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Can Licensed Shared Access bring benefits to Developing Countries?

A comparison of the potential benefits of LSA in Europe and Latin America

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Abstract

Spectrum is a key factor for network deployments, since it determines the capacity of the network. Nonetheless, spectrum is a limited natural resource, i.e. a finite, non-exhaustible common resource. In order to fulfill the high performance targets of future mobile broadband (MBB) systems, a more efficient use and more effective management of spectrum resources have to be developed.

Licensed Shared Access is a new complementary spectrum access scheme that allows for the sharing of partially used licensed spectrum from an incumbent (e.g. a government organization), by a limited number of "LSA licensees" (e.g. Mobile Network Operators). The LSA agreement follows pre-defined dynamic or static sharing conditions, that determine where, when and how to use the incumbent's spectrum.

The implementation of Licensed Shared Access needs the support of a very good regulatory framework and follow the harmonized spectrum pathway. Spectral harmonization or the uniform allocation of frequency bands across an entire region lowers the technology costs, making it easier for any country to consider its implementation. Once adopted throughout the regions, economies of scale are achieved.

The approach taken in this research covers the interrelations between technical, market and regulatory conditions in Latin America, in order to present the possible value LSA could bring to the region. The research showed how the region still has a vast amount of spectrum to be allocated as exclusive spectrum, which is preferred by operators. The low mobile broadband penetration in most of the region is another factor for the low value of LSA at the time of this study.

Keywords

LICENSED SHARED ACCESS; SPECTRUM ALLOCATION; TECHNO-ECONOMIC ANALYSIS

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1 Introduction and motivation

Mobile networks have been struggling with the increase in mobile broadband consumption due to faster networks, powerful devices and more traffic-demanding applications, as well as a higher penetration volume. The soaring traffic that is expected for the coming years represent a massive challenge all around the globe. Cisco forecasts that mobile data traffic will grow to 15.9 exabytes per month by 2018, nearly a 11-fold increase over 2013 (CISCO, 2014). The increasing amount of data and video traffic carried by mobile networks, and the expected traffic from Machine-To-Machine (M2M) services has recently raised the demand for enhanced network capacity, which is likely to exceed spectrum capacity in the near future.

In order to correspond to the new network's demands and economical concerns, and address the spectrum shortage, new spectrum sources and schemes have been pointed out. Spectrum sharing is considered to be particularly interesting; with this scheme a given portion of the electromagnetic spectrum is shared by two or more parties. The main purpose of spectrum sharing is to make use of these unused gaps of spectrum in order to improve coverage, or more importantly: capacity.

Licensed Shared Access (LSA) is a new complementary spectrum access scheme considered as one possible solution for spectrum shortage. LSA allows the sharing of partially used licensed spectrum from an incumbent (e.g. a government organization), by a limited number of "LSA licensees" (e.g. MNOs). The LSA agreement follows pre-defined dynamic or static sharing conditions, that determine where, when and how to use the incumbent's spectrum.

It is essential to consider that every spectrum scheme must follow a fundamental pathway in its development: Firstly, spectrum harmonization must be reached, to a have a seamless international adoption and provoke economies of scale. On paper, Licensed Shared Access can be considered to be an attractive and robust sharing option for the industry. However, the implementation of Licensed Shared Access needs the support of a very good regulatory framework and follow the harmonized spectrum pathway.

Currently only the regulatory bodies from the European Union and the United States have started to take the initial steps into LSA. However, the potential of LSA, is still not clear. It is crucial to consider how other regions around the world can be affected by this new approach in order to see if LSA is a viable option or not.

The aim of this paper is to analyze the potential value that LSA can bring to the telecom markets developing countries in Latin America and compare it to the value it is expected to bring in Europe. The main focus is to assess its technical and economic feasibility; and understand the current spectrum landscape in the region. In this regard we aim to answer the following two questions;

RQ1: What potential benefits can LSA bring to developing countries in Latin America?

RQ2: What are the challenges of LSA in Latin America? How the regulations and market conditions in the region work for or against such approach?

2 Methodology

This study is devoted to understand and analyze the possible value of LSA, focusing in Latin America. Both qualitative and quantitative research studies were adopted in this paper. First, the qualitative study was devoted to understand the current landscape of the region, and the technologies involved. It also helped to understand the challenges that LSA could face, due to the regulations and market conditions of the region. The quantitative study, considered different scenarios to complement the overall research study, by giving a clear view of the economic incentives LSA could bring to the actors in the region.

2.1 Qualitative Method

The approach taken in this study covers the interrelations between technical, market and regulatory conditions in the region in order to present the possible value of LSA. Due to its nature, the analysis of the value of LSA is multi-dimensional and it includes trade-offs between different requirements and attributes. The qualitative method deals with the market conditions found in the region to then deal with a more specific study of the market and regulatory conditions of selected countries in the region.

2.1.1 Data Collection

Statistics information describing the telecom market and regulatory conditions of each of the case-study countries was gathered from MNOs and NRAs documents. In order to understand in detail the studied region, a country classification was performed. The purpose of this classification was to identify and group countries based on similarities, in order to perform an in-depth analysis.

The Data Collection phase also included an analysis based on getting information by carrying out interviews and discussions with actors involved. The discussions were carried in order to know if there is interest from MNOs and/or an economy of scale feasibility from the device manufacturers' side. The interviewees were asked about their opinion about the current market and regulatory environment, the business feasibility of and the potential impact of unlicensed spectrum schemes and of LSA in specific.

2.2 Quantitative Study

The quantitative analysis of bandwidth and demand describes the impact of LSA, and any other spectrum scheme, and identifies when and where its implementation could bring more benefits for the actors. In order to understand the effects of adding new spectrum, the tradeoff between the targeted QoS and Total Cost of ownership is investigated in selected urban areas.

To have an exhaustive assessment of the impact of LSA, the cost analysis was based on a sensitivity analysis that considered different values for network costs, user demand, and allocated bandwidth. The sensitivity analysis approach is important because spectrum costs depend on factors such as the frequency band, and on spectrum availability.

3 LSA

Licensed Shared Access is a complementary way of authorizing and accessing spectrum. It is based on cognitive radio techniques, to determine spectrum availability. The LSA framework enables the sharing of spectrum between a limited number of users. In this novel access model a primary license holder, called the incumbent, would grant spectrum access rights to one or more other users, called LSA licensees, following specific service conditions established in a LSA agreement. The conditions on the LSA Agreement may be static or dynamic. Static conditions establish a fixed use of the shared spectrum on a frequency, location or time basis, while dynamic conditions could establish a use of the shared spectrum on frequency, location and time basis (e.g. Geographic-time sharing, on-demand authorization/restrictions). A key feature of LSA is to ensure a predictable Quality of Service for all spectrum rights of use holders, the incumbent and the LSA licensee whenever each has exclusive access to the spectrum.

The sharing concept behind LSA provides an attractive alternative to a permanent segmentation and re-farming of a frequency band. Another advantage is the fact that LSA utilizes existing assets; no special radio protocol needs to be supported by the user terminals. One very interesting advantage is the fact that LSA could contribute to a global harmonization of International Mobile Telecommunications (IMT) bands. Some IMT bands cannot be exclusively assigned globally, however shared bands through LSA can open more IMT bands.

3.1 LSA Stakeholders

There are three key stakeholders in the LSA Architecture: the incumbent, the LSA licensee, and the regulatory body. They all interact via a LSA Agreement that establishes the way the spectrum is going to be shared. Figure 3.2 shows the stakeholders in a LSA scheme.

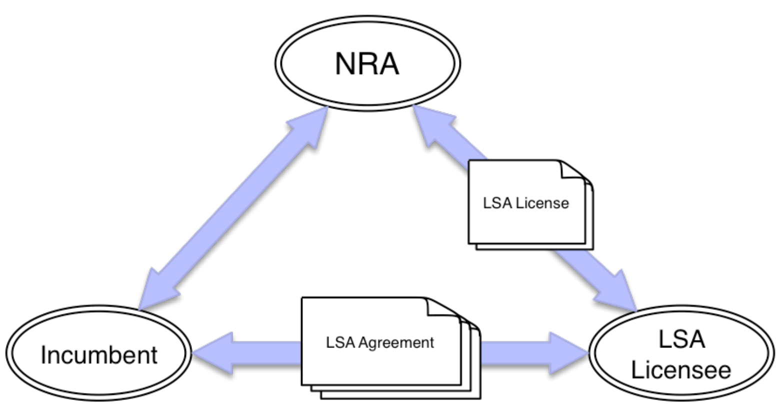

FIGURE 1 - LSA STAKEHOLDERS

3.1.1 Incumbent

The incumbent could be the holder of an individual license, or a governmental organization (e.g. Defense, Civil Aviation) with allocated frequency bands. It provides spectrum to be shared with the LSA Licensees (e.g. mobile industry and MNOs).

3.1.2 LSA Licensee

A LSA Licensee (e.g. MNO) makes use of the incumbent's shared spectrum in a dedicated way where, and when, the spectrum is not used by the incumbent following the pre-defined LSA agreement. LSA Licensee needs to comply as a prerequisite, to the LSA Spectrum usage license granted by the NRA

3.1.3 NRA

In the LSA framework the National Regulatory Agencies will be in charge of issuing licenses to MNOs that allow them to use a band as a LSA licensee. These licenses can be issued on individual or general basis.

3.1.4 LSA Agreement

The LSA Agreement must have clear conditions for proper spectrum usage by both parts: the incumbent, and the LSA licensee. The incumbent is the primary license holder, thus LSA should ensure full certainty, without operational restrictions, for the incumbent. The LSA has the requirement to not cause harmful interference to the incumbent. The LSA Agreement must also include detailed conditions under which the incumbent can take back access to the spectrum in use by the LSA licensee.

4 The Region

By the first half of 2013, the Americas had more than one billion wireless subscriptions, i.e. 16 per cent of all subscriptions worldwide. Latin America's market grew from 60 million subscribers in 2000 to 680 million in 2012. In the same year the mobile data traffic grew 77 per cent in North America, and 105 percent in Latin America. The region has a 130 percent mobile penetration. According to Cisco's Visual Networking Index the 4G connections in Latin America will grow from 0.3 per cent in 2013 to 9.1 per cent in 2018, while in North America they will grow from 24.5 percent to 50.6 per cent in the same period. GSM and HSPA networks are present all along the region. However LTE is having an aggressive deployment throughout the region. Eighteen countries from the Americas have deployed LTE.

4.1 Revenues

Several factors such as increasing investments in 3G and 4G networks, proliferation of smart phones, tablets and notebooks, local production of smart devices, and subsidized prices and installment schemes, are accelerating the uptake of mobile services in Latin America. According to Frost & Sullivan (Sullivan, 2010), the Latin American market earned $ 86.32 billion in 2012 with expectation of reaching $ 112.45 billion by 2017.

However, the contribution of mobile broadband to the ARPU of the Latin American region is still low. According to OVUM (OVUM, 2014) data ARPU accounted for 33% of service revenues in the region. The average Data ARPU from Q1 2014 was $2.88 in comparison to $6.84 from Voice ARPU. It is more than three times lower to the Data ARPU found in Western Europe where the Data ARPU on the same quarter was $9.82 and the Voice ARPU $11.89.

4.2 Spectrum

In order to serve the growing demand, more internationally harmonized spectrum throughout the region is required; harmonized spectrum would bring benefits from the economies of scale. Currently the 850 MHz and 1.9 GHz spectrum bands are common along the region. North America and some Latin American countries have auctioned parts of the AWS 1.7/2.1 GHz bands, while other countries have gone with the 2.5 GHz band. Regarding the 700 MHz band, Latin America decided to take the Asia Pacific Telecommunity (APT) 700 band.

Two trends in the Latin American markets are having an impact on spectrum allocation. Firstly, state-own operators are getting spectrum directly allocated, without any kind of auction process. And secondly, there are operators with unused allocated spectrum. Bringing more spectrum to the market will help to deploy new technology faster, increase the network's performance and throughput speeds overcoming the low ARPU and limited Capital Expenditure (CAPEX) in the Latin American region.

4.3 The Countries

The following graph helps to have an idea of where does each country stand in comparison with the rest of the region. Some countries with similarities can be identified. In order to have a deep analysis it is better to divide the countries in zones or regions. In figure 2, three values are used, the mobile penetration, the market competitiveness, and the allocated spectrum per country. The amount of allocated spectrum for each country is represented by the size of the bubbles. This is an important measure since LSA can lose value if there is still plenty of free spectrum to be allocated as exclusive spectrum.

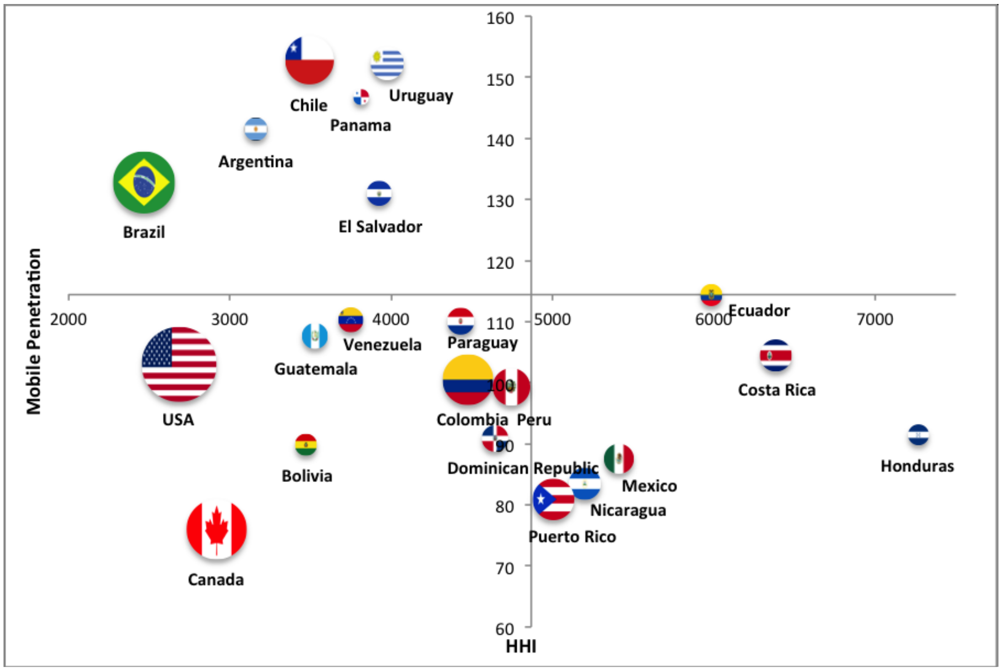

FIGURE 2 - COUNTRY GRAPH (THE AMERICAS): HHI VS MOBILE PENETRATION VS ALLOCATED SPECTRUM (GSMA, 2013)

5 Case-Study: Chile vs. The Netherlands

The country classification presented in Figure 2 helps to understand the landscape in the region of Latin America. This paper will use Chile as a case-study due to its good position among the rest of the Latin American countries. Chile showed to have both, a very high mobile penetration (the highest of the region), and a competitive market. The main goal behind this country analysis is to know if LSA can be considered as an option.

In order to enrich the study a comparison with the European region will be treated. The study will analyze The Netherlands due to have similarities to Chile, regarding country population, market share among players, and mobile penetration. The following figure (fig. 3) shows the comparison and relation between the two countries as well as other countries from around the world. The main purpose of the figure is to have a global overview of the countries.

It is important to understand that this study is focused on the value of LSA in the developing countries, thus the comparison with the European market will serve as a mere example to understand the current situation of the market.

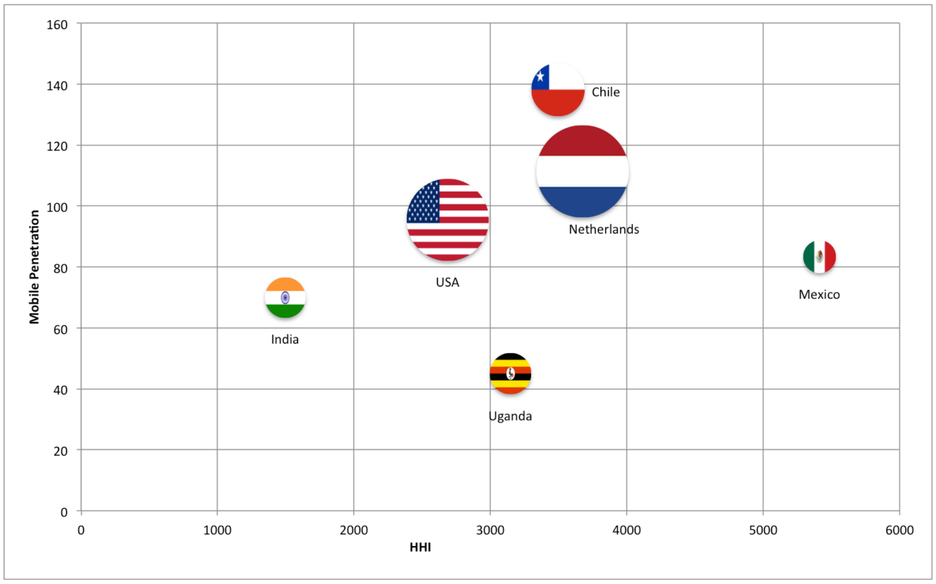

FIGURE 3 - COUNTRY GRAPH (WORLD WIDE): HHI VS MOBILE PENETRATION VS ALLOCATED SPECTRUM (GSMA, 2013)

5.1 Market Share

The telecommunications sector in Chile is considered to be one of the most modern and dynamic in Latin America. Chile telecommunications market consists of five mobile operators (Claro, Entel, Movistar, Nextel and VTR) and two mobile virtual network operators (MVNOs) (Telsur-GTD and Virgin Mobile). MBB is offered by all the operators through UMTS/HSPA networks. LTE is offered by the three major MNOs (Claro, Entel, Movistar) on the 2.5 GHz and 700 MHz frequency bands.

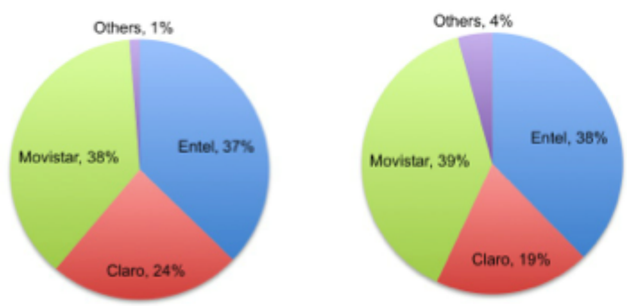

FIGURE 4 – A)CHILE MOBILE MARKET SHARE B) MBB MARKET SHARE (GSMA, 2013)

The market in Chile is highly competitive among the region (fig. 3a). The most important players in the market are Claro, Entel and Movistar. The latter two have a very similar market share, 37%. On the other hand Claro has a market share of 24%. The rest of players have a total of 1.3%. In terms of mobile broadband (fig. 3b) the market is similar. Movistar has 38.7%, Entel 37.7% and Claro 19.3%. Nextel, Virgin, and VTR Móvil divide the rest of the market share.

In the Netherlands the situation is very similar. The Dutch market consists of three MNO, T-Mobile, KPN, and Vodafone and one main MVNO, Ziggo. However there is a greater difference between the players.

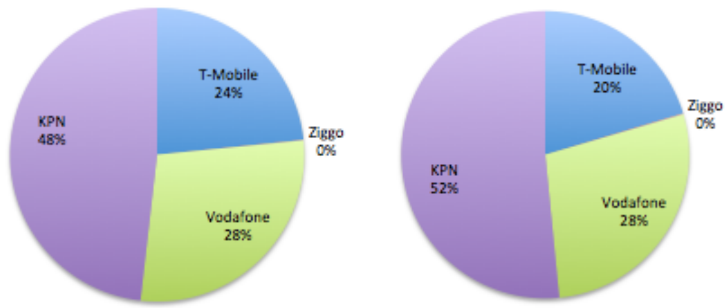

FIGURE 5 A) NETHERLANDS MOBILE MARKET SHARE B) MBB MARKET SHARE (GSMA, 2013)

The Figure above shows how KPN has a clear dominance of the market by having 50% of the market share. The rest is evenly distributed between T-Mobile with 24% and Vodafone with 28%.

5.2 Penetration

The penetration of mobile telecom services (fig. 6) in the country is the largest of the region, reaching 152% by the end of 2012. Mobile broadband penetration has shown a remarkable increase from 2009, to 2013, where it increased more than eight times. This growth has increased the need of more capacity in the networks. In order to provide more capacity, Subsecretaría de Telecomunicaciones (SUBTEL), Chilean NRA, launched auctions for the 2.6 GHz (2012) and 700 MHz spectrum (2013). Currently the main operators are already utilizing the 2.6 GHz band for their LTE networks deployments, and are starting to take advantage of the newly allocated 700 MHz band.

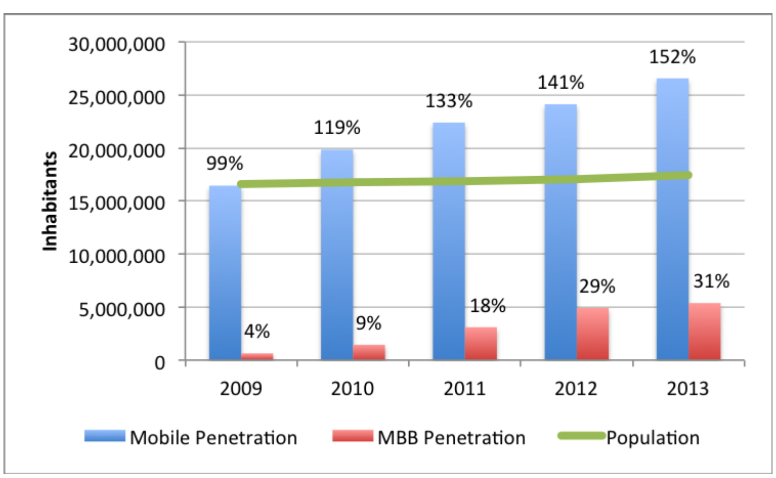

FIGURE 6 - CHILE: MOBILE PENETRATION (GSMA, 2013)

On the other hand, the Netherlands showed to have a smaller overall mobile penetration, but a much larger mobile broadband penetration of more than twice the Chilean MBB penetration of 2013.

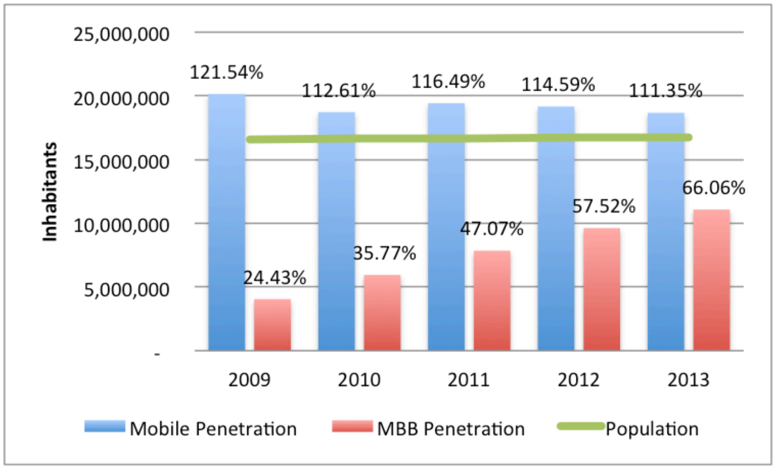

FIGURE 7 - NETHERLANDS: MOBILE PENETRATION (GSMA, 2013) (SUBTEL, 2012)

5.2.1 Penetration analysis

The increasing mobile penetration reflects an increasing demand for mobile services. In order to provide these services, more spectrum is needed. Currently the spectrum allocation and spectrum policies in the studied countries are very different.

Chile is the country with the highest mobile penetration (of the region); however it has a low mobile broadband penetration. Still, the fact that more than 100% of the population has access to a mobile phone is a good start and can be a trigger for a further development of mobile broadband strategies to increase MBB penetration.

The fact that the mobile penetration surpasses that one of the Netherlands means that there is even more room for improvement in terms of revenues. If the current MBB adoption increases, the revenues for the players in the Chilean market can be bigger due to a higher penetration. This will not happen in the Netherlands where the Mobile Penetration is in fact decreasing, marking a limitation for the rapid adoption of MBB.

5.3 Spectrum Allocation

In Chile spectrum is not assigned with the purpose of maximizing revenues for the State. It is awarded in light of assessments of the investments, technologies and other aspects of the business plans of the bidders for the spectrum, and the contributions their proposed wireless networks will make as a crucial element in the country's efforts to close its gap with the most advanced countries (Roetter, 2011).

Chile has a total of 485 MHz allocated spectrum, being one of the countries with more allocated spectrum in the region. The bands currently allocated are the recently allocated 700

MHz band, 850 MHz, 1900 MHz, AWS (1700/2100 MHz), and 2500 MHz. Chile does not impose a spectrum cap for mobile services. Table 5.1 shows the spectrum allocation per band and per operator of the main MNOs of Chile.

Operator	**700 MHz**	**850 MHz**	**1900 MHz**	**AWS**	**2.6 GHz**	**Total**
Entel	30	0	60	0	40	130
Movistar	30	25	30	0	40	125
Claro	30	25	30	0	40	125
Nextel	0	0	0	60	0	60
VTR Móvil	0	0	0	30	0	30
Total	90	50	120	90	120	470

TABLE 1 - CHILE: SPECTRUM ALLOCATION (SUBTEL, 2012)

In the Netherlands the distribution of spectrum is similar among the operators. However in comparison with Chile there is almost 150 MHz more of allocated spectrum. The three main operators (KPN, Vodafone, T-Mobile) have more spectrum than the operators in Chile. This comes in handy for their MBB offerings.

Operator	**800 MHz**	**900 MHz**	**1800 MHz**	**1900 MHz**	**2.1 GHz**	**2.6 GHz**	**Total**
KPN	20	20	40	5	39.6	50	175.6
Vodafone	20	20	40	5.4	39.2	20	144.6
T-Mobile	0	30	60	24.6	40	35	189.6
Others	20	0	0	0	0	85	105
Total	60	70	100	35	118.8	190	614.8

TABLE 2 - NETHERLANDS: SPECTRUM ALLOCATION (KPN, 2013)

5.3.1 Spectrum Analysis

While it is a fact that they will need more spectrum to provide mobile broadband services to their users, the source of this spectrum and the time frame for this to take place are not necessarily the same. Chile still has a good amount of free spectrum in the traditional IMT bands. However, North American countries like USA, or European countries like the UK are in need to find new sources to provide new spectrum.

In terms of spectrum per operator, the distribution is a little bit different. Despite having less allocated spectrum in total, Chilean MNOs have more spectrum per operator than any of the other countries in the region.

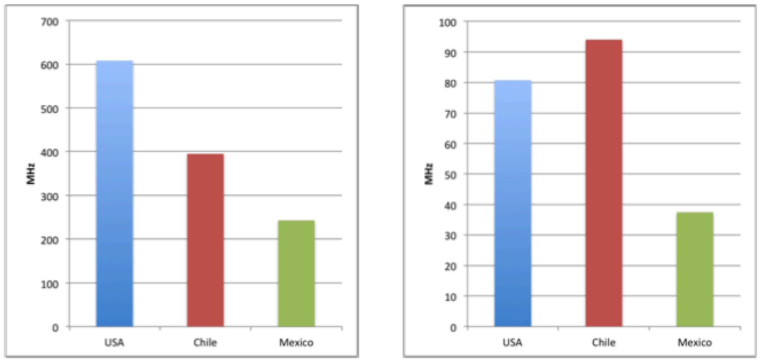

FIGURE 8 - SPECTRUM ALLOCATION COMPARISON; A) ALLOCATED SPECTRUM B) AVERAGE SPECTRUM PER MNO

From the spectrum allocation table, it is appreciable how regulations and spectrum allocations in Chile have brought advantages to its telecom industry. Chilean current situation of Chile is the most promising one of the Latin American region.

However, the analysis also shows how regarding LSA adoption, Chile is the least benefited. This is due to the low MBB penetration and that the operators still have plenty of spectrum resources to be exploited.

5.4 Summary

Overall, Chilean telecommunication industry is strong and highly competitive. The three main MNOs, Claro, Entel and Movistar, distribute the market almost evenly. Regardless of the medium-low mobile broadband penetration, Chile has a very high mobile penetration, which can help to increase mobile broadband adoption. However it is clear the there is still a big gap with countries in Europe. Despite having shown to have similarities, the adoption of MBB is still higher in the Netherlands, where the operators benefit of a much better spectrum distribution that allows them to offer higher MBB bandwidths.

Nevertheless, the comparison helped to see how the future for Chile looks promising. The fact that the mobile penetration is higher than that one of the Netherlands can represent a good point to focus. With a higher mobile broadband penetration, the revenues for the operators can increase, and this can be considered as an incentive to increase their CAPEX. The regulations and spectrum allocations look for a fair market, giving opportunities to both emerging and established actors. The average spectrum per MNO is high; hence, the majority of MNOs are able to handle current data traffic needs.

6 Cost Analysis

There are several factors to be considered when valuing spectrum; the user demand, the population and geography to be covered, regulator's rules in terms of spectrum costs, and usage rules, as well as technical specifications are some of the important factors to be considered. Spectrum value can vary depending on these factors, hence this analysis considers: population density, MBB penetration, coverage area, spectral efficiency, number of sectors per site, site cost, radio equipment cost, and spectrum cost.

In the following table, the values used for the analysis are presented. It is important to notice that the prices paid for any frequency band are different in every country. As it was mentioned on the methodology, the analysis contemplated urban areas of Latin America due to their soaring traffic and their high penetration numbers.

Population Density	
Santiago de Chile	430 people per Km^2
Amsterdam	4,908 people per Km^2
MBB Penetration	
Santiago de Chile	30%
Amsterdam	66%
Area	1 Km^2
Spectral Efficiency	1.6 bps/Hz
Sectors	3
Site Cost	$140,000
Radio Equipment Cost	$14,000
Spectrum Base Cost (AWS Cost)	
Chile	.057 $/MHz/Pop
Netherlands	.83 $/MHz/Pop

TABLE 3 - ASSUMED NUMERICAL VALUES

Another very important factor to consider is the data traffic. The current and expected average traffic per user is presented in the following table. Because some of these values are still low, and in order to give a complete analysis of LSA spectrum the sensitivity test also considered a 10-fold increase on the user demand of 2018. The main reason for this approach is the fact that forecasts are predictions, but can have flaws. The 10-fold increase study will give the results of an extreme case scenario; to see how much do the results vary.

Average Traffic Per User (MB per Month)			
	2014	**2018**	**Ten-fold 2018**
Chile	217	1,545	15,450
Netherlands	826	2,155	21,550

TABLE 4 - ASSUMED TRAFFIC VALUES

Based on the values presented in table 2, a cost analysis was performed. The following figures show a comparison of the network deployment costs for the two countries. In figures 9 and 10, the current generated traffic and penetration is considered and compared to the traffic in 2018 and to the 10 times the traffic of 2018. The traffic assumed in the figures corresponds to the values presented in table 3.

Because spectrum costs depend on the frequency band, a sensitivity test is performed for the two countries. Another reason for the sensitivity test is that spectrum value can also depend on spectrum availability. Spectrum will be more expensive in markets where spectrum is scarce. In Chile, the cost paid for the AWS spectrum is considered to be the base cost, and alterations of its value were made. For the case of Netherlands, an average cost of the LTE multi-frequency auction of 2012 was considered. The sensitivity test considered: 1) Base cost value, 2) One third of the base cost value and 3) Eight times the base cost value.

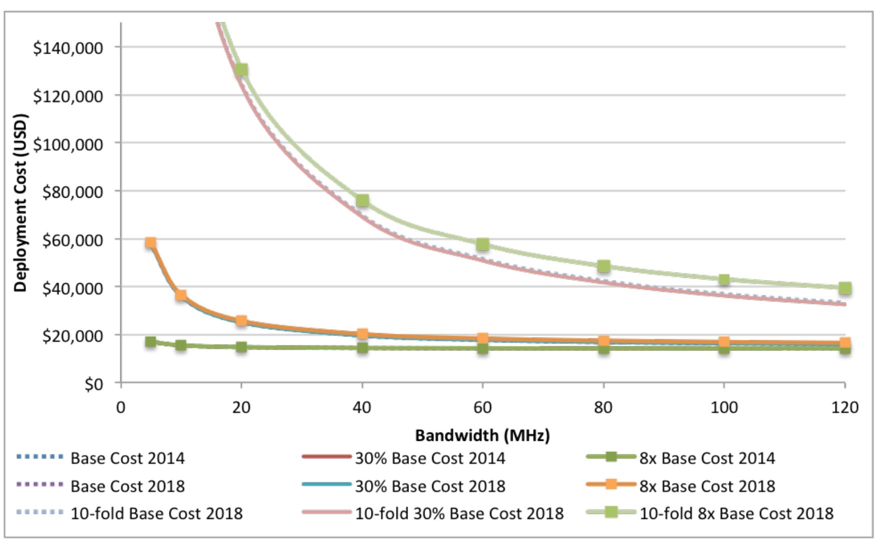

FIGURE 9 - CHILE: BANDWIDTH VS DEPLOYMENT COST

The figure shows how the benefits for Chile are almost nonexistent. In all the studied scenarios, the difference between the deployment costs is negligible. This implies that in countries with low spectrum cost, such as the AWS spectrum cost in Chile, LSA will not bring any cost benefits. In general, the figure helps to understand how the total costs of deployment change when the available bandwidth increases. There is an overall decreasing trend for the total costs.

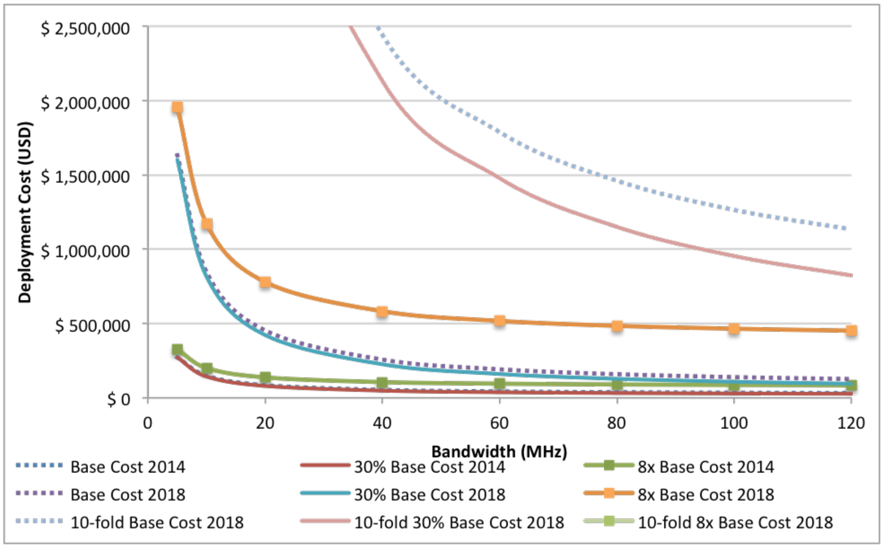

FIGURE 10 - NETHERLANDS: BANDWIDTH VS DEPLOYMENT COST

On the other hand, the benefits brought to the Netherlands are more perceivable. Due to the higher spectrum cost, the benefits of LSA are magnified. Figure 10 shows how the difference in the deployment cost is rather large among the different cases. However one thing that is common in both cases is the fact that LSA does not bring any real benefit with the current situation of the markets. The value of LSA is present, in the Netherlands, only when the data traffic folds several times.

Regarding Chile and based on the cost assumptions consider for this study, (which assigned the AWS spectrum cost as the base cost, and followed the proposed value for LSA of 30% of the base cost) it can be seen that the adoption of LSA would not represent a remarkable improvement. The main reason behind this is the considerable low AWS spectrum costs in the region. The only benefits are seen when a massive user demand is considered, and/or when the base spectrum cost is very high.

As expected, more bandwidth results in fewer sites and lower costs. However, the total deployment costs depend more on the actual deployment of the sites, considering the building and installation works, than on the spectrum cost. The sensitivity test confirms this; the spectrum cost was changed from the base (i.e. AWS Spectrum Cost) to different values and still, the impact of spectrum in the cost structure was not significant. Hence, this option is more feasible for established incumbents which already own the sites.

Because of this, incumbent operators that already have sites and do not have to consider site expenses, are going to be considered in the following analysis. This second analysis considers only the spectrum and radio equipment expenses, and omits the site installation costs. The purpose of this analysis is to exhibit the minor effects of spectrum cost to the whole cost structure.

The study compares the user demand per square kilometer with the total deployment cost. When the user demand increases the deployment cost will also increase. Figure 11 gives a general picture of the effect of this in both countries. It reveals what the difference between the base cost and LSA cost can be.

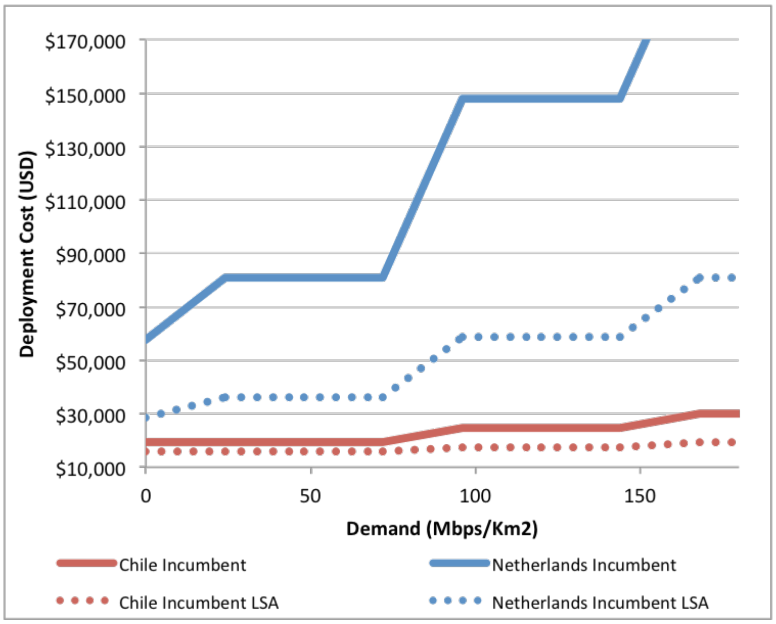

FIGURE 11 - DEMAND VS DEPLOYMENT COST

Figure 11 show how LSA Spectrum has a cost advantage in all the studied countries. This advantage increases when the user demand increases. This shows how not only the demand is important but also the spectrum costs factor is important. The higher the spectrum cost is, the more benefits LSA can bring, only if NRA sets LSA costs significantly lower than exclusive spectrum.

It is important to reiterate that the cost benefits depicted in figure 11 and explained in the previous paragraph are not present for all actors. The advantages of a lower cost spectrum through the LSA scheme are only present when the actors either have already installed the sites, or are in a site sharing agreement with other actors.

Other consideration to be taken into account is the fact that this second cost analysis was performed to evidence the change of the deployment cost as the demand increases. However, this does not mean that the studied countries have, or will reach that demand. Meaning that the benefits of LSA will be reduced if these conditions are not met in the countries.

Primarily, the cost analysis showed the low value and benefits of LSA for the countries in the region. The main reasons for this are the following:

- Low Spectrum Costs
- Low Traffic Demand
- Low Penetration of Mobile Broadband

7 Conclusions

The telecom markets differ a lot from each country. While the market European countries can be considered as a mature market, the markets of Chile are young growing markets. Much of this has to do with the contrast in the countries' GDP per capita. Higher levels of GDP per capita enable higher ARPU.

In European countries, while a big amount of spectrum has been allocated, most of the MNOs need more spectrum to comply with the high penetration and increasing traffic. Under these conditions, LSA could also bring additional spectrum and thus, benefits to the telecom industry in the country. In Chile and most of Latin America, there is still a lot of spectrum to be allocated and/or to be fully used. Hence, the implementation of LSA is not a priority.

7.1 Research Questions

What potential benefits can LSA bring to developing countries in Latin America?

Based on the performed analysis the most beneficial actors are the established actors and not Greenfield actors. Depending on the established cost of the LSA spectrum in comparison with the exclusive spectrum, operators can reduce the total deployment cost.

However, and regardless of the advantages brought by LSA, the timing is not there yet. The region still has plenty of spectrum to be allocated as exclusive spectrum, which is preferred by operators. The low mobile broadband penetration in most of the region is also a factor for the low value of LSA in the time of this study. With a low penetration, and a low data usage, there is no need for actors, either established or emerging, to get LSA spectrum.

What are the challenges of LSA in Latin America? How the regulations and market conditions in the region work for or against such approach?

As shown by the study, the value of LSA depends on the specific market and regulatory conditions of the countries. There are different terms that determine how much and to what extent the LSA spectrum can bring value to the actors. These terms are supposed to be identified in the LSA Agreement. LSA can bring more value when there are small geographical or time exclusions and limitations, when a static sharing approach is taken, and when the frequency band is harmonized.

The value of LSA depends directly on the NRAs. Apart from being in charge of setting the spectrum cost, which can increase or decrease the economic impact for operators, NRAs can affect the markets by leveling the competition through giving priority to disadvantaged operators to obtain LSA spectrum.

Once again, and coming back to the answer of the first question, the market itself defines what it needs and when it needs it. If the development of mobile broadband in the region is poor, there is no reason for the market to adopt new approaches based on improving the network's capacity. Most of the region is currently analyzing the value for the 700 MHz band.

7.2 Comparison with other spectrum schemes

The value of LSA in comparison with other spectrum schemes showed to be low. First, considering only the spectrum scheme characteristics, LSA brings more uncertainties and complexities than exclusive access spectrum. The most important difference between LSA and exclusive access spectrum is that MNOs depend directly on the incumbents and regulators in order to make use of the spectrum, while exclusive access spectrum gives the MNOs the right and ability to use the spectrum the way they wish.

Second, in terms of cost, the analysis presented factors that reduce the value of LSA when compared to other spectrum schemes. The analysis showed that due to the low spectrum costs in the region, the possible difference brought by LSA is in fact insignificant in terms of the overall total deployment cost. Due to this small difference, and considering the advantages and availability of exclusive spectrum in the region, LSA does not bring any cost benefit to the operators.

Moreover, regarding the market conditions, neither LSA nor any other new spectrum scheme could really add any value to the region. The reason for this is mainly the low mobile and mobile broadband penetration in the region. Another great factor that reduces the value of LSA dramatically is the big amount of free spectrum to be exclusively allocated.

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