provision. However, most regulatory agencies in the region have expressed their interest in auctioning spectrum on 700 MHz in the near future and at least eight countries have already made allocations in the first quarter of 2016.

The main obstacle encountered by Latin American governments is warranting those 700 MHz frequencies are free from interference. In addition wherever appropriate, that spectrum will be available once the TV analog signals have migrated to digital formats and thus freed up spectrum to obtain what is commonly known as digital dividend. This band (700 MHz) is considered to be an opportunity to allocate harmonized spectrum in the region.

Postponement in spectrum licenses could be said to hinder market development, and could in turn limit the investment flows that licensees should gear at the acquisition of spectrum as well as infrastructure, terminals, administrative and operating costs and advertising.

Regulators in Latin America should be diligent in understanding the importance of making more radio spectrum available for mobile services in the market. This will lead to a boost in economic growth and connectivity in their countries. Several studies have demonstrated that investment in mobile broadband has a positive impact on GDP. Mobile broadband is capable of bridging the digital divide and offering new development opportunities in areas such as education, health, government and transport. This is especially important in rural and remote areas, where fixed telecommunication operator infrastructure is rare, making wireless technology the only alternative for offering broadband services to the population and working toward reducing the digital divide.

INTRODUCTION

Mobile markets in Latin America and the Caribbean share several characteristics. One such commonality is penetration, which at the end of 2015 stood above 100 percent in the region, with five markets boasting penetration rates in excess of 130 percent, seven others in the range of 100 percent to 130 percent, and the remaining markets slightly below 100 percent.

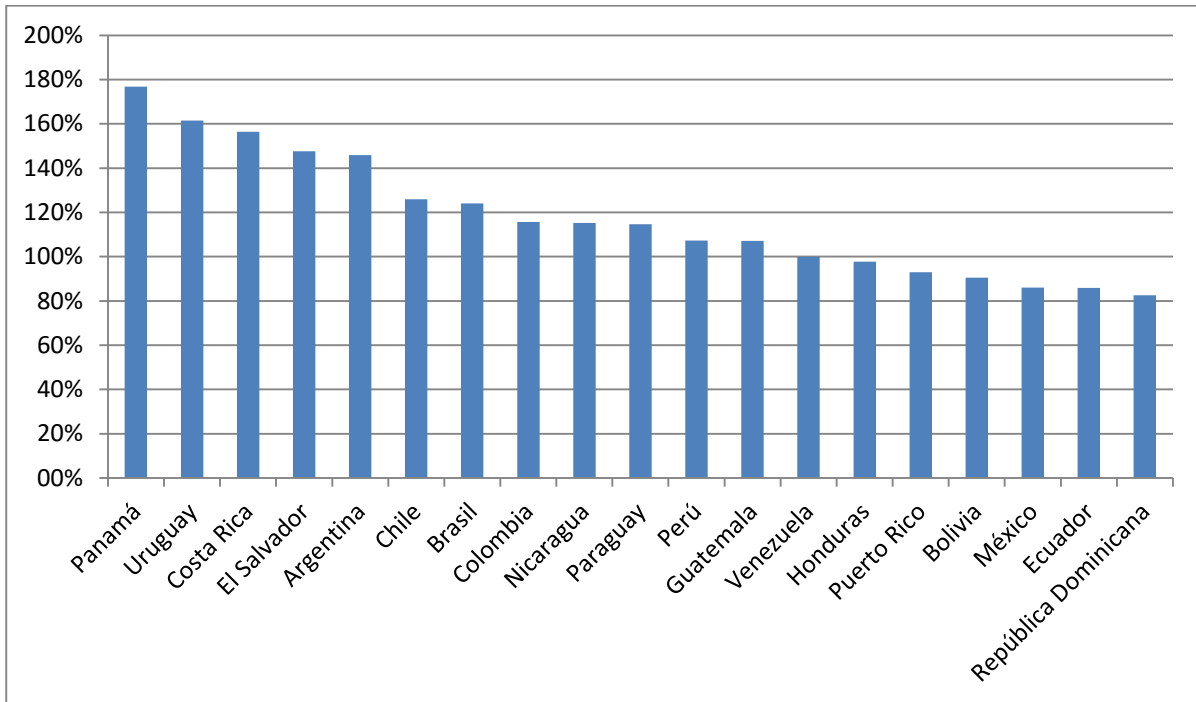


Figure 1: Latin America and the Caribbean, Mobile Penetration in 4Q 2015.⁴

All country markets in Latin America currently have UMTS/HSPA networks and operators that offer some mobile broadband option. Likewise, by the end of the first quarter of 2016, all markets except for Cuba and El Salvador had launched commercial services using LTE technology. In at least 13 markets, the AWS (1.7/2.1 GHz) spectrum band was allocated and in six others, frequencies on the 2.5 GHz band (2500 MHz to 2690 MHz) were allocated.

There are several drivers behind government initiatives to allocate spectrum, the main being the need to foster technology innovation through new technology development. This will provide higher data throughputs, allowing users to access mobile broadband internet services and video-centric applications. For this to be done efficiently, operators should keep separate networks (each one with its own bandwidth requirements) with different technologies.

Another factor contributing to higher spectrum demand is the evolution of the Latin American mobile market, which grew from 60 million users in 2000 to 706 million in 2015. Over the same period, mobile use evolved from voice-based services to advanced data-intensive applications and mobile broadband services. This trend will continue in the future, with mobile broadband accounting for 88 percent of all

⁴ Ovum, WCIS+, December 2015

mobile lines in the region by 2020.⁵ According to Cisco, data traffic will climb from 276.416 terabytes per month in Latin America in 2015 to 2.091.073 by 2020.⁶

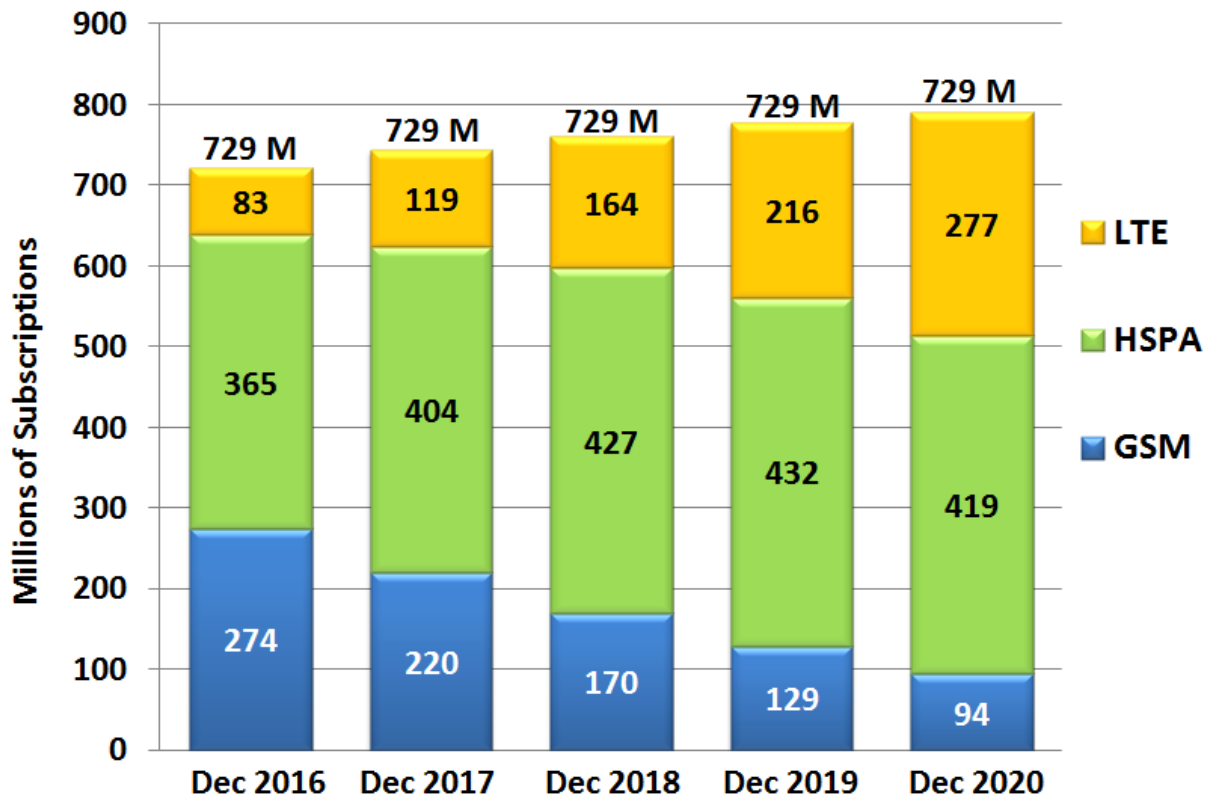


Figure 2: Mobile Broadband Forecast in Latin America.⁷

⁵Ovum, WCIS+, December 2015

⁶[Cisco](#) Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015–2020 White Paper

⁷ Ovum, WCIS+, December 2015

ITU SUGGESTIONS FOR MOBILE SPECTRUM

The Radiocommunication Report ITU-R M.207⁸ published in 2006 by the International Telecommunication Union establishes suggestions for allocating enough spectrum to enable the development of IMT-2000 and IMT-Advanced. In this connection, the ITU seeks to help governments allocate spectrum efficiently to allow for the expansion of mobile broadband service.

The ITU-R M.2078 Report was developed in preparation for item 1.4 of the WRC-07 agenda. In preparation for item 1.1 of the WRC-15 agenda, ITU-R developed an update of estimated spectrum needs. The work in the new draft Report ITU-R M. [IMT.2020.ESTIMATE] uses the suggestions in ITU-R M.1768-1 and is based on Reports ITU-R M.2072, ITU-R M.2074, ITU-R M.2078 and particularly ITU-R M.2243. Nevertheless, Report ITU-R M.2078 continues offering guidance until an updated version is available with the finalization, approval and publication by ITU-R of the new ITU-R M. [IMT.2020.ESTIMATE] Report at the end of 2014 / beginning of 2015.

The ITU-R M.2243 Report published in 2011 analyzes both market and traffic projections for International Mobile Telecommunication (IMT) developed in earlier study periods (2000-2007) and evaluates present prospects for mobile broadband and the needs for IMT in the next decade (2012-2022). It also presents new traffic forecasts provided by different industry sources until 2015 and a source for the forecast from 2015 to 2020 taking into account new market trends and drivers. The ITU-R M.2078 suggestion was made in a context of growing pressure on operators' mobile networks, after the fast increase in mobile data traffic globally. Therefore, the ITU establishes a minimum amount of spectrum allocated to IMT-2000 and IMT-Advanced, for the years 2010, 2015 and 2020 depending on the market development stage: lower user density environments to higher user density environments. The ITU suggestion classifies the Radio Technology Group Access (RATG) spectrum needs. RATG 1 covers pre-IMT and IMT, as well as improvements on IMT, while RATG 2 covers IMT-Advanced.

The ITU-R M.2290 Report updated the spectrum forecast requirements for the year 2020, which results in a range between 1340 and 1960 MHz, depending on the market environment.

⁸ [Report](#) ITU-R M.2078 Estimated spectrum bandwidth requirements for the future development of IMT-2000 and IMT-Advanced (2006)

Table 2: ITU Suggestions: Spectrum Allocation for IMT and IMT-Advanced Technology Development.⁹

Market environment	Spectrum requirement for RATG 1 (MHz)			Spectrum requirement for RATG 2 (MHz)			Total spectrum requirement (MHz)		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
Year	2010	2015	2020	2010	2015	2020	2010	2015	2020
Higher user density setting	840	880	880	0	420	840	840	1300	1720
Lower user density setting	760	800	800	0	500	480	760	1300	1280

The goal of spectrum allocations represents the total amount of spectrum in a given market. These ITU suggestions allow mobile operators to visualize the growing needs in society, which uses connected devices at an increasing rate.

New services and applications, new terminals and the ongoing increase in the use of connected smartphones, tablets and machines affect all aspects of users' lives, including government, education, transport and health. The increase in the use of these applications on mobile networks is a forecast to undergo an annual cumulative compound growth of 50 percent in the period from 2015 to 2020 and to increase from a monthly average of 276.416 terabytes (TB) per month in 2015 to 2.091.703 TB in 2020.¹⁰

⁹ ITU-R M.2078 and ITU-R M.2290, International Telecommunication Union, February 3, 2015

¹⁰ [Cisco](#) Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015–2020 White Paper

SPECTRUM OUTLOOK IN LATIN AMERICA

Results indicate that, at best, only 41.7 percent of the spectrum allocation goal for 2015 has been met. The need for additional spectrum allocations is shown by the launch of LTE networks throughout the Latin America region in the new spectrum, as indicated in Table 3. The LTE Frequency Division Duplex (FDD) frequency bands corresponding to those defined by the Third Generation Partnership Project (3GPP) for LTE in commercial mobile networks are the following: bands 12, 13, 14 and 17 for 700 MHz with the USA channel plan and band 28 for the 700 MHz band with the APT channel plan; band 10 and 4 for 1.7/2.1 GHz, commonly referred to as AWS and band 7 for 2500 MHz (2500-2570/2620-2690 MHz); band 3 for 1700 MHz and band 2 for 1900 MHz.

Most LTE mobile commercial services in the Latin American region have recently gone through auction processes.

It is important to understand that the Latin American region has characteristics that are quite distinct from other zones in the Western Hemisphere. A monthly Average Revenue Per User (ARPU) of US\$ 9.19¹¹ was estimated for 2014¹². Internet connectivity has been low and per capita regional Gross Domestic Product (GDP) in that same year was approximately US\$ 8.990.¹³

Therefore, offering new spectrum in the market allows mobile operators to increase the network capacity efficiently to support the new world of connectivity in smartphones, which currently use 35 times more spectrum. On the other hand, different technological and economic studies have shown that the increase in mobile broadband penetration and higher throughput rates increase GDP and employment¹⁴

Using ITU's suggestion of 1300 MHz for 2015 as a benchmark, the situation in the region may be summed up as follows: only four markets exceed 30 percent of the goal and 11 are above 20 percent. On the other hand, three countries are below 20 percent. As at the first quarter of 2016, 330 MHz have been allocated on average in the region, that is, 25.38 percent of this parameter. The regional situation may be summed up as follows: five countries have allocated over 400 MHz; five are below 400 MHz and above 300 MHz; and the remaining countries range from 208 to 290 MHz.

¹¹ [Iniciativas para el cierre de la brecha digital](#), Telecom Advisory Services, LLC , December 2015

¹² [Towards a sustainable approach for 4G deployment in Latin America](#), Calum Dewar, Dennisa Nichiforov-Chuang, Mark Giles, 13 May 2015

¹³ [World Bank Open Data Statistics](#), March 2016

¹⁴ Socioeconomic Impact of Broadband Speed, Ericsson, Arthur D. Little & Chalmers University of Technology. 2011.

Table 3: Allocated Spectrum Percentage According to ITU Suggestion for 2015 and 2020.

Market	Total Spectrum	ITU 2015 Suggestion	Percentage Achieved 2015	ITU 2020 Suggestion	Percentage Achieved 2020
Argentina	403	1300	31%	1720	23.47%
Bolivia	274	1300	21.1%	1720	15.93%
Brazil	542	1300	41.7%	1720	31.51%
Chile	465	1300	35.8%	1720	27.03%
Colombia	355	1300	27.3%	1720	20.64%
Costa Rica	460	1300	35.4%	1720	26.74%
Dominican Republic	312	1300	24.0%	1720	18.16%
Ecuador	290	1300	22.3%	1720	16.86%
El Salvador	208	1300	16%	1720	12.12%
Guatemala	210	1300	16.2%	1720	12.24%
Honduras	290	1300	22.3%	1720	16.86%
Mexico	314	1300	24.2%	1720	18.27%
Nicaragua	420	1300	32.3%	1720	24.42%
Panama	220	1300	16.9%	1720	12.79%
Paraguay	280	1300	21.5%	1720	16.28%
Peru	304	1300	23.4%	1720	17.7%
Uruguay	270	1300	20.8%	1720	15.7%
Venezuela	324	1300	24.9%	1720	18.84%
Average	330	1300	25.38%	1720	19.19%

Two developments affect the amount of spectrum allocated in regional markets in Latin America. The first refers to the direct allocation of spectrum. Since 2000, there has been an increase in the number of direct spectrum allocations (with no spectrum tenders) to state-owned companies. For example, since the first quarter of 2013 eight markets have allocated spectrum to a state operator-- Argentina, Bolivia, Costa Rica, Ecuador, Honduras, Paraguay, Uruguay and Venezuela. In Mexico, the legal reform of the telecommunications regulatory framework ordered the creation of a wholesale mobile service network. The allocated number of MHz differs in each case and ranges from 30 to 130 MHz.

The second development is allocated spectrum that stands unused when it is timely to do so. Allocation of additional spectrum to service providers leads to higher and better use of spectrum. There are certainly legitimate reasons behind operators' decisions to postpone mobile service deployment on a spectrum band: the wait for finalization of technology or interference standards. In recent years, it has become evident in Latin America that part of the spectrum allocated by regulators still remains unused.

THE FUTURE OF RADIO SPECTRUM IN LATIN AMERICA

In spite of the fact that the maximum amount of spectrum allocated to telecommunications operators for the commercial offer of mobile services accounts for only 41.7 percent of the ITU suggestion for 2015, at least through October 2017, several spectrum licensing processes are expected in different markets in the region. This is a first step toward reducing mobile network congestion and increasing mobile broadband services to attain higher quality levels.

Table 4: Latin America Spectrum Auctions by Country.¹⁵

Country	Type of Auction/Award	Date
Mexico	700 MHz	2016
Mexico	2600 MHz	2016-2017
Peru	700 MHz	2016
El Salvador	806-894 MHz and AWS	TBD
Paraguay	700 MHz and 2600 MHz	End 2016
Puerto Rico	600 MHz	2016
British Virgin Isles	450 MHz, 700 MHz, PCS, AWS and 2600 MHz	TBD
Costa Rica	1800 MHz and 1900/2100 MHz	2017
Costa Rica	900 MHz	Late 2017
Colombia	700 MHz, 900 MHz, remaining 1900 MHz and 2600 MHz	2015-2017
Colombia	AWS-3, 2300 MHz and 3500 MHz	2017-2019

When considering spectrum allocations, regulators must make note of the benefits of spectrum harmonization, including economies of scale, lower price points on devices to consumers and better roaming. New spectrum allocations must configure licenses with adjacent spectrum bandwidths, without interference and the bundling of other similar services.

Participation in many of these future spectrum auctions may be limited due to present spectrum caps in several markets in the region; this possibly hinders investment and economic growth.

Several regulatory agencies and consumer protection entities in Latin America have reacted against market concentration by taking precautionary measures to protect consumers. In some cases, demands included the request for returning or transferring the spectrum obtained by means of consolidation. Changing the rules on spectrum rights-- whether after the acquisition of additional spectrum through procurement, or after having reported it, or as available at the start of a tender-- distorts the free market system and denies access to the most attractive and valuable resource acquired (or about to be acquired, in the case of a tender) by the purchasing company. Imposing new rules that restrict or deny the use of

¹⁵ 5G Americas & Telconomía- Chart prepared by Telconomía for exclusive use by 5G Americas.

this resource after the purchase has taken place, or after the tender has started, severely distorts free market principles and is detrimental to investors' needs for regulatory certainty.

On the other hand, the lack of interest on the part of operators in entering the market from a reserved spectrum tender precludes the state from obtaining fresh financial resources. Moreover, it is inefficient because radio spectrum remains in surplus if the operators already in the market cannot use it. Thus, consumers may suffer from poorer service quality due to network congestion, or be prevented from enjoying new mobile broadband services. If incumbent operators could use the "reserved" spectrum, the State, in turn, could benefit from higher revenues through the collection of spectrum usage fees.

SPECTRUM ALLOCATION CHALLENGES

Current macroeconomic conditions in many Latin American markets present an unfavorable outlook for radio spectrum auctions. Economies worldwide are still recovering slowly from the pressures of the slowdown triggered by the global financial crisis in 2008. As a result, license deferment has become a possibility in Latin America, for governments are trying to avoid issues such as lower than expected bids or even vacant tenders.

Of course, spectrum licensing is not as simple as it may seem, since a host of internal and external interests are at stake in this process. There is no doubt that spectrum licensing must continue in a region where wireless technology adoption rates are asymmetrical.

Governments, operators, providers and industry associations all agree that spectrum licensing has become a hindrance to the market development because:

- It limits investment flows, since potential awardees will fail to invest in spectrum acquisition, infrastructure, operating and administrative costs, as well as advertising. In addition to the negative impact on the GDP, the immediate social impact is the absence of numerous direct and indirect new jobs in a region marked by high unemployment rates.
- It may create congestion in the spectrum auction calendar; national regulators should determine how the deferment will affect the rest of their spectrum auction calendar. Regulators will have to either prioritize the spectrum licenses to be auctioned first or face the risk of conducting simultaneous auctions of different spectrum bands. Because many operators have stated their interest in acquiring licenses in different parts of the spectrum, the lack of consistent planning no doubt limits the number of parties submitting their bids at auction. Financial constraints will force the companies to "pick and choose" which licenses to acquire.

The region's regulators must focus on creating fair and transparent auctions that support investment in networks and enable the deployment of mobile access technologies and their integration in the public policy programs that foster adoption of Information and Communication Technologies (ICTs).

On the other hand, the government's decision to auction 2.5 GHz and AWS provides an opportunity for other markets in the region to improve the economic scale of LTE services on these bands throughout Latin America and the Caribbean. As digital television increases its presence in the region and analog networks start to be eliminated, more spectrum on 700 MHz (i.e. digital dividend spectrum) will become available and allocated to the different market players.

CONCLUSION

No Latin American market has reached 50 percent of the 1300 MHz suggested by 2015 at the ITU-R M.2078, a document establishing the spectrum allocation requirements for optimum performance of IMT-2000 and IMT-Advanced.

The lack of enough spectrum to develop these services has negative consequences for consumers and restricts the growth potential of the telecommunications industry. Without further spectrum, technological development will not meet the growing broadband demands of society, which is a risk because broadband connectivity is essential to a country's future. More harmonized spectrum is needed throughout the region.

Only four markets in the region have allocated more than 30 percent of the ITU suggestion by 2015: Argentina (31 percent), Brazil (41.7 percent), Chile (35.8 percent), Costa Rica (35.4%) and Nicaragua (32.3 percent). These countries have allocated the 700 MHz band. Three markets are below the 20 percent threshold of the allocated spectrum target by 2015: Guatemala (16.2 percent), El Salvador (16 percent) and Panama (19.6 percent). These countries have yet to announce a date for the next licensing process. The remaining countries are below 30 percent compliance relative to the date, but above 20 percent compliance.

The ITU is not alone in requesting more spectrum. Most of the studies conducted on spectrum requirements show more spectrum is needed. A Next Generation Mobile Network Alliance (NGMN) study from 2007 determines that the net spectrum requirements would be between 500MHz and 1 GHz by 2020, depending on the world region. In the United States, the Federal Communications Commission (FCC) requested 500 MHz of new spectrum to be allocated by 2020. Some countries' governments are increasing their efforts to allocate spectrum as they realize that, currently, spectrum is comparable to the need for roads, railways, airports, water, and sewage infrastructure in previous years.

One outcome from greater spectrum allocation would be mobile network efficiency, especially in densely populated urban areas where spectrum limitations are aggravated by other restrictions, such as delays in the authorization of new tower or technology deployments. For example, LTE will be more efficient in terms of spectrum usage. It is worth noting that, in many cases, new spectrum is preferred for new technology deployments, while allocated bandwidth is already being used by mature mobile technologies such as Global System for Mobile Communications (GSM) or Universal Mobile Telecommunication System (UMTS) / High Speed Packet Access Plus (HSPA+).

Most new LTE deployments worldwide have taken place after operators obtained new spectrum. Technologies such as LTE benefit from wider radio channels because they enable greater efficiencies that reflect on aspects such as higher data throughputs. With an ARPU of U\$9.19 in the region on average, limited Capital Expenditure (CAPEX) and bureaucratic delays in tower installations, granting new spectrum is the most efficient way for operators to increase network capabilities and deploy new technology.

On the other hand, allocating spectrum to dedicated data channels may enable mobile operators to offer increased mobile broadband throughputs, which raises customer satisfaction and meets government's goals of broadening broadband coverage in their markets. The lack of robust mobile broadband connections delays the adoption of advanced applications that seek to solve coverage issues in education, health, transport and government services.

A study¹⁶ quantified the isolated impact of broadband speed in 33 Organization for Economic Cooperation and Development (OECD) countries, showing that doubling broadband speed increases the GDP of an economy by 0.3 percent. A 2010 study showed that for each 10-percentage point increase in broadband penetration, a country's GDP grows by 1 percent. In turn, an ITU study from 2012 indicates that for each 10-percentage point increase in broadband penetration, there has been a direct impact on efficiency (of up to 3.6 percent, and economic growth (from 1.21 percent to 1.36 percent of GDP).

Latin American regulators must continue to be diligent in bringing in more spectrum to the market with the purpose of promoting economic growth and global connectivity in their countries for the benefit of their citizens. This is particularly relevant in rural and remote areas, where wireline infrastructure of fixed service providers is absent, making wireless technologies the only viable choice for broadband service offerings to the population. It is of utmost importance for the Americas region to work towards a harmonized spectrum plan for the region as a whole to achieve economies of scale. Such a plan should encompass the entire ecosystem of chipsets, devices and infrastructure, as well as LTE mobile broadband roaming.

¹⁶ Analysis of ITU Spectrum Recommendations in the Latin America Region , 4G Americas, August 2013, Page 8

APPENDIX A: LATIN AMERICAN MARKET PROFILES

ARGENTINA

In late 2015, Argentina had a population of 43,298,264 over an approximate territory of 2,780,400. The mobile market had 63,173,714 lines, or 145.9 percent penetration, with three network operators providing service--Claro, Movistar and Personal. In addition, there is an MVNO - Nuestro - that belongs to the cooperative companies operating in the interior of the country.

The Argentine market was awarded 403 MHz for mobile service. According to the total spectrum awarded to operators, Argentina's mobile market meets the targets proposed by the ITU-R M.2078 at a 31.05 percent rate by 2015, and at 23.47 percent by 2020.

BOLIVIA

At the end of 2015, Bolivia had an estimated population of 10,737,266, on a territory of 1,098,581 km². The mobile market closed the year with 9,715,261 lines, which accounts for a service penetration rate of 98.48 percent.

The market consists of three network operators--the National Telecommunications Company (Entel), Tigo and Viva (Nuevatel). The scenario is completed with Comteco's MVNO, Mio.

In total, the market has 274 MHz awarded to operators for the provision of mobile services, which yields a total of 38,249.06 users per MHz awarded. Thus, Bolivia only meets 21.1 percent of the spectrum that should be allocated as per International Telecommunications Union suggestion ITU-R M.2078 by 2015, and 15.93 percent by 2020.

BRAZIL

Brazil has a population of 207,749,810. In 2015, the country reported a penetration rate of 124.1 percent of mobile service, and a total of 257,814,274 lines. The market has 5 national operators -Claro, Nextel, Oi, TIM and Vivo- in addition to two regional mobile operators (Algar -CTBC- and Sercomtel). There are also several companies with MVNO licenses.

In total, the market has 542 MHz awarded to operators for the provision of mobile services, which accounts for 41.7 percent of the amount of spectrum suggested by ITU-RM 2078 for 2015- 31.51 percent of the spectrum allocation suggested by the ITU by 2020.

CHILE

Chile has a population of 17,943,052. The latest official figures (3Q15) showed 22,597,874 mobile lines, with a service penetration rate of 125.94 percent.

There are five operators in the market with spectrum holdings -Claro, Entel, Movistar, VTR (in the process to become an MVNO) and WOM- in addition to several MVNOs, including Telsur-GTD and Virgin Mobile.

The 465 MHz allocated in Chile account for 35.77 percent of the suggestions established by ITU-RM 2078 for 2015 and 27.03 percent of the ITU suggestions by 2020.

COLOMBIA

Colombia has a population of 48,228,607. By late 2015, the country had a mobile penetration rate of 115.6 percent from 55,785,880 lines in total.

There are five mobile operators in Colombia - Claro, Movistar, Tigo/UNE, Avantel and ETB. In addition, there are at least five MVNOs in the Colombian market -Éxito, Metrotel, Telebucaramanga, Uff! Móvil and Virgin Mobile.

The 355 MHz that were awarded to the Colombian operators account for 27.3 percent of the amount of spectrum suggested by ITU-RM 2078 for 2015, and 20.64 percent of ITU's spectrum suggestions by 2020. The 355 MHz listed don't contemplate the 40 MHz that Tigo/UNE needs to return to the government.

COSTA RICA

Costa Rica has a population of 4,820,782. In late 2015, the country had 7,538,700 mobile lines and a service penetration rate of 156.37 percent. The market consists of three network operators -Claro, ICE-Kolbi and Movistar) and two MVNOs - Tuyo Móvil and Full Móvil.

In total, the market has 460 MHz awarded to operators for the provision of mobile services, which accounts for 35.4 percent of the ITU-RM 2078 suggestions for 2015, and 26.74 percent of the spectrum suggested by this international body to be awarded by 2020.

DOMINICAN REPUBLIC

The Dominican Republic has a population of 10,530,929. As at December 2015, the mobile service penetration rate was 82.53 percent, from 8,692,168 lines. There are three mobile operators in the market- Claro, Orange/Tricom and Viva.

In total, the market has 312 MHz awarded to operators for the provision of mobile services, which represents 24 percent of the amount suggested by the ITU-RM 2078 for 2015 and only 18.16 percent of the ITU's suggestion on allocated spectrum by 2020

ECUADOR

Ecuador has a population of 16,144,346. By late 2015, the mobile market had 13,859,020 lines. There are three operators -Claro, Corporación Nacional de Telecomunicaciones (CNT), and Movistar.

In total, the market has 290 MHz awarded to operators for the provision of mobile services, which accounts for 22.31 percent of the amount of spectrum suggested in ITU-RM 2078 for 2015, and only 16.86 percent of the amount suggested by the international body by 2020.

EL SALVADOR

El Salvador has a population of 6,298,489 as at 2015. At year-end in 2015, the country had a penetration rate of 147.6 percent from 9,297,165 mobile lines. The market has four mobile operators - Claro, Digicel, Movistar and Tigo- and one operator providing service on an iDEN (RED Intelfon) network.

In total, the market has 208 MHz awarded to operators for the provision of mobile services, which represents 16 percent of the amount of spectrum suggested in ITU-RM 2078 for 2015, and only 12.12 percent of the ITU suggestions by 2020.

GUATEMALA

Guatemala has a population of 15,920,077. As at December 2015, the market had a total of 17,067,129 lines, which meant a mobile service penetration rate of 107.2 percent. There are three network operators in the market -Claro, Movistar and Tigo- in addition to an iDEN (RED Intelfon) operator.

In total, the market has 210 MHz awarded to operators for the provision of mobile services, which represents 16.2 percent of the amount suggested in the ITU-RM 2078 for 2015, and only 12.24 percent of the international body's suggestion by 2020.

HONDURAS

Honduras has a population of 8,075,034. In 2015, the country had a mobile service penetration rate of 97.68 percent from 7,887,951 lines. The market consists of three operators -Claro, Hondutel and Tigo.

In total, the market has 290 MHz awarded to operators for the provision of mobile services, which accounts for 22.31 percent of the amount of spectrum required as per the ITU-RM 2078 for 2015, and 16.86 percent of the international body's suggestion by 2020.

MEXICO

Mexico has a population of 124,612,397. As of December 2015, the country had a mobile penetration rate of 86.1 percent from 107,281,000 lines.

Mexico has three operators -AT&T, Movistar and Telcel. In addition, at year-end in 2015, there were six MVNOs operating in the market--KuboCel, Virgin Mobile, Maxcom, Megacable, Maz Tiempo, Cierito- and new launch announcements are expected during 2016.

In total, the market has 314 MHz awarded to operators for the provision of mobile services, which represents 24.2 percent of the amount suggested by the ITU-RM 2078 for 2015, and only 18.27 percent of the ITU suggestion by 2020.

NICARAGUA

Nicaragua has a population of 6,085,528. As at December 2015, the country reported a mobile penetration rate of 115.24 percent from 7,013,198 lines. There are three mobile operators in the market -Claro, Movistar and Xinwei.

In total, the market has 420 MHz awarded to operators for the provision of mobile services, which accounts for 32.3 percent of the amount of radio spectrum suggested in ITU-RM 2078 for 2015, and only 24.42 percent of the ITU suggestion by 2020.

PANAMA

Panama has a population of 3,929,105. At year-end 2015, the market had a mobile service penetration rate of 176.79 percent from a total of 6,946,636 lines. There are four operators in the marketplace --Cable & Wireless, Claro, Digicel and Movistar.

In total, the market has 220 MHz awarded to operators for the provision of mobile services, which accounts for 16.9 percent of the ITU-RM 2078 suggestion on the amount of spectrum necessary for 2015 and only 12.79 percent of the suggestion by 2020.

PARAGUAY

Paraguay has a population of 6,639,157. As at December 2015, the country had a mobile service penetration rate of 114.7 percent, resulting from 7,615,550 lines.

The Paraguayan market has four operators--Claro, Personal, Tigo and Vox.

In total, the market has 280 MHz awarded to operators for the provision of mobile services, which represents 21.54 percent of the amount suggested in the ITU-RM 2078 for 2015, and 16.28 percent of the ITU's spectrum allocation suggestion by 2020.

PERU

Peru has a population of 31,383,479. In 2015, the country reported a mobile service penetration rate of 107.2 percent, resulting from 33,646,198 mobile lines. There are four mobile operators in the Peruvian marketplace--Claro, Movistar, Entel and Bitel.

In total, the market has 304 MHz awarded to operators for the provision of mobile services, which accounts for 23.42 percent of the amount of radio spectrum suggested in the ITU-RM 2078 document for 2015, and 17.7 percent of the ITU's suggestion by 2020.

URUGUAY

Uruguay has a population of 3,430,277. At year-end 2015, the mobile service market had 5,540,254 lines and a penetration rate of 161.51 percent. There are three operators in the market-Antel, Claro and Movistar.

In total, the market has 270 MHz awarded to operators for the provision of mobile services, accounts for 20.77 percent of the radio spectrum suggested by the ITU-RM 2078 for 2015 and only 15.7 percent of the amount suggested by the ITU by 2020.

VENEZUELA

Venezuela has a population of 30,553,587. At year-end 2015, the Venezuelan market had 30,529,714 mobile lines and a service penetration rate of 99.92 percent. There are three operators in the market- Digitel, Movistar and Movilnet.

In total, the market has 324 MHz awarded to operators for the provision of mobile services, which represents 24.92 percent of the resource suggested by ITU-RM 2078 for 2015, and a mere 18.84 percent of the ITU's suggestion by 2020.

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