Deloitte.

Insights about Digital Transformation and ICT Opportunities for Brazil

Report and Recommendations

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Contents

With the honorable contribution of

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**CIÊNCIA, TECNOLOGIA,
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Preface

Brazil is a country with continental dimensions, with a vast dispersion in development parameters across regions. Urban centers concentrate the most part of the population. Their financial situation enables them to reach out for mobile phones, broadband and education. In contrast, rural areas and low-income neighborhoods of urban centers often fall behind in technological advances. Inhabitants from these regions usually do not have or have limited access to technological advances, aggravating the social exclusion. Private companies do not have the financial motivation to invest in these areas, leaving these communities even further away from the benefits of the digital world.

This perverse cycle can be broken. We hope to address viable considerations in order to overcome the limiting barriers of the Brazilian integration to the digital era.

The Brazilian government has already conducted some studies and is placing a lot of effort to improve the current situation of the country in terms of digitalization. The signature of MoUs (Memorandum of Understanding) with high-technology companies highlights this effort to promote knowledge exchange and learning through practical experiences.

In order to incentivize the development of the ICT sector in the country, the Ministry of Science, Technology, Innovation and Communication (MCTIC) established a MOU with the high-tech company Huawei. Among the requirements of the document, there was the elaboration of a report related to the ICT sector in Brazil, which would be a third party product from a consulting company hired by Huawei. Through an open call to the market, Deloitte won the RFP selection to conduct this work.

Deloitte is proud to be part of this initiative and to contribute with all its knowledge and experience for the benefit of Brazil. This report was written with the most independent and impartial view, based on internal analysis, market research and interviews with different sectors of society (government, public agencies, regulators, universities, industry, associations and representations), and intends to bring a neutral yet inclusive perspective that could benefit the development of Brazil.

Additionally, the study also addresses viable actions, propositions and cases that the Brazilian public and private sector can jointly collaborate, for the purpose of positioning Brazil into the tier of countries that leveraged the ICT infrastructure to enable new business models and improve competitive advantage.

Craig Wigginton
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With the honorable support of

André Müller Borges
Telecommunications Secretary of Brazil

Thiago Camargo Lopes
Secretary for Digital Policies of Brazil

"Telecommunications infrastructure is the foundation for a new digital economy. Investments in this sector generate intensive potential in economic activity, digital inclusion, and social welfare."

André Müller Borges
Telecommunication Secretary of Brazil

1. Executive summary

A lot of effort is being made by the governments to adapt and incorporate new technologies to digitalize the world.

Information technology and communications are considered among the most important topics in the digital era. New services, enterprises, start-ups arise changing the way established companies drive the market. ICT brings a disruptive point of view for business models and daily tasks.

These changes demand the adaptation of markets, companies and the government as well. In this way, a lot of effort is being made by governments to adapt and incorporate new technologies to digitalize the world.

It is a challenge that is not restricted only to the government intervention. Both the citizens and the companies/enterprises play an important role in these changes towards a digital environment, encouraging the ICT sector to create eminence in the global context.

Specifically, in Brazil, the government has already conducted several studies and has generated some reports taking into account the challenges and gaps that need to be addressed to improve the ICT market and drive the country towards a digital strategy. Associations and other entities related to the ICT market are also motivating the Brazilian market.

There are many gaps between supply and demand of skills across different sectors in Brazil. The challenges of the ICT sectos, the lack of adequate policy direction and the slow pace in human capital development programs have caused a widening in the existing gaps. The Brazilian government, however, has been making efforts to change the current situation.

For instance, the "Brasil Eficiente" program (Efficient Brazil) has created the National Council for de-bureaucratization to address

directives and assertions to simplify and modernize the public administration, as well as to enhance and improve public services provided to society, ranking priorities and goals for the de-bureaucracy. The program also recommends the main targets for the new versions of the Digital Governance Strategy (Estratégia de Governança Digital – EGD).

The "Brasil Eficiente" program's structure has 08 programs, including the Brazilian digital strategy.

Efficient Brazil

1	2	3
Interoperability of Gov Systems (GovData, ConectaGov e PREDIC) (MP)	Brasil Cidadão (MP)	Digital Citizenship Platform (MP)

4	5	6
E-Health: e-SUS AB and scheduling of appointments, e-Citizen and e-Manager (MS)	Innovaton policies Connected Schools (MEC e MCTIC)	Projects of simplication of tax, social security and work services for both enterprises and citizens (MF, MDCI, MTb, MCid e MDS)

7	8
Digital Work Identity (MTb)	Brazilian Digital Strategy (EDB) (MCTIC)

All initiatives under the "Brasil Eficiente" program's umbrella are strategic to the country's development. In terms of the ICT market, the Brazilian Digital Strategy, led by the Ministry of Science, Technology, Innovation and Communication (MCTIC, in Portuguese) stresses the importance of the sector to catalyze the economy and other segments of the industry, as well as to improve the social well-being of the population.

Therefore, the objective of this report is to contribute to the knowledge base already developed by the government in order to move Brazil onto a prominent position in the global ICT and Technological scenario.

The Brazilian digital strategy (e-Digital) is an extensive study conducted and published by the MCTIC, where 100 actions for the development of the digital country were presented in two axes - enabling axis and axis of digital transformation.

Enabling axis

Axis of digital transformation

Actions foreseen

Axis of digital transformation	Infrastructure and access to ICT	Research, development and innovation	Trust in the digital environment	Education and Professional Training	International dimension economy	Actions foreseen
Data-based economy						6
World of connected devices						6
New business models						24
Citizenship and government						11
Actions foreseen	9	10	15	9	10	**Total actions 100**

The main objectives of the Brazilian digital strategy include (non-exhaustive):

- **Network infrastructure and broadening Internet access.** Examples include expanding mobile Internet access coverage to municipal districts without cell towers and bringing high-speed terrestrial Internet to schools and rural schools.

- **Research, development and innovation.** One example is expanding the connectivity of the cybernetic infrastructure (high-capacity Internet and datacenters).

- **Trust in the use of ICTs.** Examples: Approval of a law on the protection of personal data; definition of policies and procedures for greater articulation between the Internet and the public sector incident response centers.

- **Education and professional training**. Example: to improve initial and continuing teacher training for the use of technology; to include in the basic education content, skills and competences for the digital world; to reinforce in the High School the disciplines of the STEM group (science, technology, engineering and mathematics).

- **International dimension.** Examples: prioritizing integration processes, including OECD, G20 and eLAC - Regional Digital Market in Latin America; export support for SMEs via marketplaces' digital images.

- **Economical digital transformation: data based economy, a world of connected devices and new business models.** Examples: Expanding the e-commerce, an activity that grows 12% per year, with R$ 50 billion in annual revenue, and in which Brazil represents 50% of the Latin American market. This represents a boost for SMEs in digital platforms and marketplaces - simplify and streamline bureaucracy for digital businesses.

- **Citizenship and digital government, in articulation with the strategy of digital governance and the platform of digital citizenship.** Example: partnerships with startups to provide services to the citizen, based on the Open Data platform of the Federal Government.

Considering all the government efforts related to the digital strategy, this report does not aim at replicating or discussing the work that has already been conducted and developed. The main contribution of this paper goes beyond, considering these e-Digital initiatives as a starting point.

This report will not discuss each one of the 100 actions in particular but it will prioritize the most important aspects to the Brazilian economy, justifying its importance and relevance for the country.

The report is structured as follows: Section 1 describes and positions this paper considering the initiatives already implemented by the Brazilian government. Section 2 presents a worldwide overview of the ICT sector highlighting the importance of the investments and the spillover effect of these investments over the economic and social variables. In Section 3 we detail the ICT sector in Brazil, presenting analyses and comparisons between the present situation of the sector in Brazil and in other countries. Section 4 describes which areas should be prioritized in the effort to develop and improve the position of the country in the ICT sector. Section 5 describes in detail the framework of each one of the selected areas and Section 6 presents the final remarks of this report.
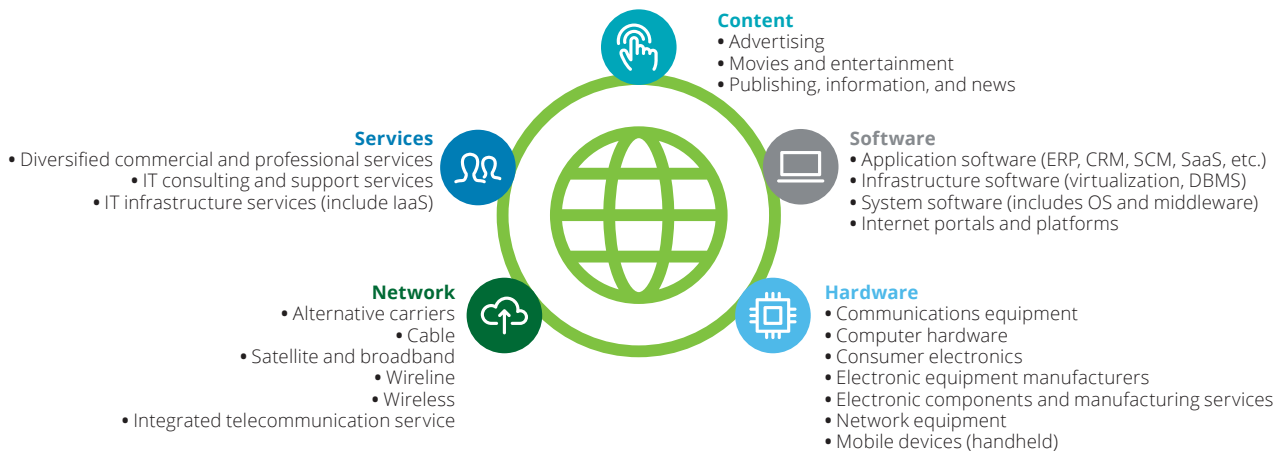
"Brazil can be a strong competitor in the new digital economy. Our challenge is to create the infrastructure conditions to enable new business models."

Thiago Camargo Lopes
Secretary for Digital Policies of Brazil

2. Investments in ICT improve a country's economy and social welfare

The Information and Communications Technology (ICT) sector is an enabler of economic progress and also an important driver for the future development of the global digital economy. It integrates the digital ecosystem, which is a global network of economic and social activities, such as the Internet, mobile and sensor networks.

The ICT sector is an enabler of economic progress and also an important driving force for the development of the global digital economy.

Content
- Advertising
- Movies and entertainment
- Publishing, information, and news

Services
- Diversified commercial and professional services
- IT consulting and support services
- IT infrastructure services (include IaaS)

Software
- Application software (ERP, CRM, SCM, SaaS, etc.)
- Infrastructure software (virtualization, DBMS)
- System software (includes OS and middleware)
- Internet portals and platforms

Network
- Alternative carriers
- Cable
- Satellite and broadband
- Wireline
- Wireless
- Integrated telecommunication service

Hardware
- Communications equipment
- Computer hardware
- Consumer electronics
- Electronic equipment manufacturers
- Electronic components and manufacturing services
- Network equipment
- Mobile devices (handheld)

Source: Deloitte

The Digital Ecosystem can be defined as a subset of the Telecommunication, Media and Technology (TMT) companies that are specialized in the development of hardware, content, and software applications and provide a platform for the creation, distribution, and consumption of content, applications, and services. These companies are part of the ecosystem by the virtue of their complex interrelationships and their collective impact on a wide range of customers.

The trends that drive the evolution of a digital ecosystem can be divided in three clusters: foundational (trends that lead to the emergence of others), first order (those emerging from foundational trends), and second order (those that emerged from first-order trends). This categorization helps in understanding how one or more trends enabled the emergence of another wave of value creation in the digital ecosystem.
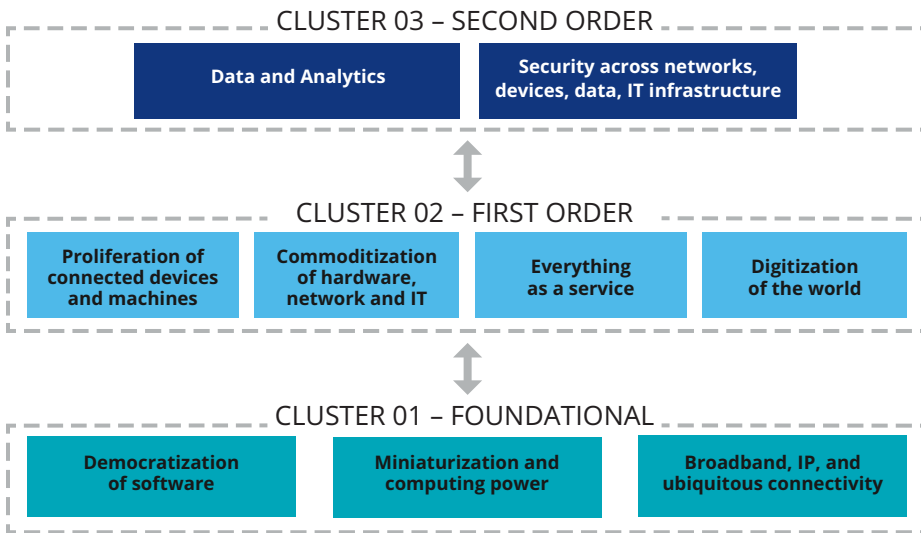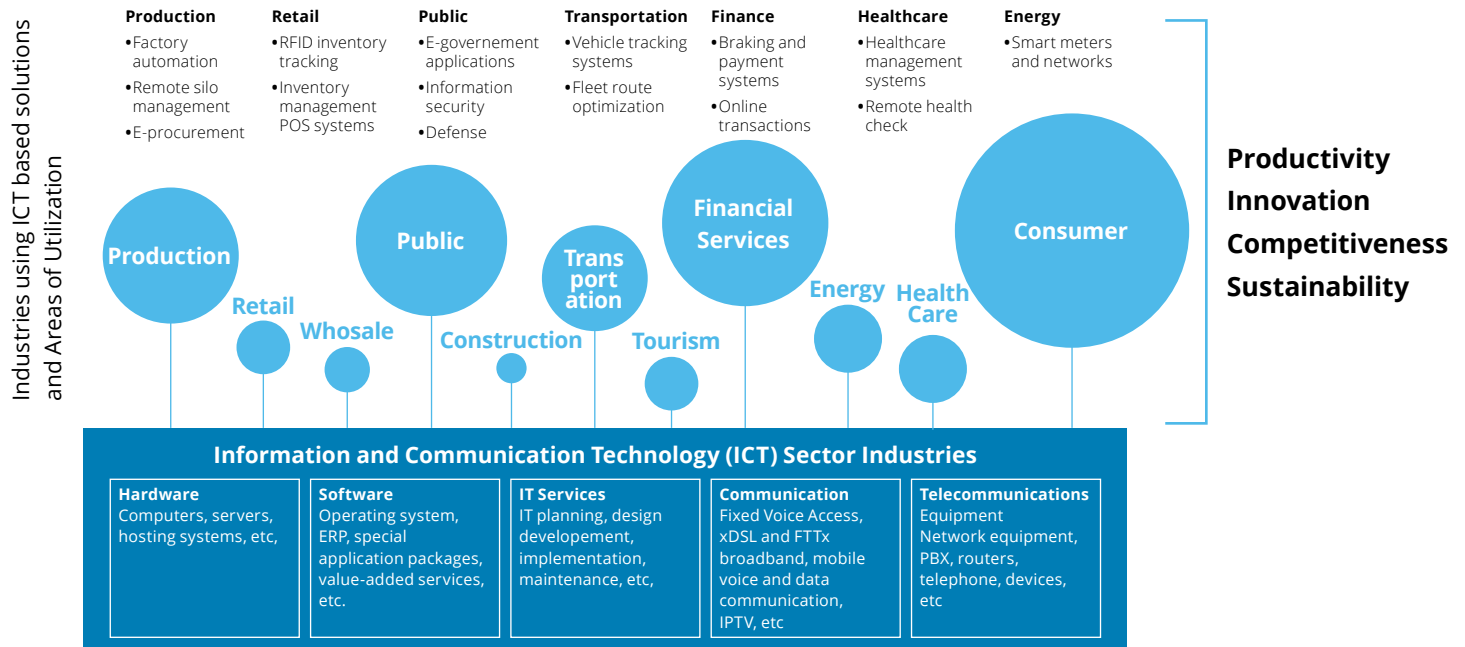
Digital Ecosystems trends

Cluster 1 – Foundational

Enabled the digital revolution. The most recent concepts such as artificial intelligence and IoT are possible due to these capabilities

Cluster 2 – First order

Key trends that gained prominence as direct beneficiaries of the foundational trends. Each of these factors continues to exert influence inside and outside the digital ecosystem

Cluster 3 – Second Order

Emerges from the first order cluster and reflects that companies within the digital ecosystem master the digitalized business environment.

CLUSTER 03 – SECOND ORDER

Data and Analytics	Security across networks, devices, data, IT infrastructure

CLUSTER 02 – FIRST ORDER

Proliferation of connected devices and machines	Commoditization of hardware, network and IT	Everything as a service	Digitization of the world

CLUSTER 01 – FOUNDATIONAL

Democratization of software	Miniaturization and computing power	Broadband, IP, and ubiquitous connectivity

Source: Deloitte

The ICT sector and its impact on other industries

Production
- Factory automation
- Remote silo management
- E-procurement

Retail
- RFID inventory tracking
- Inventory management POS systems

Public
- E-governement applications
- Information security
- Defense

Transportation
- Vehicle tracking systems
- Fleet route optimization

Finance
- Braking and payment systems
- Online transactions

Healthcare
- Healthcare management systems
- Remote health check

Energy
- Smart meters and networks

Industries using ICT based solutions and Areas of Utilization

Production · Retail · Whosale · Public · Construction · Transportation · Tourism · Financial Services · Energy · Health Care · Consumer

**Productivity
Innovation
Competitiveness
Sustainability**

Information and Communication Technology (ICT) Sector Industries

Hardware	Software	IT Services	Communication	Telecommunications
Computers, servers, hosting systems, etc,	Operating system, ERP, special application packages, value-added services, etc.	IT planning, design developement, implementation, maintenance, etc,	Fixed Voice Access, xDSL and FTTx broadband, mobile voice and data communication, IPTV, etc	Equipment Network equipment, PBX, routers, telephone, devices, etc

Source: Deloitte
Note: The circumference size is an illustrative representation of the macro effects generated by ICT in each sector, through productivity gains, innovation, increased competitiveness and sustainability.

In this way, the ICT sector is seen as the foundation to the development of technology and innovation. It's a horizontal sector which affects all industries, increases productivity, and takes an active role as a facilitator.

Concept and definition of the ICT Sector

Some entities define the ICT sector considering different perspectives. The Organization of Economic Cooperation and Development (OECD) pioneered the discussion of the activities that compose the ICT sector. In 1998, the OECD defined the ICT sector as a combination of both manufacturing and services industries[1] that capture, transmit and display data and information electronically. It was the first step in obtaining initial measurements of the ICT sector core indicators.

In Brazil, the Brazilian Institute of Geography and Statistics (IBGE) defines the ICT sector as the integration of technologies based on microelectronics, telecommunications and information. Considering the classification of the economic activities ("CNAE", from IBGE),

the ICT is divided into the manufacturing and the service segments with specific economic activities in each one of them.

The ICT sector in the world

The boom of the ICT sector during the last decade is especially related to the development of the telecommunications technologies that have revolutionized the regular means of communication and access to information. Improved connectivity has

become the major driver of the ICT sector, with broadband Internet access being a crucial resource for accessing information.

The mobile-cellular subscriptions penetration in the ICT sector in 2016 was significant. Mobile-broadband subscriptions and access to the Internet, which have become fundamental indicators for the digital economy evolution, have presented high representativeness in the developed economies.

ICT Sector		
Manufacturing		**Services**
Electronic Components		Electronic Components
Computer Equipment and Peripherals		
Equipment Communication		Computer Equipment and Peripherals
Apparatus for Reception, Reproduction, Recording and Amplification of Audio and Video		
Virgin Media, Magnetic and Optical		Virgin Media, Magnetic and Optical

Source: National Classification of Economic Activities (CNAE), IBGE; International Standard Industrial Classification (ISIC), United Nations.

**ICT penetration by level of development, 2016**
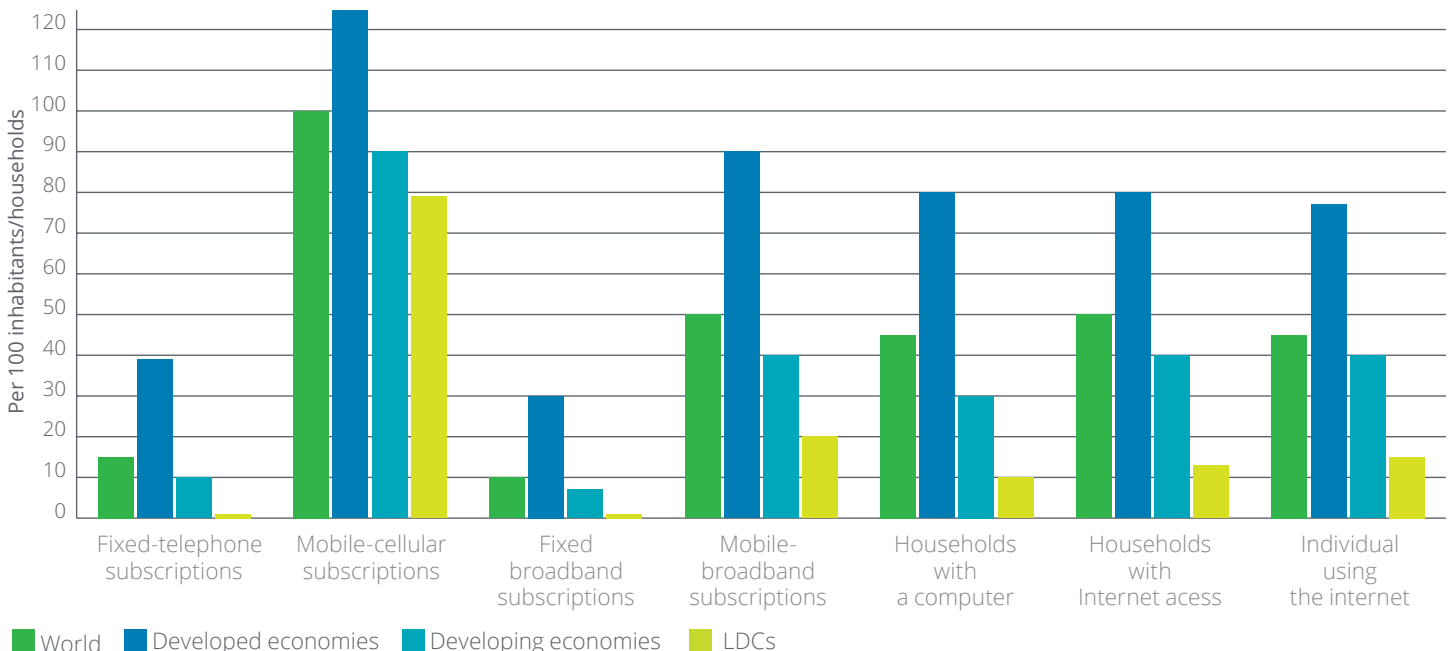
Source: ITU, 2016. (Data are estimated)

There is a long-term upward trend in the availability of the telecommunications services and broadband. Between 2007 and 2017, global fixed-broadband subscriptions increased by 183 per cent. Active mobile-broadband subscriptions grew rapidly, from 4.0 subscriptions per 100 people in 2007 to an estimated 56.4 subscriptions per 100 people in 2017.

According to the International Telecommunications Union (ITU), after 2005 it is possible to see an upsurge in mobile-cellular telephony, leading to near-saturation penetration rates. At the same time, global fixed-telephone subscriptions have been decreasing worldwide since 2005, becoming more and more obsolete, reflecting the growing importance of mobile phones.

The following charts show global mobile cellular subscriptions and global fixed-telephone subscriptions, total and per 100 inhabitants, 2005-2017.

Global ICT developments, 2001-2017*

- Mobile-cellular telephone subscriptions
- Fixed-telephone subscriptions
- Individuals using the Internet
- Active mobile broadband subscriptions
- Fixed broadband subscriptions
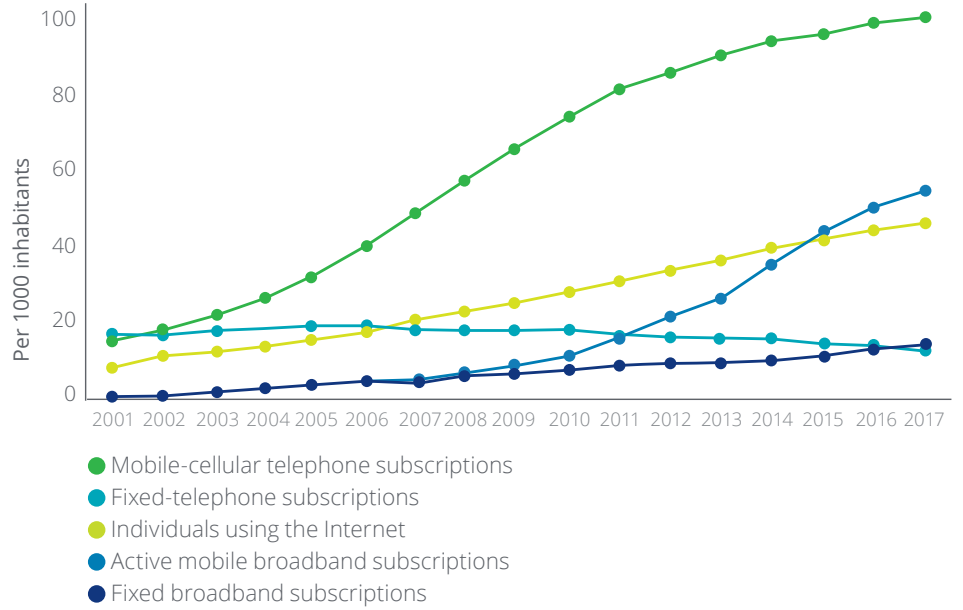
Source: ITU
*ITU estimate

Mobile-cellular subscriptions (millions)
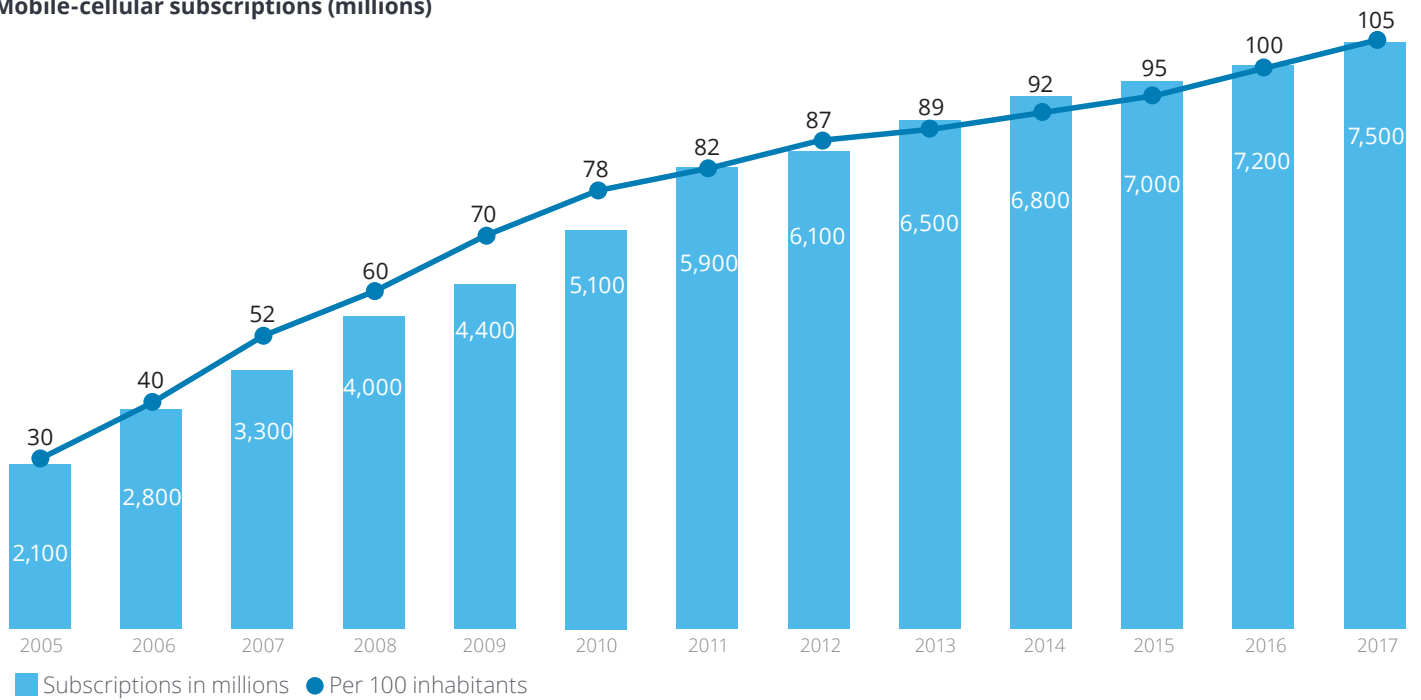
Source: ITU Measuring the Information Society Report, 2017 – Volume 1

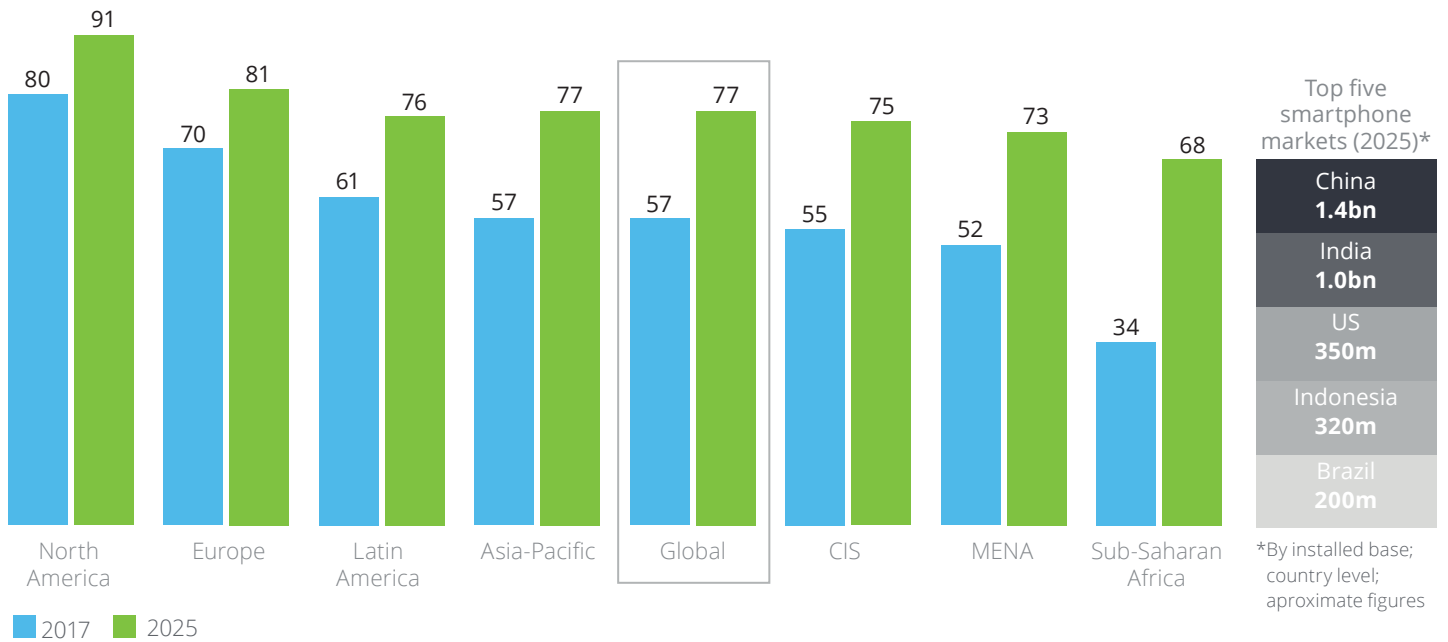**Global fixed- telephone subscriptions (millions)**
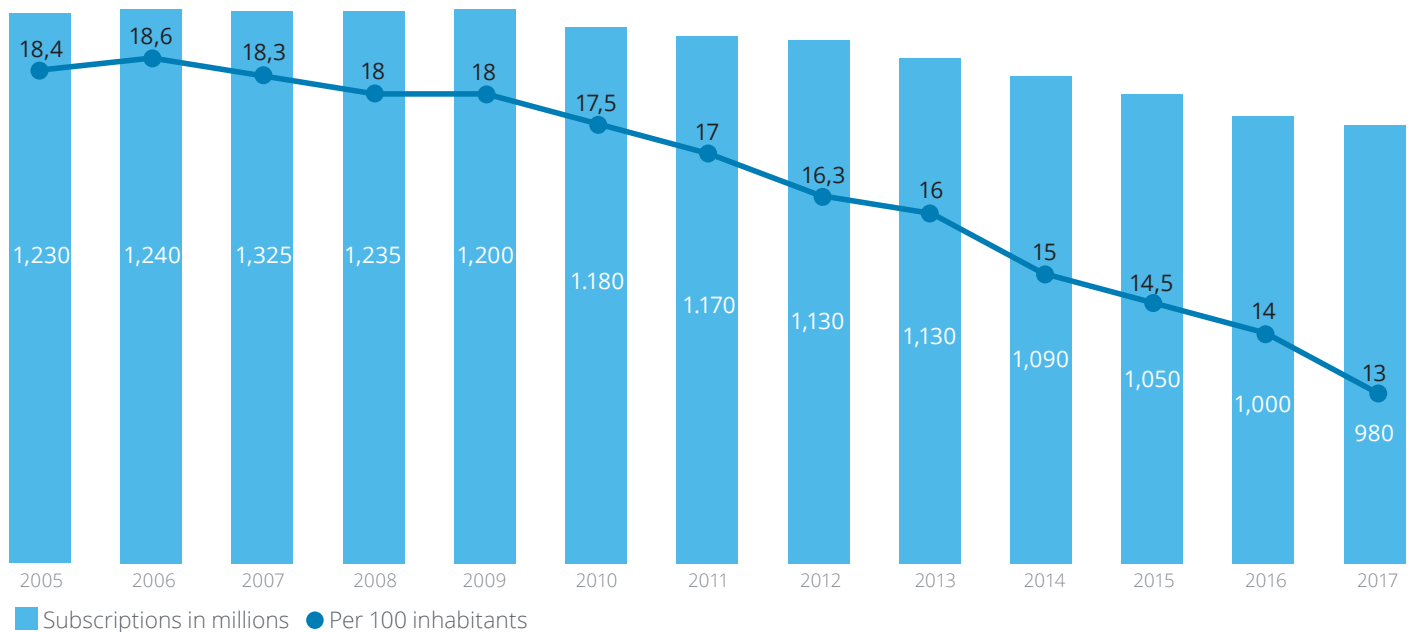
Source: ITU Measuring the Information Society Report, 2017 - Volume 1

Given the growing importance of the mobile telecommunications services, the mobile Internet adoption has become the key metric for evaluating the performance of the ICT industry worldwide. In 2017, 43% of the population had access to mobile Internet, while the forecast from GSMA for 2025 is that the mobile Internet penetration will reach 61%, i.e. about 5 billion people around the world will be mobile Internet users.

Smartphone adoption is projected to grow by 20% between 2017 and 2025, driven by more affordable devices and a higher demand for access to different online services and contents. Smartphones are expected to become the leading type of handset by 2025 in all regions around the globe. Brazil will be among the five major smartphone markets by 2025, with 200 million mobile connections, along with China, India, the US and Indonesia.

Smartphone adoption
Smartphones as a percentage of total mobile connections excluding cellular IoT (in %)

Region	2017	2025
North America	80	91
Europe	70	81
Latin America	61	76
Asia-Pacific	57	77
Global	57	77
CIS	55	75
MENA	52	73
Sub-Saharan Africa	34	68

Top five smartphone markets (2025)*

China	1.4bn
India	1.0bn
US	350m
Indonesia	320m
Brazil	200m

*By installed base; country level; aproximate figures

■ 2017 ■ 2025

Source: GSM Association

Brazil will be among the five major smartphone markets by 2025 with 200 million mobile connections.

The growing importance of mobile telephony demands improvements in service-providing, especially for developing countries, raising challenges in the expansion and an upgrade of the existent network. Investments in services, infrastructure and network became strategic to market expansion and sometimes they need assistance from the government, particularly for non-profitable areas.

Considering the mobile network technology, in 2017, 29% of the global mobile connections were based on the use of 4G technology, according to the GSMA. In 2019, about 10 years after its launch, 4G is projected to become the leading mobile network with more than 3 billion connections worldwide and will continue to dominate until 2025, reaching a 53% share of mobile connections.

Global mobile adoption by tecnology
Share of mobile connections excluding cellular IoT
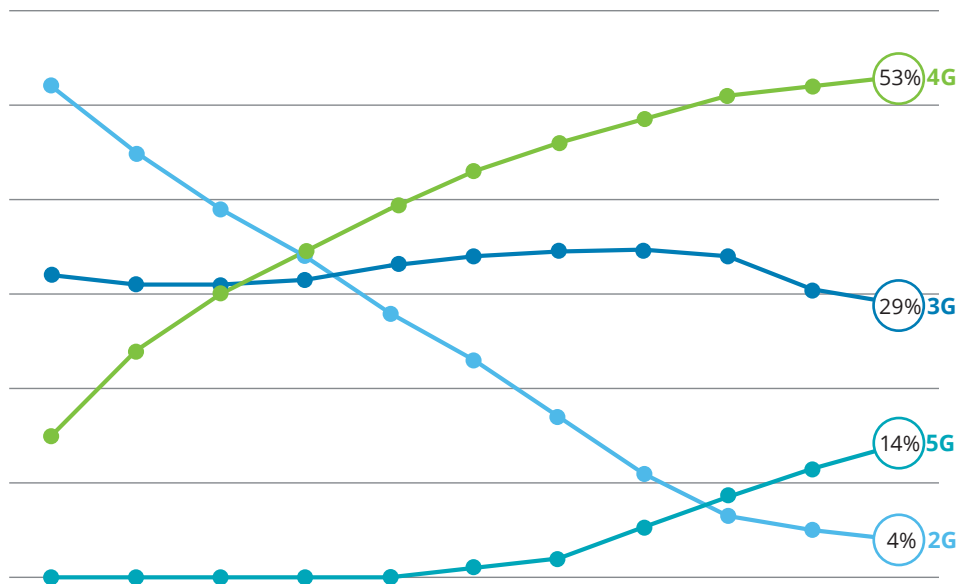
Source: GSMA

The global leaders in the growth of the 4G technology are the developing economies (countries from Asia, Latin America, Middle East, North Africa and Sub-Saharan Africa), which will be responsible for 84% of the newly generated 4G connections around the world in the next eight years.

China, the US, the European Union and Japan will lead the 5G technology adoption by 2025, and will be responsible for 70% of the global 5G market.

Regarding the development of the 5G technology, the GSMA estimates that in 2025 there will be 1.2 billion connections in the world, accounting for 14% of the total mobile SIM cards.

Developed countries are already engaging in commercial launches of 5G conducting trials using various spectrum bands. The GSMA estimates that China, the US, the European Union and Japan will lead the 5G technology adoption by 2025, and will be responsible for 70% of the global 5G market.

The fixed Internet broadband, along with mobile telephony, plays a relevant role in the ICT sector. The growing demand for new services – i.e. streaming music and videos services – requires increasing improvements in network in order to meet the consumer's expectations related to the quality and the speed of the connection.

The number of individuals using the Internet is growing, driving the development of the global ICT industry and becoming an important resource for accessing information. Since 2005, the number of individuals using the Internet has been increasing, especially in Europe and the Americas, according to the International Telecommunication Union (ITU).

Individuals using the Internet (in %)
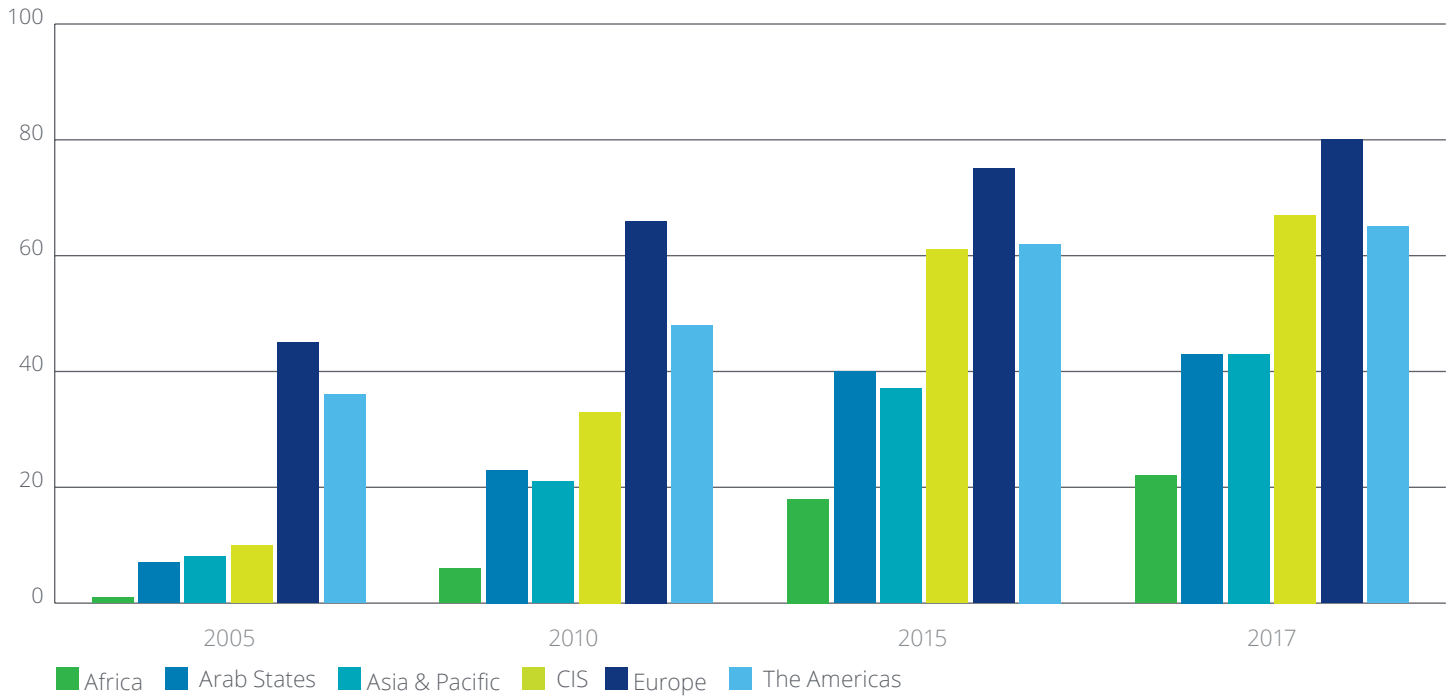
Source: ITU, Measuring the Information Society Report – 2017 Volume1.

The proportion of households with access to the Internet is also unequally distributed across different countries.

In developed countries, 84.4% of the households have Internet, while in the developing economies this percentage is twice as low (42.9%).

During the last five years, the number of fixed broadband subscriptions around the world has grown at a CAGR[2] of 9%, with an addition of 330 million new subscribers.

The existing gap between developed and developing economies in terms of fixed broadband subscribers is rather prominent with 31 subscriptions per 100 inhabitants in the developed world against 9 in the developing world. The reason for this large gap lies in the considerably more expensive fixed broadband, especially in the Least Developed Countries (LDCs)[3].
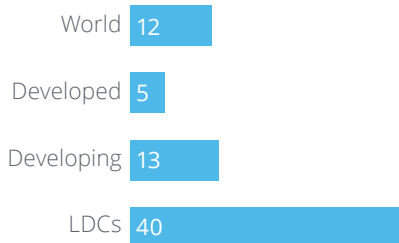
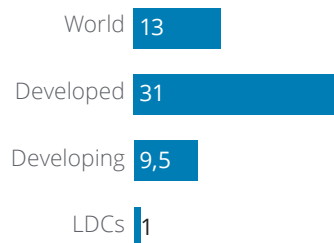**Proportion of households with Internet access, 2017*** (in %)
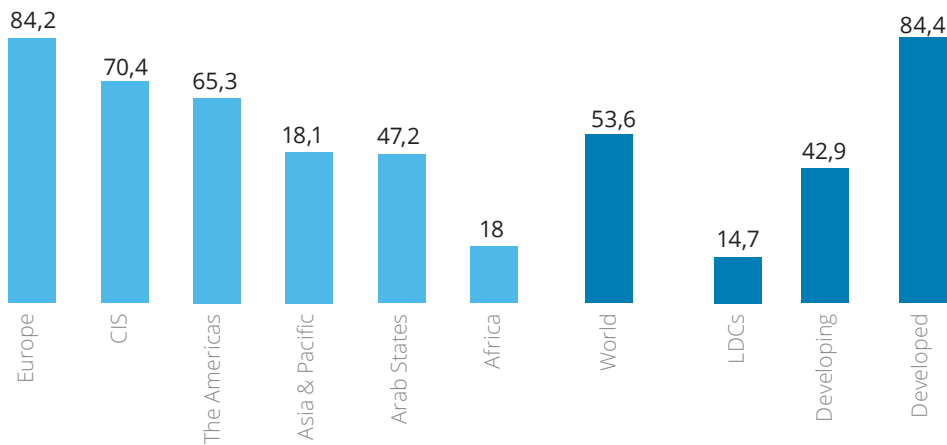
Source: ITU
*Estimated CIS refers to the Commonwealth of Independent States.

Growth of fixed-broadband subscription, CAGR, 2012-2017* (in %)

Fixed-broadband subscription, 2017* (per 100 inhabitants)


Source: ITU
*Estimated CAGR refers to the compound annual growth rate.

Considering the importance and relevance of the ICT sector in the economy, the investment for the sector is crucial for its development. According to a Gartner study, the 2018 worldwide spending on ICT will reach more than USD 3.5 trillion, registering a 6.2% annual growth. The figure also highlights the importance of the communication services among worldwide spending.

The International Data Corporation (IDC) estimates that in 2018 the United States are expected to be the major investor within ICT, spending USD 1.3 trillion. They present a projected growth at a CAGR of 3.6% over the period 2016-2021. China will be the second major geographical market for ICT, with an investment of USD 499 billion in 2018 and a significant growth of 5.2% CAGR through 2021. Japan, the United Kingdom and Germany will be among the top five countries in ICT investment in 2018, while the fastest growing spending between 2016 and 2021 will be observed in the Philippines (7.5% CAGR), India (7% CAGR), and Peru (6.7% CAGR). Peru's position can be partially explained by the purchase of smartphones and investments in hardware.

Gartner's forecast for 2018 worldwide dollar-valued IT spending
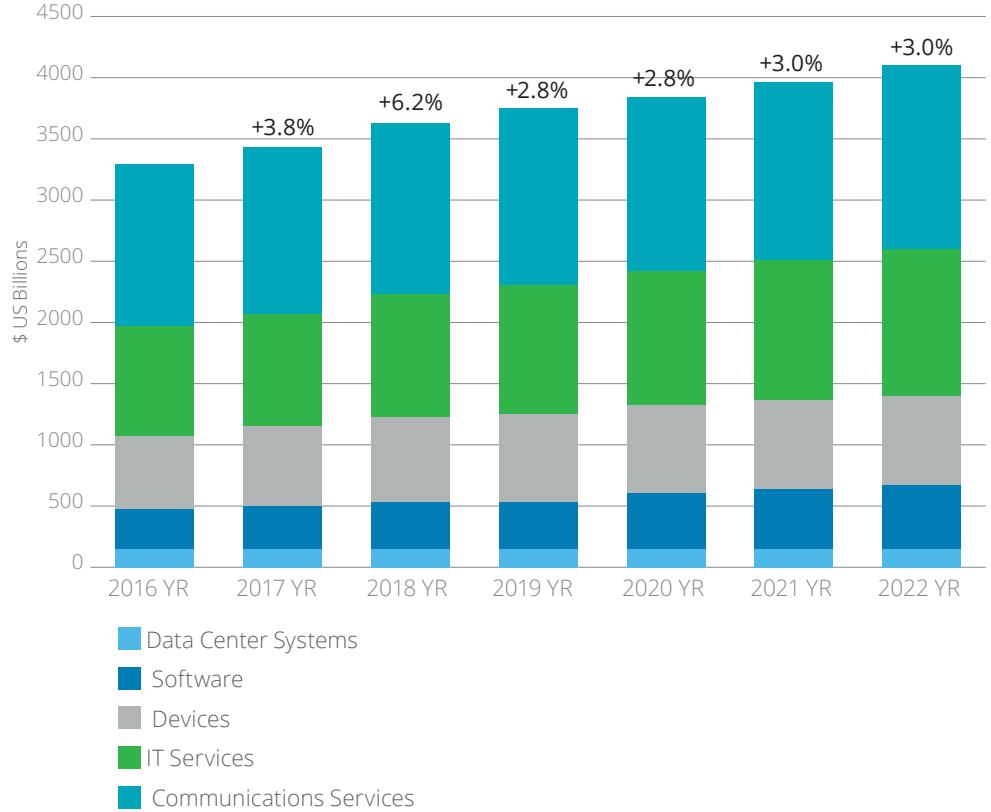
Source: Gartner

Even though the global digital economy is evolving at a rapid pace, there is a significant disparity among the development of the ICT sectors in different countries around the world. Some countries have quickly adapted to the new reality, enhancing their digital transformation. Many developing countries, however, especially the Least Developed Countries (LDC), are not adequately prepared to face the changing global digital environment and to benefit from the existing opportunities related to the digitalization processes.

Some examples from the experience of other countries in the context of digital transformation

Singapore: Singapore Smart Nation was launched by the government in 2014. The objective was to drive the comprehensive adoption of digital and smart technologies throughout the country. The government puts policies and legislation in place to facilitate innovations by the public and the private sector and to encourage the adoption of new ideas.

Canada: Digital Canada 150 was also launched in 2014 with the objective to create a digital policy for Canada. It set goals for the celebration of Canada's 150th birthday in 2017, and they were updated when the date got closer. The new version of the program focused on five pillars: Connecting Canadians, Protecting Canadians, Economic Opportunities, Digital Government and Canadian Content.

Malaysia: Digital Malaysia is a program based on strategic trusts to advance the country towards a developed digital economy by 2020. The goals are to increase the contribution of the digital economy to the Gross National Income (GNI), to enhance productivity and to improve the standard of living.

Germany: Industry 4.0 is a national strategic initiative from the German government. It aims at driving the digital manufacturing forward by increasing digitalization and interconnection of products, value chains and business models. It also aims at supporting research, networking of industry partners and standardization.

China: Internet+ (Internet Plus) was a program implemented through a five-year plan to integrate cloud computing, big data and the Internet of Things with a variety of industries from manufacturing to commerce, Internet banking, agriculture and many others.

Brazil ranked on 44th place on GCI, among the 79 examined countries for the second consecutive year and was classified as an adopter.

The Global Connectivity Index (GCI) highlights the importance of the ICT sector and analyzes how the countries are positioned in terms of investment, adoption, experience and potential ICT development.

The US, Singapore and Sweden remained the top three nations in 2018 (with 2017 data), according to the GCI ranking. Brazil ranked on 44th place among the 79 examined countries. The country was classified as an adopter and, as such, should focus on developing the implementation of cloud services across the entire economy, which can open the door for earning a frontrunner[4] status in the coming years.

When the GCI report compares the evolution from 2015 to 2018, it reveals that, on average, frontrunner countries advanced more than the adopters, which in turn advanced more than the starters.

At the same time, the improvement of the GCI score leads to significant economic gains: an increase of 1 point on the GCI score generates a 2.3% increase in productivity, a 2.2% rise in innovation and a 2.1% growth in national competitiveness.

Global Connectivity Index (GCI)

The Global Connectivity Index (GCI) is a tool for measuring a country's status in ICT investment, adoption, experience and potential of ICT. In 2018, the report analyzed 40 indicators from 79 different nations. The countries were classified in three main categories: starters, adopters and frontrunners.

The starters category refers to countries in the early stage of ICT infrastructure with focus on increasing the access to the digital economy. The adopters are countries focused on increasing ICT demand to boost industry digitalization and economic growth. The frontrunners are the nations focused on improving user experience, using technologies like Big Data and IoT to develop an intelligent society.

The potential future gains (or losses) related to the development (or the lack of such) of the ICT sector differ across countries and regions. They depend on the preparation of governments and adaption of enterprises to the new reality and to cope with various challenges and costs.

GCI S-curve, 2015 and 2018

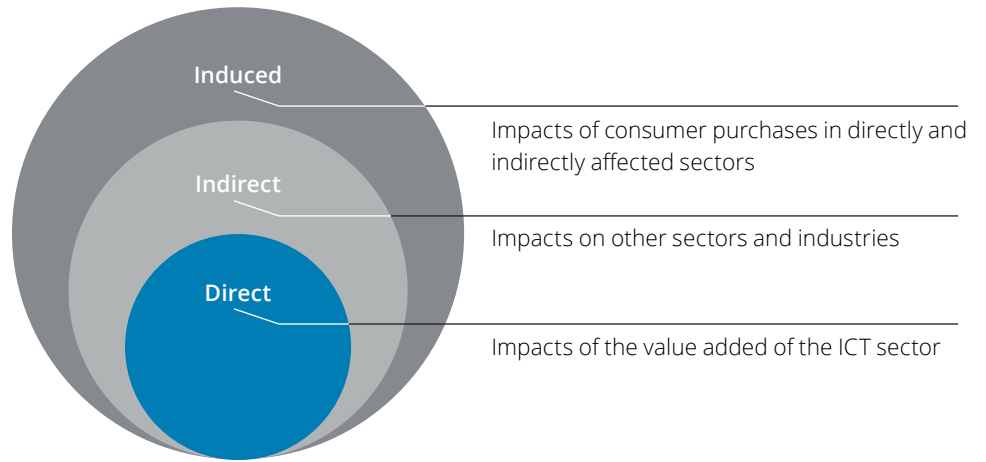Source: Global Connectivity Index (GCI), 2018..
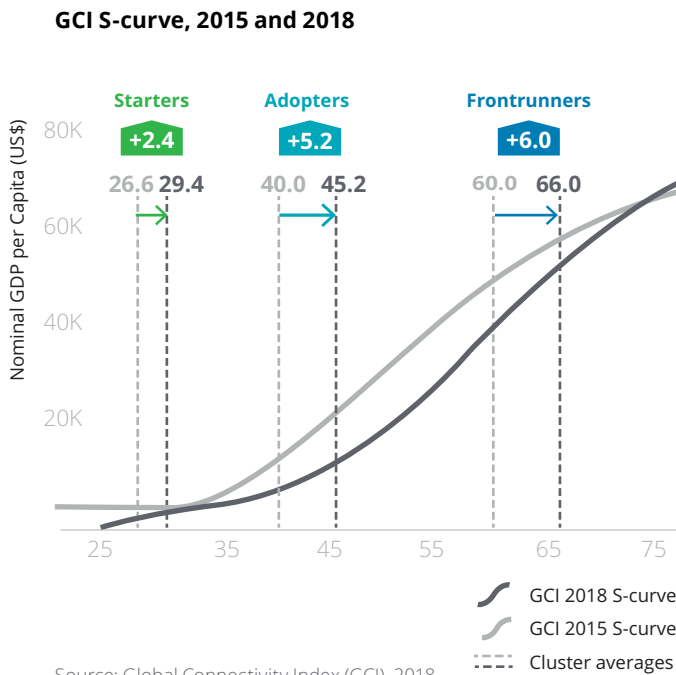
Improvements in the ranking position are directly related to the development of the ICT sector. This report will present some suggestions in the next chapter that will help Brazil move up on the GCI's ranking.

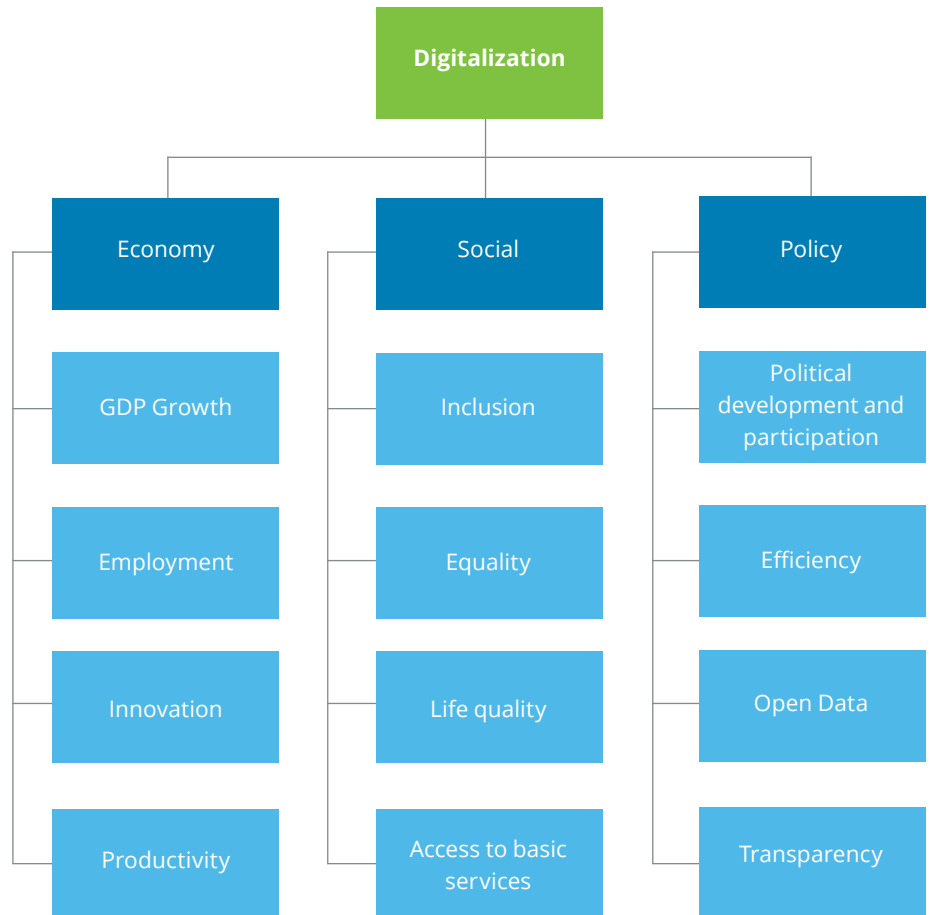**Impacts of ICT development on economy, society, and policy**

The development of the ICT sector and the process of digitalization have direct and indirect impacts on the economy, on the society and on the government policy. When it comes to the economy, the ICT sector can contribute to the GDP growth, create new jobs, boost the process of innovation and the adoption of new technologies, as well as lead to increases in productivity.

The direct economic impacts can be estimated by measuring the contribution of the value added of the firms operating in the ICT sector to the economy, while the indirect economic impacts are related to the purchases of inputs from different providers in the supply chain.

Regarding the gains for the society, the increased levels of digitalization of the economy can lead to higher social inclusion, equality and better life quality. Moreover, the ICT sector can boost the political development of the country, enhance the efficiency of the public administration and increase the transparency and diminish the bureaucracy.

Induced — Impacts of consumer purchases in directly and indirectly affected sectors

Indirect — Impacts on other sectors and industries

Direct — Impacts of the value added of the ICT sector

Source: Deloitte

Digitalization

Economy	Social	Policy
GDP Growth	Inclusion	Political development and participation
Employment	Equality	Efficiency
Innovation	Life quality	Open Data
Productivity	Access to basic services	Transparency

Source: Mexico National Digital Strategy, 2013

Concerning the representativeness of the ICT sector in the global GDP, The Mobile Economy 2018 report from the GSMA estimates a continuous expanding in the next five years. The GSMA also concludes that the biggest impact of the development of the sector will be on productivity, due to the adoption of new technologies and Internet solutions that would lead to more efficiency and higher productivity.

Given the increase in the representativeness of the ICT sector in GDP, this sector becomes an important driver for global GDP growth and prosperity. Traditional ICT spending, which refers to investment in IT and telecom services, has been significant during the last decade, registering twice as higher growth rates as the real GDP.

Between 2007 and 2017, traditional global ICT spending and real GDP growth exhibited similar behavior[5].

It is possible to observe a significant increase in ICT spending after the global financial crisis of 2008-2009 and also a considerable increase in real GDP growth. After 2015, investments in new ICT categories – such as Internet of Things (IoT), robotics, augmented and virtual reality, cognitive computing and artificial intelligence (AI) – gained importance in the developed world and are considered as innovation accelerators. Investments in these new technologies are expected to drive the growth of ICT spending in the developed countries over the next years, while investment in traditional ICT activities will be the major driver of the sector in the developing world.

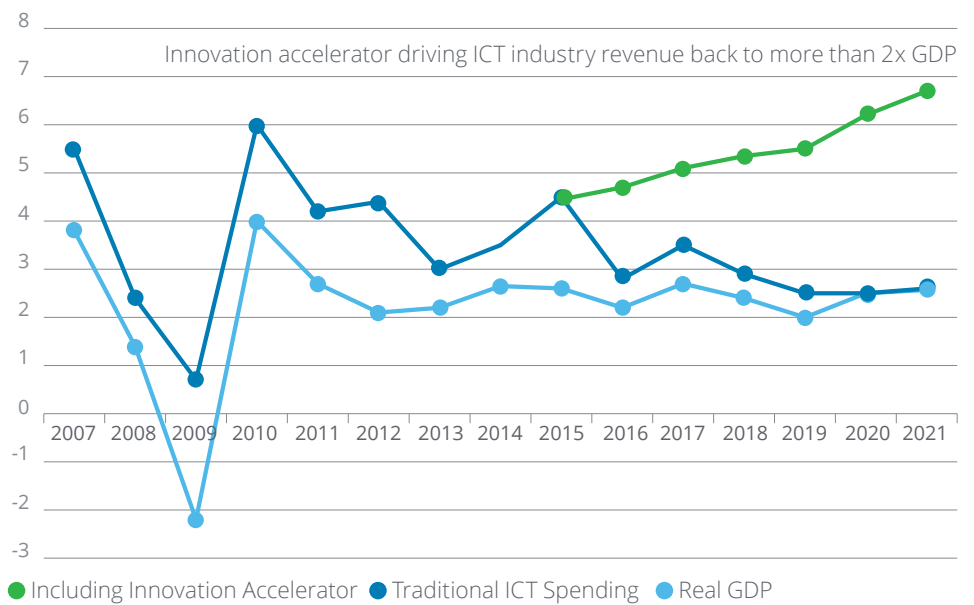**Outlook to 2022, value added** ($ billion, % of GDP)
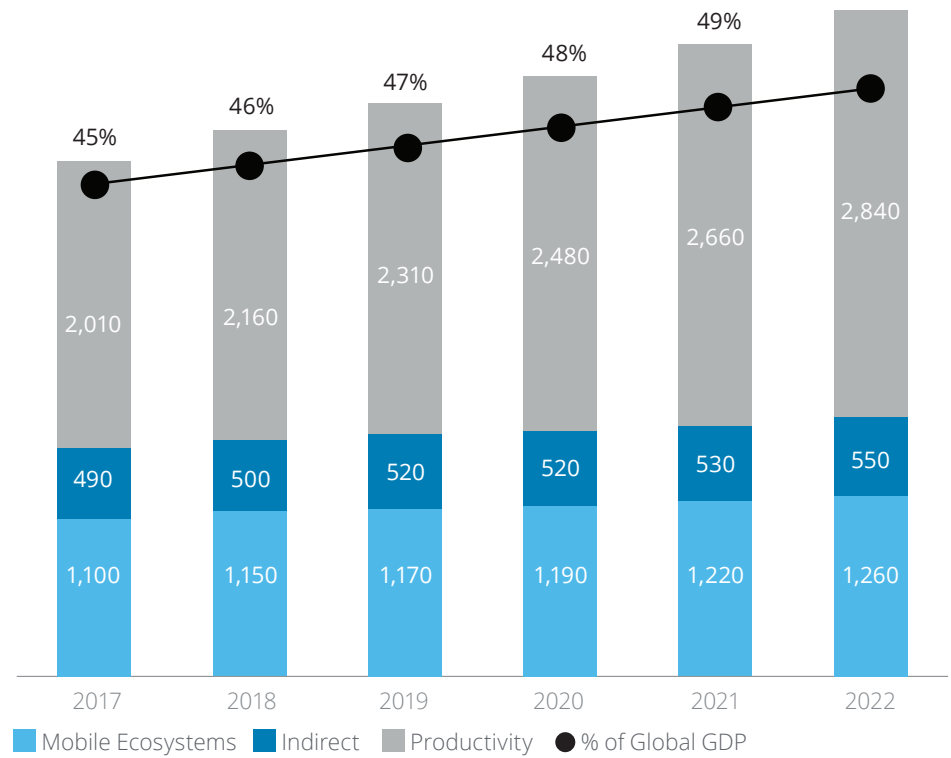
Source: The Mobile Economy, 2018, GSMA

Worldwide ICT Spending
Growth, constant currency (in %)

Innovation accelerator driving ICT industry revenue back to more than 2x GDP

Source: IDC

Investments in the ICT sector are also associated with increases in labor productivity. In the developed world, ICT capital had a significant positive impact on labor productivity between 1991 and 2000. Afterwards, this impact started decreasing and became rather small after 2011. This is expected once the level of development of the domestic ICT sectors in these countries achieves maturity.

The situation looks different for countries from the developing world, where the potential for the development of the domestic ICT sector remains prominent.

The ICT capital in East Asia has become the second major contributor to labor productivity growth after non-ICT capital between 2011 and 2016. In countries from Africa, Latin America and the Caribbean, on the other hand, the contribution of ICT capital to labor productivity growth remains insignificant, which indicates the existing possibilities for investment in digital technologies in these countries and the potential for boosting the performance of the domestic labor market.

In this way, it's possible to see the importance of the ICT sector for the economy and its possible effects. All over the world this sector is playing a significant role as an enabler of the digital ecosystem, increasing its representativeness in GDP yearly. However, the development of the ICT sector in Brazil faces a lot of challenges that need to be addressed.

Contribution to labor productivity growth in developed economies (in %)
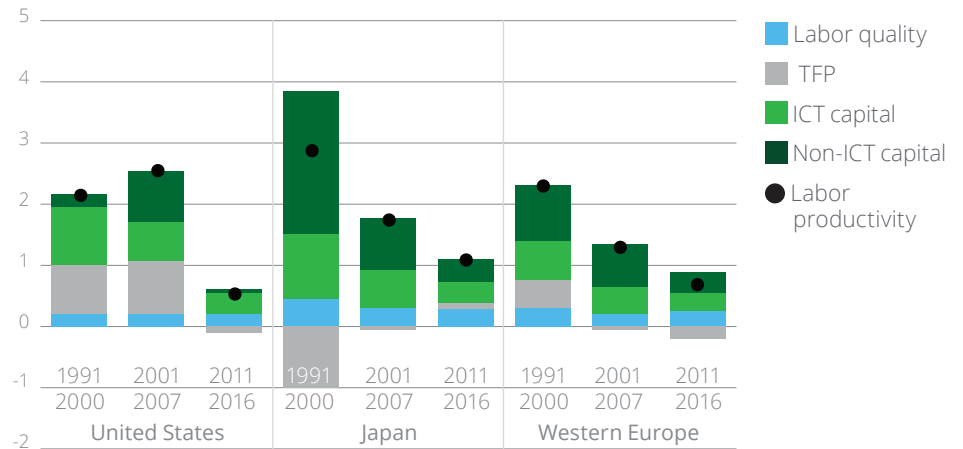
Source: United Nations

Contribution to labor productivity growth in developing regions (in %)
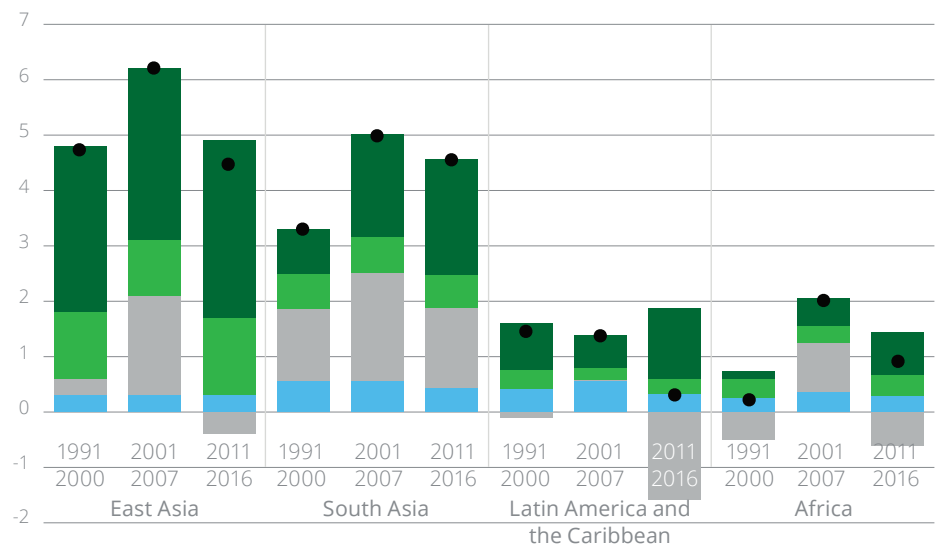
Source: United Nations

"Integration and collaboration between Private sector, the Federal Government, States and Municipalities is fundamental for the expansion of the Brazilian technology and communications ecosystem. Strengthening the network among professionals in these sectors is a way of accelerating bureaucratic processes."

Marcio Iorio Aranha
UnB

3. Brazil is underperforming in ICT, therefore there are opportunities to improve competitiveness

Given the importance of the ICT sector worldwide and its trends to continue and amplify its representativeness in global GDP, this section aims at presenting the Brazilian situation of the sector and how the country is positioned in comparison to the rest of the world.

According to the World Economic Forum (WEF), through the Global Competitiveness Report (GCR) from 2017-2018, Brazil is the best country in terms of market size, one of the twelve pillars analyzed by WEF. However, regarding other pillars from the ICT sector such as technological readiness and innovation, Uruguay and Costa Rica, are respectively the best and second best countries in Latin America.

GCI score range for Latin America and the Caribbean (LAC) across the 12 pillars, 2017-2018 edition
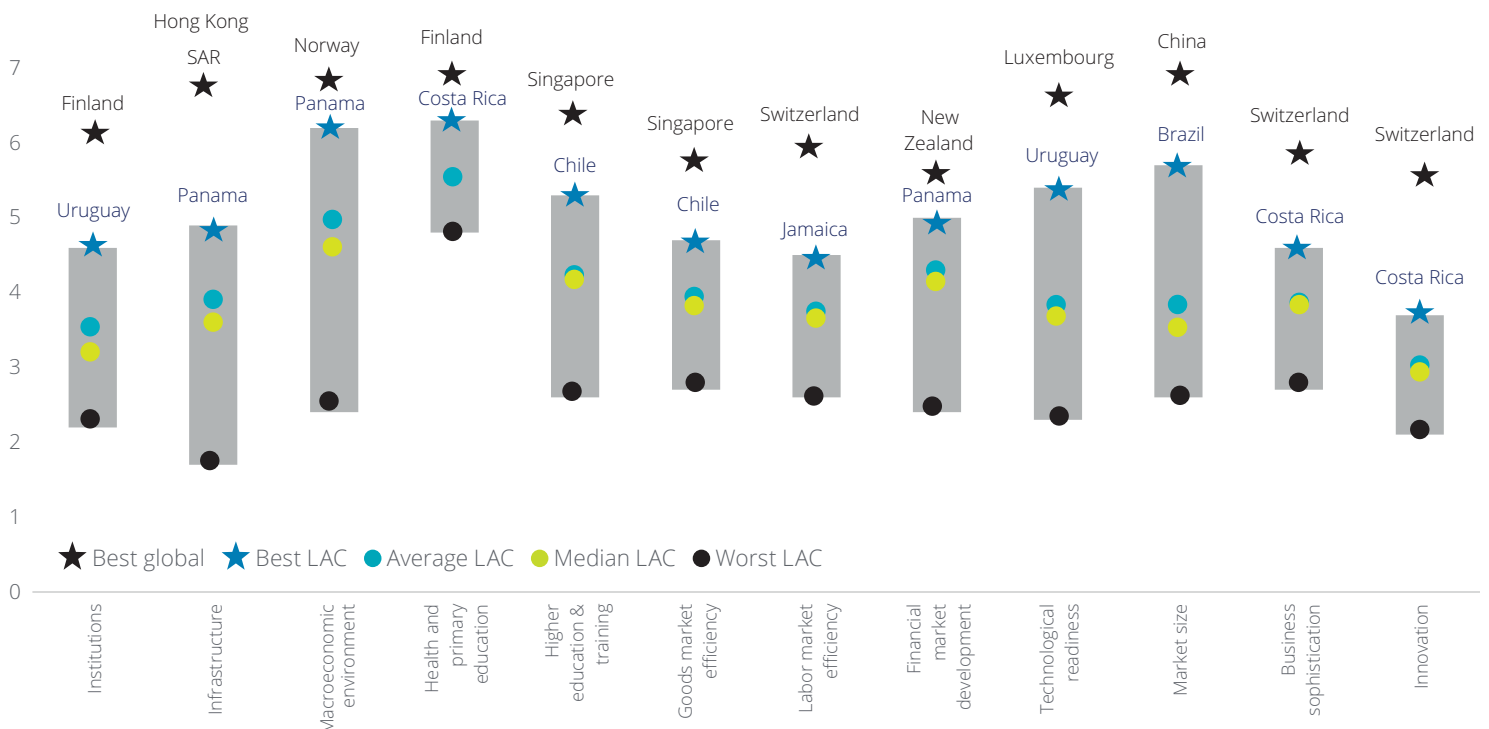
Source: World Economic Forum based on GCI 2017-2018

The WEF's competitiveness index also lists the main problematic factors for businesses. For Brazil, tax rates, restrictive labor regulations, corruption and inefficient government bureaucracy were the main barriers listed in the World Economic Forum's Executive Opinion Survey.
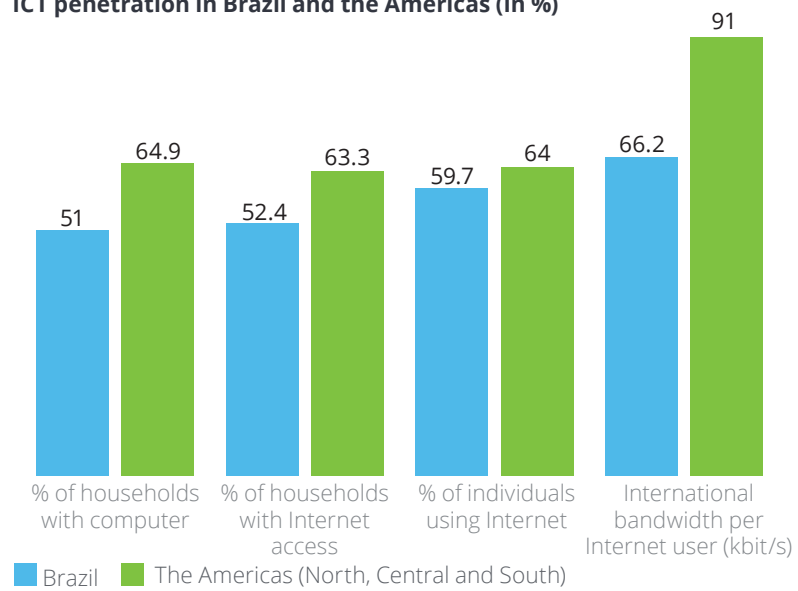
Similar to other sectors, the ICT also faces difficulties and barriers for its development in Brazil. Even though it has one of the major telecommunications markets, Brazil needs to improve the connectivity and services. According to the ITU in the Measuring the Information Society Report 2017, Brazil has a dynamic telecommunications market that is in expansion.

The numbers presented by the ITU compares the Brazilian numbers with The Americas' (North, Central and South America countries). It is possible to identify that the percentage of households and individuals with access to the Internet in Brazil is lower than the regional average. Thus, there is still space for development of the domestic ICT sector in the country.

Regarding the Telecommunications sector, specifically mobile telephony, net revenues of data services surpassed the revenues of voice services in 2017, according to Teleco[6].

Mobile telephony is Brazil's largest ICT subsector, accounting for 43.5% of the sector's gross revenues in 2017 and for 72.9% of subscribers. Also in Brazil, gross revenue from mobile telephony services reached 98.9 billion reais, which demonstrates the increasing potential of this market.

ICT penetration in Brazil and the Americas (in %)

	Brazil	The Americas (North, Central and South)
% of households with computer	51	64.9
% of households with Internet access	52.4	63.3
% of individuals using Internet	59.7	64
International bandwidth per Internet user (kbit/s)	66.2	91

Source: World Economic Forum

Voice and data services revenues in Brazil (in %)

	2013	2014	2015	2016	2017
Voice services revenues	74,4	68,9	59,2	50,6	38
Data services revenues	24,6	31,3	40,8	49,4	62
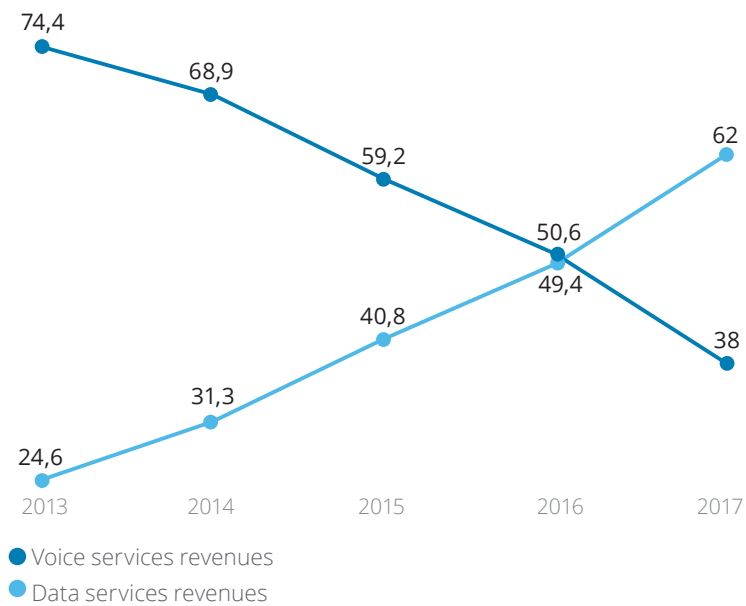
Source: Teleco

The net revenue of mobile data reached 62% in 2017, demonstrating that Brazilian consumers are demanding more services regarding data, which increases the relevance of broadband expansions and coverage. These changes in consumer behavior highlight the importance of the development of a consistent mobile broadband infrastructure to meet demands and provide services with high quality to consumers. Revenues from voice services have been reducing since 2013, which can be justified in parts by the emergence of text message services through data usage (i.e. WhatsApp, Telegram, etc). These numbers reinforce the hypothesis of the intensive services data in Brazil.

Considering the mobile technologies in Brazil, 4G has been increasing its share since 2013 and became the leading technology surpassing 3G for the first time in 2017. Significant investment in expansion of the 4G and 4.5G coverage across the country is expected in the next few years.

According to Teleco (2017) the number of 4G users continues to increase in Brazil, which indicates that operators are still monetizing their investments in the 4G infrastructure. As a result, the amount of users is expected to keep increasing for the next years, especially with new technologies like the 5G that will provide high-speed connections between numerous devices.

In terms of investment in the domestic mobile industry, it registered a peak in 2001 as a result of the boom in the use of mobile phones. Afterwards, there was a slowdown in the investment in the sector, followed by a wave of capital entry in the mobile industry, starting in 2011 with the boom in the use of smartphones around the globe.

Mobile technology in Brazil (million R$)
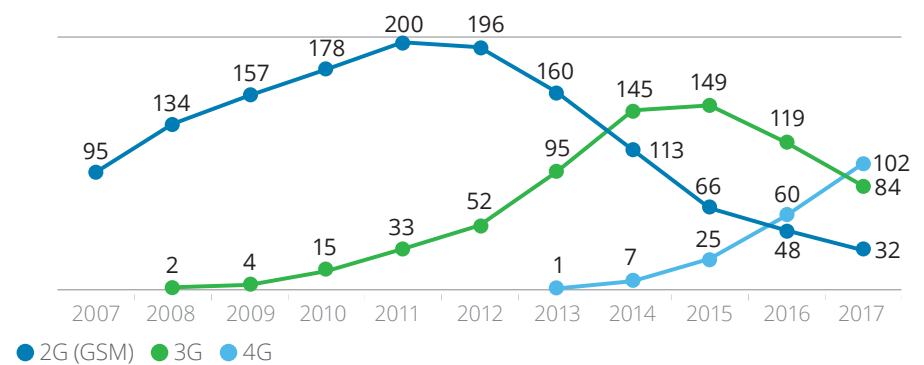
Source: Teleco. Analysis of the Brazilian Mobile market, 2017.

Investments and their relation with gross fixed capital formation, 2016
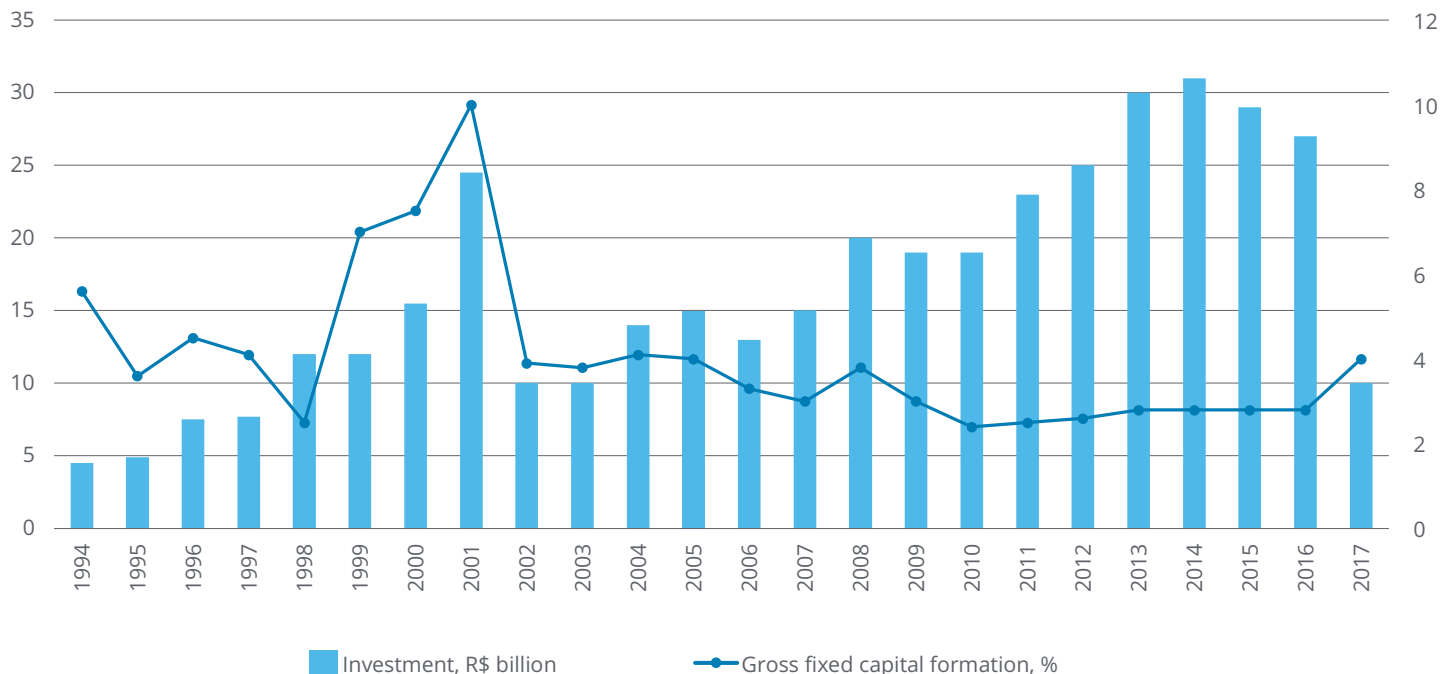
Source: TeleBrasil

Despite the growth of investments after 2011, the Gross Fixed Capital Formation - that measures the value of acquisitions of new fixed assets that are used to produce other goods[7], indicates whether the country's production capacity is growing and also the future confidence in the sector – was almost flat during the period.

This behavior indicates that the companies from the ICT sector are not actually investing in increasing production capacity. The lack of expansion can result in a significant detachment of Brazil in comparison to other countries regarding the effort in digitalization and innovation.

Even though Brazil has a relevant mobile market, the country was considered among the top 10 unconnected markets in terms of absolute subscribers in 2016, according to the ITU. These top 10 countries account for 61% of the unconnected people in the world. Brazil was positioned in 5th place with 40.6% of the unconnected population in 2016.

Brazil ranked in 5th place with 40.6% of the unconnected population in 2016.

The competitiveness of the domestic ICT sector depends on the country's capability to produce and export high-technology products. Brazil's intensity in high-tech manufacturing exports (13.5% in 2016) is below the average for the OECD countries (17.6%). In addition, Brazil falls significantly behind China in terms of export of high added value products. Among the countries analyzed by the Economic Forum, China is one of the countries with the largest representativeness in the exports of high-tech products.

Increases in the share of exports of high value-added products are crucial for the future development of the ICT's sector, and are directly related to skilled labor, which, in turn, generates greater value added for the country's economy.

In this way, the characteristics of a country's workforce affect the level of technological development. High-skilled people are a key factor for the processes of innovation and digitalization of the economy. Brazil remains among the countries that rely significantly on low-skilled labor with low productivity potential. According to the WEF's estimation for 2016, only 21.6% of the population was employed in highly knowledge-intensive jobs. Within the Latin American countries, Brazil falls behind Argentina and Chile.

Top 10 unconnected markets

	Top Ten Markets	Unconnected (millions)	Score (millions)	% Unconnected (penetration)
1	India	660.19	1,334.66	49.05
2	China	362.28	1,385.28	23.06
3	Nigeria	101.68	189.41	53.7
4	Pakistan	101.12	194.79	51.9
5	Brazil	85.35	210.41	40.6
6	Bangladesh	75.73	163.87	46.2
7	Ethiopia	68.45	103.10	66.4
8	Indonesia	64.45	262.05	24.7
9	United States	61.88	325.30	19.0
10	Congo, Dem. Rep	59.93	80.98	74.0

Source: ITU, 2016

Share of high-technology products, 2016 or latest observation
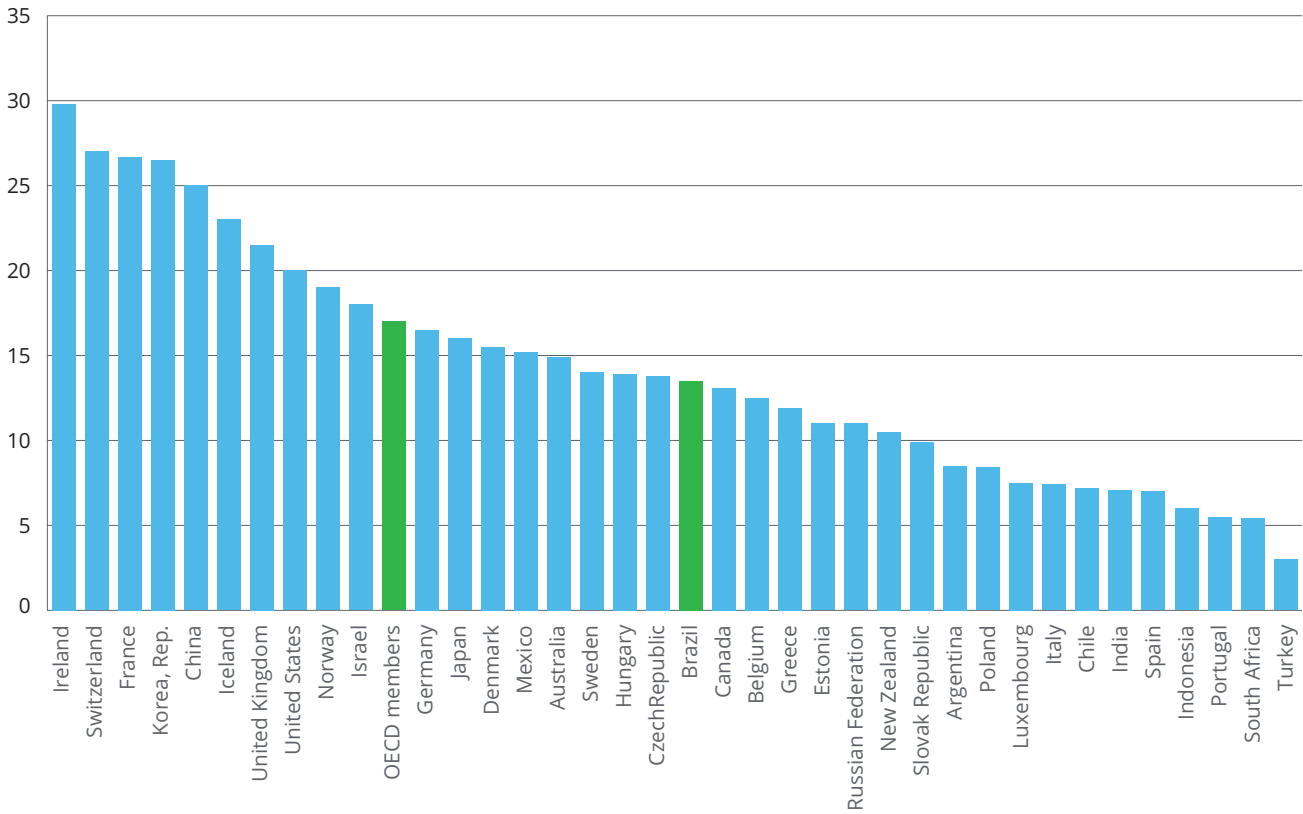
Source: World Economic Forum, 2016.

Share of knowledge-intensive jobs in the workforce, 2016 (%)

Source: World Economic Forum, 2016.

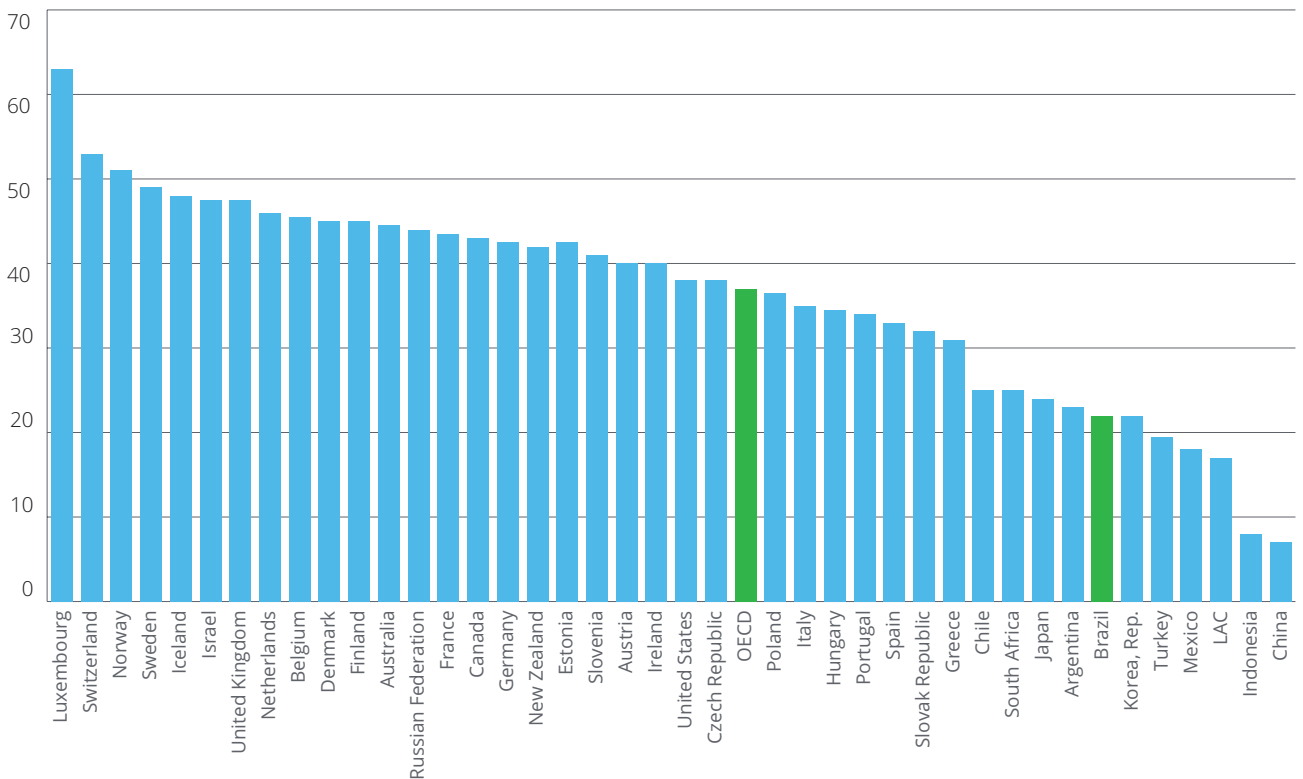## In 2016, only 21.6% of the Brazilian workforce performed highly knowledge-intensive jobs.

Increasingly, companies seek skilled workforce to integrate and develop a digital ecosystem. Efforts are needed in this sense for decreasing the gap between the actual and the future workforce generations, since high skilled professionals generate more value for the country.

Domestic technological development and innovation are also enhanced by the presence of high-tech firms that generate high-value products. The graph below presents the majority of
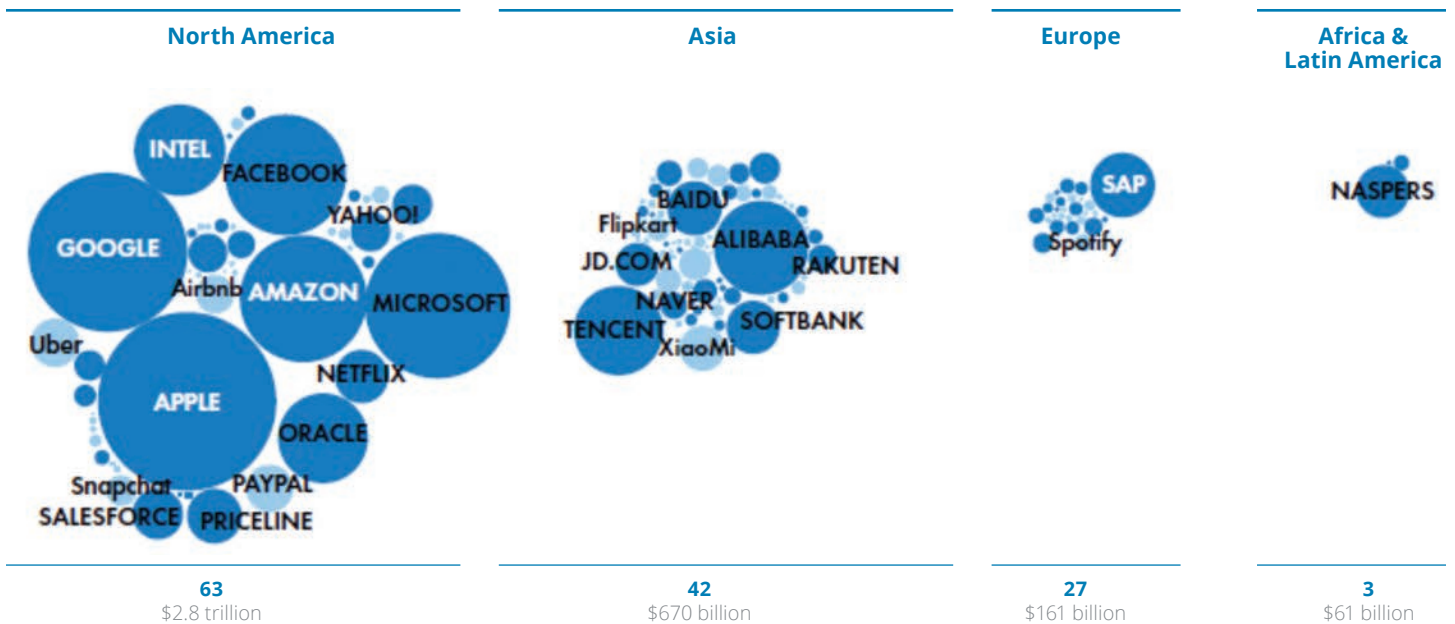
digital multinationals originated in North America and Asia, indicating a high level of geographical concentration of the global digital economy.

In comparison to Asia and North America, Europe has fewer players on the global market but Latin American and African countries are lagging behind, accounting for only 2% of the total market capitalization value of digital companies around the world, according to the United Nations Conference on Trade and Development (UNCTAD). Brazil lacks high-tech companies that generate high-value products, which makes it difficult for the country to compete on the global digital market.

Brazil lacks high-tech companies that generate high-value products.

According to the Doing Business Report of 2018, from the World Economic Forum, which evaluates how easy it is to start new business in each respective country, Brazil figures below the Latin American and Caribbean average, ranking in the 125th position with 56.45 points, while the mentioned region's average is 58.66 points. The Doing Business indicator covers 11 sets of quantitative regulatory indicators to open a business: dealing with building permits, obtaining electricity, registering property, obtaining credit, protecting minority investors, paying taxes, negotiating across borders, enforcing contracts, and resolving insolvencies. They evaluate the distance to the frontier (DTF), which shows

Geographical concentration of headquarters of "digital MNEs" with a market capitalization of more than $1 billion, by region, 2016

North America	Asia	Europe	Africa & Latin America

North America	Asia	Europe	Africa & Latin America
63	**42**	**27**	**3**
$2.8 trillion	$670 billion	$161 billion	$61 billion

Source: UNCTAD

the distance of each economy to the "frontier" represented by the best observed performance in each of the indicators in all the economies analyzed since 2005.

In the report, the WEF concluded that Brazil has reduced the average time consumed to start a new business by implementing an online portal for commercial licenses. However, the country also hindered the process to start a business by reducing the opening hours of business registration. Some taxes related to the transfer of ownership were also high, compared to the previous year's analysis, indicating that transferring the ownership became more complex. Brazil also introduced a new certificate of good standing on labor debts, increasing the number of due diligence procedures. In addition, despite the initiatives to reduce bureaucracy, there are still barriers to start new business in the country.

High skilled professionals, high tech-companies, infrastructure and network improvements are, among others, the challenges faced by Brazil and other countries in the digital economy. This report presents some suggestions to help to put in practice some actions for Brazil, highlighting the improvements and developments that are necessary for the digitalization of the country.

Efforts for the development

Given the present situation of the ICT sector in Brazil, the government through the Ministry of Science, Technology, Innovation and Communications (MCTIC) has developed a number of studies related to the digital strategy of the country. These efforts are reflected in some initiatives and consolidated in the e-Digital document. Below are listed other examples of MCTIC initiatives in order to promote Brazil as a connected country:

- Brazil-Europe submarine cable: a project between Brazil and Spain to enable data traffic between the countries. The objective, among others, is to connect research communities from Europe and Latin America;

- National Plan of Internet of Things (IoT): directives to the implementation of public policies related to the sector's development;

- National Strategy of Science, Technology and Innovation (ENCTI) 2016-2022: states the robust and articulated National System of Science, Technology and Innovation (SNCTI) as an essential condition to the scientific and technological development;

- Telecentros: public places with free Internet connection and ICT tools, available computers connected to the Internet especially to training and capacity building;

- Electronic Government - citizen service (GSAC – Serviço de Atendimento ao Cidadão): provides free broadband Internet connection to "telecentros", schools, hospitals and health units, indigenous villages, border posts and quilombos;

- Internet for all (Internet para todos): program to connect more than 40 thousand municipalities that do not have Internet access. The coverage expansion will be promoted through GSAC.

Digitalization experiences

A lot of challenges arise when talking about new digital economy and ICT sector. Some countries have overcome the challenges to promote their digitalization and the development of the ICT sector.

Considering these challenges and efforts, we present some examples regarding the implementation of a digital strategy by some countries.

Government of Canada Technology Strategic Plan 2016-2020: a strategic plan that sets out the four-year digital direction of the federal government, introduced in 2016. The plan aims at guiding federal organizations on the use of IT as a strategic asset for delivering better programs and services that bring value to the citizens. The proposed strategy has four major goals – service, security, value and agility and is based on the development of four key areas: Service IT (promotes the use of cloud computing and information-sharing platforms), Security IT (focuses on reduced exposure to cyber threats and the adoption of proactive measures), Manage IT (related to strengthening the governance approach), and Work IT (seeks actions for building high-performing IT workforce and a modern workplace). Some of the actions that are already underway in Canada include the development of digital policy, the adoption of cloud services, the complete consolidation and modernization of data centers, and the development of API strategy, among others.

Germany's Digital Agenda 2014-2017: a program in which the German government sets out the digital policy guidelines for achieving three core objectives: growth and jobs, access and inclusion, and trust and security. The Agenda will be implemented together with all stakeholders involved in the process of digitalization: businesses, social partners, civil society and academia. Moreover, in 2016 the Federal Ministry for Economic Affairs and Energy (BMWi) introduced the Digital Strategy 2025. It is a strategic action program, which suggests measures and policy instruments for the successful digital transformation of the country. Ten areas of action were identified as enablers for digital Germany by 2025. The focus is establishment of gigabit fiber network, cooperation with start-ups, regulation that stimulates investment and innovation, data security, modernized production and Industry 4.0, digital education at all ages, and creation of a Digital Agency as a centralized competence entity in the ICT sector.

"The development of the Brazilian information and communications technology is core to positioning Brazil in the new Economy."

Moacyr Martucci
USP

4. Investments in priority areas can speed up Brazil's development and address current gaps

Some areas are strategic to the development of a country, especially when talking about the digital era. They bring innovation to all aspects of the society, affecting from citizens' daily activities to huge companies' business models. Given the ICT sector behavior and the digital environment in the world, Brazil is far from the most developed countries when talking about the development, improvement and innovation in the ICT sector.

New technologies will drive competitiveness and can improve the development of the country, positively affecting its economy, workforce, and other social and economic variables. This kind of conclusion raises a lot of doubts and questions related to the main areas or dimensions that should be prioritized in this new economical context.

On what sector/areas should Brazil focus?
Many studies were conducted highlighting the importance of the ICT development in all countries and its possible economic and social impacts. In 2009, the World Economic Forum pointed the ICT sector as a catalyst to the economic transformation. The WEF's report assigned a vital role to the ICT sector in the creation of a sustainable global economy, drawing attention to the challenges of the ICT ecosystem.

In Brazil, the government has already placed a lot of effort to enable and start a digital transformation, encouraging the ICT ecosystem. Along with the "e-Digital", the National Plan of Internet of Things (IoT) from the National Bank of Economic and Social Development (BNDES) is another example, besides many other studies conducted by the government to drive the country towards the digital agenda.

"Internet of things: an action plan for Brazil"

The National Plan of IoT is a study conducted by the BNDES and the Ministry of Science, Technology, Innovation and Communications (MCTIC) which aimed at reaching a diagnosis and proposing public policies about the Internet of Things in Brazil.

The study contemplated the following themes: general diagnosis and aspiration for Brazil; selection of vertical and horizontal; elaboration of an action plan (2018 - 2022); and details of the main initiatives of the action plan.

The national plan created an aspiration for Brazil, in order to accelerate the implementation of the Internet of Things (IoT) as a tool for sustainable development, especially regarding smart cities, health care, agriculture and industries.[8]

5G:

It is considered a disruptive technology that will enable new ecosystems such as the Internet of Things, connected cars and several others. The way people interact and perform their daily activities will be directly affected, as well as industries, which will have available higher speed connection and greater data traffic. It is the basis for the technological use and improvement of several sectors, from health (remote monitoring of patients) to agribusiness (monitoring of crops and plantations). New business models should emerge and the population will be more connected.

Optical Fiber:

The development of new technologies and innovation is directly associated with the infrastructure of telecommunications services. New technologies such as streaming in 4K and 5G will require a better connectivity experience, which may force the infrastructure to comply with this new increase in demand. Thus, the optical fiber plays a vital role in facilitating the expansion of new business models, bringing connectivity to the population.

Cloud:

It was also selected as one of the main pillars of the development of the national ICT sector, since it changes the concept of supply of some products, directly impacting the economy. With the increased connectivity made possible by 5G and fiber optics, the massive data generation by the various sensors and devices in IoT, 4K, Games on Demand, among others, will require dynamic allocation of space, increased processing power and cost reduction.

New cloud-enabled business models and user-friendly services generate immediate benefits for the population by reducing bureaucracy for access to services (public and private).

Safe City:

Technology may be responsible for multiplying surveillance, communication, intelligence, command, and control capabilities to make cities safer. Security is considered a major problem in Brazil, but technology can change the way these issues are addressed at all levels of the federation. Improved security through technology - that is, smart cameras, artificial intelligence software, facial recognition - are strategic and can increase the well-being of the population. Technology is an ally to increase the safety of the population, especially in Brazil.

Talent:

Without qualified people, development and innovation are restricted. As a basis for the new generations, education plays one of the most important roles and can not be disregarded when talking about ICT development. Education is considered the basis of the country's development and needs to be aligned with labor market needs reflecting technological innovations.

Considering the importance of the ICT sector for the Brazilian development and taking into consideration the government's effort to enable digital transformation, some initiatives from the Brazilian digital strategy (e-Digital) were selected and prioritized in order to move to a tactical level, addressing what should be done to help the country to improve its ICT sector and be considered a reference in at least one of the pillars of the digital ecosystem.

The e-Digital highlighted 100 actions related to the development and improvement of the country in the digital environment. From this starting point, all initiatives from e-Digital were tabulated considering the insights and overview of the ICT sector worldwide and in Brazil described in Sections 2 and 3 of this paper. The initiatives were selected based on criteria such as adherence and relevance to the ICT sector and based on their impact on e-Digital. After this analysis, a matrix was built in order to identify those initiatives that present high relevance and high impact.

Among all initiatives, 27 were identified as the most relevant to the ICT sector as well as those that impact mostly other initiatives from e-Digital. After another round of prioritization and analysis, the number of initiatives was reduced to 10.

The initiatives were grouped in 5 main pillars that were identified as the head drivers and the most relevant to the development of the country.

The initiatives from e-Digital that were considered the most relevant and impacting are related to three digital transformation axes – data based economy; new business models; and citizenship and government – and to four enabler axes – infrastructure and research; development and innovation; digital environment confidence; and education and professional qualification.

In order to explore the tactical level of these initiatives, the next section describes each one of the pillars highlighting the challenges and alternatives to overcome them with suggestions of approaches and cases of success from other countries that have already passed through or are in the middle of the adaptation to the new technological and digital ecosystem.

5G	**Accelerate 4G implementation**
	Stimulate state governments to implementate **tax incentives for wireless expansion to rural areas,** once the multiplier effects go beyond the sector
Optical Fiber	Connect **22.000 urban and rural schools** with broadband
	Reformule FUST to allow its use on broadband expansion
Cloud	Promote the policy approval of **incentives for datacenters implementation**
	Promote **migration of government IT to cloud-based infrastructure**
Safe City	Implement **platforms** to provide **interoperability and control** among public security agencies
	Establish cooperation between public and private entities to adopt **best practices**
Talent	Promote **cooperation among government representatives**, **universities** and **private sector**
	Promote intersection between private sector and education institutions to supply **skilled workforce**

"Brazilian research in 5G is vital to address the country's needs in terms of geographical and demographic distribution."

Jose Marcos Camara Brito
INATEL

5. Initiatives in infrastructure, education and public safety create the foundations for the Brazilian ICT development

To better approach the problematic, the suggested framework is used to develop proposals and recommendations on infrastructure, applications, skills and training capabilities. The following figure summarizes the key strategical elements of the ICT pillars to be further addressed throughout the chapter. Additionally, on the operational level, the framework stresses supply and demand aspects to enable ICT development.

The Deloitte framework intends to address how specific actions may impact the ICT sector, unlocking the development of multiple areas. Considering the strategic and operational levels, an overview of the segment is delimited to enable drawing recommendation for improvement.

The strategic level is focused on defining what has to be done to enable the future successful development of the specific pillar and why it is crucial that the government takes actions. On this level, the strategic direction of the government initiatives is defined. This includes aspirational goals, definitions, barriers, and critical aspects to be considered when policies are implemented.

The operational level answers the question "How can it be done in Brazil?", focusing on the specific initiatives that the government should undertake in order to stimulate supply and demand for each pillar. This stage concentrates on the path for creating an ecosystem suitable for Brazil.

Framework structure

Strategic

Operational

Supply

Demand

World cases and examples :

Cases
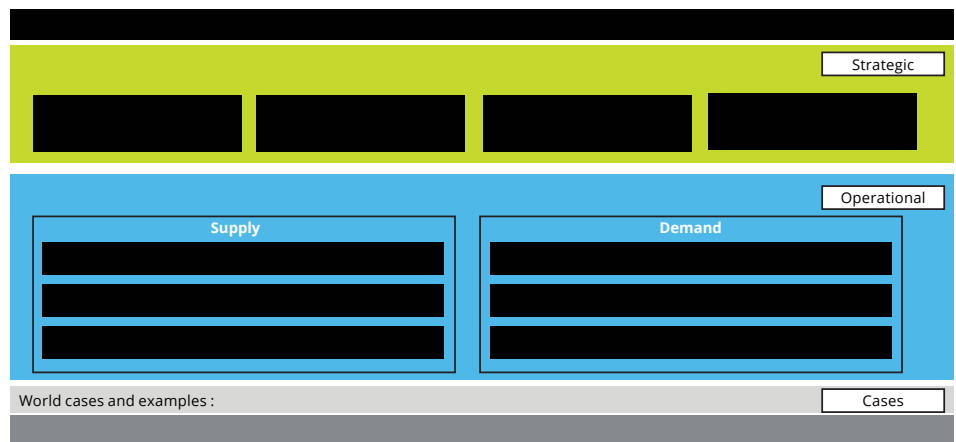
Source: Deloitte development throughout the project

Recommendations for stimulating supply include initiatives that enable infrastructure deployment, that boost the implementation of new technological solutions and facilitate the execution of innovation projects. In order to foster demands for new technological solutions, the government needs to implement initiatives that ensure the citizens' security and protection and demonstrate the relevance of the adoption of such solutions.

The case studies related to the five pillars of interest bring examples of successful models already implemented and fully functioning.

Considering the fact that, in Brazil, each one of the examined pillars is at a different stage of development and maturity, the proposed framework allows the identification of specific gaps and the development of a personalized strategy that focuses on supply, and demand based on some examples of successful experience of already implemented projects.

The remaining of this chapter is devoted to the deployment of the Deloitte framework for each of the considered pillars – 5G, optical fiber, cloud, safe-city and talent.

Pillars details

5G

5G ready, everything connected: foundation for connecting mobile and fixed devices under 5G standards.

Insights and recommendations for 5G ready

5G ready

5G ready, everything connected: foundation for connecting mobile and fixed devices under 5G standards	Strategic

Synergy between 2G, 3G, 4G, and 4.5G	New business models and increased competitiveness	Optimization of the 5G spectrum selection standards	Enablement of new ecosystems of IT and Telecom

Initiatives that enable supply and demand for 5G: | Operational

Supply	**Demand**
Reduction of bureaucracy for the installation of new antennas (site acquisition and licensing)	Incentive models for enabling infrastructure (backhaul, site acquisition)
Standards for long range signal coverage	Broadband "fixed" wireless distribution
Standards for Micro Operators	Standards for measuring user experience

World cases and examples : | Cases

• Incentive models: tax strategy

Source: Deloitte

The deployment of 5G is considered a revolutionary step for mobile connectivity, providing a foundation for "everything connected". In order to ensure that the country will follow the rest of the world in the transition to 5G until 2022, the government has to consider actions related to the definition of a strategic direction of 5G implementation, such as promoting a synergy between 2G, 3G, 4G and 5G, optimizing the spectrum standards, and enabling the new ecosystem of IT and Telecom.

A crucial step for overcoming the major challenges related to 5G implementation is the investment in initiatives that enable supply and demand, which include the de-bureaucratization of the process for installing new antennas, and the creation of a long-range standard requirement and definition of measures for user experience. For the successful process of implementation of 5G in Brazil, the government needs to pursue specific tactical actions, such as changes regarding telecom taxes on mobile usage.

5G is the next generation of mobile technology, which offers significantly faster data speed and lower latency rates in comparison to its predecessors. The term is used to refer to a number of different technologies and, as pointed out by the GSMA[9], there is a discussion regarding the definition of 5G, which is based on two major views. The first view is based on the service-led school of thought, which defines 5G "as a consolidation of 2G, 3G, 4G, wi-fi and other innovations providing far greater coverage and always-on reliability", while the second view describes 5G as "a step change in data speed and order of magnitude reduction in end-to-end latency".

Due to the high potential of 5G to extend wireless capacity and to create significant opportunities for the development of advanced new technologies, industry, academia and governments around the world are putting efforts into the development of the 5G technology. In 2017, 5G did not participate in the global technology mix (2G, 3G, and 4G). The deployment process is expected to start in 2020 and the GSMA estimates that by 2025 the share of 5G in the technology mix worldwide will reach 14%. The first commercial launches of 5G are expected over the next three years in North America, Asia and Europe.

5G adoption in major countries/regions (forecast for 2025, percentage of connections excluding cellular IoT)

49% US

31% Europe

14% Global

25% China

7% LATAM
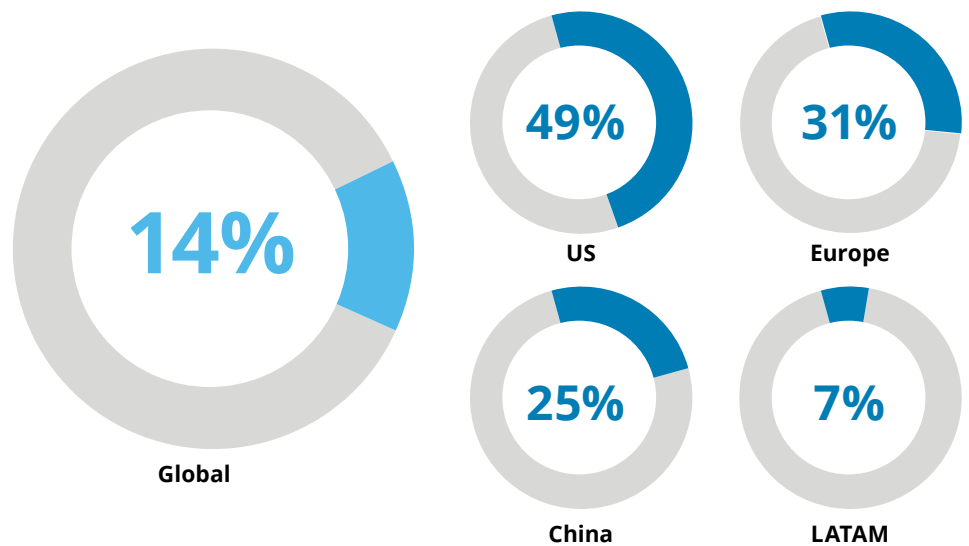
Source: GSMA

Countries and telecoms around the world have been performing tests with 5G technology with various spectrum bands. 5G-based fixed wireless commercial launches are expected to start in the United States already at the end of 2018, performed by the telecom giant Verizon.

Even though the implementation of 5G around the world is expected to reach 14% of the global technology mix by 2025, the distribution across countries and regions will not be equal.

In the countries from Latin America 5G is expected to reach a share of only 7% by 2025. In Brazil, in particular, there still exists a gap in the deployment of 4G in comparison to the rest of the world. The country will face significant investment in this type of technology in the next few years and by 2020, 4G is expected to have a share of 57%, thus, closing the existing gap with the rest of the world.

Technology mix in Brazil (in %)

Source: GSMA

Commercial launches of 5G are expected to start in Brazil in 2019. The deployment of the new technology, however, depends on the release of the 3.5 GHz spectrum, for which Anatel is planning to release a bidding process in the second semester of 2019. The initial use of 5G will be for fixed broadband delivery with speed between 200 Mbps and 400 Mbps.

Telecoms are already preparing for the deployment of the new technology. The national operator TIM performed successful laboratory tests for establishing fixed 5G connections at the end of 2017.

Moreover, in 2016, Brazil and the European Union signed an international agreement to develop the 5G technology standard. The signing of the joint declaration happened in Barcelona, during the Mobile World Congress and followed the fundamental agreements signed with China, Japan and South Korea.

Because of the features of 5G, the evolution from 4G to 5G differs significantly from the one from 3G to 4G. A whole new economic and technological paradigm will be created with 5G.

However, a number of new and existing conditions need to be in place to reap the full benefits of 5G. Those requirements are hereby called the 5G Ready Components, which include all foundational aspects that will allow 5G deployment in the future.

They include, but are not restricted to:
• Antennas
• Backhaul
• Frequency
• Spectrum allocation
• New technologies and equipment

Antennas play a significant role in the 5G architecture because they are the point of contact between the network and the devices. Although the 5G technology can make use and orchestrate antennas from previous standards (2G, 3G, 4G and 4.5G), it is fundamental that new antennas are deployed in order to support the increase in (1) number of connected devices and (2) bandwidth consumption. However, Brazil currently faces a major challenge regarding site acquisition and licensing for antennas' installation. Although there is a Federal Law regulating the Service Level Agreement (SLA) for municipalities to answer a request for antenna installation, that SLA is frequently not met.

Backhaul provides the dataflow between antennas and the network. Current infrastructure can also be used, but the deployment of new antennas in new locations will also require that a backhaul infrastructure is set in place to support it.

Most backhauls are built with optical fiber, and currently the major challenge for Brazil is how to overcome the same barriers faced in broadband distribution (and fiber deployment).

Frequency and spectrum allocation will determine the user experience. An optimal harmonization of frequency with global demands will allow almost seamless user mobility while on international roaming. Wide spectrum allocation will allow increase in bandwidth of data transfer. Both items are currently being taken care of by Anatel (Brazilian Agency of Telecommunications) and discussed in international forums.

New technologies, which go from radio to core, are yet to be developed and/or implemented. Among these, the new generation of radio technologies (e.g. cognitive radio) coupled with new equipment and technologies (e.g. Software Defined Networks) in the Access and Core networks.

Chalenges that need to be addressed for 5G deployment

Standards
As operators begin 5G activities ahead of standadization, identifying use cases and moving faster than standards work, there is an increasing risk of divergence in 5G deployments.

"Killer use cases"
There is a need to definitely answer to the question of where is the intersection between economics and long-term infrastructure for the 5G 2020 deployment.

Transformation
From an operator point of view, transform its current OSS and BSS platforms into a convergent MANO solution across its overall network operations will be a major challenge to be solved prior to full 5G adoption.

CHALLENGES STILL AHEAD

road to **5G**

2020

Spectrum
Decisions are yet to be made on spectrum availability for 5G. New bands below 6GHz and above 24GHz are still yet to be defined, and judgments on spectrum refarming are yet to be made.

IPv6 & Massive IoT
The needed IPv6 adoption to support the massive IoT will have to be guaranteed by operators in their networks, if one wants to take advantage of the full spectrum of 5G possibilities.

Security
With the IT-driven 5G architecture, and its non-telco protocols more susceptible to hack, the critical services on top of the network will demand extra attention to security.

Source: Deloitte

With the increasing quality of connectivity, more and more value-generating IoT use cases can be deployed for the benefit of people and organizations.

The Internet of Things (IoT) is nothing but a network that connects physical objects, such as vehicles, machine tools, street lights, wearables, wind turbines, other devices and people, via connectivity solutions in order to enable communication, exchange data, and derive actions.

IoT already makes this possible by connecting more devices, even in areas that are difficult to reach, at lower battery consumption than other connectivity technologies. However, with the deployment of 5G technologies in the near to the medium future, a truly big shift in IoT will take place.

Key characteristics of 5G enable largescale IoT adoption and success to a degree that is impossible with the current state of connectivity technology. Two of those key characteristics are lower latency and higher throughput. The combination of these aspects enables real-life implementations of use cases that are currently only possible in small-scale lab environments, such as self-driving cars, remote surgery, remote construction robots, and real-time AR/VR applications. However, lower latency and higher throughput alone are not enough for the large-scale adoption of such use cases. Two other key aspects enable mass adoption of these types of innovations: support for more simultaneously connected devices and a more efficient use of energy.

Finally, 5G makes 'network slicing' possible, a technology that enables network operators to create multiple (virtual) networks within one network. This means that different priorities, availability, latencies, and throughput can be set to meet the requirements of different use cases. For instance, mission-critical latency can be provided for applications relating to self-driving cars, while de-prioritized traffic could be offered for more price-sensitive uses cases like tracking bulk containers during road or rail transport. All these aspects combined mean that organizations will have access to connectivity technology that enables scaling up their current proof-of-concept setups.

This scenario comes right in hand with the Brazilian aspirational vision on IoT, written by MCTIC, MPDG (Ministry of Planning, Development and Management) and BNDES in 2007: *"Accelerate the implementation of IoT as the instrument of sustainable development for the Brazilian society, capable of increasing the competitiveness of economy, strengthen the national productive chain and promoting the improvement of quality of life".*

Recommendations

Currently the main barrier for 5G deployment in Brazil is the installation of the required infrastructure (antennas and backhaul). There are mainly two types of barriers: impediments for site acquisition/licensing and economic motivation. Government actions that address the overcoming of these barriers are crucial for the successful future adoption of 5G in Brazil.

(i) Reduction of bureaucracy for the installation of new antennas (site acquisition and licensing)

Site acquisition in Brazil is regulated by the so-called Law of Antennas (Lei Geral das Antenas Nº. 13.116 / 2015), which is a Federal Law that determines the requirements and service-level agreement (SLA) for any public administration to answer to a requirement for antenna installation.

That SLA was set to 60 days and it states that all municipalities' administrations have to go through the entire local-specific bureaucracy within that time frame, no matter how many internal departments have to be accessed or how complex local processes are.

This law, however, is not followed by most of the cities in Brazil, and eventually operators have to negotiate independently with the administration of each municipality, which causes delays and legal uncertainty.

A study conducted by SindiTeleBrasil in 2017 mapped that in Brazil, there are around 300 municipal and state laws that restricts the installation of telecom infrastructure inside cities. Most of those restrictions are related to limitations on radiation exposure, which divert from what is regulated in the Federal Law 11.934/09, based on WHO standards.

This diversity and legal uncertainty reflects on the time that takes for an antenna to be installed in different cities across Brazil.

A study from Teleco shows that from the 100 biggest Brazilian cities, 99 took more than 2 months to provide a license for antenna installation (this is the maximum time stipulated by the Law of Antennas).

Number of cities according to the ERB's authorization time (in %)

Source: Teleco

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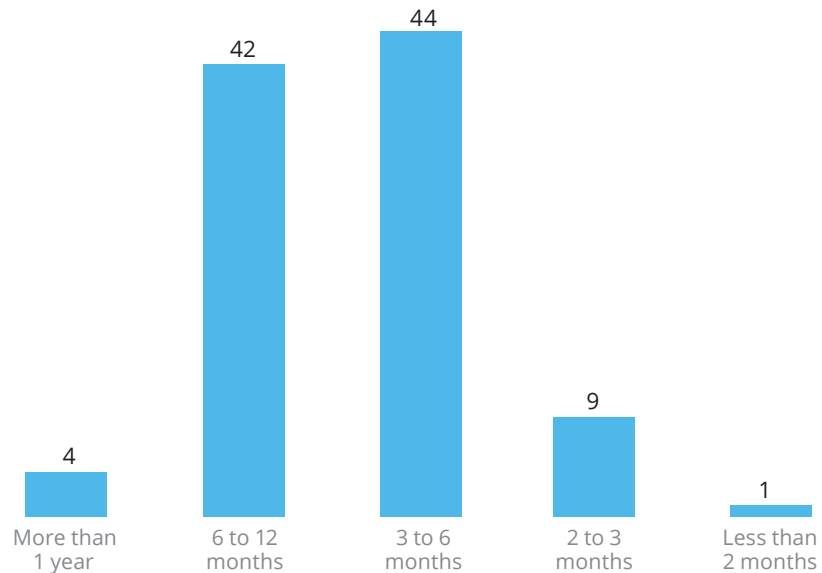
Comparison between legal requirements and typical timescales for permission granting for base station deployment (in months)

Source: GSMA – Base Station Planning Permission in Europe, 2012.

While in Brazil there is such an uncertainty regarding site acquisition, other countries are managing to be more agile in this respect. For example, in the UK it takes 2 months to obtain a license, while in the US and Portugal, it takes only 1 month.

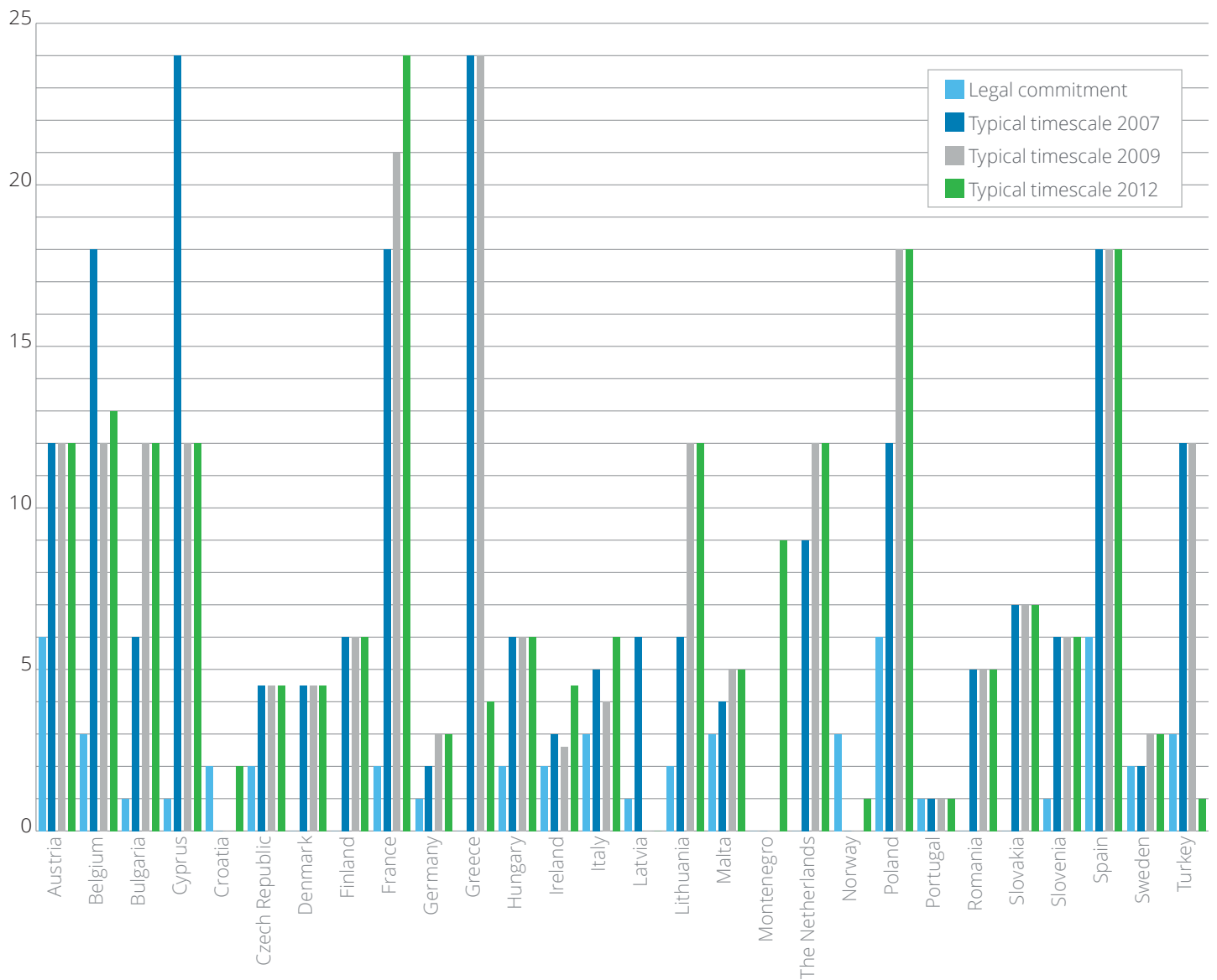Therefore, in order to make 5G infrastructure more broadly available, it is required that the government in Brazil invests in legal actions to enforce the Federal Law of Antennas, which was approved on April 20th, 2015.

One possible way of achieving this goal is creating a decree. Since the Antenna Law determines the 60 days SLA for municipalities administration to respond to a license request, whenever that SLA is not met, the request can automatically be considered approved. Such a mechanism can drastically reduce the current figures of antenna deployments lead-time.

In order to extend the coverage, it is necessary to establish a standard in the regulation of antennas. According to SindiTelebrasil, there are municipal laws that restrict the installation of antennas, such as those that establish minimum distances for the installation of ERBs, others that prohibit the installation of ERBs near hospitals, clinics and schools, laws that restrict installation in certain zoning, neighborhoods or artistic and cultural patrimony areas, as well as in squares, avenues, streets and other public spaces.

The process of requesting the installation of antennas in a municipality is costly and consists of many steps, including requirements of several documents and studies, manifestations of various organs and secretariats and with the collection of licensing and renewal fees, as well as collection by the use of the public space.

There are alternatives for the installation of antennas, according to the technical report prepared by CPqD for SindiTelebrasil and Abrintel in December 2015. The CPqD describes models of installations of radiocommunication transmitting stations with comparable infrastructure characteristics for the purpose of dispensing of licenses. In this paper, international experiences were analyzed and it was observed that some self-regulation proposals reduce the asymmetry of information between public and private agents.

(ii) Long-range standard requirement
5G is a standard that will surpass 4G in every feature. Currently, standard definitions are being set in the 5G Infrastructure Public Private Partnership (5G-PPP), which is a joint initiative between the European Commission and European ICT industry.

Brazil is an important player in the existing global discussions for 5G standards because of the relevance of its mobile user base and internal market. This relevance can be used to defend standards that are more adequate for Brazil's conditions and its consumers. One example is the long-range standard, which is related to 5G signal coverage and distance.

The country has supported the Long Range standard, due to its extensive territorial dimension, with very populated urban centers along the coast and sparse agglomerations in the most central areas of the country. Such a standard would also be extremely beneficial for rural areas, allowing them to have access to a higher quality of connection.

These sparse areas present economic challenges in terms of mobile signal distribution, since it may become cost inefficient to install antennas (and correspondent backhauls) to cover all that population.

One way of reducing that cost is adopting standards that allow more coverage and bigger distance of the 5G signal, which, in turn, can decrease the number of antennas required to cover a specific area. Thus, it is important that Brazil works together with international committees to establish long-range standards for 5G deployment.

There is still a huge connectivity gap in the world, and particularly in Brazil. ITU studies indicate that more than 3 billion people do not have Internet access in the world. In the case of Brazil, 44% of the population does not have access to it. For technical or economical reasons, currently available communications technologies have not been able to eliminate this access deficit in the country. The 5G networks are a great opportunity to create a technology that is capable of taking Internet access to remote and rural areas, with great potential to reduce the country's digital exclusion scenario. However, In order to do it, technical, regulatory and governmental policy challenges must be overcome.

It is important to observe that, historically, Brazil has always used technologies conceived by major technological powers and has adapted them to meet national needs. This resulted in a partial coverage of several important applications for the Brazilian society society and, in some cases, services of great necessity were not met because the technology adopted was not designed for this purpose. Internet access in remote areas and rural areas can be seen as the prime example of this reality.

Requirements 5G x LTE

Source: INATEL, 2018

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5G Architecture Proposal

Enhanced Broadband
10 Gbps with high
cells density mmWave.
Fragmented spectrum.

5G for Remote Areas
Large coverage.
Sparse network nodes.
Scarce backhaul links.

5G

Ultra-Reliable
Latency < 1ms.
Robustness.

Sub-1GHz operation
Large coverage.
High transmission power.
High propagation delay.
Interference management.
Integration with satellite
backhaul.

Massive MTC
Loose synchronization
Multitude of devices
Low energy

For 5G networks, which are currently in the stage of technological definitions and standardization, there is a unique opportunity. For the first time Brazil is in a position to participate actively in the development and standardization process of this new technology, enabling the development of national technological solutions in line with what is being developed in the main technological powers of the planet.

These sparse areas present economic challenges in terms of mobile signal distribution, since it may become cost inefficient to install antennas (and correspondent backhauls) to cover all that population.
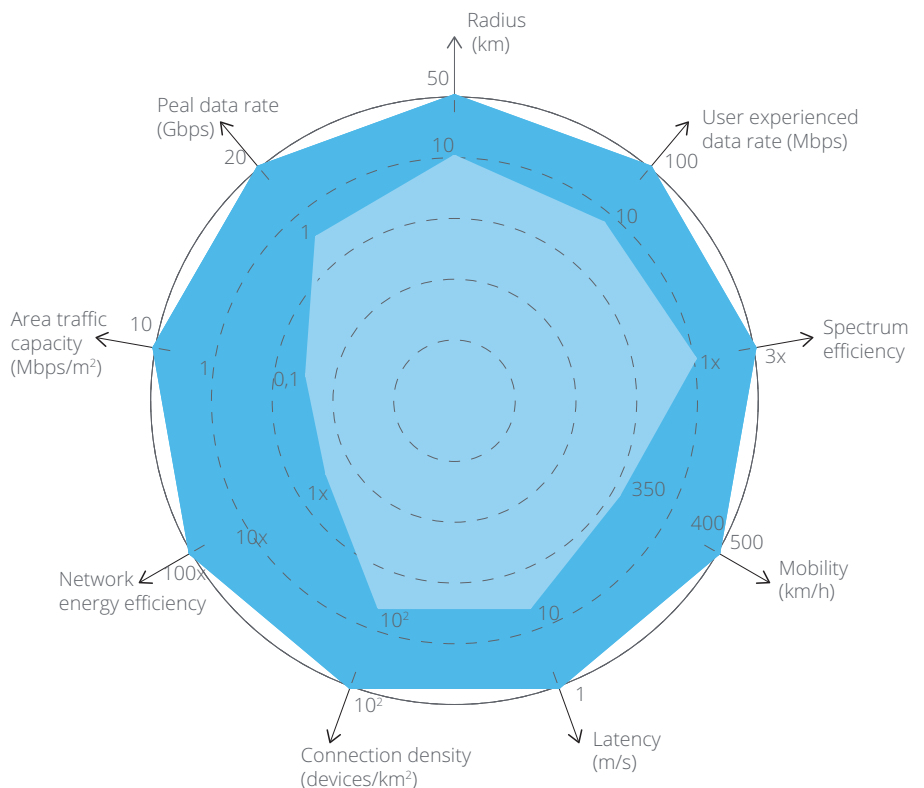
One way of reducing that cost is adopting standards that allow more coverage and bigger distance of the 5G signal, which, in turn, can decrease the number of antennas required to cover a specific area. Thus, it is important that Brazil works together with international committees to establish long-range standards for 5G deployment.

(iii) Smart cells technology
Another way of increasing 5G coverage is by allowing operators, small and medium size Internet service providers (ISPs) to deploy antennas and provide telecom services in remote areas. This can be achieved by defining operating models for ISPs and operators to provide mobile services through "small cells", which basically consist of a cost-reduced infrastructure of antennas designed to cover a small region.

That small region can be a remote area (rural area), or even urban locations where mobile signal is weak (for example, inside buildings).

The smart cells technology can also be associated with smaller sites, which can therefore be more easily regulated. These sites are known as "cell sites" and are characterized by less coverage and less footprint.

Moreover, "all-in-one" solutions that support a range of frequency bands (sub-3 GHz and 4T4R high-band) already exist on the market. The deployment of this type of technology allows for the effective use of space for the installation of antennas, once those solutions decrease the need of various antennas for covering multiple sets of frequencies. This technology also produces benefits related to visual pollution – an aesthetic issue related to multiple antennas spread throughout the cities, and can resolve possible conflicts raised during the antenna installation process. Thus, in the case of 5G deployment, operators could opt for installing new antennas based on this technology.

Additionally, it is important to highlight the marginal cost effect on installation of new antennas and small cells.

This effect occurs when an antenna is planned to be installed in the vicinity of an existing one. Because all the backhaul infrastructure was already built to the first one, the cost-analysis for the second needs only to consider the marginal cost of extending the backhaul and overhead operational management to the second antenna.

This kind of analysis plays a major relevance when operators or ISPs decide if a certain region may provide the economic ROI (return on investment) from a wireless infrastructure deployment.

In order to stimulate domestic demand for 5G deployment in Brazil, the government needs to promote actions related to the development of incentive models for enabling the infrastructure (tax incentives), as well as the creation of standards for measuring user experience.

(iv) Develop incentive models for enabling the infrastructure (tax incentives for municipalities - site acquisition)

In order to make the Law of Antennas more attractive to municipal administrations, and enhance economic conditions for operators to deploy antennas in non-connected areas, the Brazilian government could pursue three actions regarding telecom taxes on mobile usage:

1) Promote to municipalities' administrations that 5G is an enabler for other new business services that can run on top of it. For example: connected cars, smart public illumination, real-time health monitoring etc. Those new business models can provide increased tax revenue to the city, but for that to happen, the cities' administrations need to accelerate the time for licensing new sites for antenna installation.

Taxes levied on consumers in Brazil, 2015

Payment base	Type	Tax rate (in%)
Calls and SMS	ICMS*	25 – 35
Mobile broadband	ICMS*	25 – 35 regional exemptions
Handsets and SIM card	ICMS	17 – 20

* Mobil specific
Source: GSMA & Deloitte Brazilian Telecom tax analysis, 2016.

2) Rebalance the tax income distribution across public entities:

While the municipal administration in Brazil currently has the power to issue licenses for antenna installation, it receives only a share of the collected ICMS tax from calls, SMS, mobile broadband, handsets and SIM cards. Therefore, one way of increasing the incentives for expanding the mobile service and allowing more antennas to be deployed, is rebalancing the distribution of the ICMS[10] tax collection across public entities in the country.

3) Reduce tax rate on mobile telecom, with consequential increase in overall tax revenue due to usage increase.

A study conducted by Teleco[11] shows that Brazil has some of the highest tax rates in telecom when compared to other countries.

Taxes/net revenues (%)
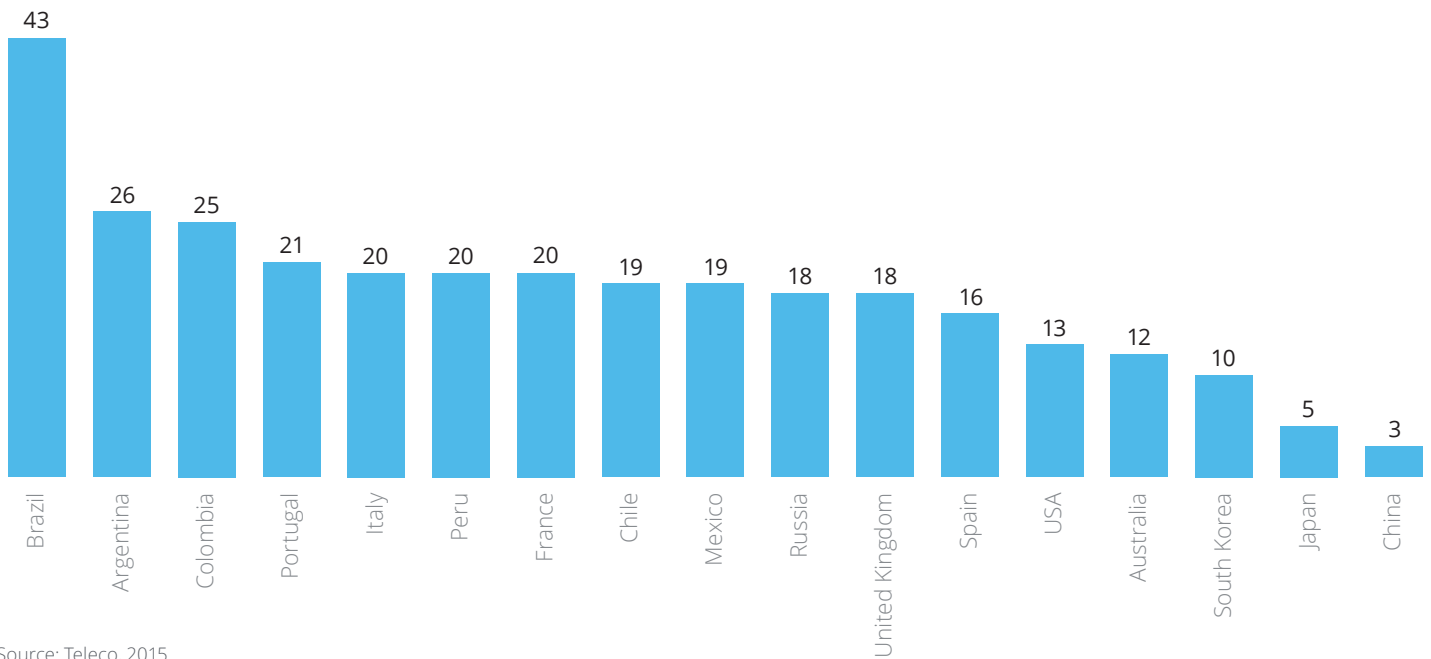
Source: Teleco, 2015

The reduction in the level of taxation on the mobile sector may have a negative impact on government revenues in the short term. By increasing mobile penetration and promoting economic growth, however, the reduction in tax burden on mobile will also increase the tax base, enabling the government to recover the lost revenues.

Moreover, the telecom industry is an enabler for the development of other sophisticated business models. By creating incentives to improve the telecom foundation, the government can leverage tax revenues from products and services that will emerge based on this technology. Successful cases of countries that have adopted this strategy of reducing taxes on the mobile sector include Uruguay and Kenya.

1 TAX AND FEE PROPOSAL	2 PRICE OF MOBILE SERVICES	3 CONSUMPTION OF MOBILE SERVICES	REVENUE FROM MOBILE SERVICES	EMPLOYMENT OF OPERATORS
		PROFITABILITY OF MOBILE SERVICES	INVESTMENT	TAXES AND FEE PAYMENTS

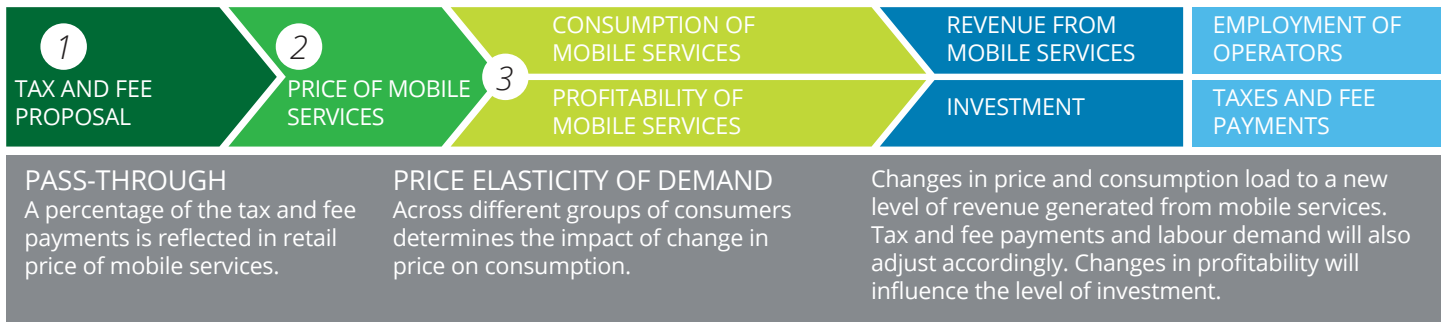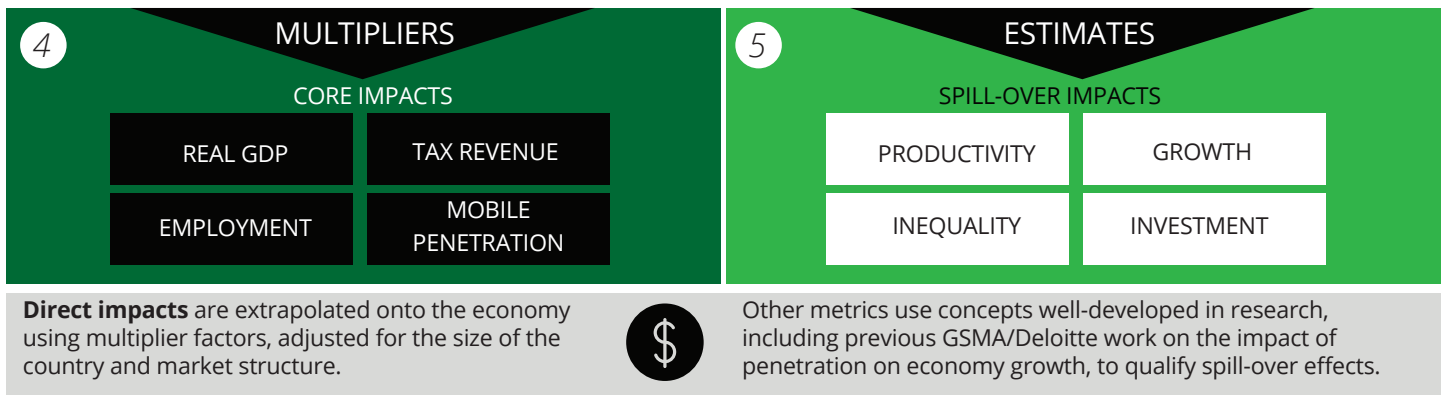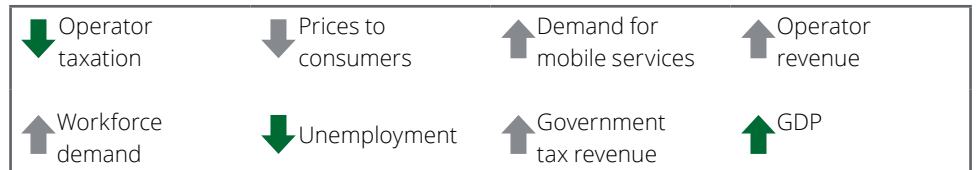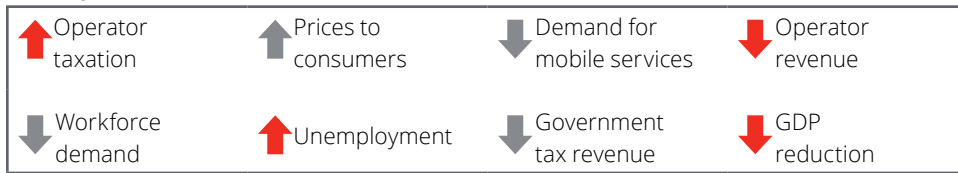| PASS-THROUGH A percentage of the tax and fee payments is reflected in retail price of mobile services.	PRICE ELASTICITY OF DEMAND Across different groups of consumers determines the impact of change in price on consumption.	Changes in price and consumption load to a new level of revenue generated from mobile services. Tax and fee payments and labour demand will also adjust accordingly. Changes in profitability will influence the level of investment.

Economy-wide impacts

4 MULTIPLIERS	5 ESTIMATES
CORE IMPACTS	SPILL-OVER IMPACTS
REAL GDP TAX REVENUE EMPLOYMENT MOBILE PENETRATION	PRODUCTIVITY GROWTH INEQUALITY INVESTMENT

Direct impacts are extrapolated onto the economy using multiplier factors, adjusted for the size of the country and market structure.

$

Other metrics use concepts well-developed in research, including previous GSMA/Deloitte work on the impact of penetration on economy growth, to qualify spill-over effects.

1 The level of taxation and regulatory fees applied to the mobile sector are reflected in the retail prices operators charge for using their services. Therefore, a change in taxation or regulatory fees will lead to a change in the retail price of mobile services. A passthrough rate represents the percentage of the tax and fee payments which is reflected in the retail price of mobile services.

2 The price of mobile services determines the demand and therefore the aggregate consumption of mobile services. The price elasticity of demand describes the responsiveness of demand to a change in the price, and is defined as the percentage change in demand resulting from a given percentage change in price.

3 Changes in the level of consumption of mobile services lead to a new level of revenue generated by operators, which changes the level of taxes and fee payments and labour demand accordingly.

4 These changes to the mobile sector lead to direct impacts on value-add and employment and, through spillover effects on the wider economy, in particular on real GDP, tax revenues, employment and investment.

5 An elasticity determines the impact of a change in mobile penetration on GDP growth. Multipliers are assumed which allow changes in mobile sector employment to affect the wider Brazilian labour force. Productivity is calculated using the total factor productivity impact, described in the appendix.

Source: GSMA & Deloitte Brazilian Telecom tax analysis, 2016.

Tax Impact Chain

| ↑ Operator taxation | ↑ Prices to consumers | ↓ Demand for mobile services | ↓ Operator revenue |
| ↓ Workforce demand | ↑ Unemployment | ↓ Government tax revenue | ↓ GDP reduction |

| ↓ Operator taxation | ↓ Prices to consumers | ↑ Demand for mobile services | ↑ Operator revenue |
| ↑ Workforce demand | ↓ Unemployment | ↑ Government tax revenue | ↑ GDP |

Source: Deloitte

(v) Promote Broadband "fixed" wireless distribution

Modern technologies can deliver wireless broadband to fixed locations. These technologies are marketed by some manufacturers as WTTH – Wireless to the Home, or WTTx – Wireless to the X, X being anywhere (Home or Office).

This type of broadband access can be an alternative to locations where fixed landlines are difficult to distribute and high bandwidth through satellite connections are cost prohibitive.

Rural schools, remote learning centers, remote public administration offices can largely benefit from such technology.

(vi) Define a standard on measuring user experience

Another challenge for the Brazilian government is the definition of standards for measuring user experience, since the telecommunications sector has moved from network-centric to user-centric in the recent years.

The use of smartphones has increased significantly in Brazil during the last decade, and their use is becoming prevailing in the life of Brazilians. Such an increase in use requires better and more sophisticated methods of evaluating service quality.

A recent survey conducted by Deloitte in 2017[12] concluded that in Brazil the greatest increase in penetration rates between 2016 and 2017 has been for smartphones and that smartphones are the most frequently used devices among the population.

Currently, the main drivers for measuring mobile service quality are related to network technical measurements and consumer complaints registered in official and non-official bureaus (eg Reclame Aqui, Proteste, Procon).

Although those key performance indicators (KPIs) can provide a fair overview of the network conditions, they lack in providing a deterministic measure of how customers are experiencing the network service.

Frequency of usage by device (en %)
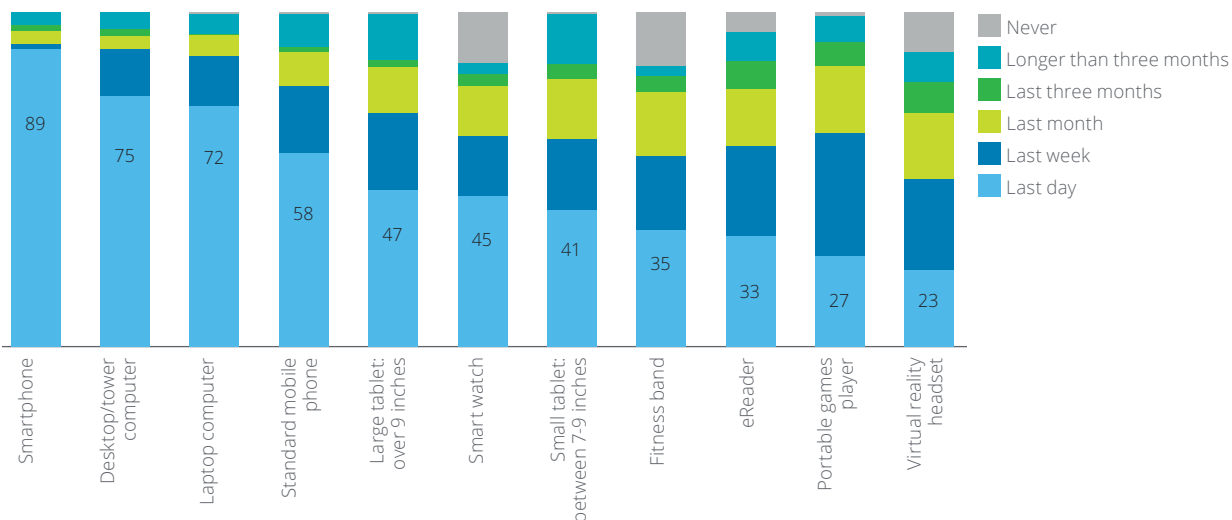
Source: Deloitte

In the GMSC 2017, it became evident that quality of the network and the cost are the major factors for consumers when considering switching mobile network supplier or renewing the contract. On the other hand, the availability of additional services is not a major factor for most users.

Therefore, it is important to implement mechanisms that can measure in the end point (cell phone) how the quality of the provided service is evaluated by the final consumer.

Device penetration 2017 and year-on-year growth (in %)

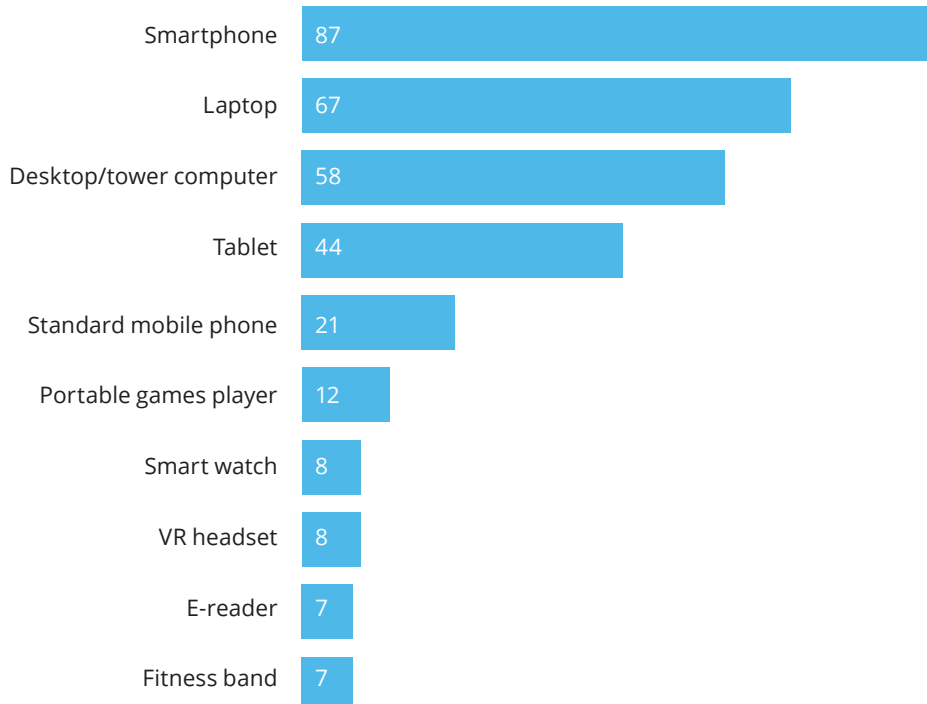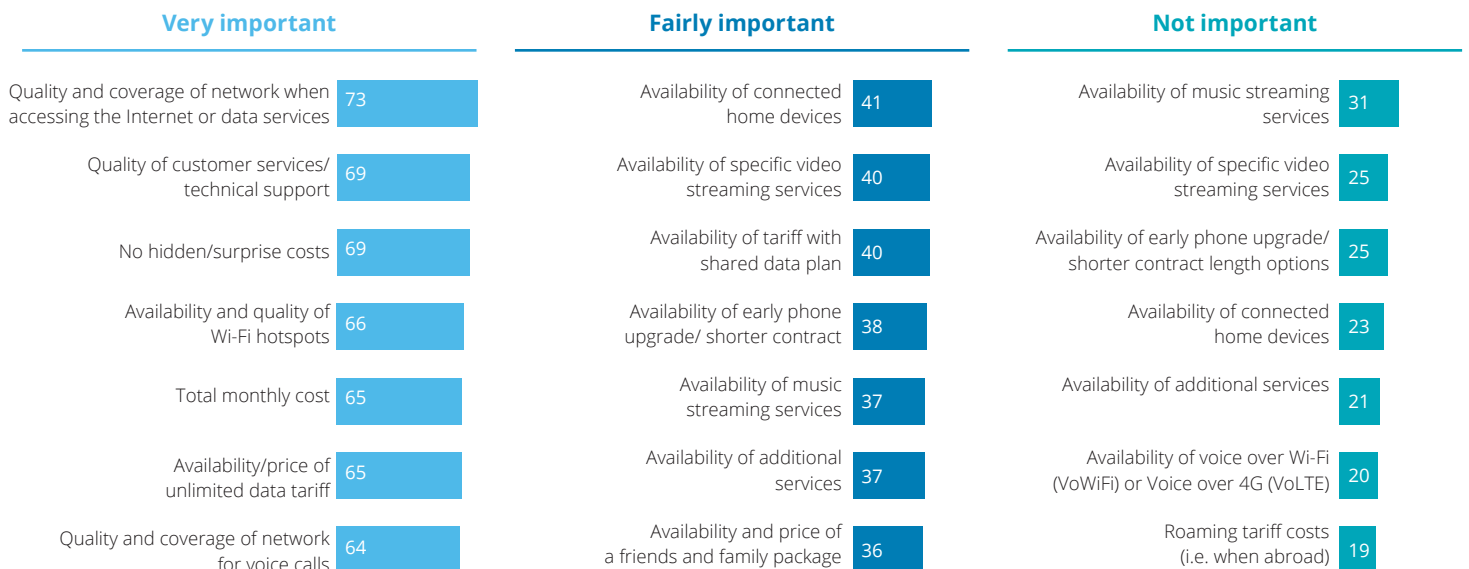| Device	Value
Smartphone	87
Laptop	67
Desktop/tower computer	58
Tablet	44
Standard mobile phone	21
Portable games player	12
Smart watch	8
VR headset	8
E-reader	7
Fitness band	7

Source: Deloitte

Top 7 reasons in each category (in %)

Very important		Fairly important		Not important	
Quality and coverage of network when accessing the Internet or data services	73	Availability of connected home devices	41	Availability of music streaming services	31
Quality of customer services/ technical support	69	Availability of specific video streaming services	40	Availability of specific video streaming services	25
No hidden/surprise costs	69	Availability of tariff with shared data plan	40	Availability of early phone upgrade/ shorter contract length options	25
Availability and quality of Wi-Fi hotspots	66	Availability of early phone upgrade/ shorter contract	38	Availability of connected home devices	23
Total monthly cost	65	Availability of music streaming services	37	Availability of additional services	21
Availability/price of unlimited data tariff	65	Availability of additional services	37	Availability of voice over Wi-Fi (VoWiFi) or Voice over 4G (VoLTE)	20
Quality and coverage of network for voice calls	64	Availability and price of a friends and family package	36	Roaming tariff costs (i.e. when abroad)	19

Source: GMSC, 2017

Case study

Lower taxation boosts mobile sector growth in Uruguay

In 2007, the Uruguayan government abolished an excise tax (ITEL) on airtime that affected telecom usage, directly impacting mobile consumers. This fixed tax, consisting of UYU 0.4 per minute for local calls and UYU 2 per minute for long distant calls, accounted for 30%-50% of the cost of calls.

This fixed tax affects usage and also contributed to increasing barriers to mobile ownership, especially for low income consumers. Consequently, the removal of this tax has led to a number of positive effects:
- Call prices have fallen by 67%.
- Mobile penetration more than doubled, from 65% to 141%, after the taxes abolition.
- Usage increased by more than three times.

As a result of the growth in the market the tax contribution of mobile operators has also increased four-fold, providing a significant windfall to the government. This illustrates that revenues lost through reductions in distortive, mobile-specific taxes can be recovered through more broad-based taxation on the sector as it grows.

Through the reduction of mobile specific taxation, the government of Uruguay increased the usage of mobile services by removing barriers to affordability. By developing supportive taxation and regulatory policies, the government enabled the growth of the mobile sector, and the associated benefits from increased employment and investment.

Tax as a percentage of total cost of mobile usage, 2011 (in %)
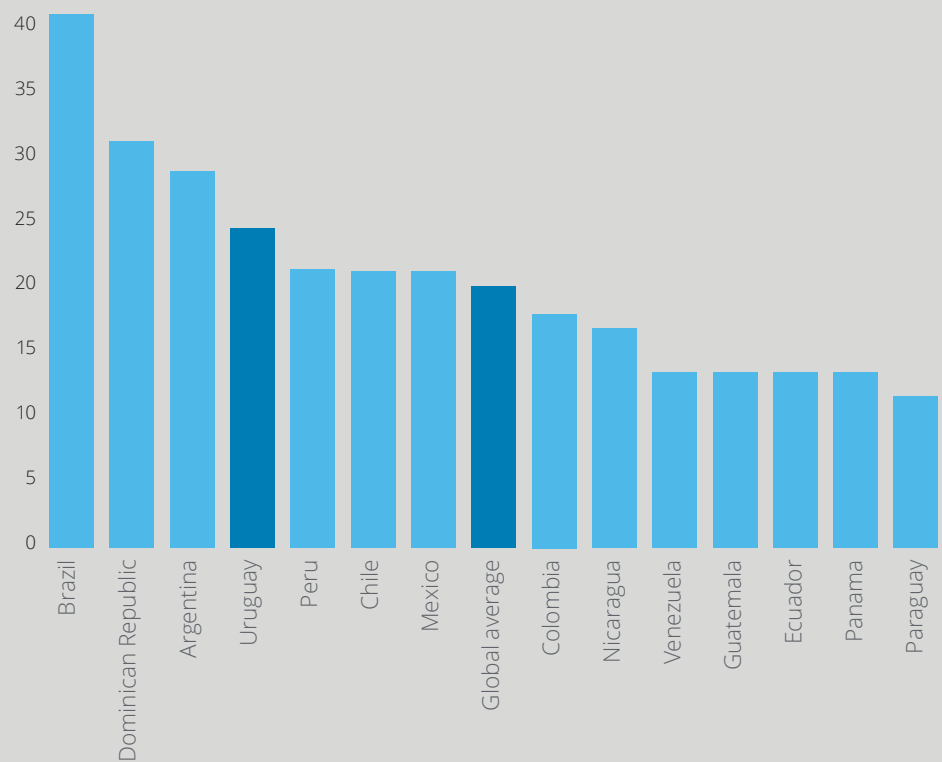
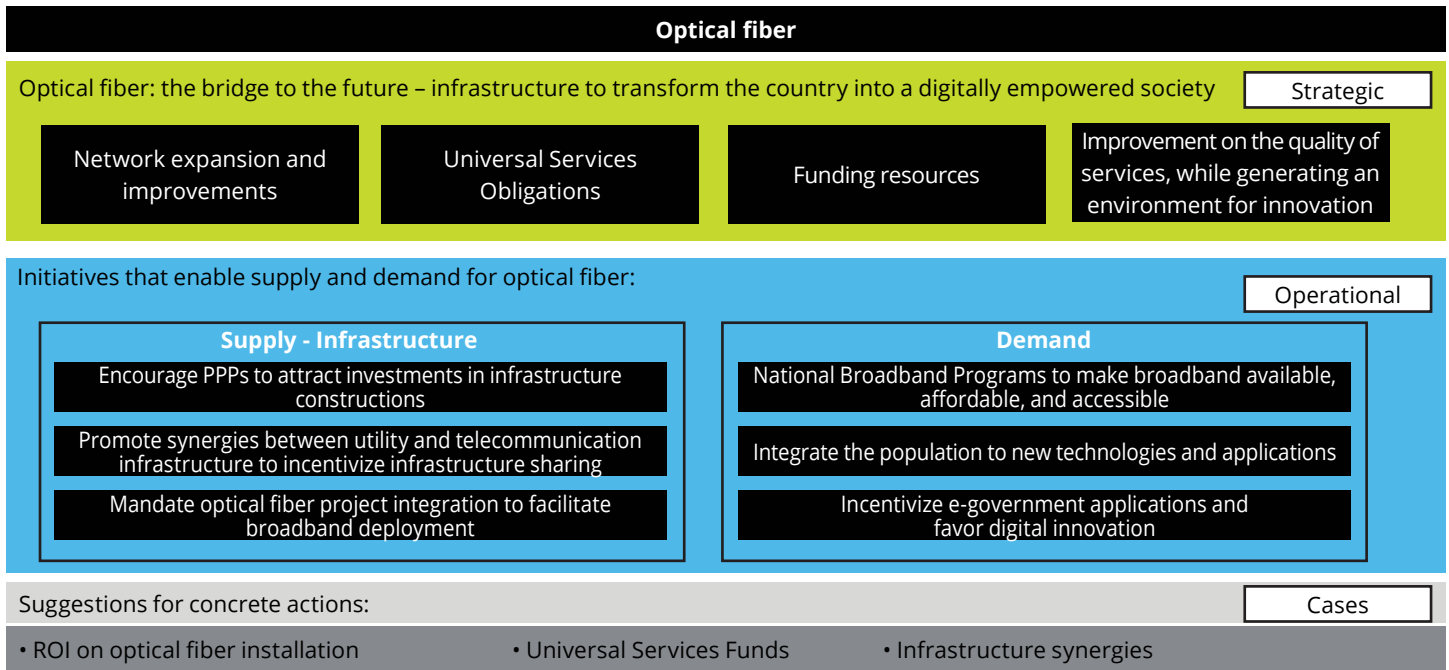**Uruguay's mobile and smartphone penetration**
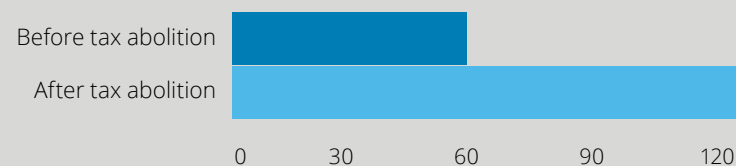
Source: GSMA Latin American Mobile Observatory 2011

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Optical fiber

Optical fiber: the bridge to the future. Infrastructure as a first step towards achieving digital transformation.

Insights and recommendations for optical fiber

Optical fiber

Optical fiber: the bridge to the future – infrastructure to transform the country into a digitally empowered society	Strategic

Network expansion and improvements	Universal Services Obligations	Funding resources	Improvement on the quality of services, while generating an environment for innovation

Initiatives that enable supply and demand for optical fiber:	Operational

Supply - Infrastructure	**Demand**
Encourage PPPs to attract investments in infrastructure constructions	National Broadband Programs to make broadband available, affordable, and accessible
Promote synergies between utility and telecommunication infrastructure to incentivize infrastructure sharing	Integrate the population to new technologies and applications
Mandate optical fiber project integration to facilitate broadband deployment	Incentivize e-government applications and favor digital innovation

Suggestions for concrete actions:	Cases

• ROI on optical fiber installation   • Universal Services Funds   • Infrastructure synergies

Source: Deloitte

The digital ecosystem has incentivized innovation, resulting in new products and services available to society. To respond to the agility required by daily activities, broadband connection has become a necessity for the entire population, being part of the digital agenda of every country.

Service providers and telecommunications carriers must deliver applications with tangible value to the population. Networks need to be upgraded and expanded in order to meet the increasing data traffic – streaming content (4K and 8K resolution), e-commerce, and social media – which can be efficiently handled by optical fiber.

New emerging technologies have improved the image quality, which requires an improvement in data transmission and connectivity of Internet services for the population. The 4K technology, also

known as Ultra HD, is one of these recent advancements and represents one of the leading commercial applications on the market, while 8K technology is still in testing phase with no expressive market representation. The consumption of 4K content, however, requires high connection speed (minimum of 25 Mbps) which currently represents only 5% of Brazilian households market, according to the Internet Management Committee in Brazil (CGI.br).

Considering the Brazilian performance indicators related to coverage expansion, connecting remote areas to the Internet, as well as the initiatives and actions presented at e-Digital[13], there are some critical challenges that need to be overcome in order to expand broadband connection. Some strategical points, highlighted below, might be developed in order to move Brazil

into the digital era. These points are:
- The dig once policy, which mandates construction project planning to facilitate optical fiber deployment;
- Right of way[14], to address the right to pass along a specific route;
- Infrastructure synergies between utility distribution and optical fiber network;
- The Universal Services Fund intends to assure that the entire population has access to the country's universal services.

2.1. Broadband in Brazil and in the world

Countries are investing to lead the global digital transformation, with broadband and optical fiber as the base for innovation. In 2016, the broadband penetration in Brazil (12.9%) was still below the global average (13.9%), figuring at the 83rd position in the access to fixed-broadband subscription rate.

Fixed-broadband subscriptions per 100 inhabitants.
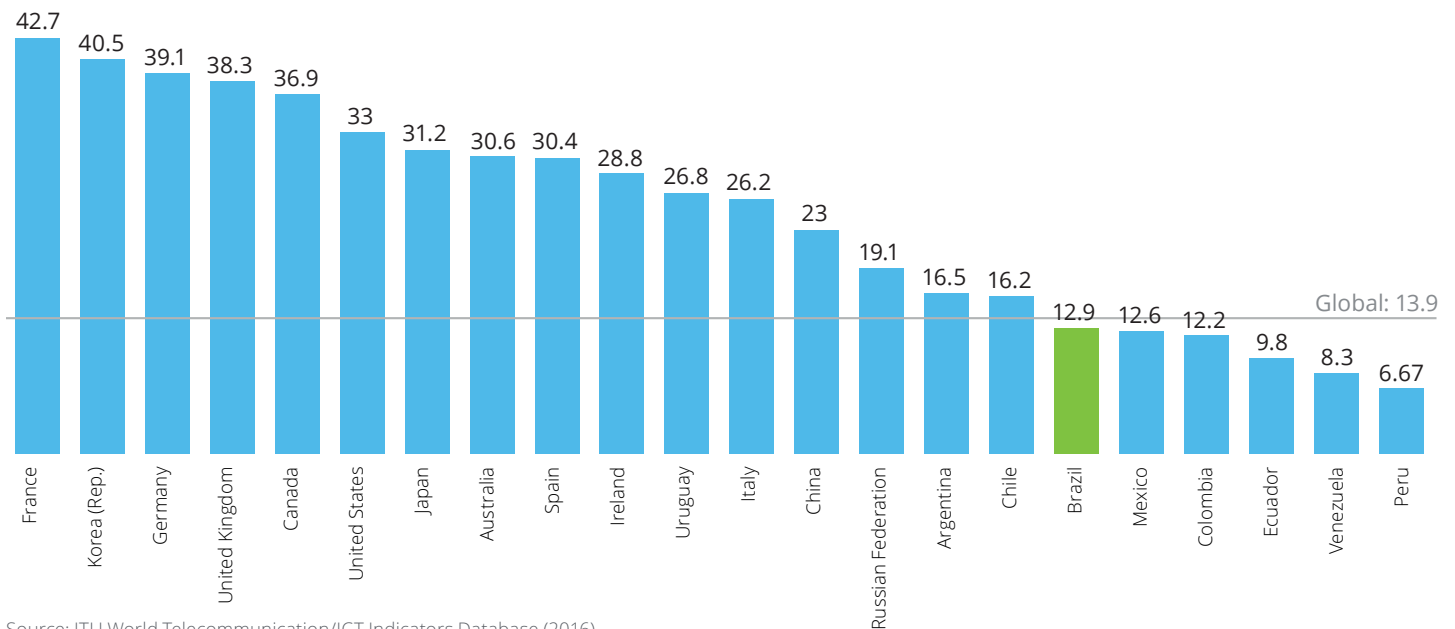
Source: ITU World Telecommunication/ICT Indicators Database (2016)

Insights about Digital Transformation and ICT Opportunities for Brazil

The Global Connectivity Index 2018[15] presents the indices for the years of 2015 and 2018 on a S-curve divided in three different clusters - starters, adopters, and frontrunners - and shows that the digital divide between the clusters increased during the period (behavior observed between 2015 and 2017, according to the GCI 2017), a factor that could lead to a new form of segregation, the digital one.[16]

In Brazil, since the early 2000s, the figures related to the expansion of broadband coverage across the country are remarkable, mainly due to the low rates at the beginning of the century. Brazil has the potential to surpass the global average on fixed-broadband subscription.

According to the Brazilian Internet Steering Committee (Comitê Gestor da Internet no Brasil, CGI.br), there are some constraints to the expansion of Internet penetration countrywide. Among the reasons for not using the Internet in Brazil, are the lack of computer use and skills, high costs to connect or to have equipment to access the Internet and the unavailability of broadband infrastructure (ICT Households 2016).

A significant part of the Brazilian population remains unconnected. When we compare the number of Internet providers per municipality to the GPD per capita, it is possible to observe the providers' concentration at important economic areas, with higher GDP per capita, which could be an indication of scale economics.

In Brazil, cities with more than a hundred thousand inhabitants have complete broadband infrastructure coverage, representing only 5% of the total, or 300 cities out of 5.570. The phenomenon is a consequence of scale economics, business plan models, and high costs to deploy broadband infrastructure in remote areas.

Fixed-broadband subscriptions per 100 inhabitants

● Brazil ● China ● United States ● Russian Federation ● France ● Global
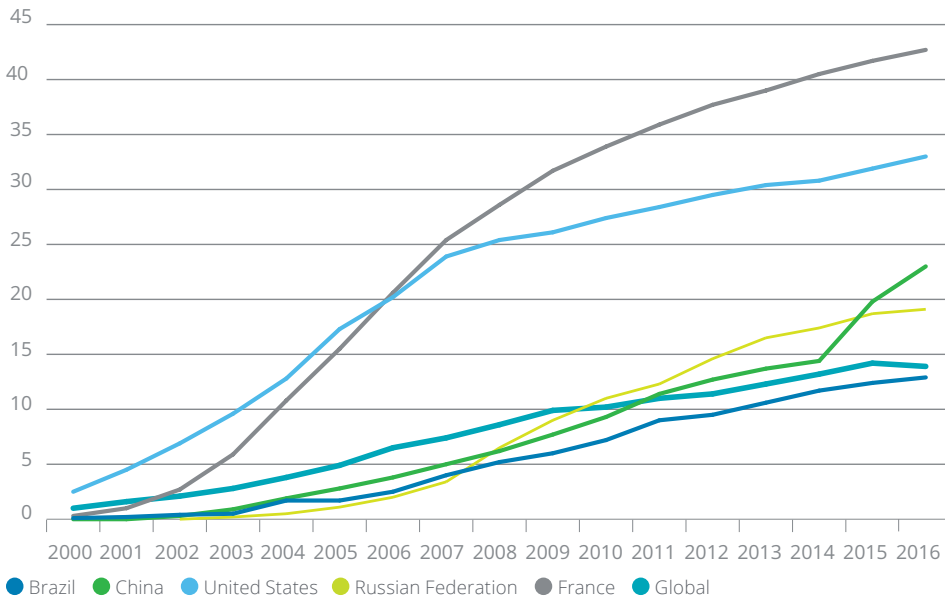
Source: ITU World Telecommunication/ICT Indicators Database (2016)

GDP per capita and number of providers per municipality
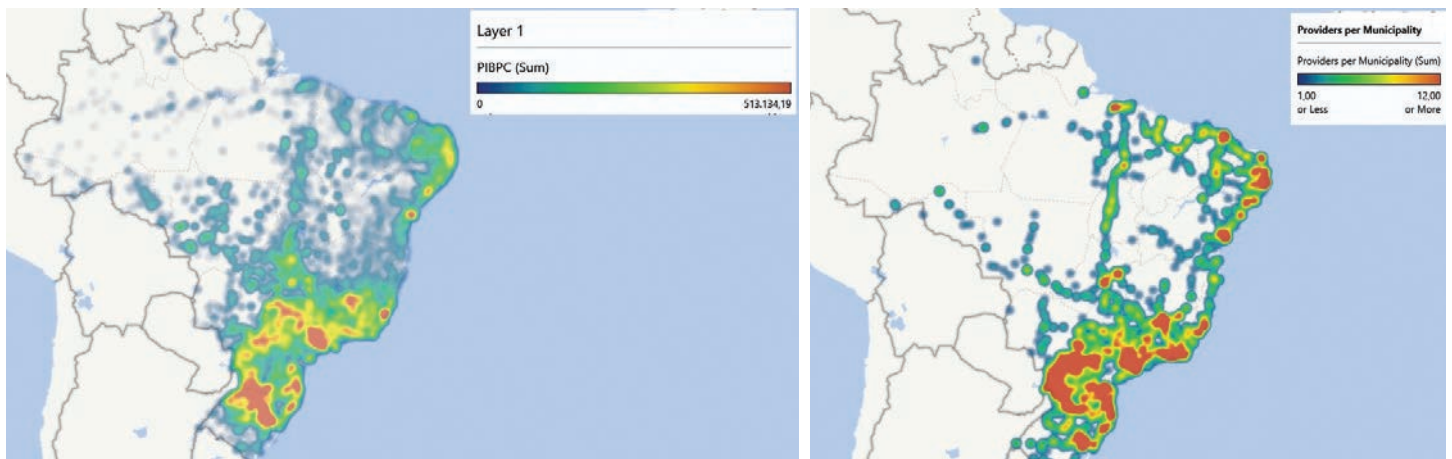
Source: IBGE 2016 and Teleco, respectively.

In Brazil only 5% of the cities, 300 out of 5.570, have complete broadband infrastructure coverage

As shown for the Internet connection in mobile devices example, Brazil has almost a third of the total number of mobile internet users in Latin America, corresponding to 85 million of a total of 231 million.

The projection for the fixed or mobile Internet users in Brazil, when compared to Latin American, is expected to reduce by 2020.

Regarding mobile devices, it is observed that 72% of the population has an Android smartphone and WhatsApp is the most popular mobile application (47 million users) in the country. The average number of applications installed by Brazilians is 63 per device, and social applications represent 20% of the frequency of use.

On the other hand, mobile data traffic is estimated to grow twice as fast as the IP traffic between 2016 and 2021, and 77% of the local mobile access will be made on smartphones by 2021.

In order to improve the infrastructure and connect the entire population, the Brazilian government has already included discussions over the optical fiber expansion on its agenda, to transform the country into a digitally empowered society, providing Internet connection to citizens.

In this context, the National Plan for Connectivity (Plano Nacional de Concectividade, PNC), in reference to the National Broadband Plan, aims to expand access to broadband and mobile Internet through the allocation of public resources. Following guidelines for public rules, the government intends to enhance the capacity expansion to increase the coverage of the country at least with 3G technology.

According to the U.S National Broadband Plan[17], the largest cost for broadband deployment is not the fiber itself, but the process of burying optic fiber cables and conduit underground or attaching it to poles in an aerial build.

1. City of Boston, dig once policy[18]:
To minimize excavations along the roadways, the city of Boston adopted a dig once policy in 1994 that required all telecommunication companies to install the conduits in a shared infrastructure on a shared-cost basis. Under this policy, any company that approaches the city for a request, takes on the coordinating efforts for planning and implementing the installation process in consonance with the other telecommunication companies. All companies work together to draw the engineering plans, estimate construction costs and submit the application for review and approval. Besides minimizing excavations and expediting the broadband deployment process, this approach allows the inclusion of additional shadow conduits for future use by either the city of Boston or a later entrant.

2. City of San Francisco, dig once policy[19]:
The dig once legislation approved in 2014 requires the city of San Francisco to install conduits during projects involving public right-of-way, reducing the need for future excavations. It applies to street or sidewalk excavations longer than 900 feet (approximately 300 meters). As the conduit network across the city grows, the city is able to generate revenue by leasing the infrastructure. At the same time companies lower their costs to install optical fiber network. Once the trench is repaved, there is a five-year moratorium on excavating the roadway (Connectivity Plan, City & Council of San Francisco 2017). Through a notification process, the city ensures that other interested parties have the opportunity to install conduits and cabling in the open trench.

2.2 Recommendations

(i)Dig once

Among the different aspects to incentivize optical fiber installation across the country, the concept of dig once stands out and should be approached at every level of the government, crossing the borders of the federal, regional and local level. This concept translates itself into policies and regulations to minimize the amount of excavations required to install conduit infrastructure and to facilitate the access to rights-of-ways.

These policies encourage the deployment of conduit and fiber that would house Internet cables in public rights-of-ways during infrastructure improvement projects. Instead of digging up the roadway multiple times, the dig once policies facilitate the access to infrastructure and cables as

needed, increasing the Internet access to communities across the country.

For the development of a consistent broadband network, it is necessary to deploy a complex infrastructure to support its advances. Frequently, the process of optical fiber installation requires excavations in already developed areas, increasing costs, disruptions, disturbances and risks. To minimize digging up public ways, the different government spheres ought to encourage a dig once policy implementation, throughout conduit installation during compatible construction projects.

The government has to incentivize the installation of conduits whenever and wherever there is an underground improvement construction in the public way, whether the construction is for general repairs, new utility equipment installation or roadwork. With this infrastructure

in place, the government will then have the opportunity to lease it to broadband providers and telecommunication carriers interested in deploying fiber networks. The private sector may join this approach and incorporate the pre-deployment of optical fiber in new construction projects, such as residential or commercial buildings, to facilitate the integration to the consumer.

Governments have to incentivize the installation of conduits whenever and wherever there is an underground improvement construction in the public right-of-way.

The initiative of incorporating FTTH (fiber-to-the-home) installations into construction projects through the dig once policy facilitates not only broadband access to the end user, but also introduces the concept of smart buildings. Communication facilities, such as basic infrastructure of smart buildings, should be designed by construction companies according to the requirements of telecom operators in order to ensure the quality of Internet services. Moreover, FTTH standardization accelerates the popularization of the broadband network.

As a result, the dig once policy encompasses a conjunction of benefits, such as:

a. Minimizing repeated excavations, allowing companies to access a shared conduit network: each additional excavation exposes the surroundings to risks of causing underground equipment damages and service outages, traffic disruptions, as well as road deterioration and shortening of their lifespans. Additionally, the process wastes government resources, due to processual, safety and environmental concerns, in each excavation turn.

b. Reducing entry barriers, which increases competition and improves service options

to customers. The costs associated to deploying broadband services are remarkably high and represent the main entry barriers in this market, resulting in a lack of competition. The dig once policy in particular addresses cost reduction, stimulating the competition and facilitating the entrance of new players to the market.

c. Increasing the reliability of broadband networks, for it incentivizes installing optical fiber underground. Broadband providers and telecommunication carriers have access to an underground conduit network infrastructure, allowing an easier and more cost-efficient optical fiber installation.

On the other hand there are some issues related to the dig once policy that should be taken into account. Considering the example of the United States, according to the U.S. Government Accountability Office (2012), a federal dig once policy could:

- Lead to an unused conduit infrastructure, mainly for a short-term period, while companies have yet to decide to explore new markets or expand their existing operations;

- Increased costs of public infrastructure projects, requiring extra funding sources; but, as leasing fees may be applied, the government should face it as an investment;

- Conflict with regional and local broadband deployment policies, demanding additional administrative costs to maintain the program.

It is essential that the government orchestrates the use of the conduit infrastructure built from the dig once policy, guaranteeing the most efficient usage of this infrastructure.

In the United States, the dig once policy demands that the government installs the conduits. For public projects, the government assures the installation of a conduit infrastructure in consonance with the project. In contrast, for private excavation projects, the government pays

for the installation costs, which may include additional materials, extra labor fees, and any design variation in the project to facilitate the conduit deployment.

A well-defined policy also minimizes legal controversies. The government already possesses authority and permission to construct in the public right-of-way, which decreases the bureaucracy involved. As the dig once policy is in place, conduit installations occur with each new infrastructure improvement project and progressively increase the coverage of the network, making the area ready for the deployment of broadband services, as well as eliminating the necessity for any additional excavations.

Evaluating the return on investment of optical fiber installation costs

The recovery of the investments starts when companies lease the conduit infrastructure assets. Costs for the installation of optical fiber cable conduit, independently of the excavation cost itself, vary between US$10.00 and US$20.00 per meter installed[20]. In contrast, the lease rates paid by the private sector vary from US$2.50 per meter up to US$3.00 per linear meter of conduit per year[21].

Conduit installation cost	US$20.00 per meter
Conduit lease rates	US$2.50 per meter per year

Once the government manages to secure multiple leases for different telecommunication companies at the same time, the additional revenue could be used to cover internal costs for managing the public right-of-way. In case the conduit network is leased to four different providers, the payback timeframe may be reduced to 2 years, if we consider a yearly lease rate of US$2.50 per meter.

The dig once policy stands out as a recommendation to broadband expansion. Note that governments interested in developing the broadband infrastructure should enact the dig once regulation promptly, due to the enhanced benefits for the conduit network.

(ii) Universal Service Funds

The Universal Service Funds (USF) have been endorsed as a financing mechanism for expanding the coverage of telecommunication services. Combined with regulations and public policies, these Universal Funds reaffirm the concept of universalization of services, considering that no one should be excluded from technological advances.

In Brazil, the Telecommunication Services Universalization Fund (Fundo de Universalização de Serviços de Telecomunicações, FUST) is composed by a percentage contribution from the telecom service providers' operational gross revenues and was created with the purpose of universalizing services provided under the format of public regime. This applies only to the fixed telephony. However, as people migrate from voice to data, the fund might become without purpose.

Among the Brazilian telecom regulatory agency's attributions (ANATEL) we may point out assuring the quality and universality goals, as well as promoting competitiveness in the sector. However, an analysis of the Brazilian telecommunication market reveals how it is concentrated in the major conglomerates that provide fixed switched telephony, mobile telephony, broadband and paid-TV services. The three biggest ones control 75% of the market.

Net revenue market share (in %)

- Vivo
- Claro
- Oi
- Tim
- Sky
- Nextel
- Algar
- Others
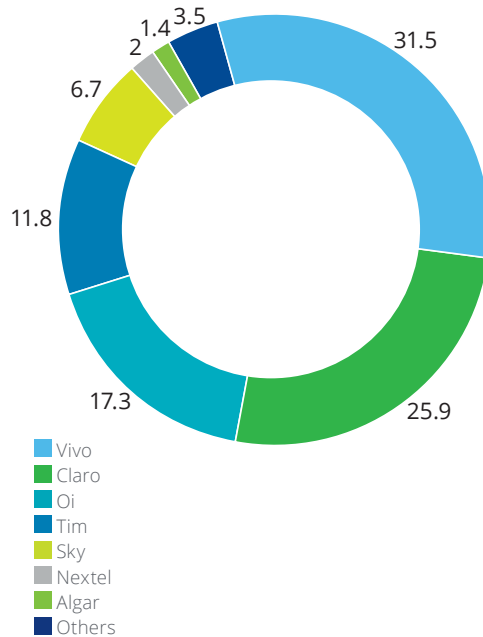
Source: Teleco

In the particular case of the Brazilian regulator, ANATEL is also responsible for establishing which services are considered universal. According to the General Plan for Universalization Goals (Plano Geral de Metas de Universalização, PGMU), ANATEL can propose a review of goals related to the universal service obligations (PGMU, 1998, art. 2, par. 2). In the same decree, the PGMU defines universalization as the right of access, by all people and institutions, regardless of location and socioeconomic condition, to fixed switched telephony service provided by a public regime (PGMU, 1998, art. 1). Therefore, the PGMU specifies that the scope of the Universal Services Obligations (USOs) is limited to fixed telephony.

The universal services evolve over time due to the dynamism of the ICT sector, mainly because of the innovations on technology and services. As a result, worldwide regulators set criteria to reevaluate which services are universal, considering availability, affordability and accessibility[22].

I For the European Union[23], the process for reviewing the scope of Universal Services considers whether the USOs have been changed or redefined following:
   - "Are the specific services available to and used by a majority of consumers and does the lack of availability or non-use by a minority of consumers result in social exclusion?";
   - "Does the availability and use of the specific services convey a general net benefit to all consumers such that public intervention is warranted in circumstances where the specific services are not provided to the public under normal commercial circumstances?"

II For the USA[24], Universal Services shall be revisited periodically, taking into consideration advances in technologies and services. A Universal Service that may be supported by Federal Universal Service support mechanism shall consider if the development of the telecommunications services:
   - "are essential to education, public health, or public safety;
   - have, through the operation of market choices by customers, been subscribed to by a substantial majority of residential customers;
   - are being deployed in public telecommunications networks by telecommunications carriers; and
   - are consistent with the public interest, convenience, and necessity".

All the innovation that the ICT Market faces emphasizes the importance of reviewing periodically the regulatory definitions and public policies for the Universal Service Obligations (USO). After revisiting its USO definitions, Brazil has included in the PGMU, 2008[25], the installation of backhauls in every city of the country, addressing the availability of broadband infrastructure, with the purpose of growing broadband penetration rates.

By reviewing the scope of broadband diffusion, the Brazilian government reveals its concern to universalize the access to new technologies and services, notably in underserved areas, such as remote or low-income communities. However, the incentives and mechanisms for universalizing telecommunication services from FUST address only fixed telephony access, resulting in conflicts of interests in designing public policies and regulations for a broader concept of telecommunication services.

Revisiting the regulatory agenda and public programs to reevaluate the scope of Universal Services might be conceived as a dynamic and periodic process, in accordance with availability, affordability and accessibility requirements to mitigate the digital exclusion countrywide.

In terms of Universal Service Funds (USFs), their designation to fulfill universal service obligations conflicts between covering disparities over existing networks and deploying new infrastructures for underserved areas. Deploying USO may also require great consonance between the public and private sectors to enhance expertise and investments capabilities. However, to consolidate this public-private partnership it is necessary to adapt funding mechanisms in existing USFs, possibly facing political pressure and opposition. Therefore, the government ought to review the characteristics of USFs in order to meet universal services obligations. Technological neutrality, political independence and investments efficiency must be assured in these reforms in order to prevent negative impacts to society.

Broadband National Plans

To increase demands for Internet services, governments worldwide have deployed national programs to incentivize public inclusion. For Brazil, the following programs intended to create a demand for this new digital market:

- The Brazil's Broadband at School Program[26] (Programa Banda Larga nas Escolas, PBLE): Its goal is to provide broadband Internet access to all public urban schools. A recently launched Connected Education Innovation Policy aims to provide quality broadband for up to 22.4 thousand public schools, reaching 12.8 million students. The program is coordinated by the Ministry of Education (Ministério da Educação, MEC) and financially supported by the Ministry of Science, Technology, Innovation and Communications (Ministério da Ciência, Tecnologia, Inovações e Comunicações, MCTIC);

- The Electronic Government – Citizen Service (Governo Eletrônico – Serviço de Atendimento ao Cidadão, GESAC)[27]: It offers free broadband Internet connection to public institutions; to non-profit entities that promote digital inclusion; to public institutions in the fields of education, health and safety; and to public units located in remote, border or strategic areas;

- The Digital Cities Program (Programa Cidades Digitais)[28]: It promotes digital inclusion for municipalities, by implementing optical fiber network with broadband Internet services to integrate public institutions, as well as offering free Internet access spots to the population. For the municipalities where the initiative is already in place, the goal is to facilitate the access to education, health and safety services;

- The Brazilian National Broadband Plan (Programa Nacional de Banda larga, PNBL)[29]: The program intends to provide broadband access to remote and low-income locations. The program aims to improve coverage and reduce costs of broadband access. A variety of other measures has been discussed, as tax exemptions, reduction of broadband licensing fees and acceleration of efforts to make additional radio spectrum available[30].

The programs above can be a significant step towards the broadband universalization in Brazil, in line with the initiatives adopted by the developed countries.

(iii) Sinergy between telecom and other sectors

Utility companies can also play an important role in the installation of conduit and fiber optic cables, integrating it to construction projects. One disadvantage of this alternative is that providers and telecommunications carriers willing to lease conduit network structure would have to negotiate with different parts and several entities depending on where it is located and who controls the asset.

The optical fiber is already often installed alongside utility infrastructures, for instance gas, water, telephony and electricity. Coordinating optical fiber installation with other infrastructure projects could result in considerable savings, as demonstrated during the dig once policy considerations.

The National Electric Energy Agency (ANEEL) regulates electricity generation, transmission, distribution and commercialization in Brazil. In addition, ANEEL is responsible for overseeing the concessions and permits of electric power services. Within ANEEL, the Access and Technical Standards Group, part of the Superintendency of Regulation of Distribution Services (SRD), is responsible for activities related to sharing of distributors' infrastructure with other sectors and can be considered an important enabler of the synergy between electrical distribution and broadband in Brazil.

To facilitate and stimulate the synergy between broadband distribution and other sectors, it is necessary to create standards for infrastructure sharing in the construction of buildings, as part of the Brazilian Association of Technical Standards (ABNT) attributions, which establish norms for civil engineering in the country. Within ABNT, the Brazilian Civil Construction Committee is responsible for the standardization of civil construction, which includes structural projects, general construction requirements and construction systems. In addition, the Brazilian Electricity Committee establishes the rules for transmission and distribution

SIRO

SIRO, a joint venture between ESB[33] and Vodafone[34], has been created to deliver broadband network directly to the final consumer, using existing electricity network[35]. While the joint venture deploys and manages the broadband infrastructure, authorized broadband providers are able to openly access it to provide broadband Internet services to end consumers[36].

As SIRO expands broadband infrastructure, providers may lease the network, significantly reducing the costs of Internet services. The process is similar to the benefits presented during the dig once explanation.

of energy and telecommunications in terms of terminology, requirements, test methods and generalities.

In addition, within the MCTIC, the Broadband Office, as part ot the Department of Telecommunications, has as an objective the facilitation of the deployment of telecommunications infrastructure and the expansion of broadband access in Brazil. Thus, this department plays an important role in the elaboration of a connected construction policy.

The National Telecommunication Agency (Anatel), another important agency to stimulate the synergy between telecommunications and other sectors, aims to promote the development of telecommunications in the country. The National Information Infrastructure Committee is responsible for formulating proposals and recommendations related to the sector that contribute to the expansion of information infrastructure in Brazil. Therefore, the Committee could be an important player for the creation of a connected construction policy as one of its objectives is related to promoting and disseminating the information technology infrastructure.

In Brazil, the synergy between electric distribution and broadband can lead to significant advances in broadband universalization. Because of the successful campaign Light for All (Luz para Todos), electrical coverage has achieved a vast territory across the country, reaching 99% coverage in urban areas and 90% in rural regions, according to IBGE[31]. The electrical infrastructure emerges as an alternative to expand the Internet connection to remote areas. Differently from the technology of ANATEL's sanction[32], Broadband over Power Line, the proposed expansion of the Internet connection would be enabled by the optical fiber already installed by energy companies. New business models can emerge from this synergy and improve the market's competitiveness.

By promoting the implementation of optical fiber networks, the dig once policy benefits public and private sectors, as well as communities for it facilitates broadband new entrants, affecting competition. In addition, conduit installation in public right-of-way significantly decreases the costs for providing broadband services making communities more attractive for new and underserved markets or for existing operations expansions. As a result, the new competition structure leads to lower prices for consumers.

The Universal Service Funds, in contrast, must be continually modernized to keep up with technology and service innovations. The government, in turn, should incentivize and coordinate projects that promote broadband development to respond to a new spectrum of services by funding policies that integrate the population to a new digital era.

According to the OECD (2006)[37], USF advantages are related to its flexibility incentivizing universalization rather than a mandatory regulation for a specific service or technology provision. In addition, the Universal Service Funds are more transparent, cost-efficient, competitive and technologically neutral, as operators

Infrastructure Sharing Model and Telecommunications Network
Infrastructure sharing models enable lower start-up costs and better efficiency in business operations. Different sharing models exist, driven by commercial and efficiency reasons. Among them, we highlight Mast Sharing, Site Sharing, Full RAN Sharing and Shared Core Network Elements and Platforms.
Thus, infrastructure sharing enables better utilization of available resources, reduction of installation and operation costs. By avoiding replication of resources, the model can reduce the time of installation of antennas, for example, besides allowing the emergence of new business models, such as companies specializing in the installation of infrastructure, towers and antennas, and that make it available for different operators.
That is, the model has the potential to reduce operator costs by reducing the number of antennas, while increasing coverage in new geographic areas and strengthening competition.

and carriers are required to contribute to a common fund. Complementary to the universalization policies, other market interventions are suitable to address the high costs and low rates of broadband penetration in Brazil. Such intervention could address competition regulation, as shared lines or direct stimulus for new entrants.

Therefore, a holistic view of both supply and demand sides to ensure the success of broadband services in Brazil must be carefully addressed. The Brazilian ICT market is not mature for both sides, involving risks and large investments.

On the supply side, the current strategies incentivize all players in the broadband value chain to provide high-speed Internet connection with optimum user experience.

The telecommunications regulatory agenda and the public programs to expand broadband network infrastructure and access should be continually supervised and evaluated through policies and initiatives to encourage competitiveness. Briefly,
- Encourage new public-private models to attract investments in infrastructure constructions;
- Intensify funding support by making use of Universal Service Funds;
- Promote competitiveness in the market, incentivizing the expansion of providers operations or facilitating the entrance of new players in the market;

- Incentivize application service innovations to intensify Internet service consumption;
- Reinforce broadband network on education, health, security, and public services to improve quality and efficiency on operations.

In contrast, on the demand side, strategic stimulations are crucial for developing the country to increase awareness making broadband services affordable for the population. The government has already taken several initiatives to improve the adoption of Internet in remote areas:
- Open broadband network facilities to provide ease of access at public institutions, as well as accelerate public-sector procurement of services through online platforms;
- Promote consumption of information at all levels of education, reinforcing skills and trainings of technologies;
- Nurture technical professionals and talents to stimulate innovation;
- Make broadband available, affordable, and accessible for the population;
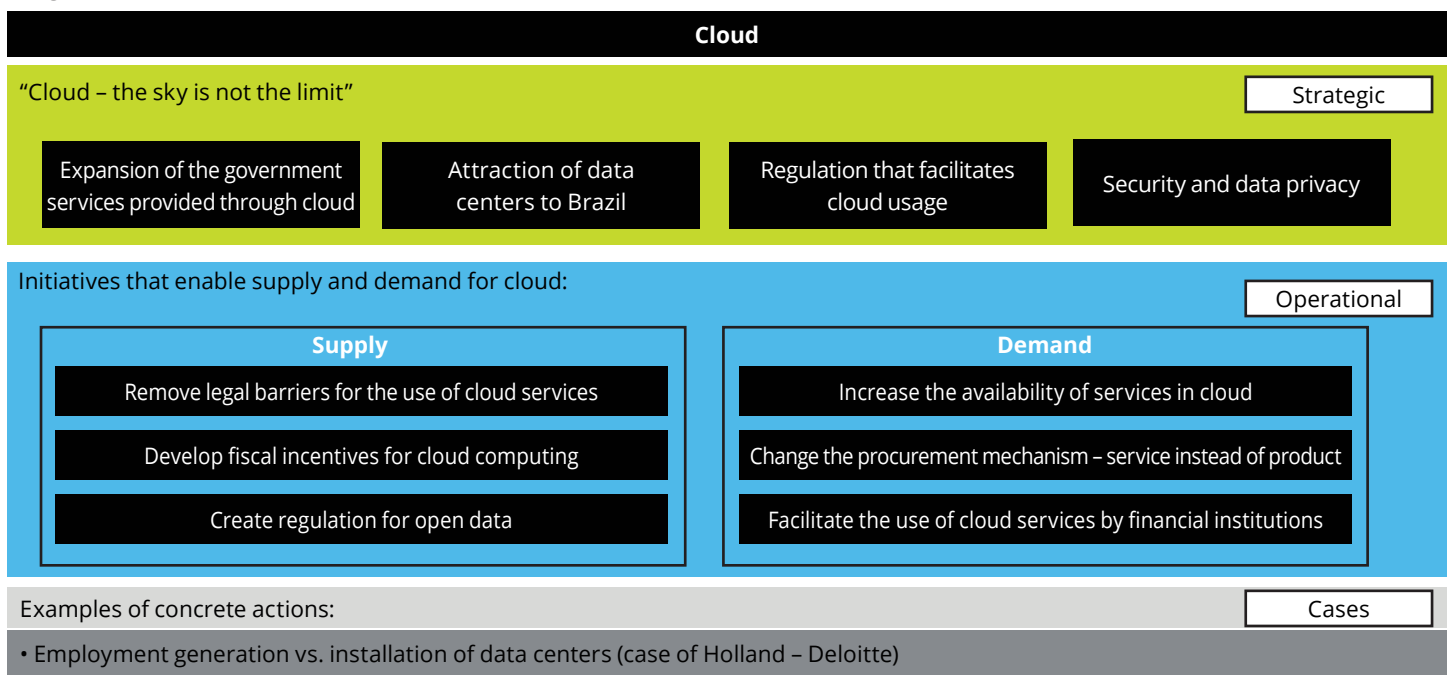
The telecommunications regulatory agenda and the public programs to expand broadband network infrastructure and access should be continually supervised and evaluated through policies and initiatives to encourage competitiveness. They might raise the levels of penetration rates by furthering broadband infrastructure diffusion and adoption, as well as reducing Internet connection costs.

Cloud

National security, regulation, costs and local government services are the main drivers of cloud and local data centers in Brazil.

Insights and recommendations for cloud

Cloud

"Cloud – the sky is not the limit"	Strategic

Expansion of the government services provided through cloud	Attraction of data centers to Brazil	Regulation that facilitates cloud usage	Security and data privacy

Initiatives that enable supply and demand for cloud: **Operational**

Supply	Demand
Remove legal barriers for the use of cloud services	Increase the availability of services in cloud
Develop fiscal incentives for cloud computing	Change the procurement mechanism – service instead of product
Create regulation for open data	Facilitate the use of cloud services by financial institutions

Examples of concrete actions: **Cases**

• Employment generation vs. installation of data centers (case of Holland – Deloitte)

Source: Deloitte

The adoption of cloud computing by the government agencies and organizations offers considerable advantages to the user, among them: the reduction of costs, the enhancement for processing information, and the improvement of services for the citizens. The general strategic direction for cloud computing by the Brazilian government should focus to the expanding the migration of public services to the cloud, attracting more data centers on Brazilian territory and reducing the existing barriers for cloud computing by creating a favorable legal environment and developing fiscal incentives.

Cloud computing is a concept that combines several technologies and, as a result, there are multiple definitions and interpretations. The US National Institute of Standards and Technology (NIST) defines cloud computing as "a model for enabling ubiquitous, convenient on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". In a report from 2014[38], the OECD focuses on the idea of cloud as a service and defines cloud computing as "a service model for computing based on a set of computing resources that can be accessed in a flexible, elastic, on-demand way with low management efforts".

Cloud computing includes different types of service models, such as software, platform and infrastructure services.
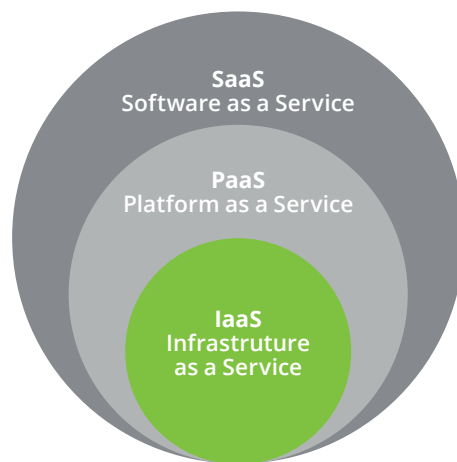
Source: OECD, Deloitte

According to the NIST definition, in the Software as a Service (SaaS) model consumers have access to the provider's applications on a cloud infrastructure (web-browser or a program interface). The Platform as a Service (PaaS) model offers the user a structured platform to create their own applications and services through programming languages, libraries and tools offered by the provider, without having access to the underlying cloud infrastructure. In the Infrastructure as a Service (IaaS) model, users are provided with computing resources such as processing, storage, network and others to deploy and run different operating systems, software, and applications. This model allows significant level of flexibility to the consumer.

Cloud deployment models and their importance

There are four main deployment models for cloud computing, depending on if the cloud is deployed within an organization and remain private or if it is deployed more broadly and the data centers are made publicly available – private clouds, public clouds, community clouds, and hybrid clouds.

Cloud computing deployment models:

(i) Private cloud: It is characterized by having a structure of unique cloud for a single organization, composed of several users. Can be managed and operated by the organization, by third parties or a combination of the two;

(ii) Public cloud: it is the pay-by-use model, where the infrastructure is provisioned for open use. They are the cloud providers.

(iii) Community cloud: a cloud created for a particular group of organizations, usually with common interests. It can be managed by an organization, a group of them, third parties or still a combination of these;

(iv) Hybrid cloud: a combination of two or more implementation (private, public or community), where normally what is less important is intended for the public cloud.

According to Brasscom[39] (2017), the cloud computing was one of the fastest growing sectors in Brazil in terms of revenue, registering an increase of 51.7% when compared to the previous year, reaching a revenue of R$ 4.4 billion. In the same year, ICT companies' revenues summed R$ 467.5 billion. The report also project a growth of 27% per year between 2017 and 2021 in the sector. The prospect for growth should be driven mainly by investments in new technologies of digital transformation, such as Internet of Things, Big Data and Artificial Intelligence.

Government cloud, in particular, relates to products and computing solutions in cloud developed and used by organizations and government institutions.

While public institutions are very concerned about data security and privacy, governments are expected to deploy private cloud services at twice the public cloud rate by 2021, according to Gartner.

For the successful adoption of the governmental cloud in Brazil, some points are considered strategic.

Currently some government institutions have started the process of migrating some services and systems to the cloud environment. However, it is observed that there are difficulties to be faced: (i) rigidity in the current IT contracting model; (ii) slow delivery of assets (hardware equipment, or even software in some cases); (iii) the need for a physical location to install the equipment, following hardware-specific safety standards, often requiring renovation; (iv) need for replacement of equipment after life cycle (or after finalization of manufacturer's warranty); and (v) investment in hardware and capex (capital cost) while the model of cloud is primarily marketed as a service (opex - operating cost).

Expansion of cloud utilization would allow the scalability of government services, ie they may be adjusted according to their demand and possible peaks of use.

Although some federal agencies have already begun the process of migrating to cloud systems, some manual processes still persist. However, those available online to the population significantly reduce wait times that were previously spent in queues and allow bureaucratic processes to be completed within minutes without the user having to leave home.

Hosting government services and systems in a cloud environment also simplifies systems management models, while reducing the costs associated with maintaining and updating an infrastructure dedicated to the operation of those systems. Citizens would still be able to take advantage of a more interconnected government, having their information distributed between different organs, and therefore the provision of public services provided by the state to the citizen directly, would be more efficient.

According to the Global Connectivity Index 2018 (GCI), cloud and datacenter are technologies considered the basis for sectors that are data intensive, such as financial services, logistics and retail. They can be considered regional hubs and platforms for data sharing and access to information. This movement favors the generation of insights in all sectors, increases the transparency and attraction of foreign investments. As other industries move to a digital environment, these two technologies will be the basis for meeting the existing demand.

The 2018 edition of the United Nations E-Government Survey examined how e-government and information technologies can be used to build better societies. The UN has measured e-government's effectiveness in delivering public services seeking development standards, as well as countries and areas where the potential of Information and Communication Technologies (ICT) and e-government has yet to be fully developed. In this research, it was emphasized that an open governance approach, composed of clear standards and guidelines, is necessary. He also pointed out that countries should recognize the consequences of placing cyber security as national security on the issue of data storage and cloud utilization, as this may limit the widespread adoption of ICTs, reducing confidence and leading to a possible division of geographical areas.

i. Expansion of the government services provided through cloud

The major benefit from using cloud services is the cost reduction. Behind the lower costs of cloud computing lies the concept of it being a measured service, not a product. As such, it does not rely on an incremental Capex approach. Spending on physical products, such as hardware and infrastructure, which in general have higher costs for acquisition, are not needed, since the necessary equipment is provided by the seller.

In general, it is cheaper to hire an application service, such as SaaS or IaaS for instance, instead of investing in hardware, software licensing and internal training of the staff to access information technology or hiring skilled personnel. In addition, the increased use of new technological applications such as e-commerce, big data and IoT are related to large amounts of processing and computing power, which are hard and expensive for companies to provide, since their resources and infrastructure are limited.
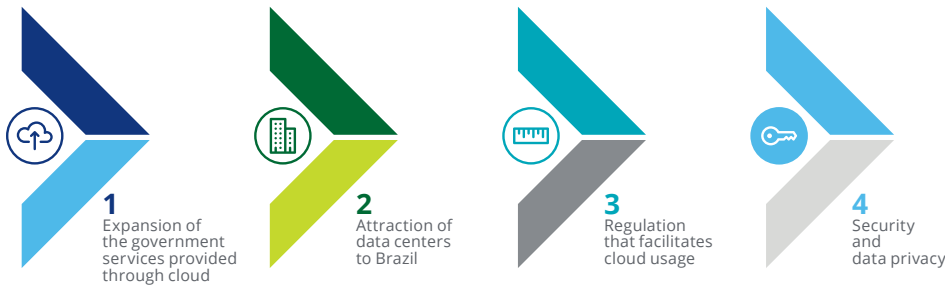
Moreover, using the cloud service allows for significant flexibility when it comes to payment models, which include using subscription plans or the "pay-per-use" model, which implies payment only for the amount of IT services effectively consumed.

Migrating to the cloud leads to positive impacts related to the IT staff of the government agencies. Using cloud computing allows IT workers to focus on specific projects instead of dealing with maintenance and updates of the local system, which becomes the responsibility of the cloud service provider.

Moreover, cloud services used by the government allow data sharing and facilitate the collaboration between different agencies and organizations, which has the potential to significantly reduce the time span of the bureaucratic processes related to government services.
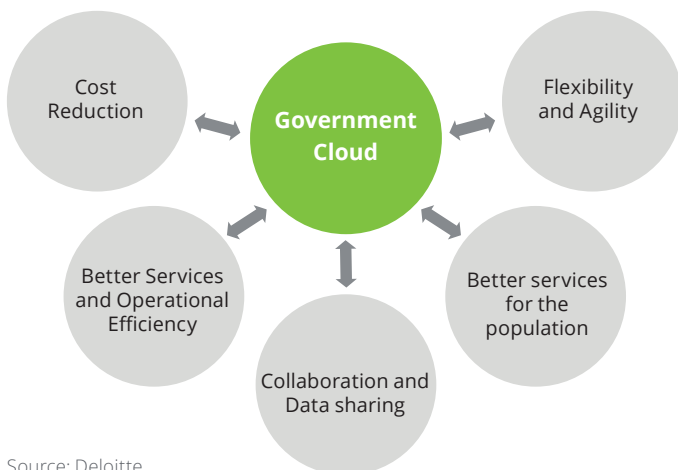
Finally, using cloud computing allows government agencies to offer a variety of self-services for the citizens, for instance, allowing them to make service requests online and follow their status, to monitor their energy and water consumption, to access their medical records, etc. In addition, the government can use cloud solutions (SaaS, PaaS and IaaS) for the creation of public data repositories, storage, monitoring, asset management, threat and fraud detection. Most of these applications are either new applications or traditional applications that have been rewritten to run on a cloud platform.

The benefits related to cloud computing – delivering better services in an effective way with lower costs – should be priority for the public institutions in every country. According to Gartner's estimates, government use of public cloud services around the world will expand significantly in the next few years, with spending forecasted to register an average growth of 17.1% per year through 2021. Justice, health, transport and other public entities in countries such as the US, Singapore, Canada and the UK have already migrated to cloud.

Cloud – the sky is not the limit

1 Expansion of the government services provided through cloud

2 Attraction of data centers to Brazil

3 Regulation that facilitates cloud usage

4 Security and data privacy

Source: Deloitte

Migrating to cloud computing has numerous advantages for the government.

Cost Reduction

Government Cloud

Flexibility and Agility

Better Services and Operational Efficiency

Collaboration and Data sharing

Better services for the population

Source: Deloitte

It is important that Brazil follows the global wave of migration to cloud computing of government services. For this purpose, initiatives need to be adopted for stimulating public agencies and institutions on all levels (federal, state and local) to move their data to the cloud, to become more digitalized, and to offer more services to the citizens based on cloud computing. This can generate a wave of domestic demand for cloud services by the public sector, leading to a necessity of higher supply and thus, the need of the construction of new data centers on national territory.

ii. Attraction of data centers to Brazil
According to CloudScene[40], currently there are 100 data centers located in Brazil[41]. The United States has 2,425 data centers, which shows how far Brazil is in this context and reflects the existing opportunities for capacity expansion of this technology.

Gartner's research confirmed this conclusion about Brazil, adding that there is a shortage of corporate computing

infrastructure and data centers in the country. Moreover, there are possibilities for building data centers in the North and Midwest regions of the country.

In terms of the process of digitalization of the government administration and the supply of public cloud services, Brazil has been moving forward with the support of institutions, such as the Federal Data Processing Service – Serpro. This is a public-owned IT company under the Ministry of Economy, with the objective to modernize the government agencies across the country.

In recent years, Serpro has developed several solutions for improving the relationship between the government and the citizens, and for supporting state and municipality authorities. An example of a solution using Data Lake and Big Data built by Serpro is the Federal Government's Data Analysis Platform - GovData, the creation of which was also supported by Dataprev and the Ministry of Planning. In this platform many governmental databases are

The public company Dataprev that offers information and communication solutions for the improvement and execution of social policies in Brazil has three data centers in the country, located in Brasília, Rio de Janeiro and São Paulo. The company specializes in processing and handling large volumes of data. Among the services offered by Dataprev are processing the payments of social security benefits and of the social security information of the Federal Revenue Service.

integrated and several advanced analytical tools for data analysis are available[42].

In order to ensure its successful digitalization process, however, the Brazilian government needs to incentivize the creation of cloud data centers on national territory. The use of national-based cloud computing services is associated with several advantages for consumers in comparison to hiring such a service from abroad.

The major advantage of storing data on national territory is related to the fact that the cloud computing services will follow national rules. Thus, if a decision is made to store data outside of the national territory, it is important to get familiar with the risks and legal consequences of doing so. In addition, if the data center is located in a country with strict policies on accessing confidential data, the stored information may not be well protected from a confidentiality aspect and may be accessed without authorization.

To encourage the use of cloud services of national companies, the Brazilian government imposes an expressive tax burden for contracting similar services abroad. This measure, however, is not enough for boosting the installation of new data centers across the country. Additional efforts related to tax exemptions and fiscal stimuli are needed for turning Brazil

Canada: since February 2017, the Canadian government moved to the cloud, using the Shared Services Canada (SSC). The SSC is a government initiative created in 2011 to provide IT services to all government agencies across the country. These services include standardized e-mails for all departments and agencies, consolidation and modernization of the government's data centers, transformation of the communication and data sharing between organizations, the procurement of technology devices and the detection and prevention of cyber and technology attacks. Currently, the adopted cloud services will handle unclassified government data, such as archived material, government-generated open data and big data sets generated by the scientific community, which will help citizens to access new digital services and programs.

Japan is one of the top markets for growth in cloud services in the world. The government has been strengthening the cloud infrastructure in the country through the "Digital Japan Creation Project", since 2009. As a result of the initiative "Kasumigaseki Cloud" (Kasumigaseki is a district of Tokyo where the biggest institutional buildings are located) all government ICT systems were moved to cloud, a national archive for digitalized government documents was created and a number of mobile applications to access government services were published. This initiative was crucial for stimulating the development of cloud computing and to the country providers.

The "Portaria N°9" of the Institutional Security Office (GSI), from March 15th, 2018, established principles, guidelines and responsibilities related to Information Security for the processing of information in cloud computing environment by the organs and entities of the federal public administration in Brazil. According to the new regulation, cloud computing is defined as a computational model which allows access on demand to a shared set of computing resources (networks, servers, storage, application and services) regardless of its location. The text highlights the character of cloud computing technologies in offering benefits of cost-effectiveness and efficiency. However, as pointed out, in order to ensure the security of information, measures must be adopted to preserve the interests of society and the sovereignty of the State. Public administration should balance the advantages and risks associated with migrating to cloud computing services with respect to information security and communication management. Thus, the regulation mentions that Brazilian legislation prevails over the laws of other countries, which is in line with the movement of other countries on the subject.

into an attractive location for data center installation.

Moreover, the government has the power to create demand for the installation of national data centers by adopting initiatives that stimulate the migration of government agencies and systems to the cloud.

To ensure the success of the country's digitalization process, the Brazilian government must encourage the creation of data centers in the national territory to stimulate the generation of cloud services. The use of national-based cloud computing services is associated with several advantages for consumers and users, which are enhanced when the service is based in the country. The main aspects are:

1. Reduced costs: Using cloud computing services reduces the use of data centers, which reduces the number of servers and software spending, without impacting the organization's IT capabilities. Cloud costs are flexible, as fees are paid based on the use of server and infrastructure capacity as it is needed.

2. Data accessibility: Cloud service providers are extremely flexible and maintain high reliabilty levels uptime, with rare connection problem exceptions.

3. Capacity scale: Cloud usage can be adjusted according to capacity demand, for example, server crashes. Once the

operation is normalized, capacity is reduced to minimize costs.

4. Demand for professionals: The installation of cloud servers, in addition to addressing sovereignty over the information installed in national territory, generates a demand for high-qualified professionals.

iii. Regulation that facilitates cloud computing

In 2017, Brazil presented a four-position improvement in the BSA Global Cloud Computing Scorecard[43]. Despite the Brazilian advance according to the ranking, the research reveals that the legal environment and the country's regulations for cloud computing still limit innovations.

The General Data Protection Regulation (Lei Geral de Proteção de Dados, LGPD), sanctioned by the Presidency of the Republic in August 2018, aims to ensure greater control of citizens on their personal information by requiring explicit consent for the collection and use of data, either by the public authority or by the private sector, and requires the options to view, correct, and delete personal data and information. The LGPD thus aims to protect the privacy of people by establishing limits and guidelines for the use of personal information. Even though the initiative reveals advances in public policies related to information protection, there are still barriers on software and online applications that prevent the implementation of cloud services.

In Brazil, the existing current legislation and regulation is not completely adapted to the changing reality of digitalization and represents a barrier for the adoption of new technological solutions, including cloud technology.

Removing legal barriers and unnecessary regulation can boost the adoption of cloud services across the country, thus, stimulating the development of a digital economy in Brazil. Moreover, policy makers need to examine the tax implications of the fiscal policy regarding the use of cloud services and the construction of data centers. Issues related to data privacy and security must also be considered, since cloud applications for e-government deal with sensitive data.

Considering the higher taxes, the cost of services in the country is higher than in other countries around the world. Since cloud computing is a service, the use of this technological solutions is subject to high service taxes, increasing the consumer prices and leading to low demand.

Since 2014, the Brazilian government imposes taxes on the use of data centers and cloud infrastructure providers located

In April 2018, the Central Bank of Brazil established a new cyber security policy for financial institutions through the Resolution 4,658 and relaxed the rules regarding storing data in a cloud. The new resolution allows banks to hire cloud service providers in Brazil and abroad, with prior authorization from the Central Bank.

Before the issue of this resolution, financial organizations in Brazil did not have the right to use data centers located outside the national territory as a national security protecting measure, driven by the fact that banks store sensitive information about their clients. The resolution still maintains the banks' responsibility to preserve the information of their customers and they have the right to decide which relevant information should be outsourced to an external supplier.

outside of the national territory. Currently, the total tax on such services coming from abroad is 39%, according to the Regional Accounting Council of the State of Rio

de Janeiro (CRC-RJ), and can reach 55% depending on the way the contracting of the service is made, as well as on the type of the service. This can increases significantly the final price of the provided service.

Moreover, data centers and providers of cloud computing are subject to corporate taxation as any other private organization in the country. An initial step towards solving the issue with the high corporate taxes

for these entities was taken in 2017 when the Brazilian Commission for Science and Technology, Communication and Computer Science (CCTCI) approved a change in the Lei do Bem – Law 11.196/05 that creates fiscal incentives for companies that perform research and development in technology. According to this change, all data center operations across the country are put under the special taxation regime for the export of information technology services (REPES – *Regime especial de tributação para a plataforma de exportação de serviços de Tecnologia da Informação*). Thus, companies that export software and provide computer services become exempt from federal taxes on imports of goods and services.

Another barrier for cloud computing in Brazil that can be overcome by changes in the existing regulation is the current procurement mechanism, which is inadequate, considering the concept that cloud is a service and not a product. The process of hiring cloud services should take into account the true nature of this type of technology. Since cloud is a relatively new concept, it is hard for consumers from public and private sectors to understand the nature of the offered solution. They tend to expect the delivery of a physical product, instead of a service. In this way government biddings must be adjusted in order to properly describe the solution and its characteristics, which can be achieved

The EU Commission has identified the potential of open data as an enabler for the future digital transformation and as a driver of strengthening the EU countries' competitiveness. In 2015, the Commission launched the European Data Portal, whose objective is to collect metadata from the public sector from the EU member countries. According to the 2017 Open Data Report developed by Figshare, which analyzes countries' progress in open data readiness and portal maturity, the EU28 countries are performing very well in these categories, with a maturity level of 73% and a readiness average increase of 14.5 percentage points since 2015.

through hiring experienced and qualified professionals that understand the concept of cloud computing.

Creating regulation for open data is another step that can considerably facilitate the adoption of cloud computing in the country. Open data has been gaining importance with the development of the ICT sector. It is considered one driver of economic development, efficiency gains, and benefits for the society and is associated with higher transparency of government policies and actions.

Therefore, it is crucial that public organizations and agencies in Brazil adopt open data solutions and make a priority the idea of data sharing. The open data policy of the government brings benefits to all stakeholders - citizens, businesses, researchers, journalists – since it enables improved decision making and creates transparency. The government, however, must take in consideration the issues related to security and privacy. Building a well-structured cloud computing infrastructure can allow for the public usage of private data in a secure way.

Case

In Europe, the Dutch are among the frontrunners in the area of digital infrastructure (Internet connectivity, colocation housing and hosting).

In 2013 the Netherlands had a world class digital infrastructure. The real value of the digital infrastructure sector, however, lies in internet economy and in a broader digital society. The picture emerges that Digital Infrastructure cannot be separated from a successful digital society, placing the Dutch in a favorable position to profit from digital growth.

The hosting and infrastructure cloud market was fragmented with many small players and larger international players.

The Amsterdam region is part of a leading group of tier-1 data centers and shows strong increase in supply.

London, Frankfurt, Paris and Amsterdam form the leading group of colocation data centres hot spots in Europe. There is a large distance between this leading group of four and the runner up on position 5 (Madrid).

Infrastructure cloud giants	Enterprise hosters	Mass market hosters	Small local players
• Large international players • Offering infrastructure as a service, with storage and servers on-demand • Standardized offer	• Aiming at larger enterprises • Large contracts and specific needs • Often in combination with transformation and integration services	• Standardized portfolio of hosting services • Aiming at small and medium businesses • Large scale with international activities	• Small companies • Originating from web hosting and internet access • Evolved into shared and dedicated hosting and cloud • Ability to provide local and personalized service

Source: Deloitte

Region	Supply m²	Availability m²	Increase last year	Supply m² per € bn GDP
London	298	52	7.2%	138.9
Frankfurt	159	22	3.9%	56.2
Paris	111	14	4.7%	52.9
Amsterdam	**101**	**16**	**6.3%**	**168.3**

Source: Deloitte

Amsterdam has shown a strong increase in the past year, smaller than London but larger than Frankfurt and Paris.

This position is the result of the combination of several criteria for data center location decisions.
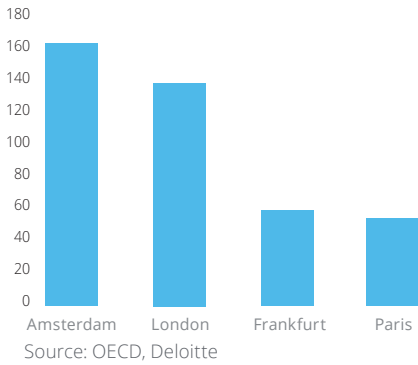
The market for data centres is characterised by a combination of large global players (e.g. Telecity, Equinix) and many smaller local providers.

The presence of most major global data center providers in the Netherlands is prove

Source: Deloitte

Colocation supply m² per € bn GDP

Source: OECD, Deloitte

of the country's attractiveness. SaaS and PaaS are two of the Digital Infrastructure's closest relatives, generating 5,700 jobs in the Dutch economy.

As a result the Netherlands is hosting the top of the world's technology and Internet companies as gateway to Europe and the Internet.

Large investments in data centres within the Netherlands by corporate multinationals like Google and IBM generate additional employment.

According to Etro (2009), fast adoption of innovative cloud services could have created as much as 10,800 new Dutch SMEs during the past 5 years in retail, wholesale, tourism, transports, communication, and real estate & business activities.

The Netherlands has a leading position in Internet exchanges, data center housing and hosting, three sectors that together with telecommunications form the Digital Infrastructure.

Internet Connectivity

1. Extremely well connected to the core Internet (terrestrial & submarine cables)
    a) Lowest latency to other major Internet hubs
    b) Large available bandwidth
2. Presence of all major carriers and MAS-IX

Energy

3. Availability of required electricity capacity (production and distribution)
4. Reliable power supply
5. Favorable electricity prices (compared to the EU average)

Geographical location

6. Good accessibility (Schiphol), central location in Europe
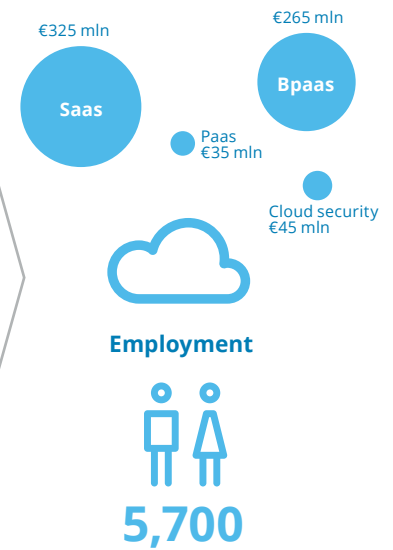7. Small country with a neutral position

Political and economic climate

8. Economic and political stability
9. Highly-educated and multilingual workforce
10. Focus on international trade
11. Favorable laws and regulations
12. Favorable tax climate

Spending on Saas per capita (in €)
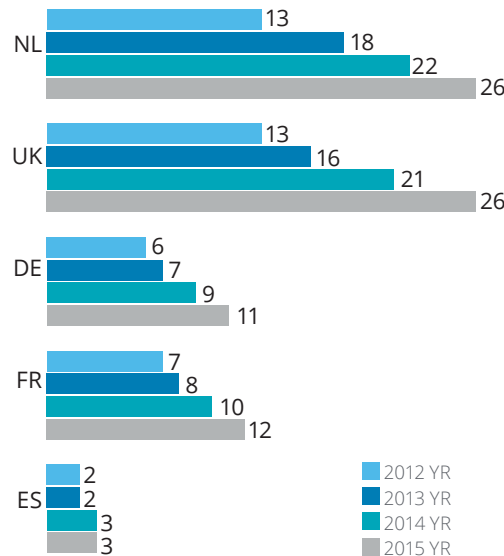
Source: Gartner's IT Spending Forecast Report; CBS Database:Deloitte analisys
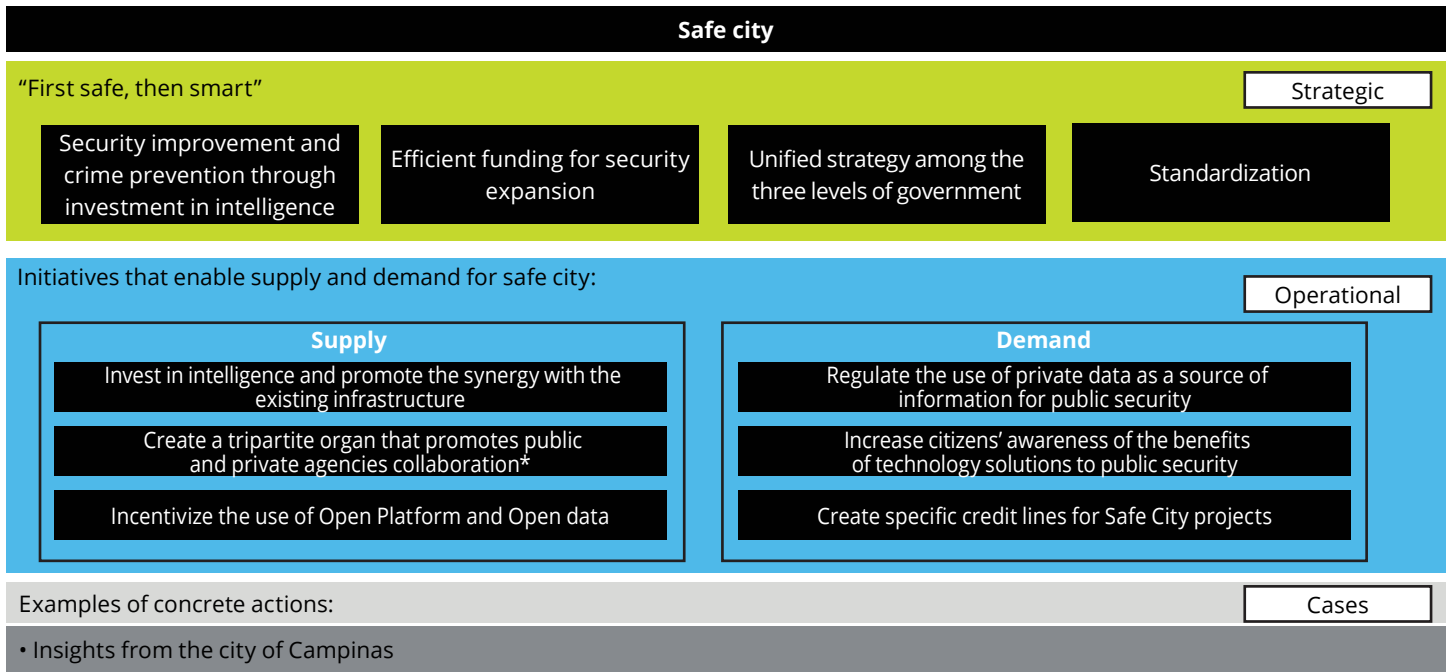
Safe city

The most relevant investment in public safety technology is also the less costly: definition of open standards. Artificial intelligence and facial recognition also play an important role.

Insights and recommendations for safe city

Safe city

"First safe, then smart" — Strategic

Security improvement and crime prevention through investment in intelligence	Efficient funding for security expansion	Unified strategy among the three levels of government	Standardization

Initiatives that enable supply and demand for safe city: — Operational

Supply
- Invest in intelligence and promote the synergy with the existing infrastructure
- Create a tripartite organ that promotes public and private agencies collaboration*
- Incentivize the use of Open Platform and Open data

Demand
- Regulate the use of private data as a source of information for public security
- Increase citizens' awareness of the benefits of technology solutions to public security
- Create specific credit lines for Safe City projects

Examples of concrete actions: — Cases

• Insights from the city of Campinas

* Tripartite Organ is an entity composed of representatives of the federal, regional and municipal spheres. Single System for Public Security (SUSP, Sistema Único para Segurança Pública), under the responsibility of SENASP, is an entity created in June 2018, after the first edition of this study. SUSP's mission intends to promote, at all three levels of the government, integrated and cooperative actions among public security institutions, such as civil, military and Federal policies, security secretariats and city guards.

Source: Deloitte

The implementation of safe city solutions can help Brazil solve one of the major problems that it is currently facing – the low level of public security in the cities. For this purpose, the government should prioritize adopting technological projects for solving the various challenges of public safety in urban spaces and make cities "first safe, then smart".

The strategic direction adopted by the government to improve public safety in cities across the country should focus on the use of intelligent solutions such as video analysis technologies, motion sensors, artificial intelligence and big data. The deployment of a nationwide mobile communication network that enables an integrated communication between armed forces and public security institutions is also an important step towards safety and intelligent model.

Many public security agents in Brazil rely only on equipment restricted to voice communication that are unable to transmit multimedia data clearly and quickly enough to be used during situations of risk. In addition, in regions where the technology used by the police communication is still analog, criminals often monitor the frequency used by them, anticipating actions and eliminating the surprise effect of operations.

Meanwhile, there are radio communications technologies available for critical missions that allow the use of smartphone-like devices capable of transmitting their GPS position, as well as videos and images. The equipment also allows the inclusion of strategy plans, maps, as well as conducting queries to criminal records. The data captured by the equipment can be transmitted in real time to command centers, so it would be possible to know in real time what the police officer sees and hears.

Communication networks used in critical missions must not become unavailable during periods of high network traffic, such as in major events or in the occurrence of natural disasters. The coverage of communication networks used by security forces should be comprehensive so that agents do not lose the signal of communication during operations in which they need to move. Finally, it is important that these critical communication systems have secure encryption.

Currently a variety of standards are used for security communications, such as LTE, TETRA, Tetrapol and P25. Among these, the LTE standard is the one that has the greatest possibility of delivering all necessary solutions for the public security communication systems. The technical work to produce improvements in the LTE standards that meet the needs for critical communication is carried out by 3GPP (3rd Generation Partnership Project), an organization formed by telecommunications associations that currently has more than 400 member companies and institutions. 3GPP periodically releases new specifications for mobile network technologies, offering increasingly more functionalities for the communication systems used by the public security forces. LTE technology will become the standard for broadband networks used for critical communication. Therefore, it is imperative that Brazil makes the necessary investments to enable its implementation.

Another necessary measure is the creation of a unified strategy between the three levels of government: federal, regional and local, that enables public agencies integration and collaboration. Defining standards that promote the use of open solutions, as well as the development of models for efficient funding of public security projects are also crucial for the successful implementation of the concept of safe cities across Brazil.

The fast development of digital technologies offers innumerous possibilities for turning cities around the world smarter. According to Deloitte's definition, cities are considered smart when investments in human, social capital, transportation and communication infrastructure sustain economic development and high quality of life, with a wise measurement of natural resources. Such investments related to improving public security in urban areas around the world can turn cities safer, resulting in a concept of a safe city as an emerged niche of smart cities.

According to the Safe Cities Index 2017[44], developed by The Economist Intelligence Unit, which ranks 60 cities around the world through the analysis of 49 indicators among digital security, health security, infrastructure security and personal security. Tokyo, Singapore and Osaka were the top three safe cities in 2017. Buenos Aires is the top city of the Latin American region, ranking on 29th position.

The ten cities best classified at the Safe Cities Index – Tokyo, Singapore, Osaka, Toronto, Melbourne, Amsterdam, Sydney, Stockholm, Hong Kong and Zurich – have high or upper middle income per capita. However, in all regions, youth violence is a problem, especially in regions where the youth unemployment rate is high. Young people who are exposed to social

The use of integrated solutions involving video, data and analytics by law enforcement officials for dealing with public security has been gaining significant importance in cities around the world.

inequality, poverty and exclusion tend to have risk behavior, such as engaging in criminal activities, violence and substance abuse. These problems also affect particular regions of Latin America and the Caribbean, which ends up reflecting in the security indexes of their cities. To support the mitigation of urban violence, cities have a growing number of safe city technologies that generate different positive impacts on public safety and the community. The installation of noise sensors contributes to the agility in detecting incidents or any kind of abnormal agitation in cities. CCTV cameras when combined with artificial intelligence technologies, such as face recognition, locomotion analysis and behavior analysis, become a powerful resource for detecting criminal behavior and suspicious activity, making it difficult to escape and conceal identity by criminals. These solutions have become increasingly popular, playing an important role in combating urban violence in large cities such as London, Tokyo and Hong Kong.

Another technological advancement that has been instrumental in increasing public safety are the applications that allow users to send information about the occurrence of accidents, fires and criminal acts. The "Fogo Cruzado" app, for example, was developed, so locals and tourists could send information in case they witness shootings cases. In this way, application users can be alerted to move away from risk zones. In São Paulo, the Municipal Department of Urban Safety launched a similar app known as "SP + Segura" which also counts on reports from citizens to map occurrences.

In some countries there are also applications that allow authorities to send alerts to the population, such as Amber alerts in the United States. These alerts are used to inform the abduction of children and allow people to send videos, photos or any information that may contribute to the police operation. In 2017, a total of 868 children were rescued through this resource.

Within this context, raising citizens' awareness on the importance of their active participation in the reporting of criminal acts, vandalism, fires and other emergencies is essential for people to increase their individual security and also for them to play a key role in enhancing security in their communities. Moreover, information submitted by citizens can be aggregated and combined with health and education data. In this way it is possible to plan police operations with more intelligence and also to invest in public policies for crime prevention in a more efficient way.

According to the ranking Connected Smart Cities developed by the company Urban Systems[45], the majority of intelligent and connected cities in Brazil is concentrated in the Southeast region. The North region remains the only one with no representants among the top ten.

In 2017, São Paulo ranked first among the 700 analyzed municipalities in the country, followed by Curitiba and Rio de Janeiro. The ranking considers 70 different indicators in the areas of mobility, urbanism, environment, energy, technology and innovation, education, health, entrepreneurship, economy and governance.

Considering the top cities in Brazil in terms of security, Urban Systems also collected and analyzed data from crime indexes. Vinhedo, located in the state of São Paulo, ranked first among the most secure cities in Brazil in 2017. Vinhedo is characterized by a significantly low crime rate compared to other cities in Brazil, with 295 municipalities in the state of São Paulo having higher homicides rates than Vinhedo. The city invested R$ 220 per inhabitant on public security in 2017, which was reflected in the increase of the rank of the city from third place in 2016 to first place in 2017.

Safe Cities Index 2017

Ranking 2017	City	Points	Ranking 2017	City	Points
1	Tokyo	89.80	16	Wellington*	83.18
2	Singapore	89.64	17	Brussels	83.01
3	Osaka	88.87	18	Los Angeles	82.26
4	Toronto	87.36	19	Chicago	82.21
5	Melbourne	87.30	20	London	82.10
6	Amsterdam	87.26	21	New York	81.01
7	Sydney	86.74	22	Taipei	80.70
8	Stockholm	86.72	23	Washington. DC	80.37
9	Hong Kong	86.22	24	Paris	79.71
10	Zurich	85.20	25	Milan	79.30
11	Frankfurt	84.86	26	Dallas*	78.73
12	Madrid	83.88	27	Rome	78.67
13	Barcelona	83.71	28	Abu Dhabi	76.91
14	Seoul	83.61	29	Buenos Aires	76.35
15	San Francisco	83.55	30	Doha	73.59

* New cities

Source: The Economist Intelligence Unit Limited 2017

Different initiatives related to safe city solutions have been implemented in cities around the world. In general, these initiatives include smart street lighting, drones for risk assessment, data-based crime prevention programs, predictive policing, emergency apps, and equipment for identifying gunshots, which solve different problems related to public safety. The best results can be achieved when they are all implemented together and operates simultaneously.

City officials in Brazil implement solutions for safe city development with traditional approaches, such as mobile apps that facilitates the communication between population and law enforcements. In general, cities start with small pilot projects to test innovation technologies and tend to choose solutions that integrate well with the existing platforms and can follow up the fast changes in technology.

Furthermore, as a first step widely adopted to increase public safety, cities often begin their technology investments by installing cameras for monitoring, which are used for inhibiting the practice of criminal activity and to support research of crimes by the authorities. This solution, however, is inefficient for the prevention of urban crimes.

When Brazil hosted the men's soccer world cup - FIFA Brazil 2014, the government created the Integrated Command and Control Centers (CICCs), located in each of the 12 host cities of the tournament, which

Ranking 2017	Ranking 2016	Municipality (State)	Points
1	1	São Paulo (SP)	33,197
2	3	Curitiba (PR)	32,472
3	2	Rio de Janeiro (RJ)	32,125
4	5	Belo Horizonte (MG)	30,785
5	6	Vitória (ES)	30,426
6	7	Florianópolis (SC)	30,281
7	4	Brasília (DF)	29,987
8	10	Campinas (SC)	29,788
9	13	São Caetano do Sul (SP)	29,418
10	9	Recife (PE)	29,339

Source: Connected Smart Cities 2017, Urban Systems

Best ranking per region

Central-West
Brasília – DF (7th place)
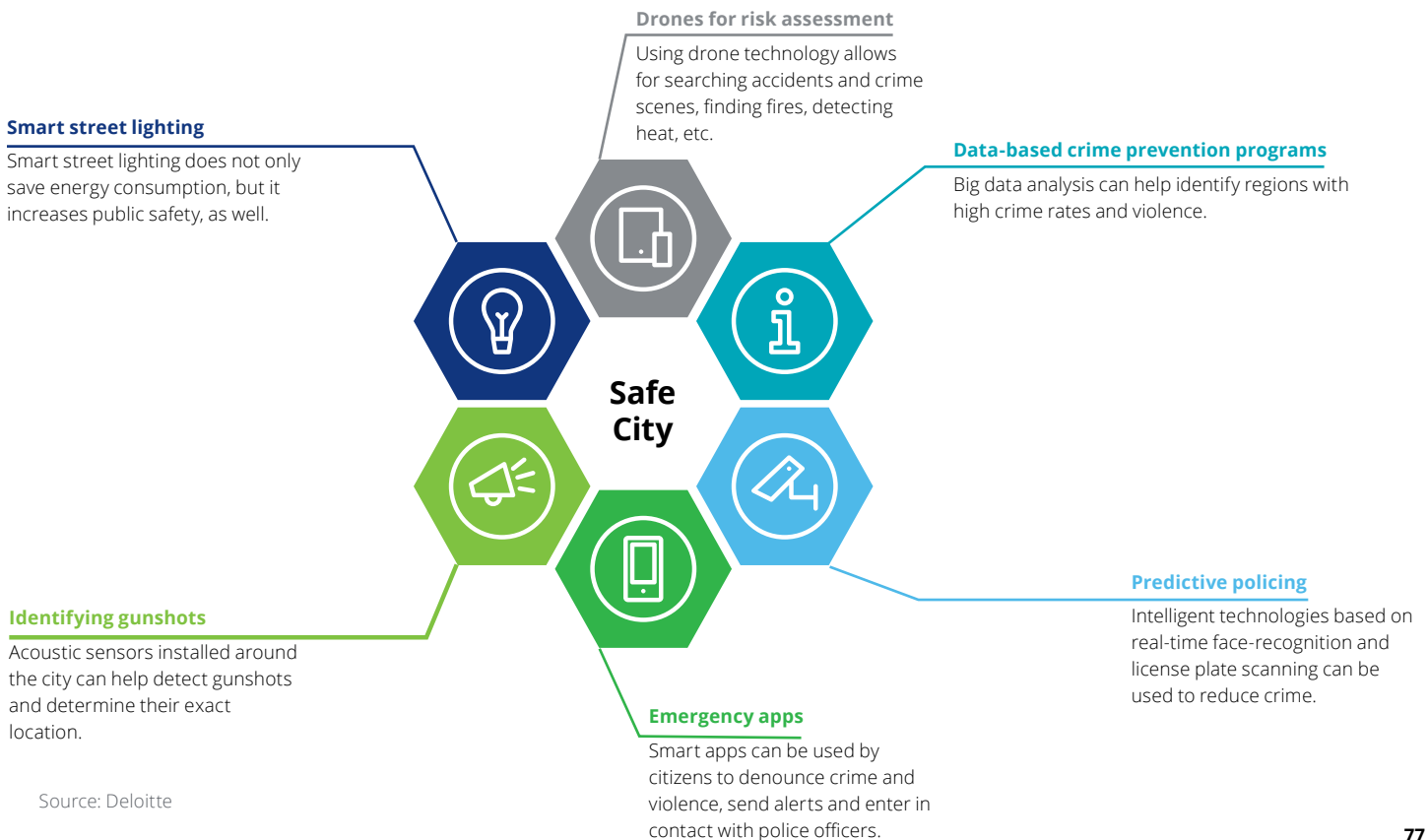
Northeast
Recife – PE (10th place)

North
Palmas - TO (15th place)

Southeast
São Paulo – SP (1th place)

South
Curitiba – PR (2nd place)

Drones for risk assessment
Using drone technology allows for searching accidents and crime scenes, finding fires, detecting heat, etc.

Smart street lighting
Smart street lighting does not only save energy consumption, but it increases public safety, as well.

Data-based crime prevention programs
Big data analysis can help identify regions with high crime rates and violence.

Safe City

Identifying gunshots
Acoustic sensors installed around the city can help detect gunshots and determine their exact location.

Predictive policing
Intelligent technologies based on real-time face-recognition and license plate scanning can be used to reduce crime.

Emergency apps
Smart apps can be used by citizens to denounce crime and violence, send alerts and enter in contact with police officers.

Source: Deloitte

remained an important legacy for national public safety. The CICC is an organ that has the capacity to articulate the elaboration of the protocols of integrated action, as well as to promote the relationship and the interlocution between the military police, organs of protection and civil defense. It aggregates emergency telephone answering services, video monitoring, intelligence service and production of statistical data. The analysis of the images is carried out in real time by the operators of the CICCs.
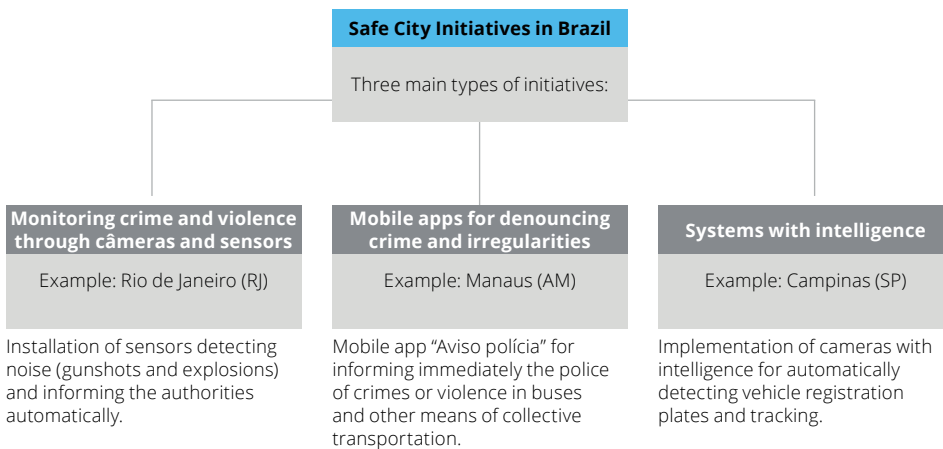
Some cities, such as Campinas, have smart cameras that allow facial recognition. These cameras can also identify clues to suspicious activities and agglomerations, besides detecting stolen vehicles by reading their license plates and reporting the direction the vehicle has taken, significantly reducing the search time for criminals.

Therefore, municipal officials need to prioritize investment in smart solutions, which will potentially make resource management more efficient and effective.

The existing projects implemented in cities across Brazil can be categorized into three main types: monitoring crime through cameras and sensors; mobile apps for denouncing crime, violence and other irregularities; and intelligent systems for collecting and analyzing data.

In general, cities in Brazil have invested in isolated and rather sporadic initiatives without necessarily following a specific strategy for the development of safe city solutions that promote collaboration among agencies and regions. Some municipalities have tried to implement joint solutions with other nearby cities in the region as a way of sharing investment costs.
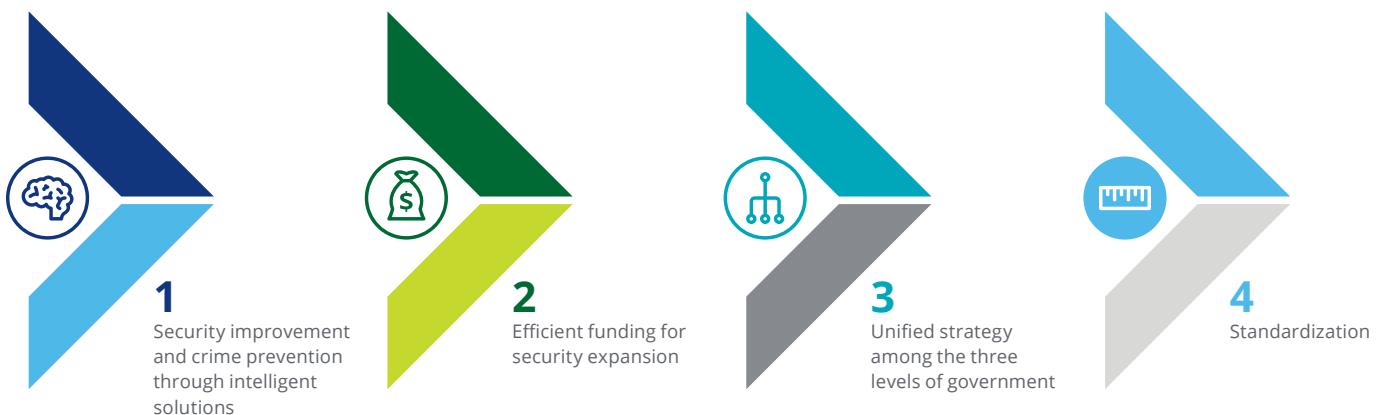
In order to boost the implementation of safe city solutions in Brazil it is important to define a strategic direction and specific goals to be achieved by municipalities. It is crucial that city officials know where to start and what they want to achieve in terms of increasing public security through the use of technology.

Safe City Initiatives in Brazil

Three main types of initiatives:

Monitoring crime and violence through câmeras and sensors	**Mobile apps for denouncing crime and irregularities**	**Systems with intelligence**
Example: Rio de Janeiro (RJ)	Example: Manaus (AM)	Example: Campinas (SP)
Installation of sensors detecting noise (gunshots and explosions) and informing the authorities automatically.	Mobile app "Aviso polícia" for informing immediately the police of crimes or violence in buses and other means of collective transportation.	Implementation of cameras with intelligence for automatically detecting vehicle registration plates and tracking.

Source: Deloitte

Safe city

First safe, then smart.

1 Security improvement and crime prevention through intelligent solutions

2 Efficient funding for security expansion

3 Unified strategy among the three levels of government

4 Standardization

Source: Deloitte

(i) Security improvement and crime prevention through intelligent solutions

Funding is one of the biggest challenges for municipalities and local governments, once budgets are limited and security secretariats need to make resources available for diversified defense policies.

In general the investment needed for safe city projects is directed towards cameras and network equipment, such as routers, switches, and storage, while intelligent solutions based on facial recognition and artificial intelligence are cheaper. Therefore, municipality officials need to prioritize investment in smart solutions, which will potentially make resource management more efficient and effective.

Public safety can be significantly enhanced by using artificial intelligence (AI) solutions based on sophisticated surveillance technologies, monitoring standards, integrating criminal databases, and combating violence.

AI can help detect patterns, predict criminal behavior, track objects and people, and ensure quick responses to incidents and crimes. Many cities around the world have already adopted secure city solutions that involve intelligent command and control centers using AI, helping to optimize operational costs and resources, making sense of the collected data available through cameras and sensors. In addition, these solutions make the crime detection

and prevention process faster, thereby optimizing the operations of the command center.

One way of reducing the government expenses with equipment is sharing private companies infrastructure to facilitate the access to images and data from private security cameras by police officers. Integration between the already installed private network of surveillance cameras with the city monitoring system can be beneficial the reduction of government costs and for the safety of cities.
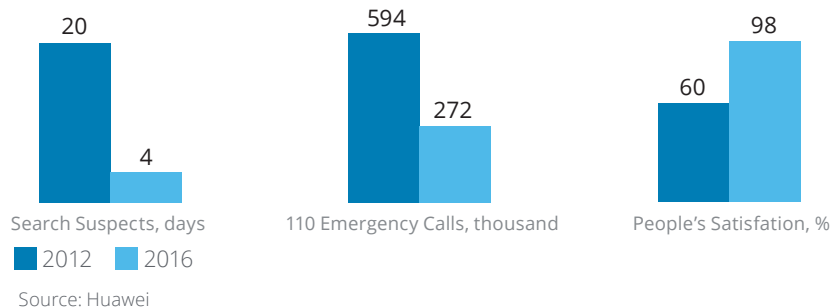
Different studies have shown that initial investment in public safety innovation leads to considerable benefits in terms of economic growth, productivity, innovation, national competitiveness, job creation and reduction in crime. According to IHS Markit[46], there is a direct relationship between government investment and the benefits of a safe city project – both in terms of safety results and social benefits.

The government, however, should consider that investment in equipment is not enough for the development of solutions that effectively deal with crime and violence. It is necessary that systems involving some degree of intelligence are implemented together with the equipment in order to achieve positive results related to increase in public safety.

(ii) Efficient funding for security expansion

The majority of the investments made in security by the Brazilian states depends on federal government transfers. While about 90% of budgets are allocated to salary payments, charges and pensions, 9% is spent on the cost of public administration, leaving only 1% for investment in new technologies. This is a situation where Public Security Secretariats have little or no flexibility. In 2016, for example, States and the Federal District spent R$67.3 billion with security. As part of this amount, only 0.7% accounted for intelligence and information expenses.

> **The foundation stone for the development of safe cities is investing in a smart way, i.e. in intelligent solutions that lead to higher public safety with lower expenditures.**

Shenzhen case: Shenzhen, located near Hong Kong, is one of China's most important cities and serves as an example for the adoption of technological solutions for solving problems related to public security. A city and district two-level video platform has been installed, collaborating with the city's ID system, transportation, and federal police through government cloud. The adopted solution combines both infrastructure and intelligence. There are more than 1.3 million social cameras for monitoring and surveillance that convert video format to a unified standard, as well as key intelligent technologies, such as face recognition (>99% recognition), vehicle registration plate recognition, open intelligent video analysis platform compatible with multi-vendor algorithm. These solutions led to less time and costly search for suspects, lower number of emergency calls, and higher people's satisfaction.

Search Suspects, days — 2012: 20, 2016: 4
110 Emergency Calls, thousand — 2012: 594, 2016: 272
People's Satisfaction, % — 2012: 60, 2016: 98

■ 2012 ■ 2016

Source: Huawei

It is therefore necessary to find new ways of complementing public safety resources so that resources are available for investments in safe city technologies.

In June 2018, the Brazilian government signed a provisional measure to relocate part of the resources of the sports lotteries administered by the bank Caixa Econômica Federal, currently destined for sport, to public safety. The expectation is that by 2022 the amount destined to the National Public Security Fund, derived from lotteries will be R$4.3 billion.

Nairobi case: As an attempt to fight the raising crime rate in Nairobi, the Kenyan government invested in technology to increase the urban safety. The first step of the project taken in 2014 was related to upgrading the infrastructure to ensure a holistic solution for the entire city. An integrated Emergency Command Center for managing emergency calls was created, over 1,800 cameras were installed across the city and a video management and storage system was established. Moreover, since 2015, the city officials have been investing in intelligence in order to increase the benefits of the installed surveillance cameras across the city, which included a system for automatic number plate recognition and the implementation of video analytics. IHS Markit estimates that an increase in government investment in city safety in Nairobi resulted in a rise in safety results of 24%. The city registered 46% reduction in crime, citizens' individual risk fell by 42%, while property risk – by 34%. The general perception of public security increased among the citizens, the positive image of the police force and the government rose as well, which was the result not only of the investment in equipment (surveillance cameras), but also of the implementation of intelligent solutions.

There are different lines of credit available to municipalities for the implementation of public safety projects, such as those offered by the National Bank for Economic and Social Development (BNDES). In 2018 the board of directors of the development bank approved a security plan to provide resources in the coming years to the Federation's entities: R$32 billion for states and R$10 billion for Brazilian municipalities. However, several Brazilian states will have difficulties in accessing the credit line disclosed due to difficulties in offering guarantees for the payment of the credit granted. In addition, the application process for such lines of credit is complex and there is a lack of well-developed projects.

Rethinking funding strategies for public safety is essential. New ways of accessing complementary funding should be created, without compromising the public budget. Above all, the destination of the funds must be monitored to guarantee an efficient application of the resources. Thinking about financing also involves a governance architecture that can guarantee the establishment of systematization mechanisms, federative responsibilities and monitoring of the projects developed. It is therefore necessary to develop robust performance indicators so that common goals and objectives can be established.

(iii) Unified strategy for safe city among the three levels of government

Individual and sporadic solutions related to safe cities require separate infrastructure costs, do not allow sharing of information between different agencies and go against the idea of collaboration between all stakeholders.

Thus, national governments should focus on drawing a broad-based unified strategy and a roadmap for the creation of a safe city ecosystem, which will enable the inter-city learning, improve knowledge sharing and reduce the waste of resources related to the implementation of individual solutions.

Cities acting by themselves cannot to migrate to safe cities efficiently and effectively without the help of a centralized guideline developed by the national government. Therefore, policies should be enacted on a national level to address challenges that cities alone are unable to deal with.

A first step towards the creation of a national public security strategy was given in February 2018, when, through a provisional measure, the Ministry of Public Security was created. The functions of the new ministry include the coordination and promotion of public security throughout the national territory with the cooperation of states and municipalities. The structure of the Ministry includes the Federal Police Department (DPF), the Department of Federal Highway Police (DPRF), the National Penitentiary Department (Depen), the National Council of Public Security (Conasp), the National Council of Criminal and Penitentiary Policy (CNPCP) and the National Secretariat of Public Security (Senasp).

In addition, the project for the creation of the Unified Public Security System (SUSP), linked to the Ministry of Public Security, was approved in June 2018. The SUSP establishes the integration of the organs and institutions of public security and social defense in Brazil by means of information sharing, knowledge exchange, and combined and planned operations. The new system will establish a 10-year National Public Security Policy with the objective of defining goals and actions for the member bodies. States and municipalities will have two years to develop and implement their security plans. The formal structure of the SUSP will be established by the formation of permanent and deliberative councils to be created with advisory capacity.

The establishment of the Ministry of Public Security serves as the basis for the development of a unified strategy for safe city solutions in Brazil. The SUSP could play the role of an entity dedicated to the development of secure urban solutions on

a larger scale that promotes cooperation and integration between the three levels of government.

Moreover, the implementation of safe city solutions requires the collaboration between federal, state and local authorities, as well as the participation of players from the private sector.

Currently, the major challenges for collaboration among different government agencies and actors at different levels in Brazil are the use of different technologies, networks, platforms and devices, as well as the lack of a reference architecture or

Singapore case: Singapore is among the most innovative cities in the world and is rather advanced in the development and implementation of safe city solutions as part of the "Smart Nation" plan. The adapted solutions across the city are advanced, based on data analytics and machine learning.

Significant efforts have been made in transforming the Singapore Police Force into a crowdsourced entity. A mobile app allows citizens to alert the police on crime and violence through texts, pictures and videos. There are Neighborhood Policy Posts (NPPs) that provide self-service features and are fully automated, providing 24/7 access to residents. The NPPs allow citizens to contact police officers through video calls and make it easier for the police to report crime and allows officers to be redeployed from desk-bound duties.

Moreover, there is a Programme Office that facilitates the collaboration between public agencies and private corporations.

Singapore spends are about USD 4.1 billion on public safety, or USD 7.41 per resident, which makes it one of the top countries in spending on public security.

standards policy for data. The fragmentation and decentralization of many policy systems and the difficulty in sharing information with other public entities limits the implementation of the safe cities concept around the country and result in lack of efficiency of the adopted solutions.

Incentivizing cooperation across government divisions and geographical regions, as well as the involvement of the private sector, is crucial for dealing with these challenges. Building a committee for managing safe city projects that includes representatives of various agencies across the city as well as stakeholders and experts on consultancy and technology development, as suggested above, is an interesting option for the government for solving the problem with the collaboration between different stakeholders.

National Council for Public Security (CONASP – Conselho Nacional de Segurança Pública)
Conasp is an advisory public entity without normative power for technical cooperation between federal entities in the fight against crime in Brazil. The Council was created in 1989 and operates under the Ministry of Public Security. The main objectives of Conasp are the formulation of the National Policy on Public Security, the stimulation of institutional modernization for the development of public security policies, the elaboration of suggestions for changes in legislation, the promotion of the integration between federal, state and municipal public security agencies. Currently, the Council follows the tripartite model composed of government representatives of the federal, state and municipal levels in addition to officials from the police force, entities of workers in the area of public security, and organizations of the civil society related to public security.

(iv) Standardization
The applied digital solutions related to safe city need to be standardized and accessible. It is crucial that the investment in safe city solutions is made in a way that allows its easy evolution and adaptation to the continuously changing available technological innovations, which can significantly lower the required investment.

SENASP – National Secretariat of Public Security
SENASP is one of the secretariats of the Ministry of Public Security (MSP). The main objectives of this secretariat are the general coordination of public security policies and legislation at the national level and the development of research, technology studies and procedures to be applied in public security. In addition, SENASP is responsible for the national force - for coordinating its planning and operations; coordination of the public security intelligence and counterintelligence system; coordination and planning of operations and activities of the national command center.
The Secretariat coordinates the CICCN – Integrated Command and Control Center and conducts studies for the modernization of communications in public security.

CNPCP – National Council of Criminal and Penitentiary Policy
CNPCP is the first of the criminal enforcement agencies in Brazil founded in 1980. Its functions include the establishment of national criminal and penitentiary plans and policies, the implementation of new policies and the evaluation of the criminal, criminological and penitentiary system. The Council is composed of social entities, researchers and professionals in criminal law, community representatives and the DEPEN (National Penitentiary Department).

Currently, there are no comprehensive and largely accepted safe city technology standards. The creation of such standards, however, can significantly facilitate the process of implementating safe city solutions, can encourage interoperability and data sharing to increase the effectiveness of safe city applications and also can increase the value proposition for such technologies.

It is also crucial for expanding cooperation and exchange of information between cities, as well as other state and federal security agencies.

Moreover, the adoption of standards that are an open platform could allow cities to invest in technologies without worrying that there might be a problem in integrating them with the existing systems in use and without taking the risk of technologies not being compatible with future technologies.

Technology providers must work together in order to understand the goals of the government in terms of safe cities as a means of establishing standards for the used technology and equipment. Even though the private sector should lead the development of standards, the government should lead the actions related to defining, specifying and adopting standards for data interoperability in different formats (texts, videos) for public safety.

(v) Incentivize the use of open platforms and open data

Safe city solutions require constant maintenance and long-term investment and usually involve the participation of various vendors. This makes potential future updates costly and sometimes additionally complicated by vendors' lock-in. The adoption of safe city solutions using open platforms can build a solid and replicable foundation for solutions to be used in other cities.

Moreover, it can reduce development time and costs, and can enable future innovation applications and updates. Thus, it is economically viable to invest in an open ecosystem that responds to a number of standards previously established by the government and allows for a continuous interaction between the involved stakeholders – technology companies, citizens and government officials. Open platforms enable the quick replacement of the existing solutions and the addition of new ones without the need of significant adaptation on a large scale.

In addition to the openness of the platform, cities implementing solutions related to public safety should consider having open data, as well. This will improve the sharing of information between the involved stakeholders, thus increasing the collaboration, which would facilitate the formulation of plans for crime prevention. Cities that adopt open data models rank higher in public safety effectiveness rankings than cities that do not share the collected information.

(vi) Regulate the use of private data as a source of information for public security

Another challenge for the implementation of digital technology for the development of safe cities is related to the privacy issues of the collected data. The government has taken important steps to ensure the protection of citizens' data through the approval of the Law No. 13,709 in August 2018, known as the General Data Protection Act (LGPD). However, this law does not apply to the processing of data carried out for the purposes of public security, national defense, state security, or investigation and prosecution of criminal offenses. For the development of safe cities, it is still necessary for authorities to develop specific regulations that allow a balance between keeping people safe and protecting their private information. To do so, one must carefully consider the nature of user privacy protection as well as the potential risks to cyber security attacks underlying the infrastructure required for the adoption of safe city solutions.

A large portion of smart city technologies are built around the Internet of Things (IoT) and data analytics and, as such, the implemented solutions will become more valuable at scale due to the network effects. If governments create regulatory barriers to these widespread deployments through limiting the public use of private data, the applications and services built around data will be less effective. Smart systems that police departments could use to reduce crime, such as networks of gunshot detection sensors and predictive analytics, would be substantially less effective if they have strict limitations on sharing data among each other.

Thus, national governments should use their leverage to require system-wide data sharing safe city solutions for analytics purposes, when appropriate. In addition, authorities should stress that only a small portion of smart city data would be personally identifiable information to begin with and should work to dispel misinformed privacy fears as they arise.

Case

Campinas, founded on July 14th, 1774, is located in the interior of the state of São Paulo, about 90 km from the capital São Paulo, with a population of 1.2 million inhabitants. It is the third most populous municipality in the state and the tenth richest city in Brazil, being the third largest research and development center in the country.

The city of Campinas, known as the Silicon Valley of Brazil, is highlighted in the national ICT scenario. Its digital ecosystem is composed of important actors belonging to the government, the academia and the private sector. Some 20 higher education institutions are part of this ecosystem, among which Unicamp and PUC Campinas, as well as around 20 research centers. Moreover, Campinas is the only city in the country with five technological parks.

One fast-growing sector is the Internet of Things (IOT), with the participation of municipality institutions in the elaboration of the National IOT Plan and the provision of an open IOT platform, which can contribute to the accelerated development of solutions across industries such as the 4.0 industry and smart cities.

Campinas has been working on its digital transformation process for several years and several services have been made available to the population in the form of digital media. It is possible, for example, to consult information about urban zoning and public transportation, to obtain information on taxpayer's financial statements, to receive certificates, school report, and many others through applications or through the City Hall website.

Campinas was one of the first cities in Brazil to have a Monitoring Center, CIMCamp, established in 2006, which monitors the city through cameras and intelligence systems. Currently, CIMCamp has about 400 installed cameras interconnecting municipal schools, health units, gas stations, and the road system. In addition, the Intelligent Vehicle Monitoring System (SIMVECAMP) performs electronic surveillance of cars and is able to inform, using a regional database, if the vehicle registered by the system is regular or participated in a crime, for instance.

Another highlight is the Campinas Digital program, which aims to bring the citizens closer to the city authorities through digital services and the online systems of the City Hall, as well as to provide free internet access for the population. In order to conduct internal processes, the City Hall makes use of an integrated information system for the elimination of paper documents, which brings greater agility and is accessible through the website or through an App.

or the upcoming years, the Municipal Council of Science, Technology and Innovation (CMCTI), which is chaired by the Municipal Department of Economic and Social Development and Tourism (SMDEST), prepared the Strategic Plan "Campinas Cidade Inteligente" (PECCI) with a duration of ten years. Like the Strategic Plan for Science, Technology and Innovation (PECTI 2015-2025) prepared in 2014, the PECCI is being developed with the broad participation from various sectors and stakeholders. This plan foresees, among other concepts, the adoption of an open platform for the

development of intelligent city projects that allow the adoption of solutions of companies of any size, including startups. Another important aspect is the implementation of an open data policy and the establishment of governance for the management of the plan.

Moreover, in the process of digital transformation of Campinas, the Living Lab concept is being incorporated, which represents an ecosystem of open innovation for the experimentation of technological solutions that can be incorporated in the day to day life of the citizens.

A first example for this initiative of Living Lab is the partnership between the municipality of Campinas, The Center for Research and Development in Telecommunications (CPqD) and the ICT company Huawei for the development of security solutions, vehicle monitoring and facial recognition, with the integration of smart cameras with cloud processing, to the CIMCamp environment. The project intends to further develop applications for civil defense and urban mobility.
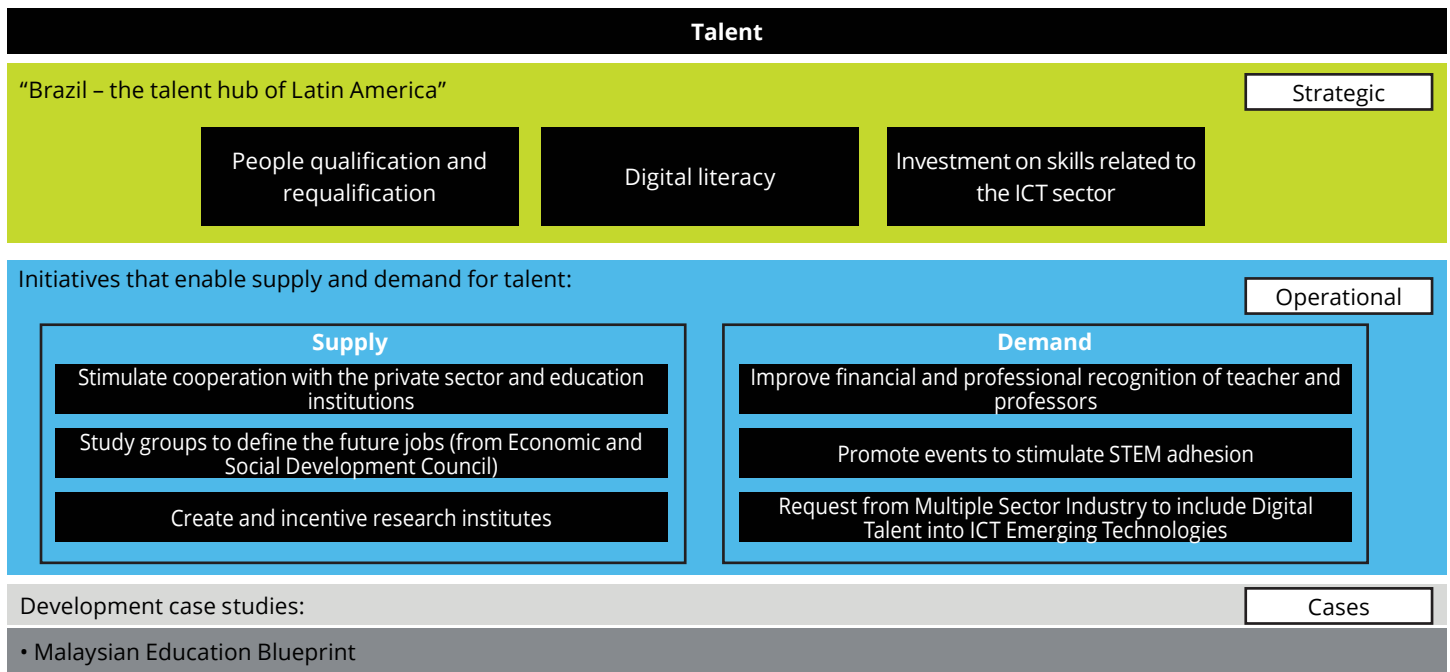
In the area of Security and Civil Defense, there are cameras distributed throughout the city and connected to CIMCamp, with images and data used for public safety. Today there are more than 400 cameras scattered throughout the city, as well as sensors installed for monitoring environmental disasters. In addition, the mobile app "Guarda Amigo" is available to the citizens for sending an alert to a user-registered contact list in case of emergency.

Talent
No digital revolution is enabled only with technology. A skilled digital talent is also an essential component to that

Insights and recommendations for talent

Talent

"Brazil – the talent hub of Latin America"	Strategic

People qualification and requalification	Digital literacy	Investment on skills related to the ICT sector

Initiatives that enable supply and demand for talent:	Operational

Supply	**Demand**
Stimulate cooperation with the private sector and education institutions	Improve financial and professional recognition of teacher and professors
Study groups to define the future jobs (from Economic and Social Development Council)	Promote events to stimulate STEM adhesion
Create and incentive research institutes	Request from Multiple Sector Industry to include Digital Talent into ICT Emerging Technologies

Development case studies:	Cases

• Malaysian Education Blueprint
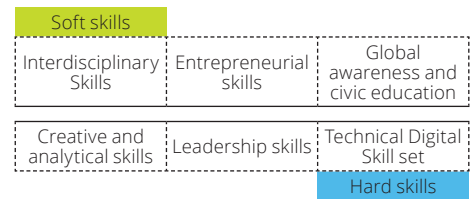
Source: Deloitte

The digital transformation comes with a lot of challenges to many countries. It brings innovation to all sectors not just for the ICT Sector alone, but cutting across Manufacturing, Finance and Banking, Public sector and changes the way how people interact with each other, conduct daily activities and business dealings. The new disruptive and emerging ICT technologies, together with the slow adaptation rate, lead to widening of the digital skills gap between the three different groups: digital leaders, digital professionals and digital users.
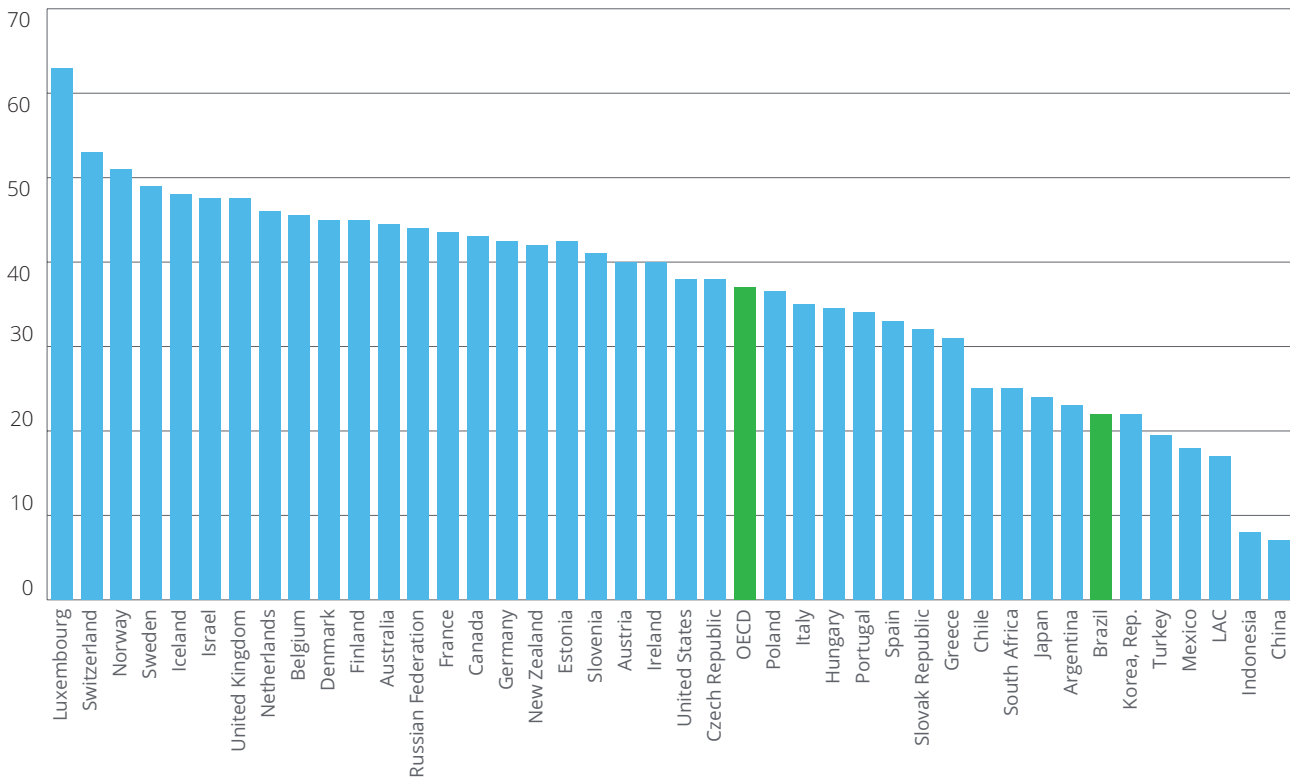
Descriptions

Digital leaders: Group having an influence on the organization of ICT planning, policies, design, and implementation according to the ICT Trend, industry demands, allocation of budget and resources.

Digital professionals: Group that provides direct development, support, integration & test into the backbone of ICT operation of the organization and ensure quality and SOP are align with organization and client objectives.

Digital users: Group forming biggest pool that directly uses the ICT Platform Services, and their products. This group can influence trends and the market insight.
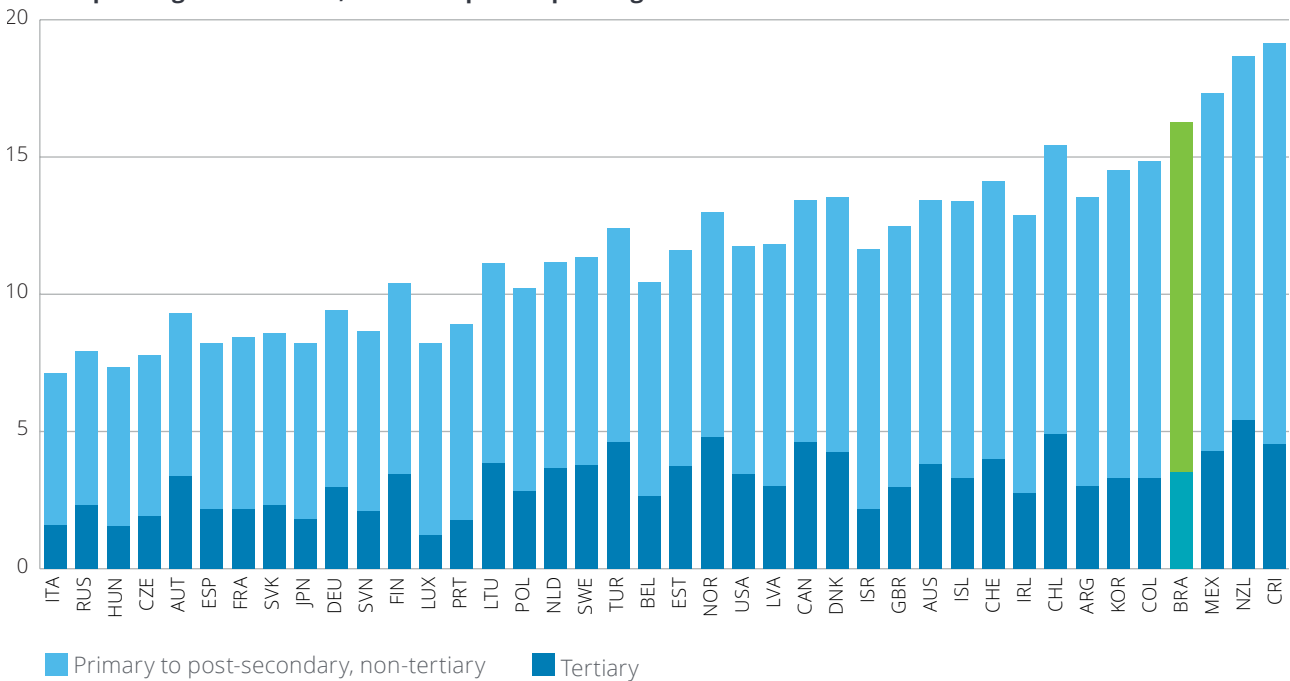
It is necessary to provide support to each different group with the right skills sets and proficiency levels in order to deal with the fast changing trends in the digital transformation process.

While the ICT sector stands out as the main driver of the new digital economy, it also plays an important role in the digital talent structure of the countries especially in Brazil, demanding a new kind of professional with multidisciplinary skills. This kind of professional is being considered as key to the economic development of the country.

Many countries, in particular Brazil, are putting substantial effort in the development of their ICT sector aiming at progressing in the digital transformation, being able to create a pool of qualified digital talent groups with the right competencies and skill set for the Brazilian economy.

According to a recent study conducted by The Economist regarding the skills of the future[48], employees will need to master not just ICT skills alone to balance them with adaptable interpersonal, problem-solving and critical-thinking skills in order to navigate through an increasingly digital and automated world cutting across different sectors in the economy. As a result, the study indicates that employees need to specialize and qualify themselves in order to get a spot in the local competitive labor market. As future trends indicate, demand from employer expectations will be higher especially in the ICT Sector. Neither only technical nor only business skills are enough. The actual market demands that employees mix both digtal skills and business and technical knowledge.

Soft skills		
Interdisciplinary Skills	Entrepreneurial skills	Global awareness and civic education
Creative and analytical skills	Leadership skills	Technical Digital Skill set
		Hard skills

Source: The Economist Intelligence Unit Limited, 2017

The digital skills stand out as an important set of abilities to the ICT sector and for the development of qualified employees especially in the emerging IT technologies that align with the Industry demands.

The development of hard skills related to the ICT sector is a challenge for many countries, especially for Brazil. A recent study done by Manpower Group, in the Talent Shortage Survey 2016, also highlighted that Brazilian employers face difficulties in obtaining employees with hard skills on the digital market.

According to the Talent Shortage Survey 2016, it is possible to identify that Brazilian employees are still generally low skilled and require substantial support from the public and private sectors to provide training programs that gear towards the need of the economy. Movements related to the development and improvement of the existing workforce are necessary, creating people that pursue knowledge-intensive jobs.

Regarding the industry and market necessity for knowledge intensive jobs, Brazil performs below average in comparison to other countries. This can be justified by the fact that Brazilian industries are not focused in high aggregated value products and catching up in the digital transformation.

However, the Brazil public spending on education is higher than other countries.

41% of the employers attribute the difficulty to fill available positions across sectors in Brazil to the lack of hard skills.

Share of knowledge-intensive jobs in the workforce, 2016 (in %)

Source: World Economic Forum, Brazil Competitiveness and Inclusive Growth Lab Report. March 2018.

Public spending on education, % of total public spending

Primary to post-secondary, non-tertiary   Tertiary

Source: OECD, Public spending on education (indicator, 2014). doi: 10.1787/f99b45d0-en (Accessed on May 2018).

Public spending on education in Brazil is high in comparison to other countries. For the tertiary level (universities) the investment represented 3.5% of the total public spending on education, while for primary and pos-secondary non tertiary reached 12.7%. The behavior of the public spending raises a concern related to the management and distribution of the spending, once the knowledge intensive workforce is not more than 20% of the jobs.

Considering the percentage of public spending on education and the knowledge intensive jobs, it is possible to observe that Brazil has been spending inefficiently.

Given that the ICT sector demands qualified employees and the knowledge-intensive jobs are below the world average, the ICT skills gaps in Brazil are getting bigger.

Brazilian companies need to invest in the competencies and the proficiency levels of their employees in order improve productivity and growth levels.

The Brazilian economy continues to grow across different sectors increasing the demand for ICT skills in particular for networking digital talent. These skill gaps are happening as a result of the increasing demand of services in many segments especially by mid-size corporation. Large data center service companies which had previously set up their operations in Brazil continue to do well, and this has created additional demand for digital talent, thus widening skills gap, and increasing the costs to hire other digital talent from the neighboring countries. The study also found that 75% of the Brazilian companies face difficulties to recruit digital talent that

require skills combination. This has led to companies looking for alternatives to outsources management of their network.

A recent IDC study suggests that Brazilian companies have to emphasize that their digital talent with network domain has to understand how technologies affect and enable the businesses, giving importance to cross technology skill sets.

Considering the information presented in the chart below of the full time equivalent (FTE) – which is a figure that represents the employee spending 100% of their time in Networking – the forecast for 2019 puts Brazil as the country with the biggest networking skills gap in terms of employees, among other countries from Latin America.

Total FTE Gap in Latin America – 2019 Forecasts
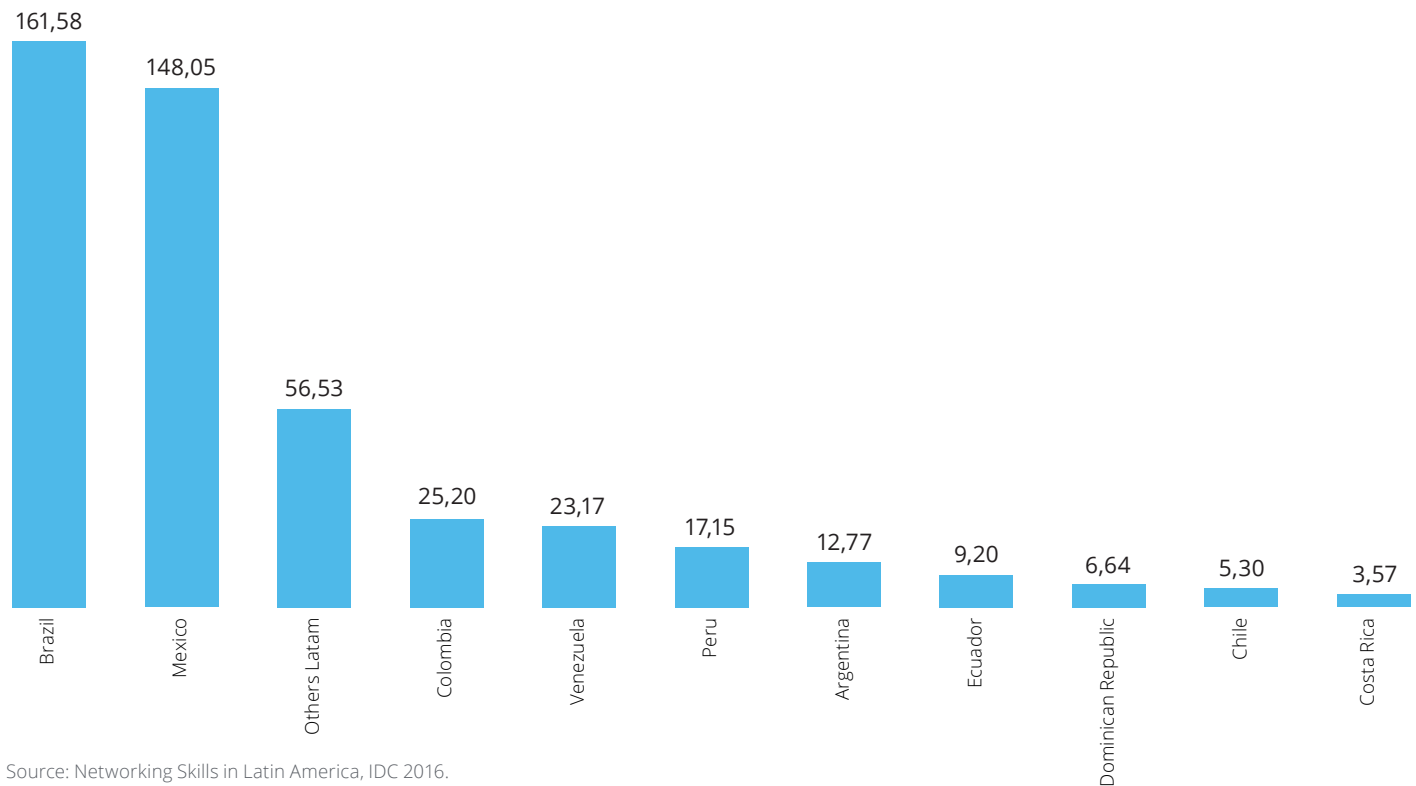
Source: Networking Skills in Latin America, IDC 2016.

This is not surprising considering that Brazil has the largest ICT market in Latin America, which is expected to grow 2.2% in 2018, according to IDC, driven by the IT sector, which is expected to grow 5.8%. In terms of IT investment, Brazil ranked first in the Latin American region in 2017, with US$38 billion in technology, followed by Mexico with US$20.6 billion and Argentina with US$8.4 billion (IDC). The projections for the coming years remain positive despite the difficulties faced by the ICT sector in the country, driving digital transformation. This trend significantly impacts the domestic labor market, leading to increased demand for IT professionals with digital skills, thus requiring investment in training and education.
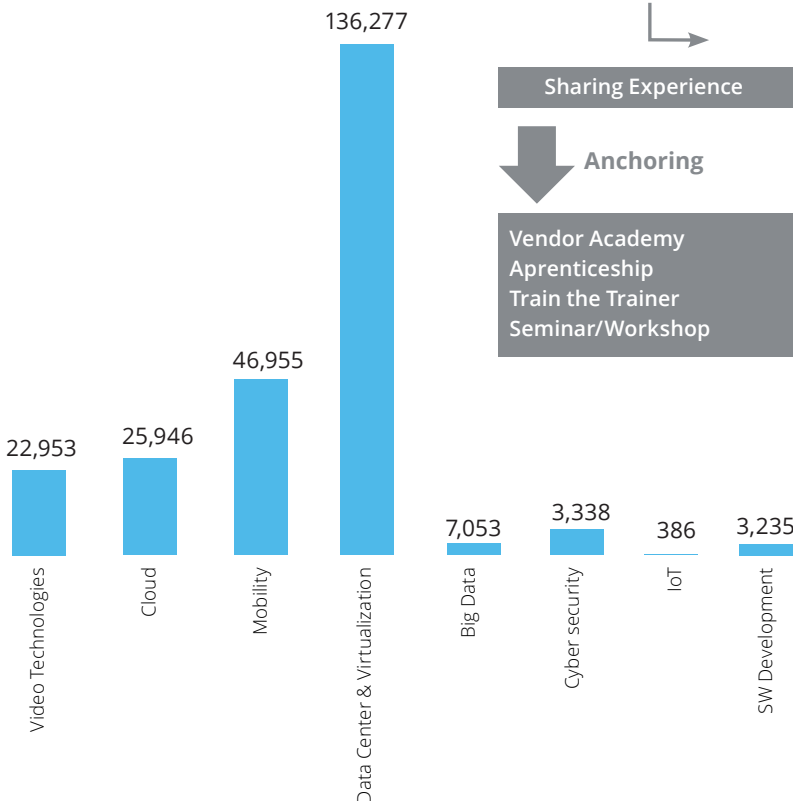
Latin America is expected to face a gap related to professionals, especially with data center & virtualization skills. For the development of IT environment within the small medium enterprises, the majority of the organizations in the region are involved in the transformation of their server virtualization and data centers. The virtualization trends will continue to play a significant role especially in the preparation of cloud ready environment, thus presenting a challenge into the complexity of the organization infrastructure in terms of reliability, cost reduction, and security.

Mobile technologies require digital talent with skills in managing wireless technologies. On the other hand, network applications will generally demand more digital talent and skills of cybersecurity, (having greater risks in the network due to connection of mobile devices) and software application development.
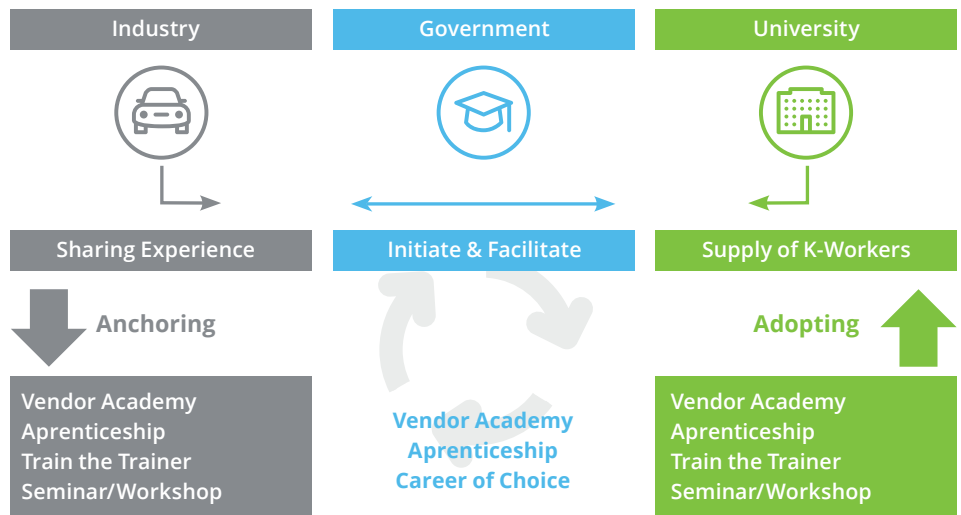
According to IDC, cloud services, data centers, mobility, Big Data and Analytics will be the segments that will register the highest growth rates in the coming years in Latin America. Thus, the top professionals demanded in the job market are related to the ICT sector and include cloud experts, information security, software engineers, business analysts, Chief Technology Officer (CTO) and PMO (Project Manager).

Skills Gaps per Technology

22,953	25,946	46,955	136,277	7,053	3,338	386	3,235
Video Technologies	Cloud	Mobility	Data Center & Virtualization	Big Data	Cyber security	IoT	SW Development

Source: IDC, 2016.

The Latin American job market, however, lacks digital talents qualified to meet the growing demand for these types of specialists. IDC has estimated that the skills gap for video technologies will reach 61% in 2019, 53% for data center and virtualization, 24% for Big Data and 21% for cloud technology. The largest gap will be observed for mobility, rising from 46% in 2015 to 62% in 2019, with 46,955 missing FTEs in the labor market in Latin America.

Another challenge is related to improving the workforce digital talent groups in order to provide the market professionals with the necessary skills to fulfill the existent and forecasted gaps. To address these skills gaps there exist some approaches that stand out as possible ways to improve the digital talents in Brazil.

Companies may also receive incentives to provide training in information and communication technology solutions. Thus, courses related to the structure and design of data networks and telephony could be taught with the objective of encouraging the qualification of professionals to work in the technology market.

INATEL and SENAI, in partnership with companies, could act to provide preparatory courses for recognized professional certifications and aligned with the main practices of the ICT sector.

(i) Industry Academia Collaboration (IAC)

To promote the convergence and synergies between government, companies and education institutions it is possible to use the model of Industry-Academia Collaboration (IAC). The main benefits of this model are:

A. Industry-relevant graduates are produced and aligned to the ICT Industry;
B. Structured practical attachment for undergraduates through mentored real-life projects by the industry;
C. Enhancement of skills of faculty members in the delivery of industry-relevant ICT curriculum;
D. Development of soft skills such as critical Problem Solving & Entrepreneurship skills.
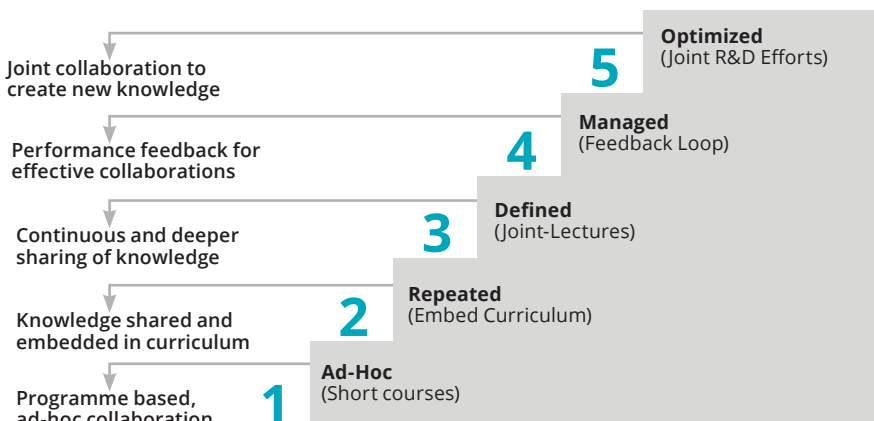
To achieve the objectives of the IAC program, there are some initiatives that must be followed. These are:

a. Train-the-trainer (TTT) programs at collaborating institutions of higher education;
b. Collaboration to embed industry-relevant modules into the present curriculum;
c. Collaboration on providing final year students with industry projects
d. Involvement of industry subject matter experts as guest lecturers to run industry relevant modules and mentor the students
e. Incorporation of key industry modules into the academic curriculum
f. Industry exposure via experimental learning programmes
• Industry supported/lead competitions
• Technology conferences
• Workshops
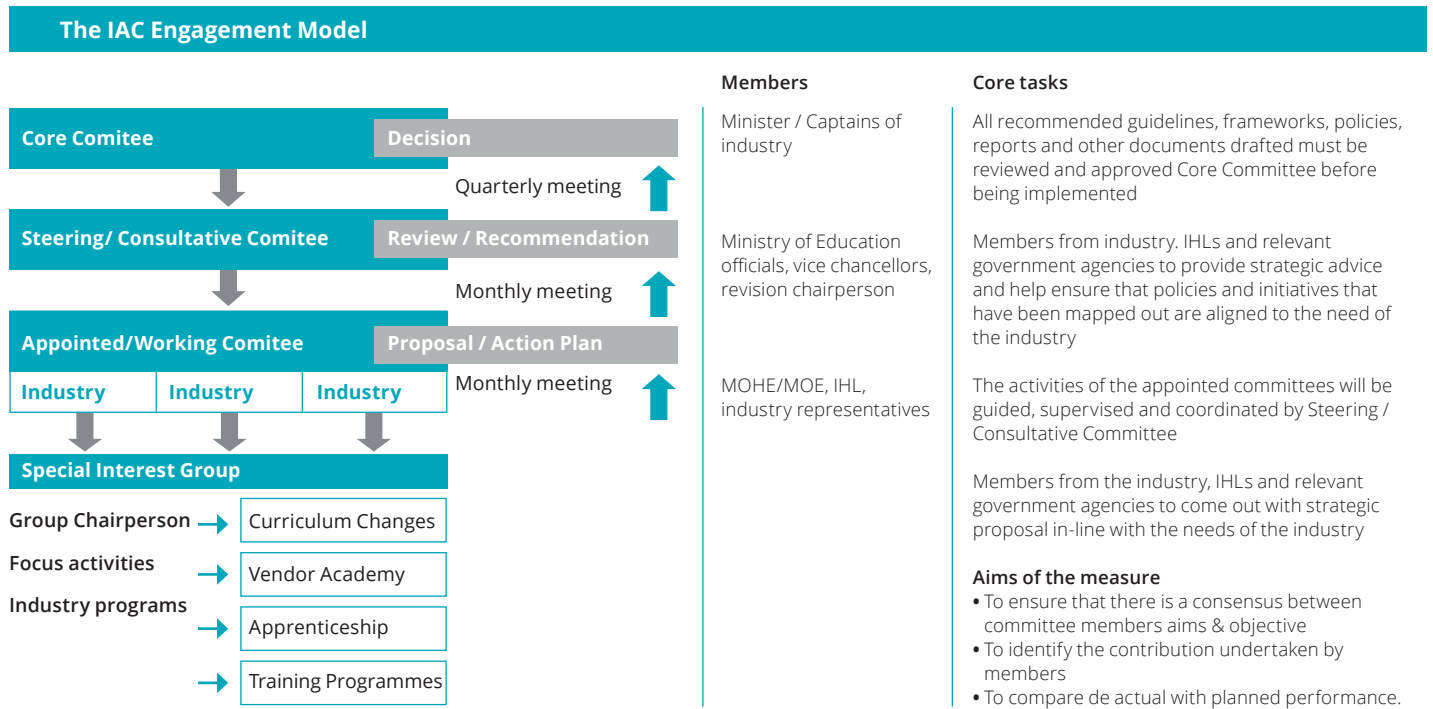• Industry exposure series
• Customized internship programmes

In this way, using the IAC it is possible to identify the synergies between supply and demand. The industry drives the development and the specialization of the workforce according to its demands, while the Academia response is direct, generating value for the country.

Therefore, by facilitating this partnership, tech companies and professional associations could provide courses, internships, scholarships, accreditations in order to train the workforce for the digital ecosystem. To ensure education remains job-relevant, it is crucial to collect insights from government, academia, businesses, and society in the curriculum design process. This collaborative initiative has to emphasize entrepreneurship as part of the curriculum to bring innovation to the market.

Setting the standards for effective industry academia collaboration

Joint collaboration to create new knowledge

Performance feedback for effective collaborations

Continuous and deeper sharing of knowledge

Knowledge shared and embedded in curriculum

Programme based, ad-hoc collaboration

5 Optimized (Joint R&D Efforts)

4 Managed (Feedback Loop)

3 Defined (Joint-Lectures)

2 Repeated (Embed Curriculum)

1 Ad-Hoc (Short courses)

Industry and IHL (International humanitarian law) needs to collaborate to progress through the maturity model

The IAC Engagement Model

			Members	Core tasks
Core Comitee		**Decision**	Minister / Captains of industry	All recommended guidelines, frameworks, policies, reports and other documents drafted must be reviewed and approved Core Committee before being implemented
		Quarterly meeting		
Steering/ Consultative Comitee		**Review / Recommendation**	Ministry of Education officials, vice chancellors, revision chairperson	Members from industry. IHLs and relevant government agencies to provide strategic advice and help ensure that policies and initiatives that have been mapped out are aligned to the need of the industry
		Monthly meeting		
Appointed/Working Comitee		**Proposal / Action Plan**		
Industry	Industry	Industry — *Monthly meeting*	MOHE/MOE, IHL, industry representatives	The activities of the appointed committees will be guided, supervised and coordinated by Steering / Consultative Committee
Special Interest Group				Members from the industry, IHLs and relevant government agencies to come out with strategic proposal in-line with the needs of the industry
Group Chairperson →	Curriculum Changes			
Focus activities →	Vendor Academy			**Aims of the measure**
Industry programs →	Apprenticeship			• To ensure that there is a consensus between committee members aims & objective
→	Training Programmes			• To identify the contribution undertaken by members
				• To compare de actual with planned performance.

(ii) SENAI: Education, companies and industry together[49]

The National Service for Industrial Apprenticeship (Serviço Nacional de Aprendizagem Industrial, SENAI) is an example of investment in education applied to the industry capacitation needs. It functions on the Brazilian territory and it is legally constituted as an institution of private character managed by representative entities from the industry and supervised by Federal authorities. SENAI is maintained by social contribution from industrial and agro industrial companies, which collect 1% of the total payroll of their employees.

This organization plays an important role in developing education applied to industry, in training and offering technical services and technological support, disseminating productive and organizational technologies. SENAI is present in 2,7 thousands cities in Brazil with 109 thousand technical and laboratory services performed and 504 mobile units. Moreover, it has 8 professional training centers abroad, as well as an environmental technology center.

On education, SENAI develops professional training programs, meeting the demands of the Brazilian industrial workforce considering the specificities of each region of the country. It acts on the three levels of vocational education – basics, technical and technological. Its courses prepare young people for their first job and provide further education for professionals who are already on the labor market. Related to professional qualification, SENAI has formed more than 64.7 million workers since 1942.

In 2015, SENAI did some actions to education quality as curriculum update, curriculum actualization, adoption of new education technologies, continuing teacher training and improving school management. In that year, SENAI had more than 3.4 million enrollments in courses of initial and continuing training, mid-level technical and higher education courses. Moreover, SENAI offers some classroom and distance ICT courses related to telecommunication and information technology.

In addition to professional education, SENAI also supports the competitiveness of the Brazilian industry, through the network of SENAI Institutes of Innovation and Technology. With infrastructure and trained professionals, the network develops innovative products and processes. By 2017, industry service expanded with the creation of 26 innovation institutes and 61 technology institutes.

Contributing to the Brazilian industry, SENAI has created the SENAI Institutes of Innovation (ISI) that will act on large, medium and small companies. In large companies they will facilitate research and development projects and in medium and small companies they will stimulate innovation initiatives and the formation of technology parks. The initiative has partnerships with the Fraunhofer Institute in Germany and the Massachusetts Institute of Technology (MIT) in the United States.

Recommendations

Inserting business in the education system brings the dynamics of the digital transformation to highlight the capabilities required by the market.

Innovations are key for the digital world, thus Brazil should have mechanisms to stimulate and protect the intellectual propriety as well as the changes it imposes. The IAC model, the financial and professional recognition of teachers and professors, as well as local innovation and patent process innovations are important factors that must be taken into consideration in the development of the ICT Digital talent strategy for the digital era.

Distance learning (EAD) has been an alternative for Brazilian qualification. In recent years, there has been a significant increase in the number of universities that offer undergraduate, postgraduate and specialization courses on online channels. This increase shows the trend of change in the behavior of the Brazilian population. People are increasingly seeking specializations given the high competitiveness of the labor market. However, companies and industries still find it difficult to find qualified workers with the required level of knowledge.
The ICT sector has favored and has the potential to continue fostering distance education in Brazil, once through mobile devices people can have access to various types of content and sources of information. Greater network connectivity and construction of teaching platforms with basic content can generate several benefits for populations in peripheral areas.

Also with regard to the development of digital talent, women have been gaining their space and are increasingly present in the ICT sector contributing in all aspects, both technical and management. It is essential that gender equality initiatives for all sectors, including ICT, to be considered and put into practice.

According to the GSMA, presented in the Panel Telebrasil 2018, when comparing the possession of a smartphone between men and women the research indicates that a woman is 15% less likely to have a smartphone in Brazil. To change that numbers initiatives such as the "International Day of Girls in ICTs", which seeks to engage girls to develop their careers in the sector, are essential and should continue to be realized.
Regarding the Brazilian scenario, the professional of the future must be idealized. Talent becomes a cross-element that involves the development of infrastructure and the deployment of new applications. Investing in education, skills, and trainings results in new perspectives for innovation, key element for responding to the dynamics of the market. The professionals of the digital era learn how to learn and, as they incorporate new skills, the boarders of competitiveness expand.

Brazilian Government initiatives and improvements

As part of Brazil's concern to address the education matter, the government has already included in its agenda education reforms, for instance the Economic and Social Development Council ("Conselho de Desenvolvimento Econômico e Social" - CDES) and the National Common Curricular Base ("Base Nacional Comum Curricular", BNCC) [50].

CDES: Recommendations of the Working Groups of the Council		
	Basic Education	National Policy for Teacher Training: Implement a national policy for initial and continuous training for teachers and managers, focusing on practice, valuing motivational aspects, interpersonal skills and leadership, articulated to careers through national certification and establishment of promotion on meritocratic bases.
		Innovation-Education Connected Policy ("Política de Inovação Educação Conectada"): Launched on 2017, it has the objective to universalize access to high-speed Internet in schools, complemented by the development of a digital culture, which includes: skills, content, tools and platforms, with the goal of training the citizen of the 21st century. Partnership between Ministry of Education (MEC) and Ministry of Science, Technology, Innovations and Communication (MCTIC).
		Intersectorial Committee on Public Policies for Early Childhood: Coordinate, through an interministerial instance, the execution and monitoring of the Legal Framework for Early Childhood (Law 13,257 / 2016), encouraging the implementation of a pact between Federal, State and Municipal Governments, that will enable its effective action.
	Employability in Brazil of the 21st century	Include in the composition and commissions of the National Education Council (CNE) representatives of the business sector indicated by their representative entities, in order to adapt the training to the needs of the labor market, stimulating the same practice in the State and Municipal Councils of Education EECs and CMEs).
		Promote regional development, based on local vocations, acting in an integrated and subsidiary way to the municipal and state responsible, in order to boost the local economy and generate quality jobs, supporting the technological improvement of the workforce to meet the demand.
		Prioritize basic education through efficient budget allocation and management, establishing quality indicators, with the objective of eradicating illiteracy and equating Brazil's performance with the best educational systems in the world.

Although some recommendations have already been addressed, new policies ought to improve teaching environment in line with the digital era. Innovation has to be incorporated in the classroom supporting the Brazilian future workforce to be part of the innovation of the digital environment.

Among CDES taskforce recommendations, some topics have to be addressed to improve employment rates in Brazil. In order to prepare students for the new economic scenario, educators must be continuously updated about new techniques, technologies, and methodologies to guide students to prepare themselves for the digital environment.
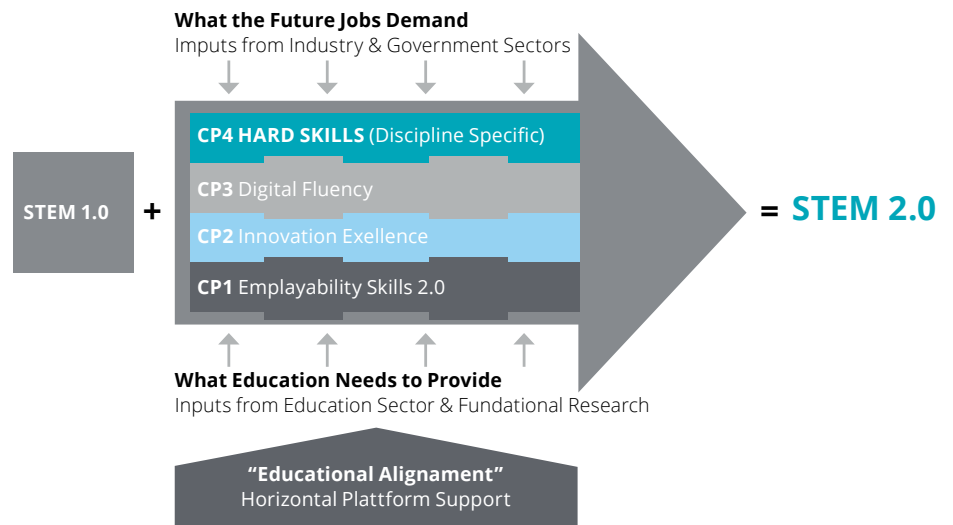
To complement digital talent development, the collaboration between the public and private forces should be considered to bring innovation to the educational system. CDES taskforce suggests the participation of the private sector to define market needs. The private sector could bring the dynamics of market innovation to assist trainings and skills requirements. The Brazilian Academy of Science ("Academia Brasileira de Ciência", ABC) also highlights the importance of initiatives combining academy and business, as mentioned in "Projeto de Ciência para o Brasil" (Project of Science for Brazil)[52].

Collaboration between the public and private sector should be considered to bring innovation to the educational system. In the US, 20% of innovations were collaborations between public-private partnerships, between private companies and universities or government research labs[51].

What the Future Jobs Demand
Imputs from Industry & Government Sectors

STEM 1.0 +

CP4 **HARD SKILLS** (Discipline Specific)
CP3 Digital Fluency
CP2 Innovation Exellence
CP1 Emplayability Skills 2.0

= **STEM 2.0**

What Education Needs to Provide
Inputs from Education Sector & Fundational Research

"Educational Alignment"
Horizontal Plattform Support

Source: STEM2.0: An Imperative for Our Future Workforce. A Publication by STEM connector's Innovation Task Force. June, 2014[54].

In the United States, part of the education system is aligned with the private sector. A national platform, regulated by the labor department, brings together education and private sector to engage students to be aligned with the market needs. The US put in place a system that develops human capital equipped with knowledge and expertise in the fields of Science, Technology, Engineering and Mathematics (STEM). It was improved to STEM 2.0[53] to define and find solutions for future critical career capabilities, beyond a STEM 1.0 education, that is believed to be the base of the workforce preparation to the market. According to the STEM 2.0, there are four capability platforms to the educational ecosystem. These capabilities are:

- Employability Skills: Behaviors beyond technical skills.
- Innovation Excellence: Requires a shift from focusing on solving complex technical problems to defining and redefining the right problem before solving it and doing this in the context of the market and business environment of the future.
- Digital Fluency: Application of STEM learnings to specific "real world" problems through digital technology.
- Hard Skills: Industry-specific skills that should be mastered by students to excel in new careers in industries

In Brazil, according to the OECD, the youth has low performance in reading, mathematics and science when compared to others countries. This result reinforces the need for improvement in education related to basic knowledge, as well as the development of other skills that are still not included in the curriculum, but are essential for the jobs of the future.

Malaysia Education Blueprint 2015-2025

In 2013, the Malaysian Ministry of Education began developing the Malaysia Education Blueprint 2015–2025 (Higher Education) or the MEB (HE). This document offers a vision of the education system and students that Malaysia needs, suggesting strategic and operational shifts to achieve the national education goal.

The objectives of the program were: understand the current situation (performance and challenges); stablish a clear vision and aspirations (access, quality, equity, unit and efficiency); and outline a program for the education system.

To achieve these system and student aspirations, the MEB (HE) outlines 10 Shifts that address key performance issues in the system, particularly with regard to quality and efficiency, as well as global trends that are disrupting the higher education landscape

Strategies and initiatives of the 10 Shifts were distributed in a roadmaps across three waves.

The first wave focused on establishing the building blocks for the transformation; the second wave introduced more structural improvements to accelerate the pace of change; and finally, the third wave strengthened the global prominence of Malaysia's higher education system.

The MEB highlighted the effort of the Malaysian government in order to improve and transform its education, creating a specialized workforce that will be capable to join the labor market with relevant skills to the development of the ICT Sector.

Source: Malaysian Education Blueprint 2015-2025 (Higher Education). Ministry of Education Malaysia, 2015. Available in: http://www.padu.edu.my/about-the-blueprint/history-of-meb/

"One of the greatest educational challenges for the digital era is the reskilling of current workers, so that they can successfully switch to new professions that arise. Finding out appropriate training curriculum and delivering it, is mandatory to building a solid workforce."

Osvaldo Lahoz Maia
SENAI

6. Final remarks

This study assessed the relevant challenges to build up the ICT foundations for Brazil. The main points addressed relate to bottlenecks in the deployment of infrastructure, development of services applications, and trainings of digital talents.

To address such challenges, this report proposes an assessment of 5G-ready, optical fiber, and cloud computing as infrastructure enablers for the country development. Moreover, it highlights the concept of safe city as an application to be conceived once the basic elements of the ICT infrastructure are deployed. Finally, it reinforces the importance of the right training of workforce with skillsets that can support the development the Digital Ecosystem in Brazil.

For each of these five pillars, Deloitte identified the barriers to its development and suggested specific actions for the government to overcome the existing challenges. With regard to infrastructure facilitators, the Brazilian government needs to ensure the successful transition to 5G technology by 2022 through the promotion of synergy of basic infrastructure (3G, 4G and 4.5G), optimization of spectrum standards, debureaucratization of the installation process of antennas, development of fiscal incentives and habilitation of a new ecosystem of IT and telecommunications.

In addition, to increase connectivity and improve optical fiber coverage across the country, the government needs to consider adopting the dig-once policy that requires construction project planning for optical fiber deployment, right of way facilitation, the promotion of synergy of infrastructure between the distribution of public services and the optical fiber network, and improvement of the FUST management.

Another important aspect to the success of the country's digital transformation is the migration to the cloud environment. There is a need to stimulate the expansion of public services provided through the cloud, to attract data centers to the national territory, elaborate regulations on data privacy and create a legal environment favorable to cloud services through fiscal incentives. In terms of enforcement, the government needs to encourage the adoption of safe city solutions across the country, which would help reduce the crime rate and violence in large cities. To this end, the government's focus should be on investment in intelligent solutions based on facial recognition, artificial intelligence and big data, as well as the creation of technology standards and a unified strategy between the three spheres of government that allows integration and collaboration of public and private actors.

The successful future development of the ICT sector cannot be achieved without professionals with a multidisciplinary set of skills appropriate for the digital age. Promoting collaboration between government, the private sector and educational institutions, aligning the educational curriculum with the demands of the ICT sector, stimulating research and creating incentives for the creation of patents are crucial aspects for improving the workforce and reducing the existing skills gap.

The ICT sector is the catalyst of further development of other sectors of the economy. The environment generated by the Digital Ecosystem creates opportunities for innovation and new business models that may make the economy more dynamic to respond to changes. Information and communication technologies ought to be exploited as an asset for competitive advantage that allows the optimization of processes, the interconnection of unexplored organization's silos, and the generation of a new system that integrates people, businesses, and things, shifting from the concept of traditional value chain economic perspective.

Brazil has already changed its agenda to address some of the key elements for ICT development, and can make a strong move to become a major player and positive influencer for Latin America. However, this depends on the specific actions of the government and requires discipline in the execution, as well as coordination and cooperation between all parties involved: public, private and academic sectors.

Appendix

Methodology

This study about Digital and ICT Opportunities for Brazil begun with the assessment of the potential of the digital transformation in Brazil and with the analysis of previous studies and projects already conducted by the government (for example, e-Digital). The objective of this report aims at designing a tactical approach to the main barriers for Brazilian ICT development, identified during the phase of assessment.

To better comprehend the variables associated, the project was subdivided into subset components of the digital ecosystem, which were related to infrastructure investments, policies and regulations, skills and trainings. The analysis of each initiative was conditioned to the discussion of strategical, operational, and tactical level, approaching supply, demand and governance dimensions. Additionally, selected benchmark cases were cited to strengthen the thesis.

The project team conducted interviews, workshops and panels to enrich the discussion over the topic. As the team transited within different sectors and was exposed to different segments of society, they collected contrasted point of views, which enriched the discussion and maintained Deloitte's neutrality and independency over the topic.

The discussions among public, private, and academic sectors were marked by the proactive participation of all entities, facilitating an exchange of knowledge on the respective subject matter. As a result, the Deloitte's group assessed government initiatives in place related to the digital economy, envisioning a coherent a tactical approach.

All interviews as well as the report elaboration and writing were conducted, build and concluded in 08 weeks. These interactions intended to identify the most relevant topics for the digital transformation strategy for Brazil, as well as the identification of priority strategic actions. Thus, some topics justified more attention, such as 5G ready, broadband, cloud computing, safe city, and talent.

With the collaboration of all stakeholders, the report was settled and consolidated to enrich Brazilian agenda over the digital transformation, proposing an active regard to address the innovations yet to come.

Notes

1. The OECD definition establishes the criteria for manufacturing for the companies that intend to fulfill the function of information processing and communication including transmission and display; using electronic processing to detect, measure and/or record physical phenomena or control a physical process. Services are considered as those activities that enable the function of information processing and communication by electronic means. For further details, see OECD "Annex 1 – The OECD Definition of the ICT Sector" from Measuring The Information Economy (2002).

2. The compound annual growth rate (CAGR) measures the average annual growth over a specific period of time, calculated as the division of the value at the end of the period by its value at the beginning of the period, raised to the power of one divided by the number of periods.

3. The list of LDCs is defined by the UN based on three criteria: per capita income, human assets and economic vulnerability. Currently, there are 47 countries listed as LDCs. (http://unctad.org/en/pages/aldc/Least%20Developed%20Countries/UN-list-of-Least-Developed-Countries.aspx)

4. The Global Connectivity Index classifies countries as starters, adopters and frontrunners.

5. A deeper analysis regarding the variables time series could statistically prove the co-integrated behavior of both series.

6. Teleco is a website that consolidates news, databases and analysis related to the Brazilian telecommunicationss sector. It is composed by telecommunicationss' professionals that also act as consultants.

7. The fixed assets are basically machinery, equipment and construction material. In Portuguese "Formação Bruta de Capital Fixo" is estimated quarterly by IPEA (Applied Economy Research Institute).

8. For more details related to the National Plan of IoT please check the BNDES website, where is possible to find all deliverables of the project. Link: https://www.bndes.gov.br/wps/portal/site/home/conhecimento/pesquisaedados/estudos/estudo-Internet-das-coisas-iot

9. https://www.gsma.com/futurenetworks/wp-content/uploads/2015/01/Understanding-5G-Perspectives-on-future-technological-advancements-in-mobile.pdf

10. State tax on the circulation of goods and services in Brazil

11. http://www.teleco.com.br/precos_pais.asp

12. Global Mobile Consumer Survey – GMCS

13. Brazilian Strategy for Digital Transformation, e-Digital

14. A robust Right of Way (RoW) rules, uniformly applicable across the country, simplify and streamline the process of RoW approvals. With regard of laying optical fiber cables, the process of licensing shall become easier.

15. The GCI's S-curve shows 50 nations' progress in digital transformation, grouping them into three clusters based on their GCI scores: starters, adopters, and frontrunners. Further details of the CGI can be found in Chapter 2 of this report.

16. The Matthew effect of accumulated advantage can be briefly summarized as "the rich get richer and the poor get poorer".

17. Connecting America: The National Broadband Plan, chapter 6 - Infrastructure

18. Executive order: Accelerating broadband infrastructure deployment, United States Department of Transportation, Federal Highway Administration, Office of Policy and Governmental Affairs – Successful practices of broadband deployment in highway rights of way: Summary paper (2013)

19. Connectivity Plan, San Francisco Department of Technology, City & Council of San Francisco.

20. The data utilized in this example was extracted from the U.S. Department of Transportation, Offices of Assistant Secretary for Research and Technology, regarding the U.S. states of Florida.

21. Values may vary if fiber optic is also deployed with the conduit infrastructure.

22. OECD (2006), "Rethinking Universal Service for a Next Generation Network Environment", OECD Digital Economy Papers, No. 113, OECD Publishing

23. Directive 2002/22/EC of the European Parliament and the Council (March 2002), annex V

24. US Telecommunicationss Act of 1996, "to promote competition and reduce regulation in order to secure lower prices and higher quality services for American telecommunicationss consumers and encourage the rapid deployment of new telecommunicationss technologies."

25. Decree 6424 (2008) - PGMU

26. Broadband at School Program, MEC, available at http://portal.mec.gov.br and http://www.brazilgovnews.gov.br

27. Digital Government, available at: https://www.governodigital.gov.br

28. Digital Cities Program, available at www.brasil.gov.br

29. Brazilian National Broadband Plan, available at http://www.anatel.gov.br and http://www.brasil.gov.br/

30. Broadband in Brazil: a multidisciplinary public sector approach to digital inclusion, Information for Development Program – The International Bank for Reconstruction and Development, The World Bank.

31. 2010 Population Census represents the last data collection conducted by IBGE.

32. Resolution 527 (2009), Regulation for the use of Power Line Communications (PLC) Technologies.

33. ESB is Irelantd's energy company, comprising power generation, networks, and supply of electricity.

34. Vodafone Group is a telecommunications provider with a wide range of services operations, including voice, messaging, data, and fixed communications.

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39. Data from March 14 of 2018, presented on 3rd Brasscom Seminar on Public Policy & Business.

40. https://cloudscene.com/datacenters-in-south-america

41. Gartner IT Infrastructure, Operations Management and Data Center 2018

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43. This annual study was initiated in 2012 examines the legal and regulatory framework of 24 countries around the world, identifying 72 questions, divided by six main topics - data privacy, security, cybercrime, intellectual property rights, standards and international harmonization and promoting free trade, which are relevant for determining readiness for cloud computing. More detail in: http://cloudscorecard.bsa.org/2018/pdf/BSA_2018_Global_Cloud_Scorecard.pdf

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