

A Theoretical Overview of Mobile Networks Environment in Ecuador Prior To 5G

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Abstract

Many countries in the Latin American region experience the technology gap when new technologies are either developing or in testing scenarios. Telecommunications services provider must be encouraged, allowing universal access to broadband networks. According to telecommunication analysts, a Gross Domestic Product (GDP) growth results when broadband penetration increases. With this background, there should not be considerations in delays regarding the technology expansion for improving data and mobile communications or for the deployment of coming technologies. This paper presents an analysis of regulatory aspects of mobile networks in the Republic of Ecuador for visualizing the current situation regarding Information and Communication Technologies (ICT) and the advent of 5G, especially in aspects such as infrastructure, penetration and economic development. The purpose is that the reader has an understanding of how government policies in accordance with international recommendations and the participation of those involved in the telecommunications sector encourage technological advances in an emerging country.

Keywords: 5G Mobile Communications; Broadband Communication; Digital Gap; Telecommunications Services

Introduction

People adopt technologies and services thinking about entertainment, information, and communication. The demand and acceptance of new services by consumers play a key role to adopt them. Consumers use technologies if they see the value or are positively affected in some way by services provided [1], considering either economic or technical aspects to access them. Technology helps in facing daily tasks. Smartphones are an illustrative example of the integration for a broad of services (e.g., multimedia, voice, SMS, browsing, GPS location) across different scenarios [2].

Despite the efforts made through governmental policies, Ecuador has suffered technological lags when implementing new technologies, turning into a digital gap, adding the lack of total territorial coverage regarding integrated telecommunication services as well. Moreover, an optimal infrastructure along with rural areas and some suburban neighborhoods turns difficult to achieve due to several factors, in particular with the ones related to technical implementations, leading the technology turns outdated.

Since 2014, Ecuador has incorporated services related to 4G-LTE. Providers of Advanced Mobile Services (AMS) with technology infrastructure cover GSM, UTMS, HSPA+, and LTE services that end-users use daily in approximately 14 million electronic devices. Public entities dictate frequency concessions, regulate, and control the services related to Information and Communication Technologies (ICT) provide by mobile operators. The National Frequency Plan allocates frequencies for the provision of mobile services.

Active lines registered by AMS allow users to attain speed connections below 100 Mbps. There are still investments for AMS deployments to enhance mobile coverage. According to information provided by the Ecuadorian Institute of Statistics and Census, 37.2% of the Ecuadorian population has a smartphone, a percentage continuously rising [3], turning into an indicator for analyzing the adoption of greater capacity technologies.

Being visionaries and comparing to previous mobile generations, 5G could overcome real-time transmission delays experienced in entertainment, productivity, and social development. Among the reasons to adopt 5G as a new generation for mobile communications are the low battery consumption in devices and the theoretical high data rates in mobility with non-harmful frequencies to human health [4]. The propose of new architectures that involve new radio interfaces, transport networks, devices, and multiple access technologies to available spectrum is necessary, expected that 5G provides services to most of the Latin American countries by 2022. Characteristics of the 5G spectrum such as path loss, attenuation effects, and the impact of the surrounding materials (including topographical issues) limit deployments with considerable traffic load (e.g., voice traffic) [5].

The organization of this paper is as follows: Section 2 details part of a governmental plan focused on a public policy aiming to the development of the telecommunications through macro-objectives for the period 2016-2021. Section 3 describes the situation of the mobile networks in Ecuador, comparing the macro-objectives with the Connect 2020 Agenda, which is a proposal from the ITU Member States for ICT development. At the same time, it describes a further situation with the advent of 5G through different stages, analyzing activities encompassed in policies determined by the telecommunications national governing body. Section 4 describes different aspects of frequency right granting and the relationship between the stakeholders. Section 5 depicts potential results through a brief analysis of the economic growth according to the implementations of ICT policies. Finally, section 6 underlines the conclusions.

Objectives of the Ecuadorian Plan of Telecommunications and Information Technology

The National Plan of Telecommunications and Information Technology 2016-2021 details programs and projects to achieve objectives defined for the telecommunications sector, whose vision is the placement of Ecuador as a regional reference in connectivity, access and production of ICT services by 2021, through the measurement of economic and social indicators. Four macro objectives are proposed [6] to promote improvement factors and generate development paths for the sector driven by the incorporation of international best practices. The purpose of these macro-objectives are:

- 1) Completing and encouraging the deployment of telecommunications infrastructure.
- 2) Increasing ICT services penetration.
- 3) Ensuring the use of ICT for economic and social development.
- 4) Establishing bases for the development of a long-term ICT industry.

The deployment advance of the telecommunications infrastructure nationwide encourages to increase the mobile coverage, since by the third semester of 2017 the density of AMS was near 89.68%, and almost 15 million of actives lines registered the mobile operators. From those, 25% corresponds to 4G; 54.2% corresponds to 3G; and, 20.66% corresponds to 2G [7]. The combined coverage of 2G and 3G was near 96%; and near 67% is 4G, mainly in the urban areas. Nevertheless, it is necessary to generate actions to ensure an efficient deployment of mobile infrastructure, especially to reach remote areas of the country through the current 4G. A goal to accomplish by 2021 is that both 2G and 3G mobile coverage ascend to 98%, and 4G to 80%. The telecommunications deployments relate to fixed broadband infrastructure, especially in households that use whether optical fiber or copper as the last mile, addressing a percentage increase of households that are less than 1.5 km away from wired networks to achieve higher speed connections.

Broadband penetration must go hand in hand according to the number of devices managed by the population. During 2017, penetration regarding computer devices and smartphones was 52% and 37.2%, respectively, representing an increase respect to previous years [3]. Because of the impact and extension of broadband access in the country's economy, by 2017 the mobile-broadband subscriptions experienced a rise of 53 subscribers per 100 inhabitants [8].

ICTs are an important tool in business processes for economic and social development, as an influence on competitiveness and strengthening in the global market, providing several services, such as the use of electronic commerce in small and medium-sized companies, encouraging payments and online trading as well. It prioritizes the use of the electronic government for transaction services and the completion of online forms (e.g., tax declarations, certificate application) by citizens and companies to enhance efficiency in procedures in both public and private organizations. Services regarding health, education, and justice associate straightforward to people's well-being. Digitization of whether processes or information achieves a higher degree of efficiency by the services provision expansion and the improvement of communication systems (e.g., promoting the knowledge, decreasing negative impacts in the environment).

The long-term industry requires the existence of key enablers, such as the existence of human talent associated with ICT, implying the presence of certified professionals (related to programming, telematics, networked systems, among others) from accredited college programs with strong skills for a worldwide interaction. Another important key enabler is financial access since it encourages the investment of both local and foreign entrepreneurs, considering the economic profit as an important aspect for the thrusting of the ICT businesses..

Mobile networks situation and environment for 5G

The macro-objectives contribute to the enhancing of mobile network coverage, regardless of the technology applied. It is expected a 5G provision in urban areas, due to fixed and mobile broadband deployments, for ensuring higher data rates through the expansion of mobile networks [9][10]. Furthermore, 4G could benefit rural areas that still use 2G or 3G..

Currently, Ecuador has a population of approximately 16 million inhabitants. It is a mobile market that has more than 14 million electronic devices in operation with mobile networks through three operators, two privates, and one public. The market has 290 MHz granted to these operators for the provision of mobile services, projecting to 17 percent of the amount suggested by the ITU-RM 2078 by 2020 [10].

At the moment of carrying out a study of the Connect 2020 Agenda (adopted by the ITU Member States) with the respective goals for digital gap reduction worldwide, it compared with the National Plan of Telecommunications and Information Technology 2016-2021 to know the current and future situation in terms of ICT advances. Ecuador is still deploying 2G, even considering toward 2021 is planned that 4G coverage will increase to 80%. Before 2020, most of the countries potentially will adopt 5G as the next generation for mobile communications.

It is expected an increase near 60% for both fixed and mobile services in 5G implementations in major urban areas but not in rural ones. This could represent a lag since the Connect 2020 Agenda proposes implementations and enhancements in communication systems to raise broadband services to 90% [11].

Frequency allocation policies in Latin America evaluates according to the mobile market. As television and radio are an important part of the economic industry worldwide, frequency rights granting turns into a political issue, thus liberalization processes are not easy to handle. The telecommunications sector has an important role in economic development, providing communications infrastructure for the population. Investors, yielding data and opening the way for empirical estimations of the social value of policy reforms [12] analyze this industry. Several countries liberalized their telecommunications markets expecting the development in services provision. In Ecuador, the strategic sector of telecommunications [13] is a powerful market for the income of the country, whether concerning taxing, concessions rights, aggregated services provision, among others.

Technically, 5G can be useful in countries with topographic accidents, such as the ones of the Andean region. Applications aim to dense urban outdoor scenarios by using antenna arrays that support high gains in case of path loss situations since wavelengths are smaller compared to other bands. Some techniques, such as MIMO, are suitable due to conventional digital beamforming, but not viable for large-scale antenna arrays because of high costs and power consumption demanding due to high-frequency components [14].

The Connect 2020 Agenda imposes great challenges in countries to deploy broadband systems with very ambitious goals for 2020. It plans to achieve ICT growth allowing improvements in social and economic sectors, resulting in a contribution to the telecommunications development and the integration of the information society [15][16][17].

An entry proposal for 5G would consist of three stages: research, promotion, and planning. Research activities focus on gathering information about the 5G situation, analysis of the frequency use, and deployment feasibility. This information let to perform spectral analysis for determining the need for frequencies granting, with tests used internationally as reference. CRM-15 assigned the frequency range of 24.25 to 86 GHz for 5G studies [18]. The FCC adopted the first 5G frequencies in the United States at the bands of 28GHz, 37GHz, and 39GHz. CITELE proposed frequencies below 30 GHz be used in region 2. The 28 GHz band is one of the most common allocated for 5G between Region 2 and Region 3 [19][20]. The National Frequency Plan establishes frequencies allocation according to recommendations coming from the ITU and similar organizations.

Likewise, the mobile coverage analysis through statistics offered by the regulator allows relevant modifications to the Plan. By 2021, 2G technology deployments will continue in rural areas, turning inconsistent with the Connect 2020 Agenda's objectives. Deployments of 3G and 4G networks in rural areas (with less Internet access) and 5G in urban areas turn mandatory. It is 96.58% of 2G coverage in contrast to the 87.9% of 3G. There are areas lacking mobile coverage, pointing at 3G deployments instead of previous technologies.

Promotion activities focus on releasing information about 5G towards the telecommunications sector and the meeting of task groups for draft analysis coming from other regulatory bodies or the private sector. Fostering information turns paramount by service providers, offering conferences to institutions to show advances regarding 5G deployments in other countries and thus incorporate newer technologies. The Ecuadorian Ministry of Telecommunications (MINTEL, Spanish acronym) promotes aspects related to mobile services to citizenship for the understanding of the economic importance that implies the adoption of a new mobile generation. To encourage technologies research, societies of professional engineers or similar organizations should collaborate lecturing informative sessions at a higher level to institutions that have academic programs related to electronics.

Regarding task groups, research projects by Academia and the public and private sectors have to focus on tools applied in international tests, considering transmission protocols, equipment, and frequency spectrum through the MINTEL sponsorship [6]. Among proposals coming from those task groups, several parameters are reviewed (e.g., technical, economic and social) for ensuring regulatory specifications through the MINTEL as the entity that establishes an observatory to argue the feasibility for 5G scenarios.

Planning activities focus on several aspects, such as the modification of the MINTEL objectives contrasting the Connect 2020 Agenda, the frequencies allocations to both existing and new operators, and the offering of spectrum allocation. It is proposed to modify some of the Plan objectives to fit with the objectives of the Connect 2020 Agenda, where is recommended that 2G no longer be deployed. Granting frequency authorizations to existing operators (or the entry of new ones) must be mandatory through a frequency review strategy by the regulatory agency, especially to incentive 5G development. The current and new operators must address the diffusion of investments, innovation, and competition.

Granting frequency rights

There could be a lack of motivation for investors to get into the business if the regulation considers telecommunications as a public service [13], especially when the relationship between a government and private operators is not so timely. Frequency rights granting agreements are not necessarily totally fulfilled in the Latin American countries, insomuch that contracts are modified to reduce commitments between an operator and a government, giving more flexibility to providers to exploit spectrum resources, endangering a government by not receiving a portion of these additional benefits. It is necessary a regulatory policy that encourages the adoption of new technologies with the promptness expected by the market, opening the road to a flexible

regulation by granting new frequencies without impairing a government by either poorly or mistaken negotiations. The adoption or expansion in deployments of the latest mobile technologies allows achievements in higher transfer rates, either in zero mobility or in very fast mobility, with the possibility of connecting several devices through the Internet of Things. Customers will maintain and improve their operations to obtain benefits from new features available.

The standards that ITU's task groups have developed for the deployment of 5G should adopt on time. Likewise, small cells convey more data without interfering between them. The purpose of 5G will be to counteract the traffic generated due to the demand for bandwidth and the number of devices connected to a network, especially for indoor propagation.

Several challenges regarding 5G deployment include infrastructure requirements, handover reliability for mobile calls and signal variations, path loss mitigation, penetration issues in outdoor propagation environments, and radio frequency behaviors as well, overcoming limitations to make this technology attractive for outdoor and long-range communication. For 5G outdoors deployments, it must work with 2G, 3G and 4G networks in the heterogeneous network configuration [5].

In Ecuador, low deployment costs and existing infrastructure are advantages for investors to provide mobile services. In addition, the government is developing the technology industry for the assembly of mobile devices [18] with the participation of the private sector to assure the inclusion of Internet as a primary service to offer to end-users.

Potential results

5G technology targets the improvements in communication infrastructure for a totally mobile and connected society, aiming to achieve higher data rates and lower latency for several emerging applications and e-services. It looks forward that 5G extends communication capabilities to things and machines, making possible sensors network connectivity for the deployment of smart homes and smart offices, Machine-to-Machine (M2M) communication, virtual environments, e-Health, e-Governance, among others [14].

Deploying 5G in the further could lead to an increase in bandwidth, increasing at the same time, the GDP due to the strong correlation that exists between them [6]. Based on the economic study depicted in [21], doubling broadband speeds for an economy can add 0.3% to GDP growth. In Ecuador, according to specialists from the telecommunications regulatory agency, each 1% of broadband penetration results in a 0.052% to GDP growth. [22].

Based on the previously mentioned and expecting 5G has a bandwidth speed ratio 100 times more respect 4G due to the anticipated theoretical average speed of 10 Gbps for 5G compared to 100 Mbps for 4G [9][18], the GDP growth will result more significant. On the other hand, studies carried out by Deloitte and Cisco in 2012 depict that the replacement of 10% of 2G subscribers by 3G raises the GDP per capita by 0.15%. Therefore, changes from previous technology to new ones will increase the GDP depending on the bandwidth available and the infrastructure that a new technology supports. According to [23], an increase in GDP per capita by 0.5% experiences when duplicate mobile data access.

Meanwhile, technology access is a latent reality for many inhabitants in the handling of communications electronic devices. When implementing new mobile technology, there is an improvement in the quality of life of the population through the different services available. Several examples can appear, such as video surveillance in the cities to improve population security with online applications that allow denouncing acts against law enforcement in a fast, efficient and safe way; or public transport system improvements with the creation of devices that report real-time roads states and jamming zones, complementing with the Internet of Things.

The MINTEL must agree on the creation of task groups aiming to study proposal plans for 5G to investigate policies, best practices, architectures, frequencies, standards, that other nations are developing, especially if they are experiencing good pilot results. In addition, a modification in the objectives of the National Plan of Telecommunications and Information Technologies 2016-2021 will fit along with the approaching of mobile network deployments.

Conclusions

Currently, 4G represents a less portion of the national mobile coverage compared to previous mobile generations. With increasing penetration regarding services, Ecuador has the potential to provide 5G advanced mobile services. The increase in bandwidth capacity is one of the main objectives of the Broadband Commission to experience considerable GDP growth, especially through 5G deployments in order to address this objective. However, there is a gap between the Connect 2020 Agenda and the National Plan for Telecommunications and Information Technologies 2016 – 2021, because there are still considerations of deploying the 2G technology by 2021, turning necessary renewal of the mobile service platforms to 4G or the coming mobile generations. It is convenient the spectrum availability for future tests (e.g., 28GHz band), due to signal propagation in this frequency is more viable for multipath environments and can be used for communication systems with non-line-of-sight, considering zones with topographical accidents, even in urban areas.

In addition, the examination of existing laws regarding AMS turns mandatory, as well as the planning of information technologies development focusing in the potential impact a policy modification will cause in order to formulate recommendations for frequencies allocations more equitably. The fulfillment of standards that end-users will receive is necessary for the achievement of economic revenues that a Government requires through the obeying of commitments and duties acquired by mobile service providers for the existing and new contracts.

Recommendations and further work

It is recommendable to set a timetable that resembles the goals proposed by the ITU worldwide by 2020 with the objectives proposed for 5G, the Connect 2020 Agenda and the National Plan of Telecommunications and Information Technology 2016 - 2021. The regulatory agency should allocate the spectrum for testing and follow recommendations to modify the Plan objectives by 2019-2020 to comply objectives of the Connect 2020 Agenda. By the period 2020-2022 through 5G deployment in the majority of nations, Ecuador potentially will be able to carry out initial tests in urban areas, projecting into areas of greatest demand for mobile transmission.

Acknowledgments

The authors would like to thank the collaboration of the engineers, administrative specialists, and other peers for all their suggestions and the time they dedicated to us throughout the development of this article.

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Conflicts of Interest

The authors have declared that no conflict of interests exist.

Funding Statement

The authors have no funding to report.