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DIGITAL PUBLIC AFFAIRS

AMERICAN TOWER®

New approaches to telecom infrastructure management in Latin America

Report commissioned by
American Tower Corporation

OCTOBER 2021

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#SURFTTHELATAMDIGITALPOLICYSCENE

Authors

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This report, prepared between July and September 2021, has been commissioned by American Tower Corporation.

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Executive summary

The COVID-19 pandemic has had a strong economic and social impact in Latin America, highlighting the technological development gaps and the lack of digital infrastructure in the region.

Less than half of the population in Latin America and the Caribbean has fixed broadband connectivity, which is essential for accessing digital media, both to study and to work. The urban-rural gap and the lack of infrastructure development, mainly in remote areas, aggravated the impact of the pandemic. In this scenario, digital infrastructure has played a key role in the region's economic and social recovery and has helped to maintain daily activities using digital tools and services to meet new demands, such as online learning and remote working among others. To a large extent, conventional activities have had to be adapted using tools that require connectivity.

When compared to the global average, Internet access in Latin America is lagging.

In addition, a key aggravating issue of the digital divide in the region is the significant gap between urban and rural populations.[1] The percentage of households with Internet access in Latin America is 33% in rural areas and 65% in urban areas. This 32-percentage-points gap is higher than in other regions, such as in Europe where it is of 7pp. Besides, 6% of Latin Americans, which accounts for 40 million people, live in areas without Internet access, while 39% (240 million people) have coverage but do not use the service[2].

Over the last decade, network traffic has continually increased and is expected to keep growing exponentially.

The widespread adoption of mobile data services, driven mainly by smartphones, online gaming and high-definition streaming services, has dramatically increased network traffic. The COVID-19 pandemic fueled this trend by introducing changes to residential internet usage. However, the rise of new technologies will multiply the need of connections to support, such as Internet of Things (IoT) services (for example, connected cars), which will require low latency and high reliability services. Likewise, according to estimates by Ericsson[3], with the early irruption of 5G, data traffic will continue to grow steadily in Latin America and, for example, a mobile device will go from consuming 6.9 Gb per month in 2020 to 30 Gb in 2026 (a 31% compound annual growth rate).

1. ITU (2021)
2. GSMA (2020)
3. Ericsson Mobility Report June 2021.

There is a need for infrastructure investments to bridge the regional gap and meet the UN's Sustainable Development Goals (SDGs).
In this regional scenario, which combines the connectivity gap with the expected increase in service demand, there is a significant need for investment in the region. Several regional studies estimate investments in infrastructure will range from 47 billion to 160 billion dollars until 2030. Besides, higher investments in telecommunications has direct and quantifiable impacts on poverty reduction, life expectancy, hunger ending, inequalities reduction and even on cutting down carbon emissions[4].

Network and infrastructure management models at a regional level have been changing in recent years, in line with the international trend.
Since 2019, infrastructure companies have owned more than 50% of sites in the region and traditional network operators have been trading these assets to enable a separate, specialized and more vertically disintegrated management. This strategic change stems from the need to lower deployment and asset management costs, which are not core for providing connectivity services for end users. By the end of 2020, there were over 195,000 communications sites in Latin America, 57% of which belonged to independent infrastructure companies. 5G deployment sets the region on a path towards network virtualization and cloudification, where new players will jump into the infrastructure value chain and where sharing, both passive and active infrastructure, will become fundamental.

However, infrastructure development poses other types of barriers, most notably, administrative barriers.
Today, local authorities or municipalities have constitutional autonomy to grant permits for installing antennas and rights-of-way for fiber laying. This could interfere with the provision of telecommunication and Internet services, which fall under national supervision. In most countries in the region local regulations have prevailed over national or federal regulations, making them very restrictive, non-transparent, bureaucratic and even irrational when it comes to obtaining municipal permits.

Maximizing infrastructure sharing offers several economic and environmental benefits. Infrastructure sharing presents financial and sustainability advantages, enabling the significant deployments that will be required for making 5G possible. Some of these advantages include:

- **More efficient markets.** Infrastructure can be delivered at lower costs, reducing unnecessary duplication of infrastructure.
- **Release of capital for mobile operators.** Tower sales to independent passive infrastructure companies, and no self-deployments, free up capital to invest in existing networks and new services and/or to pay off financial debt
- **Investing to enhance capacity and coverage.** A cost-effective and time-saving implementation in rural areas helps to reduce the digital divide.
- **Market entry simplification.** Operators of other technologies, such as IoT or fixed wireless service, have more options for their infrastructure, which reduces entrance barriers, and can benefit from a neutral *host*.
- **Positive environmental impact** by reducing the carbon footprint through savings in materials, energy and network emissions using existing infrastructure for new deployments and increasing the infrastructure sharing rate.
- **Public benefits.** Infrastructure sharing can reduce visual pollution and unneeded public spending on infrastructure by avoiding unnecessary duplication of networks and multiple civil works.

4. BID, GSMA, FRONTIER (2018)

New network management strategies using infrastructure companies significantly improve the quality of the connectivity and industry development.
According to data by IFC (2021), markets with a more developed infrastructure sector show a positive correlation with other connectivity-related factors, such as coverage, speed, price, access and even market concentration. Reducing the capital tied up in fixed asset investments by converting them into operating costs (transforming CapEx to OpEx) allows companies to release funds to focus on the main differentiating goal of their business, i.e., to improve the range and quality of their services.

Installing a large number of small cells is one of the main challenges ahead.
In the future, deployment costs will be strongly impacted by these cells, as they demand a radical change in the acquisition model for new sites and create the need for agreements with utility companies that have existing lines. As these cells operate at a radio frequency spectrum higher than 6 GHz , with much lower coverage per cell, coordination between telecommunications and Internet companies, dedicated infrastructure companies, owners of street furniture, ducts and public spaces (both national and local) will be key for achieving higher levels of sharing.

The increasing market share of infrastructure companies, and the subsequent increase in infrastructure sharing, improves the use of public space, reduces administrative costs and improves their environmental impact. From today standards, infrastructure sharing is likely to increase by up to 16 percentage points by 2030.
Sharing rates of new sites are expected to rise in the next few years, driven, on the one hand by the growing market share of infrastructure companies (naturally more prone to sharing than mobile network operators), which is expected to reach over 67% for total sites, and, on the other hand, by a higher level of network sharing as public spaces become more easily available and agreements are made with other sectors, such as utilities. If the market share of infrastructure companies were to grow by 10 percentage points by 2030, the overall level of site sharing growth would likely surpass that, at 16 percentage points.

By 2030, more than 550,000 sites are expected to be deployed throughout Latin America.
5G deployment, based on small cells and macro cells in sites with coexisting base station technologies (such as 2G and 3G legacy systems and 4G and 5G stations), demands 4x more sites than the current installed base. The pace of deployment will vary from country to country; 5G spectrum licensing will be the basis for new cell and site deployment on a massive scale[5]. As such, the expected number of sites for each market and likely site growth compared to the 2021 basis is as follows: Argentina: 55,000 (x3.1); Brazil: 240,000 (x3.7); Chile: 24,000 (x2.6); Colombia: 56,000 (x3.2); Mexico: 141,000 (x4.0); Peru: 59,000 (x3.9); Others: 198,000 (x5.5).

The investment, only considering passive infrastructure development by 2030, is expected to reach 17 billion dollars.
This accounts for 3% of Latin American operators' annual revenues, so it would not be a significant figure if they are allocated to more efficient infrastructure models that can meet the demand for passive infrastructure in the face of 5G adoption and IoT growth. It is worth noting that these estimates only consider investments related to passive infrastructure deployments, i.e. excluding active infrastructure, spectrum and operating costs, among others. It is also worth highlighting that 62% of this investment will likely be made by passive infrastructure companies, while mobile operators are expected to invest only 38%. The investment share of passive infrastructure companies will evolve along with their market share, starting under 60% in the first few years and reaching 67% in 2030. With higher investments, the level of infrastructure sharing and market benefits would consequently increase.

5. Different spectrum licensing dates were considered for each country based on public news and market expectations available within the working process for this report. These will also vary depending on the conditions and capacity of existing sites; the momentum of deployment efforts considering environmental, administrative and economic factors; demand evolution for each use case; population density in bigger cities and percentage of urban population, among other factors.

Collaboration and coordination among authorities will be essential to stimulate this growing industry that needs predictability in local government's approval processes for sites installation.

Public policy will have a key role in addressing the challenges to support these new deployments. These challenges require unique coordination efforts among the different levels of government to produce public policies, such as regulations and incentives. Local governments have the opportunity to play a key role in digital transformation, serving the needs of citizens by improving connectivity services, security or street lighting. Becoming a smart city requires intelligent use of city resources (buildings, parks, roads, etc.) and those of utility concessionaires (ducts, poles and masts). These assets ultimately belong to the citizens, who increasingly demand more advanced and better quality connectivity to carry out their activities. Failure to use those assets efficiently represents a lost opportunity cost that developing countries cannot afford.

Intersectoral roundtables and more empowered government regulators for effort coordination.

Some of the recommendations made have already been attempted in the past with mixed results; unsuccessful efforts were generally related to failures in implementation or failures to empower a regulatory entity to carry them through, such as in the case of one-stop shops. Until now, all efforts to engage other sectors have faced challenges and barriers: engaging health authorities[6], for example, could help debunk myths regarding the effects of non-ionizing radiation to the body. At the same time, there is a need for real empowerment of those who drive the agenda at the national level in order to "discipline" the other national vertical and subnational stakeholders. Consequently, in order to achieve agreed-upon and more favorable results, it is essential for national authorities to set up an intersectoral roundtable, where various stakeholders are invited to participate and contribute with measures to support infrastructure deployments, as both local and national development depends on it.

6. According to Russell E. (2020), awareness campaigns organized by mobile operators and industry organizations have had a positive impact, but fail to build trust in the general population, as they are perceived as major stakeholders—they are ultimately seen as for-profit entities acting on behalf of their business interests, irrespective of the truth and accuracy behind the technical content of their campaigns. Thus, government-led campaigns (organized by regulatory agencies or healthcare authorities) are more effective, as they seem to be focused on the greater good.

The COVID-19 pandemic has had a strong economic and social impact in Latin America, highlighting the technological development gaps and the lack of digital infrastructure in the region.

PERCENTAGE OF HOUSEHOLDS WITH INTERNET ACCESS IN LATIN AMERICA

33%
IN RURAL AREAS

65%
IN URBAN AREAS

According to ILO estimates

23M
PEOPLE IN THE REGION WORKED FROM HOME

32M
CHILDREN DID NOT HAVE ACCESS TO ONLINE LEARNING

Network and infrastructure management models at a regional level have been changing in recent years.

INFRASTRUCTURE COMPANIES OWN

+50%
SITES IN THE REGION

SINCE 2019

New network management strategies using infrastructure companies significantly improve the quality of the connectivity and industry development. (IFC, 2021)

4G 65% 75%
4G COVERAGE/POP

- Without infrastructure companies (market share <50%)
- With infrastructure companies (market share >50%)

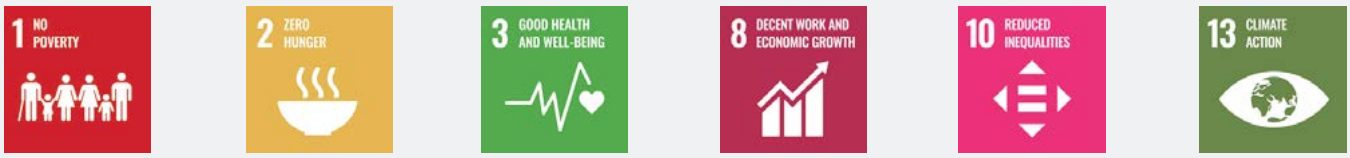
3,1 5,3
MOBILE INTERNET SPEED (MBPS)

4302 3722
MOBILE MARKET CONCENTRATION (HHI)

9% 8%
MOBILE INTERNET PRICE (GNI % PER CAPITA)

36% 39%
MOBILE INTERNET PENETRATION (% POP.)

Several studies show the need for infrastructure investments to bridge the gap and meet the UN's Sustainable Development Goals (SDGs).



Higher network densification, with a larger number of small cells, is one of the main challenges ahead.

LOCAL BARRIERS FOR INFRASTRUCTURE DEPLOYMENT

- Administrative barriers
- Regulatory barriers
- Environmental and health-related barriers
- Technological barriers

By 2030, infrastructure companies will hold over 67% of regional sites, accounting for an increase of 16 percentage points in infrastructure sharing.

Market share of passive infrastructure companies

+10PP

57% (2021) → 67% (2030)

Sites with infrastructure sharing

+16PP

34% (2021) → 50% (2030)

Measures to encourage telco infrastructure deployments

Relevance/Impact (+ / −)

- Infrastructure regulations
- One-stop shop
- Positive administrative silence
- Use of government-owned lands and buildings
- Best practice codes/guidelines
- Ranking (cities)

By 2030, more than 550,000 sites are expected to be deployed throughout Latin America

ARG	55,000 (X3,1)	COL	56,000 (X3,2)
BRA	240,000 (X3,7)	MEX	141,000 (X4,0)
CHL	24,000 (X2,6)	PER	59,000 (X3,9)
OTHERS	198,000 (X5,5)		

The investment, only considering passive infrastructure deployments by 2030, is expected to reach 17 billion dollars.

	USD MILLIONS	% of total investment
ARG	792	4,7%
BRA	4.490	26,9%
CHL	411	2,5%
COL	870	5,2%
CRI	520	3,1%
MEX	3.346	20,0%
PRY	81	0,5%
PER	2.209	13,2%
OTHERS	3.995	23,9%

BY ALLOCATING THE EQUIVALENT TO 3% OF THEIR ANNUAL INCOME TO MORE EFFICIENT INFRASTRUCTURE MODELS, OPERATORS COULD MEET PASSIVE INFRASTRUCTURE DEMAND UNTIL 2030.

Cooperation and coordination between authority tiers will be key to boost industry development. Main focus points:

REGULATIONS

- National-municipal coordination
- One-stop shop
- Positive administrative silence
- Active, passive and carrier neutral infrastructure sharing
- Expedited process for smaller infrastructure

INCENTIVES/ ADVOCACY

- Use of existing infrastructure
- Ranking of Internet-friendly cities
- Citizen perception
- Tax incentives

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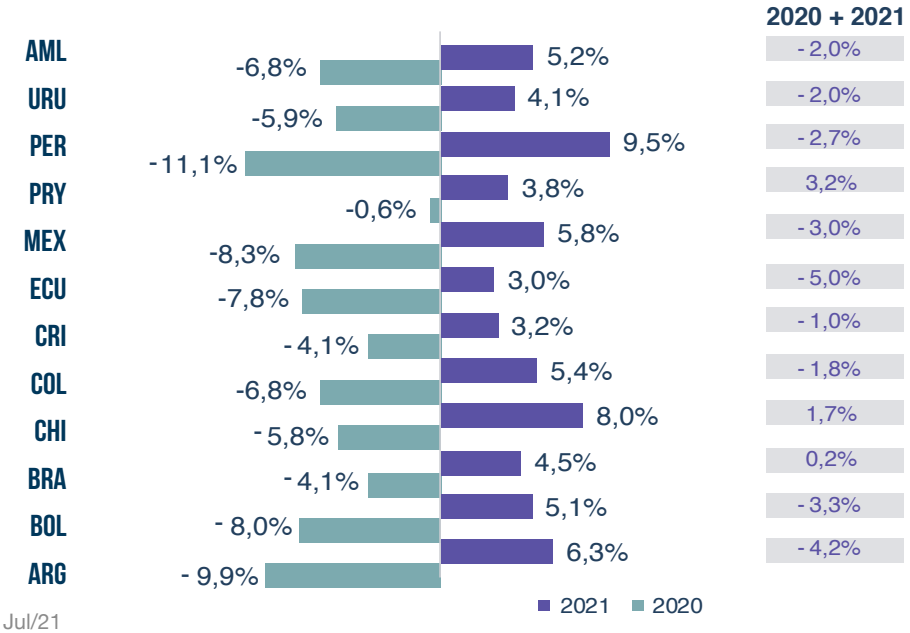
Introduction

The COVID-19 pandemic and the role of the connectivity infrastructure

The COVID-19 pandemic has had a strong economic and social impact in Latin America, highlighting the technological development gaps and lack of digital infrastructure in the region. Less than half of the population in Latin America and the Caribbean has access to fixed broadband connectivity, which is essential for accessing digital media, both to study and to work. The urban-rural divide and the lack of infrastructure development, mainly in remote areas, has aggravated the impact of the pandemic.

The economic contraction in 2020 resulted in the closure of a great number of micro, small and medium-sized enterprises and the destruction of production and human capabilities. This is reflected in the 6.8% drop in Latin America and the Caribbean's average GDP, in real terms, in 2020 (according to ECLAC estimates). By 2021, regional GDP is expected to grow by 5.2%, which will not be enough to return to 2019's pre-pandemic standards.

FIG 1.
GDP growth rate in 2020 and projections for 2021 (%)



Source: ECLAC Jul/21

During the first three quarters of 2020, and as a consequence of the containment efforts of the health crisis, labor force participation and employment rates in Latin America and the Caribbean contracted sharply. At the same time, the unemployment rate increased by almost 5%, at its highest in more than a decade (ILO, 2021).

In this scenario, digital infrastructure has played a key role in the region's economic and social recovery and has helped to maintain daily activities using digital tools and services to meet new demands, such as online learning and remote working, among others. To a large extent, conventional activities have had to be adapted using tools that require connectivity. New approaches to work, education, commerce and healthcare services, among others, have emerged to avoid social contact and enable the continuity of essential activities.

FIG 2.
Digital tools and services for business continuity during the COVID-19 pandemic

REMOTE WORK
Employees use online platforms, such as Google Meet, Microsoft Teams, Webex, Zoom, etc.

ONLINE LEARNING
Students use learning-dedicated platforms.

TELEHEALTH
Remote medical care, diagnosis and follow-up sessions.

E-COMMERCE
Demand for products and digital transactions have significantly increased. For example, MercadoLibre sales doubled in the last year.

E-GOVERNMENT
Virtualization of in-person processes, use of digital signatures, service portals, assistance bots, etc.

According to ILO estimates, 23 million people in the region worked from home, a 20-30% increase based on pre-pandemic levels.

More than 32 million children in the region did not have access to online learning solutions.

To ensure these digital tools and services enable the continuity of different activities, coverage is essential, together with a quality connection in terms of speed and latency. Internet access was declared a Human Right by the United Nations (UN) Assembly in 2011 and is considered a fundamental right under the laws of several countries.

The challenge of bridging the digital divide must be approached in a manner similar to the extension of the running water network or the electrification efforts in the 19th century: as an essential means for development. It will also be key to building more equitable and inclusive societies and, overall, to improving living conditions in terms of education, employment, public services and entrepreneurship.

In addition to this challenge, we are in the midst of what is known as the Fourth Industrial Revolution, which involves the automation of productive and industrial processes and practices, as well as a paradigm shift in the organization of the social and economic life through the use of new technologies such as big data, artificial intelligence, blockchain, cloud computing, 3D printing, virtual or augmented reality, and the Internet of Things (IoT), among others.

We are therefore witnessing a digital transformation which cuts across all activities.

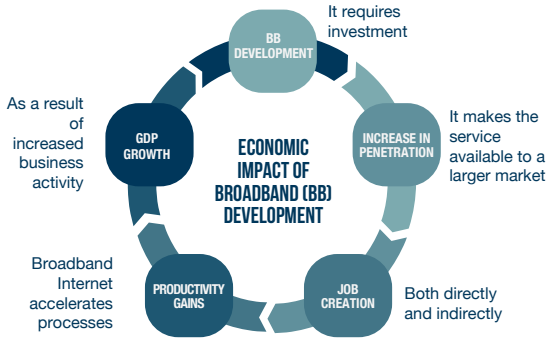
In this context, connectivity is the foundation for this transformation and for the exchange of the enormous data flows generated by everything being connected. To enable the connectivity of both people and things, and better decisions based on big data, it is necessary to have a suitable infrastructure to support this growing demand for connectivity.

In Latin America, this demand is especially significant given its chronic infrastructure deficit in all areas—transportation, logistics, healthcare and even telecommunications—and it represents a major barrier for development and growth.

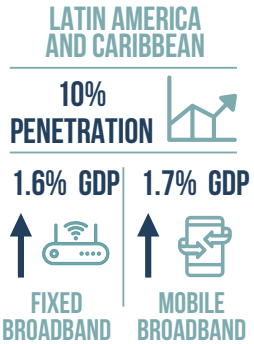
Connectivity infrastructure and the consequent increase in Internet access mitigate the cost of non-connectivity that is limiting the region's development. The economic effects of connectivity infrastructure deployments and service provision are classified as follows:

(I) DIRECT: job creation related to network deployment.
(II) INDIRECT: improved productivity as a result of more efficient processes.
(III) INDUCED: new business activities and enterprises created by increased access to information and technology deployment.

FIG 3.
Correlation between broadband network deployment and GDP

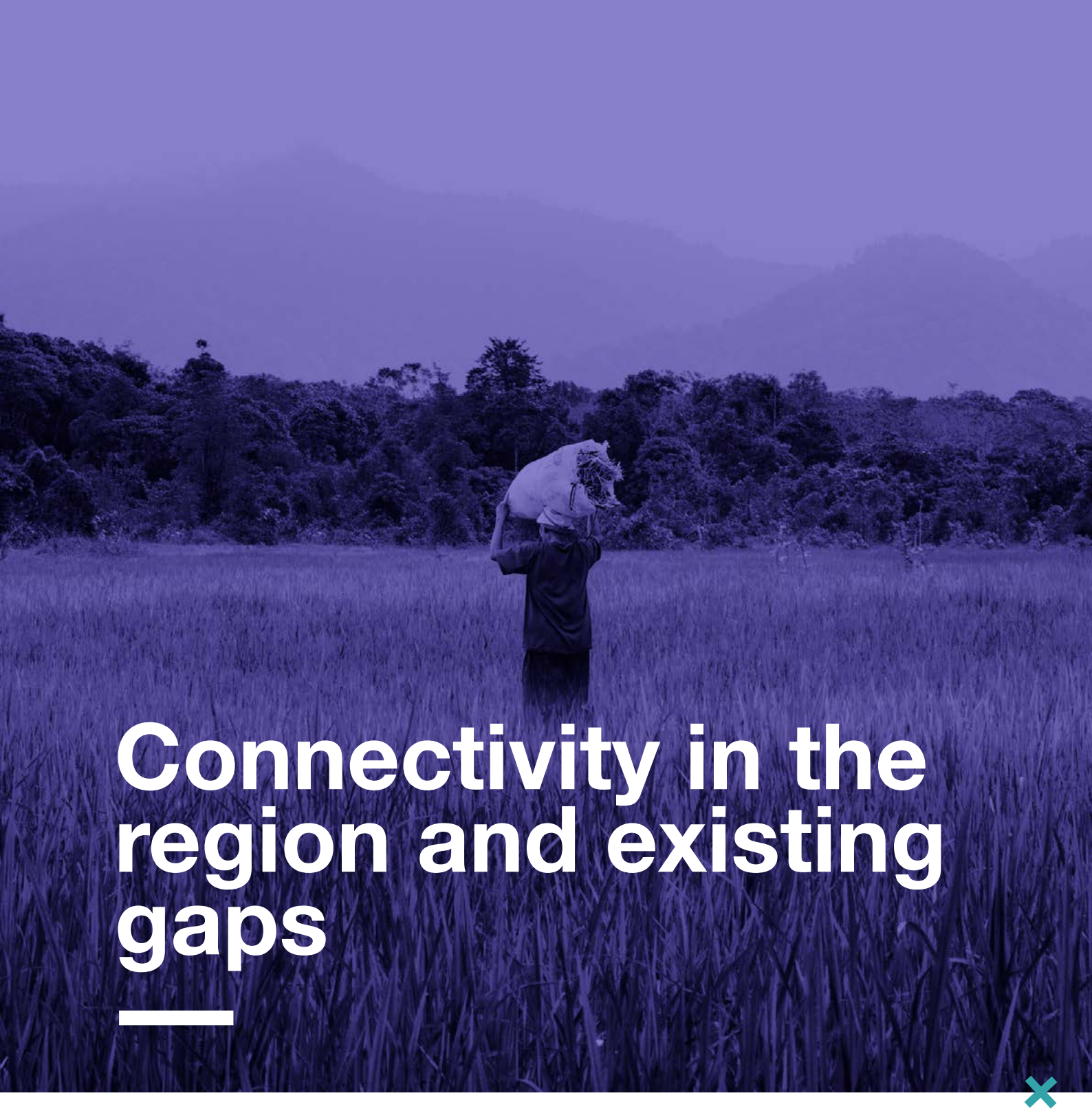


Source: SmC+ analysis based on CAF "Broadband Expansion"



Source: SmC+ analysis based on 2020 ITU Digital Trends

According to recent ITU studies (2021), which take into account all these evidence-based developments, a 10% rise in mobile and fixed broadband penetration in Latin America and the Caribbean would result in a 1.7% and 1.6% GDP increase, respectively. This correlation analysis reflects, unequivocally, that connectivity infrastructure has become fundamental to the functioning and development of an economy and its social and cultural activities. In any case, as will be illustrated in the following chapter, Latin America faces enormous challenges ahead, mainly stemming from the significant digital divide that marginalizes a large proportion of its population and which will require significant policy coordination and investment efforts.

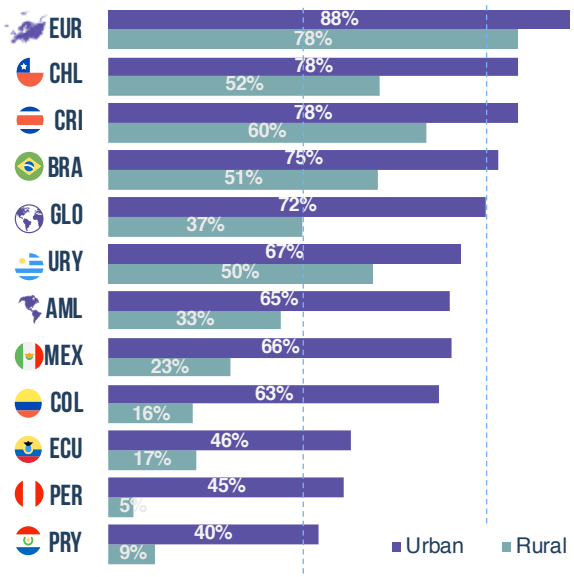


Connectivity in the region and existing gaps

The connectivity gap in Latin America

According to the latest ITU statistics (2021), corresponding to 2019, Latin American countries have a level of internet access which is lower than the global average. In addition, and including a component that aggravates this reality in the region, when talking about the digital divide, it is important to differentiate the situation between urban and rural populations.

FIG 4.
Percentage of households with Internet access in 2019



Note: Argentina is not included since data for rural areas are not available and urban area data refer to 2016 and 2017.
Source: ITU ICT Indicators Database (2021)

The percentage of households with Internet access in Latin America is 33% in rural areas and 65% in urban areas. This gap between urban and rural coverage is larger than in other regions (32pp in Latin America[7] vs. 7pp in Europe).

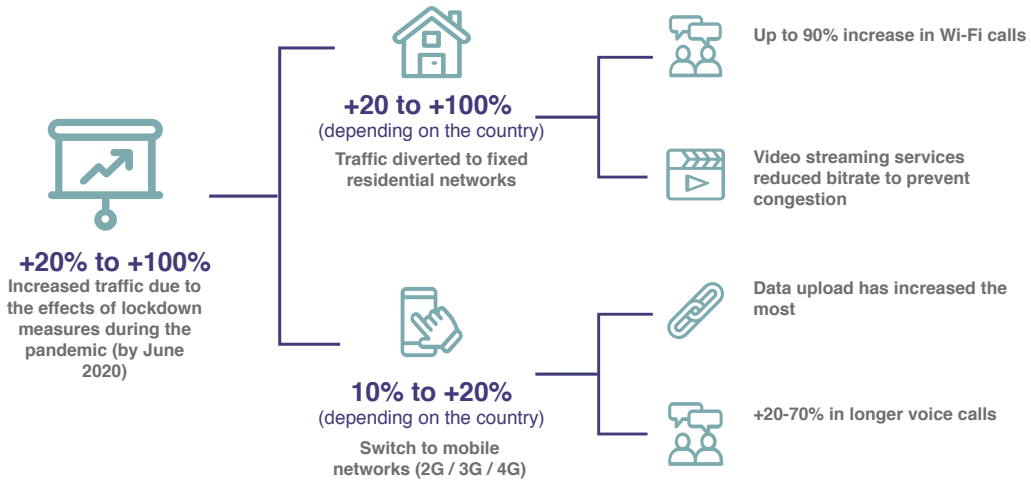
To understand the significance of the multifaceted challenge we are facing, it is worth considering a GSMA analysis (2020) which has determined that 6% of the Latin American population, equivalent to 40 million people, lives in areas without service coverage and that 39% of the region's population, that is, 240 million people, lives in areas with coverage but does not adopt the service. This distinction is key in order to better understand the causes of the gap, as being mainly attributable to three reasons: problems to access the service or devices, lack of relevant local content, or lack of skills to use and take advantage of it.

The pandemic and its impact on network traffic

Over the last decade, network traffic has experienced constant growth as a result of the significant adoption of mobile services in data consumption, the use of smartphones, online gaming and high-definition video streaming, among other factors, and will continue to grow exponentially. However, traffic increase changed the dynamics and took a visible leap during the COVID-19 pandemic. According to Telegeography, international bandwidth in Latin America and the Caribbean grew 32% in 2020, 5 percentage points higher than expected[8]. Lockdown's limited mobility resulted in an increase in the use of remote working, online learning, video applications, among others, causing the Internet consumption pattern to shift from mobile networks to fixed (residential) networks. Data growth in this period has increased from 20% to 100% depending on the country, according to Ericsson's estimates (see figure below), leveraged mainly by the increase in traffic absorbed by fixed residential networks, the longer duration of mobile calls, among others, which only returned to normal consumption levels of previous years by September 2020.

7. Based on ITU data, without specific details for Latin America, the region's penetration was estimated on the basis of the weighted average with the population of the countries in the region.
8. Refer to Lacnic (2020), Strong Growth of Broadband Due to the Effects of the Pandemic, October 2020.

FIG 5.
Increased traffic due to the effects of the lockdown measures during the pandemic



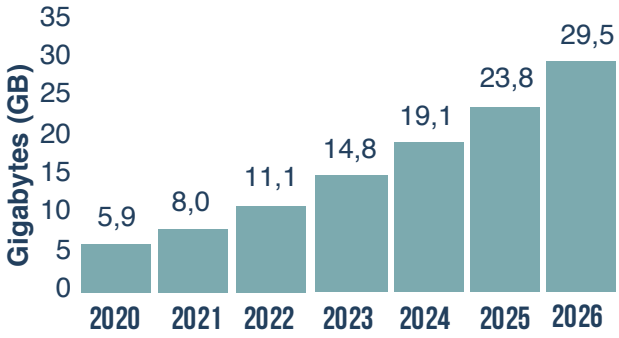
Source: SmC+ analysis based on Ericsson's "The Lockdown Effect" (June 2020) and LATAM regulators

The advent of new technologies such as 5G will lead to a proliferation of connections to support, among others, Internet of Things (IoT) services and low latency and high reliability services, such as connected cars and massive broadband. According to GSMA, 1.3 billion IoT connections are expected by 2025.

Likewise, recent estimates by Ericsson[9] indicate that, with the early irruption of 5G, data traffic will continue to grow steadily in Latin America and that, for example, a mobile device will go from consuming 5.9 Gb per month in 2020 to 30 Gb in 2026 (31% compound annual growth rate). This growth will be driven by enhanced device capabilities and more diverse data plans, as well as by an increase in data-intensive content.

Wi-Fi and 5G will play complementary roles to meet different connectivity demands and specificities. The different optimization modalities for which both technologies have been designed, both indoors (favoring capacity and density) and outdoors (favoring coverage and mobility), will allow a wide range of applications and uses. Thus, it is estimated that Wi-Fi downloading will increase from 59% (currently on 4G) to 71% (on 5G).

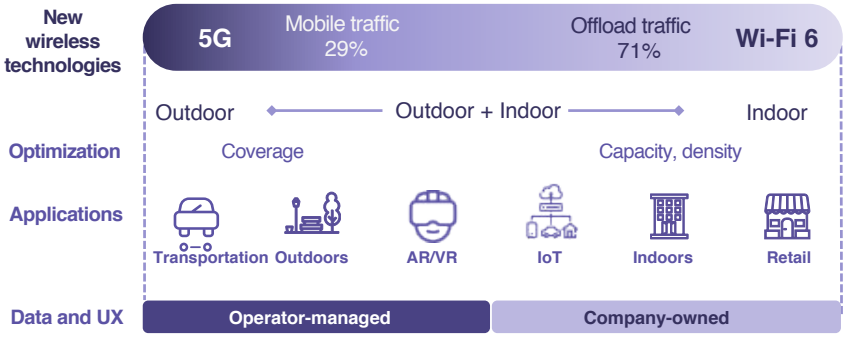
FIG 6.
Mobile data traffic per smartphone in Latin America (GB/year)



Source: SmC+ analysis based on Ericsson Mobility Report 2021

9. Ericsson Mobility Report June 2021.

FIG 7.
Wi-Fi downloading



Source: SmC+ adapted from CISCO

The use of licensed spectrum managed by operators will require subsidiary and complementary action from the unlicensed spectrum managed by each enterprise or household. Both will require significant infrastructure build-out.

Need for investments to bridge the gap

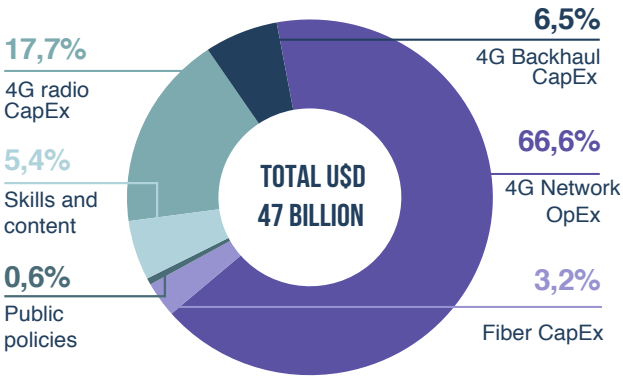
Based on this regional context, where both the connectivity gap and a significant increase in the demand for services are present, several studies have estimated investment requirements for the region. For example, the latest ITU affordability report in conjunction with the Alliance for Affordable Internet (A4AI) estimates that Latin America will require USD 47 billion in infrastructure investments to connect its entire population to the Internet by 2030. The majority of these investment requirements (66%) relate to operating expenses (4G Network OpEx) and 17.7% to mobile infrastructure capital expenditures (4G Radio CapEx).

In this regard, although with very different values, other studies also show high investment requirements to achieve an increase in connectivity coverage in the region.

- According to the Katz-Cabello study (2019) estimates, achieving national coverage of expanded mobile broadband services (i.e. 4.5G and 5G) in Argentina, Brazil, Chile, Colombia, Mexico and Peru would demand approximately USD 120 billion in investments over the next seven years. The study estimates that, in order to achieve coverage in urban and suburban centers, the investment would need to amount to USD 51 billion. These investments will have to be used mainly for the acquisition and maintenance of new sites[10].

- Studies by cet.la indicate that to reach OECD levels of digitization by 2025, USD 160 billion of investment would be required.

FIG 8.
Estimated ITU-A4AI Investment Needs for 2030



Source: A4AI Affordability Report 2020

10. According to the Katz-Cabello (2019) study, it is estimated that by 2030, 2 to 3 times more antenna sites than today and 4 to 5 times more base stations will be required. Many of these base stations will be so-called "small cells" and will be key to achieving the necessary densification required by technologies such as 5G to enable massive, low-latency, mission-critical Internet of the Things services.

Digitalization as a means of achieving the United Nations Sustainable Development Goals

Information and communication technologies are enabling the digital transformation of modern activities, and with it, promoting human development. These technologies will make it possible to achieve the United Nations Sustainable Development Goals (SDGs), which reflect the goals of all humanity for 2030. Investment in more and better telecommunications infrastructure is a necessary condition for improved connectivity and social progress.

A set of studies and methodologies conducted by the IDB, GSMA and Frontier Economics (2018) on 12 countries in Latin America and the Caribbean concluded that an overall increase in telecommunications investment has measurable direct effects on reducing poverty, increasing life expectancy, reducing hunger and inequalities, and even in reducing carbon dioxide emissions[11]. For example, increased access to the Internet and mobile communications can facilitate access to employment information and educational resources, which increases the chances of breaking out of the poverty cycle (SDG 1). Digital infrastructure and Internet of Things (IoT) technologies support agricultural sustainability and improve food security (SDG 2). Telecommunications can also help reduce inequality by connecting remote areas and providing the least developed countries and rural communities with job opportunities and free access to knowledge (SDG 10)[12]. A qualitative analysis based on case studies has been conducted for the remaining SDGs and is summarized in the following figures.

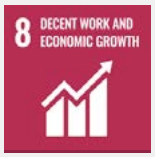
FIG 9.
Impact of Telecommunications Investment on the SDGs

A 1% increase in total investment...
- in telecommunications represents a 0.0132 percentage point reduction in the poverty rate (measured as a percentage of the population living on less than US$1.9 per day).
- in mobile telephony represents a 0.0135 percentage point reduction.
- in landline telephony represents a 0.0045 percentage point reduction.

A 1% increase in total investment...
- in telecommunications raises life expectancy by 0.0095%.
- in mobile telephony raises it by 0.0145%.
- in landline telephony raises it by 0.0022%.

11. Impact of the digital infrastructure on the Sustainable Development Goals. A study for Latin America and Caribbean countries. Prepared by IDB, GSMA and Frontier Economics (2018).
12. SDG 10.1 proposes the following by 2030: to progressively achieve and sustain income growth of the bottom 40% of the population at a rate higher than the national average. SDG 10.2 proposes to empower and promote the social, economic and political inclusion of all irrespective of age, gender, disability, race, ethnicity, origin, religion or economic or other status.

A 1% increase in total investment...
- in telecommunications represents a 0.011 percentage point reduction in the percentage of undernourished people.
- in mobile telephony represents a 0.014 percentage point reduction.
- No impact was detected in landline telephony investment.



A 1% increase in total investment...
- in telecommunications leads to a 0.09% GDP increase.
- in mobile telephony leads to a 0.097% GDP increase.
- in landline telephony leads to a 0.023%.% GDP increase.

A 1% increase in total investment...
- in telecommunications leads to a 0.0013 percentage point increase in the income share of the bottom decile of the population for SDG 10.1 and 0.0027 percentage point increase for SDG 10.2.
- in mobile telephony leads to a 0.0001 percentage point increase for SDG 10.1 and 0.0019 percentage point increase for SDG 10.2.
- in landline telephony represents a 0.0004 percentage point increase.

A 1% increase in total investment...
- in mobile telephony reduces CO2 per capita by 0.09%.
- in landline telephony represents a 0.015% CO2 reduction.

Source: SmC+ analysis based on GSMA, IDB and Frontier 2019 " The impact of digital infrastructure on the SDGs"

FIG 10.
Qualitative impacts of applications and digital infrastructure on SDGs

- Internet of Things (IoT) can provide tools to efficiently manage and monitor water consumption.

- Some applications include satellite maps that help track and monitor species, oxygen levels, temperature and others.
- Big data contribute to the analysis of oceans in terms of biodiversity and pollution.

- Networks and smart logistics reduce energy consumption.
- Smart meters provide households with a tool to enhance energy use awareness.

- Digital applications include: mobile sensors and IoT that assist in monitoring terrestrial ecosystems, desertification, etc.
- Satellite observation and mobile phones can help monitoring and tracking by providing efficient early warning systems.

- The Sustainable Cities Index has identified digital as a key metric for calculating the progress of cities.
- Indicators include availability of mobile transport applications, broadband connection costs, mobile and broadband connectivity, among others.

- Efforts to digitalize different areas are also driving public-private partnerships in Latin America.

- Reducing the ecological footprint means achieving sustainable consumption and production, for example in agriculture.
- Technology and new IoT solutions in agriculture play a crucial role in this regard.

- Efforts to digitalize different areas are also driving public-private partnerships in Latin America.

Source: SmC+ analysis based on GSMA, IDB and Frontier 2019 " The impact of digital infrastructure on the SDGs"

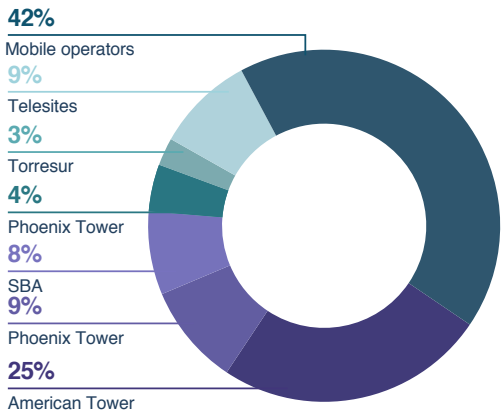
Digitalization is driven by connectivity infrastructure

Structural transformation of the infrastructure sector

Network and infrastructure management models at a regional level have been changing in recent years, in line with the international trend. Since 2019, infrastructure companies have owned more than 50% of sites in the region and traditional network operators have been trading these assets to enable separate, specialized and more vertically disintegrated management. This strategic change stems from the need to lower deployment and asset management costs, which are not core for providing connectivity services for end users.

By the end of 2020, Latin America had more than 195 thousand communications sites, of which 43% still belonged to mobile operators and the remaining to independent infrastructure companies.

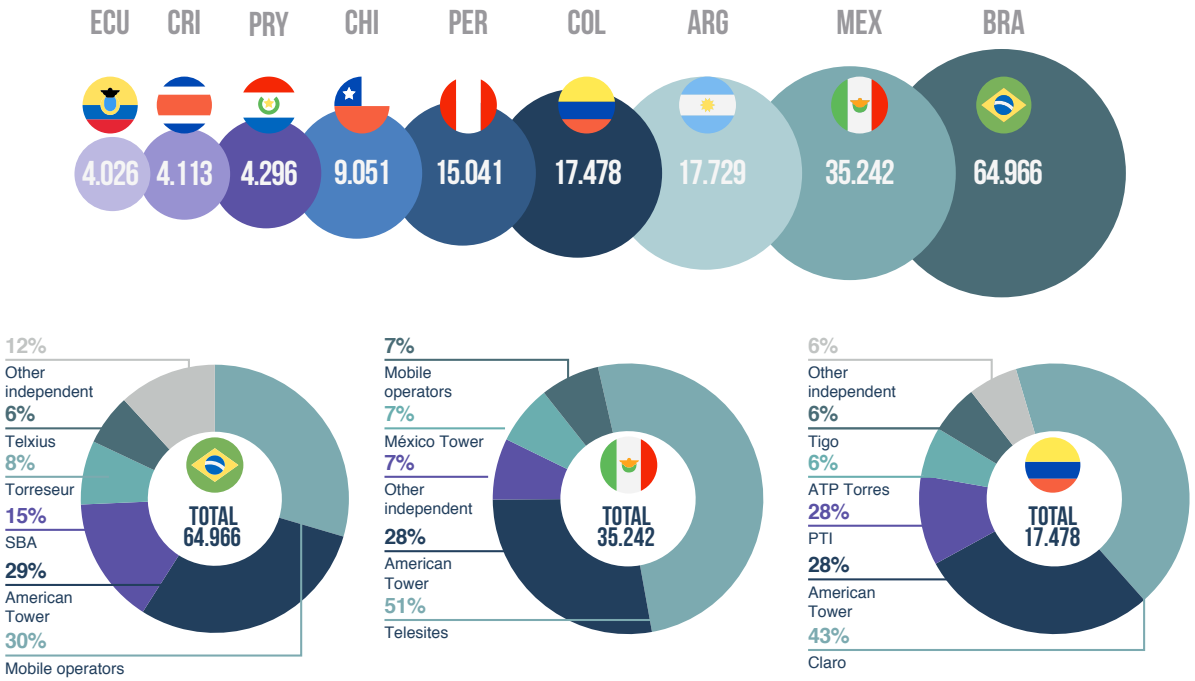
FIG 11.
Latin America site ownership (4th quarter 2020)



Source: TowerXChange CALA 2020

The behavior of the tower market distribution has followed different paths and varies among countries, and there is no pattern that defines site tenure. For example, in Brazil, the market has 30% of sites owned by communications service providers (CSPs), 29% of sites owned by American Tower and the remaining 41% is distributed among other independent infrastructure companies. On the other hand, in Mexico, the second largest market in the region, only 7% of the sites belong to CSPs.

FIG 12.
Number of sites per country and market distribution in selected countries



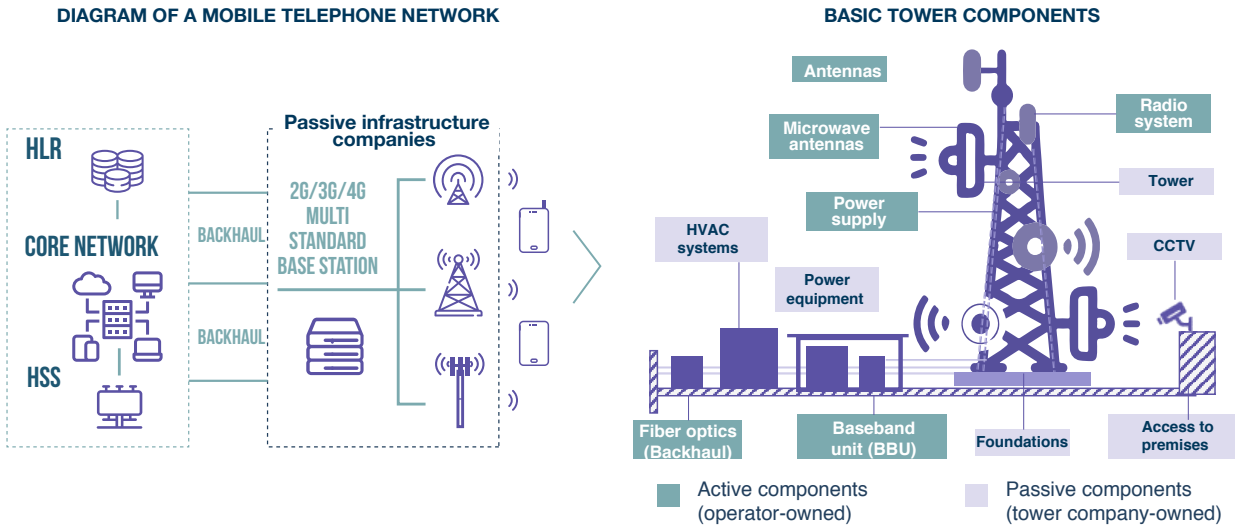
Source: Tower Xchange 2020

The digital infrastructure and its impact on the sector

Digital infrastructure enables the connectivity of households, industries, offices, businesses and enterprises and mobile devices through mobile and wireline telecommunications networks. These have different types of sites (macro cells, micro cells, among others) according to their technological requirements and market characteristics and demands (coverage, capacity, expansion). These sites may be owned by operators or by independent infrastructure companies.

The following figure outlines the components of a site owned by an independent infrastructure company, and shows who owns the various basic active and passive elements that support connectivity.

FIG 13.
General diagram of a mobile telephone network and basic tower components



Source: SmC+ analysis based on EY Parthenon information

It is clear that active components are the elements that are used for transmission media (antennas, microwave antennas, radio systems, baseband unit, fiber optic, power cables) and are, currently, mostly owned by operators. Passive components, on the other hand, are owned by the infrastructure company and function as a base or foundation for active components. These include the tower, security cameras, power supply equipment, HVAC systems, among others.

Likewise, as the industry evolved and shifted, several models of ownership and connectivity infrastructure control have emerged to satisfy the needs of mobile operators and the growing offerings of infrastructure companies. Among the infrastructure ownership and control models, the following four can be highlighted:

i. Mass divestment and subsequent lease
ii. Infrastructure companies run by mobile operators
iii. Joint initiatives
iv. Co-location

Co-location is the most widely adopted in Latin America. The following figure describes these models in detail.

FIG 14.
Connectivity infrastructure ownership and control models

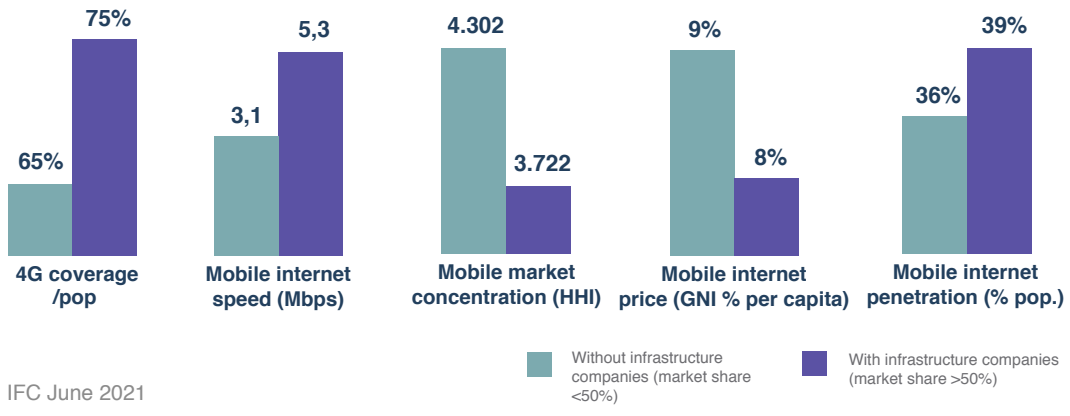
	MASS DIVESTMENT AND SUBSEQUENT LEASE	OPERATOR-RUN INFRASTRUCTURE	JOINT INITIATIVES	CO-LOCATION (Most widely used business model in LATAM)
MODEL DESCRIPTION	• The operator could sell their passive infrastructure to an independent company and lease-back the assets.	• The operator could turn its passive infrastructure into a subsidiary tower company, operating as an independent enterprise.	• Operators could become shareholders in a passive infrastructure company.	• The infrastructure company could maintain their passive infrastructure and actively seek new lease and sharing opportunities.
IMPACT OF THE BUSINESS MODEL	• Immediate upfront payment. • Transforming CapEx into OpEx.	• Total value is allocated to the operator. • Fully controlled by the entity. • Potential sale of optimized assets.	Optimized operational efficiencies: • Revenue (co-location) • Streamlined cost savings • Potential sale of shares (more complex)	• Top operational efficiency. • Full control over operations. • Reutilization of the site's passive assets.
KEY FACTOR	+ CASH FLOW			+ EFFICIENCY

Source: SmC+ analysis based on Delta Partners data

The co-location model refers to a single structure that is used to support multiple antennas operated by different wireless service providers. The economic model of each of these schemes is a key factor in the analysis and the decision to apply them to each individual case.

All this evolution in infrastructure management has its impact on the sector's performance. Some recent studies show that markets with a higher development of infrastructure companies are positively correlated with different parameters linked to connectivity (see illustration below).

FIG 15.
Connectivity parameters are better when there is a passive infrastructure business model



Source: IFC June 2021

According to IFC estimates (2021), markets with 50% or greater penetration of infrastructure companies have better ratios in terms of higher 4G coverage per capita (by 10 percentage points), faster mobile internet speed (70% faster), and lower internet price (1 percentage point lower when measuring the price of an average broadband plan against per capita income). In addition, in these countries, the concentration of the telecommunications market is lower (-13%) and Internet penetration is 3 percentage points higher.

New network models

With 5G technology, which offers a more complete virtualization and the possibility to divide the network into layers, it will be possible to enable new use cases, both for end users, the industry and for the provision of public services. This evolution entails innovations in terms of network management and architecture, which will require a wide variety of physical infrastructures, ranging from traditional fiber cables and towers to small cells with advanced antenna technologies, with early consideration of edge computing servers or *micro data centers*, to name a few. Among the most significant are the following:

- **Ultra-dense networks or *small cells*:** given the limited available spectrum in low bands, the design of current 2G, 3G and 4G networks will be insufficient to support the services expected under 5G, which require bandwidths in excess of 100 MHz. The high-frequency spectrum that can provide such bandwidth, particularly the so-called “millimeter bands”, lacks the propagation properties necessary for 5G to reach its full potential. Therefore, it will be necessary to place small cells close to end users, either through installations in public places, in stores or at strategic points. Ultra-low latency demands for applications, such as robotics or autonomous cars or telehealth, require this type of infrastructure.

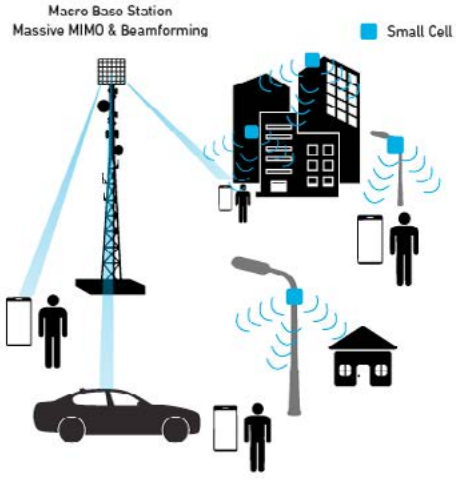
- **Transition towards large scale fiber:** the high performance offered by 5G from mobile locations to end users needs to be supported by the operator's core network. This will lead to fiber deployment in most mobile locations.

- **Macro cells:** most of the traffic load will remain in the hands of macro cells, so before deploying new technology infrastructure to serve innovative applications, operators will need to have a clear strategy for upgrading their existing transport networks.

FIG 16.
Network densification evolution

4G LTE

LTE-A, LTE-A PRO, 5G

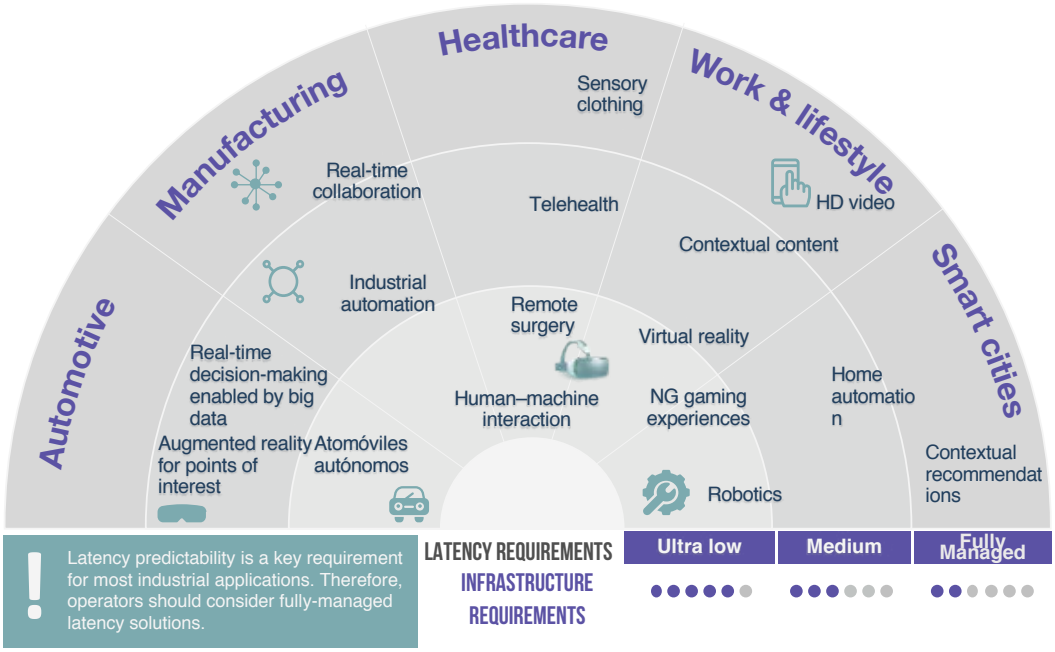


Source: Qorvo

Latin America is the second most urbanized geographic region in the world (81%), which offers a unique opportunity for smart city development. Concentration in large cities poses mobility, environmental and public safety challenges, which encourage innovative solutions that require a better digital infrastructure. Building smart cities becomes even more important for sustainable and inclusive economic growth.

The following figure shows the 5G application trends, ultra-low, medium and managed latency requirements, and the infrastructure needs for each.

FIG 17.
5G application trend mapping and latency requirements



Source: SmC+ analysis based on Detecon and IBM

This new range of services and applications, supported by technologies of the so-called "fourth industrial revolution", will require a very substantial network densification with more heterogeneous operating models with massive MIMO[13] antennas and a myriad of small cells, all connected with fiber optic.

The installation of significant numbers of small cells is one of the major challenges that will affect deployment costs, as they are not necessarily installed on roofs or towers already in place, but rather on buildings, poles or street infrastructure. This implies a radical change in the acquisition model for new sites and the development of agreements with utilities (e.g., electric utilities) that have existing power lines. The capacity of these small cells will also be limited to a number of frequencies and will support a smaller number of operators compared to macro cells.

Neutral infrastructure providers will be the key players in these new network management models, as they will enable the efficient and evolving management of resources to allow this new convergence where the telecommunications world will be integrated with the IT world, with edge nodes supported by the cloud.

With 5G (especially after its 16 release), network virtualization, the ability to provide layered services and the vertical disintegration of communications service providers, there will be different models of network management that will accommodate to new and more innovative business cases.

13. Multiple Input Multiple Output (MIMO)

- **Private mobile networks.** These are autonomous networks with more streamlined installation that can be designed based on various needs of industry verticals, companies or conglomerates of companies supported by 4G and 5G capabilities and integrated to national networks. Will enable more reliable and high-performance industry 4.0 solutions for different sectors, such as factories and industrial parks, mining, ports and airports, etc.

- ***Neutral* Host.** They offer value-added equipment and services, helping traditional network operators to extend and enhance the provision of indoor and outdoor connectivity to their subscribers. "Neutrality" means that the supply of housing is offered on an equal opportunity basis to tenants.

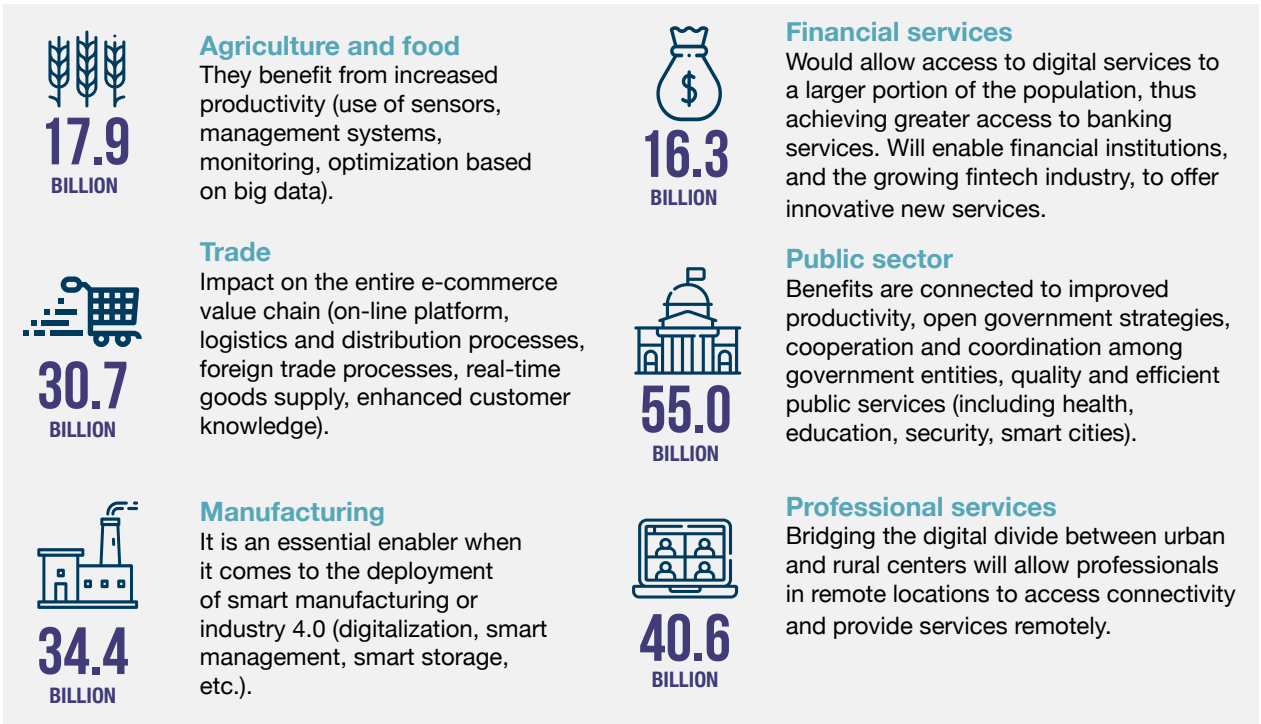
- ***Network-as-a-Service Models* (NaaS).** More adaptable network architecture designs, defined primarily by software and intended to provide core connectivity services but integrated to the needs of handling large amounts of data supported in the cloud, with flexible and automatable functionalities tailored to each customer.

This densification will form a whole new network architecture, which will make it possible to provide services and use cases including the following:

- The use of frequencies higher than 6 GHz where propagation limits cell size.
- The use of shared, unlicensed (or free) spectrum which requires less power (LTE-LAA, CBRS, Wi-Fi 6).
- High density and high traffic demand areas (stadiums, train stations, airports).
- More scalable deployments performed with relatively low-skilled personnel.
- SMEs requiring self-assembled indoor coverage.
- Extension of rural coverage to fill gaps.

These new network models and the significant densification of networks will be enabling factors for the digital transformation of value chains and increased productivity in the region. This digital transformation will lead to mobile expansion and, according to Katz-Cabello (2019), will have an impact of up to USD 195 billion in the different value chains in Latin America by 2030 where the provision of public services (health, security, education), smart manufacturing and agriculture and food processing stands out.

FIG 18.
Impact of mobile expansion on different value chains by 2030 in Latin America (in USD)



Source: SmC+ analysis based on Telecom Advisory *Service*s "Katz-Cabello" 2019 data

Passive infrastructure companies as a cornerstone of digital transformation

The need for enhanced sharing of passive infrastructure

Over the past few years, there has been a transformation in the infrastructure companies' market, where passive infrastructure providers already own 57% of the total number of regional sites[14], a trend that will continue to grow in the future.

One of the main motivations of communication service operators in their transition to 5G is vertical disintegration in pursuit of optimizing their financial resources. To this end, they seek to reduce the capital tied up in fixed asset investments by converting them into operating costs (corresponding to the lease they pay to infrastructure companies). This release of funds allows mobile operators to focus on the main and differentiating objective of their business, i.e., to improve the range and quality of the services provided to their customers.

Faced with this paradigm shift in wireless business, niche players and service providers

14. Source: TowerXchange issue 29. July 2020.

will become less vertically integrated and moving towards a separation of the network management, operational or production model (towards a more streamlined, virtualized and customized wholesale services) and finally with different modalities to reach end customers, including the *over-the-top* type.

Thus, infrastructure companies will concentrate on their area of expertise, while mobile operators will entrust them with most of the responsibilities related to connectivity infrastructure. The following are, among others, the main responsibilities that passive infrastructure companies assume, thus relieving mobile operators of them:

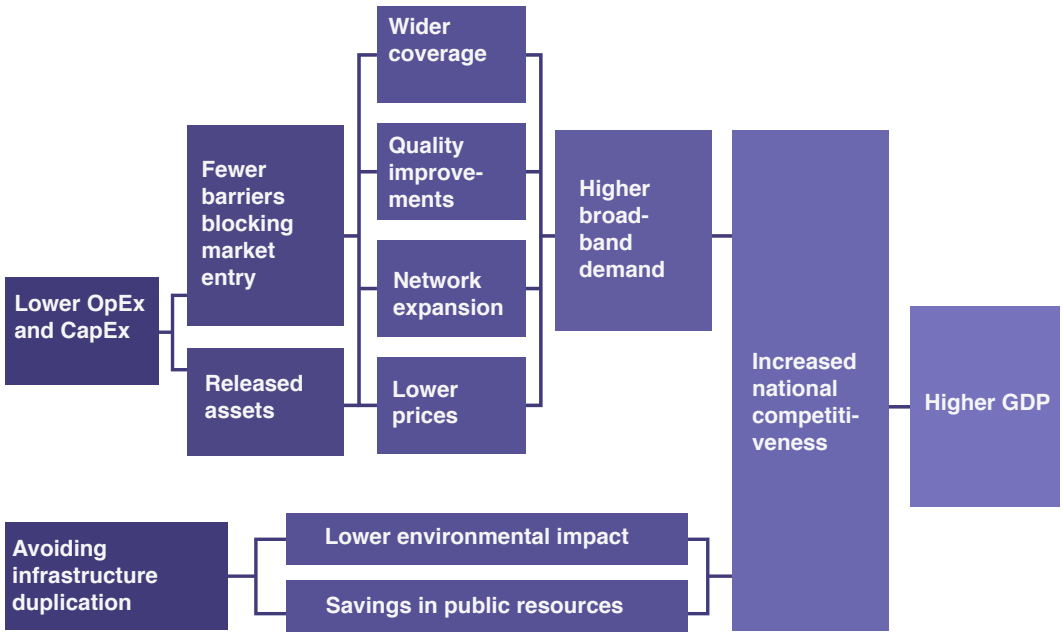
- To identify the physical site and manage and obtain the corresponding permits.
- To provide the physical site and maintain related real estate contracts.
- To install and manage the passive infrastructure, including tower structure, civil works, fencing, shelters and possibly power supply and cooling systems.
- To comply with on-site security requirements.
- To gain access to the infrastructure space and provide services to network operators.

In turn, mobile operators lease the passive infrastructure but, for the time being, mostly retain ownership of the power cables that connect the antennas to the radio equipment and the fiber connection to the backhaul network .

This migration towards greater participation in infrastructure sharing results in lower costs for infrastructure companies and, consequently, in lower leasing costs for mobile operators, which can be expected to ultimately translate into benefits for end customers, and for the economy as a whole.

Infrastructure sharing presents financial and sustainability advantages, enabling the significant deployments that will be required for making 5G possible. The following figure shows, schematically, how the role of passive infrastructure companies and infrastructure sharing generate advantages that result in benefits for end consumers and, ultimately, GDP growth.

FIG 19.
Infrastructure Sharing Impact Diagram



Source: SmC+ analysis based on GSMA (Mobile infra sharing 2020) and IDB (2020 Digital Transformation) information

Under a high densification scenario, replicating networks can be economically inefficient, creating insurmountable entry barriers for new players and having an undesirable impact on the environment. The advantages can be summarized as follows:

- **More efficient markets.** Infrastructure can be delivered at lower costs and unnecessary duplication of infrastructure is reduced.
- **Release of capital for mobile operators.** Tower sales to independent passive infrastructure companies, and no self-deployments, free up capital to invest in existing networks and new services and/or to pay off financial debt.
- **Investing to enhance capacity and coverage.** A cost-effective and time-saving implementation in rural areas helps to reduce the digital divide.
- **Market entry simplification.** Operators of other technologies, such as IoT or fixed wireless service, have more options for their infrastructure, which reduces entrance barriers, and can benefit from a neutral *host*.
- **Positive environmental impact** by reducing the carbon footprint through savings in materials, energy and network emissions using existing infrastructure for new deployments and increasing the infrastructure sharing rate.
- **Public benefits.** Infrastructure sharing can reduce visual pollution and unneeded public spending on infrastructure by avoiding unnecessary duplication of networks and multiple civil works.

In addition, it is interesting to observe new approaches to public-private partnerships (PPPs), where a strategy of reciprocity and risk sharing associated with deployment in areas of uncertain profitability is promoted. This trend, with varying degrees of ownership and risk sharing, can be considered to build infrastructure under open access, non-discrimination and low-cost principles to promote access in low-income sectors. It is a model in which the infrastructure provider normally cannot participate in the retail market and, on certain occasions, governments offer exclusive rights to exploit the infrastructure as an incentive to invest in deployment[15].

There are several PPP models[16], and in the region it is worth highlighting the case of Peru with the "Internet para Todos" (Internet for All) connectivity initiative, launched in 2019 by Telefónica del Perú, Facebook, IDB Invest and CAF Development Bank of Latin America[17]. This joint initiative company has taken advantage of the regulatory concept of rural wholesale operators in that country to create a wholesale operator, of the "*Network as a Service* (NaaS)" type, of open access telecommunications infrastructures[18]. It is an operator that covers mainly rural areas and aims to reduce the digital divide, bringing mobile broadband to remote and economically unviable populations. Telefónica del Perú contributes with its current rural business, while the rest of the players provide financing and a service and content platform, in order to deploy new infrastructure and improve the connectivity offer with local toolbox[19].

15. Garcia and Kelly, The Economic Policy implications of Infrastructure Sharing Mutualisation in Africa, *Back*ground Paper for World development report 2016: Digital Dividends, World Bank 2016.
16. García and Kelly, The Economic Policy implications of Infrastructure Sharing Mutualisation in Africa, *Back*ground Paper for World development report 2016: Digital Dividends, World Bank 2016. The main four models are as follows: 1) the cooperative model, where infrastructure and service providers jointly build and operate the infrastructure with a subsidy from the government; 2) the equity model, where governments obtain capital in exchange for their contribution; 3) the concession model, where governments open a public tender to select a private party to build and operate the infrastructure; and 4) the management contract, where governments open a public tender for a private party to build, operate and market the infrastructure.
17. BID Invest (2019). "Telefónica, Facebook, IDB Invest and CAF created Internet for All Perú to expand Internet connectivity in Latin America".
18. According to the information provided by CAF: Internet for All 2019 and also IpT Telefónica, the company has the ultimate goal of rendering services to 6 million people, having already connected more than 600,000 Peruvians that belong to more than 2,000 rural and Amazonian communities, as well as populated centers nationwide.
19. Along the same lines, Colombia, issued a Decree with the purpose of facilitating private sector participation in ICT projects through PPP models (1974 ICTMin Decree dated October 29, 2019) which aims to promote greater coverage and quality of mobile services throughout Colombia.

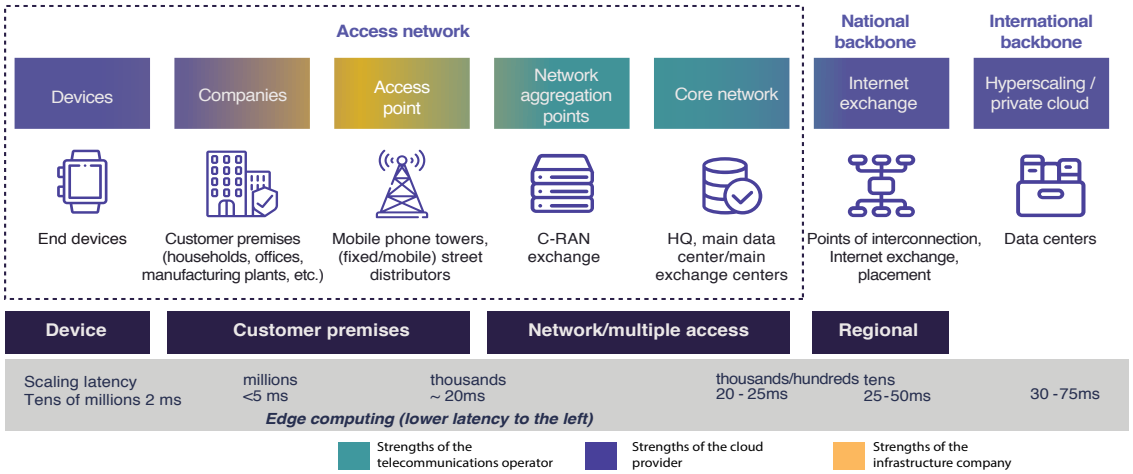
5G deployment and the evolution towards active sharing

4G technology initiated a transition towards network virtualization that will be consolidated with 5G technology. Network virtualization allows resource managers to integrate fixed and mobile services, splitting them into layers to offer each business or individual user the services they need. This is how the industry, health services, education, transportation, work, home life and cities can make innovative uses that will demand different levels of latency.

Cloud computing is one of the drivers and enablers for processing large amounts of data generated from the ever-increasing connectivity of things. As such connectivity increases, the use of artificial intelligence and cloud computing capabilities will be crucial for achieving the low latency times required for autonomous vehicles, virtual or augmented reality, or certain industrial automation services. Edge computing will be complementary to cloud computing, which will be provided in a decentralized or distributed manner as demanded by different services (network gateway, customer premises or peripheral devices) as in the so-called hyperscale (higher latency). These new needs are converging with a parallel process in the world of telecommunications operators, which are turning to "virtualization" to reduce their network costs and increase the efficiency, security and analytical capacity of the data they process.

These needs and trends are leading to a new convergence between the telecommunications world and the IT sector, provider of public cloud services. Telecommunications service operators anticipate that hyperscale public cloud providers could become competitors in the rendering of connectivity services.

FIG 20.
New players in the convergent telecommunications infrastructure value chain with the IT world

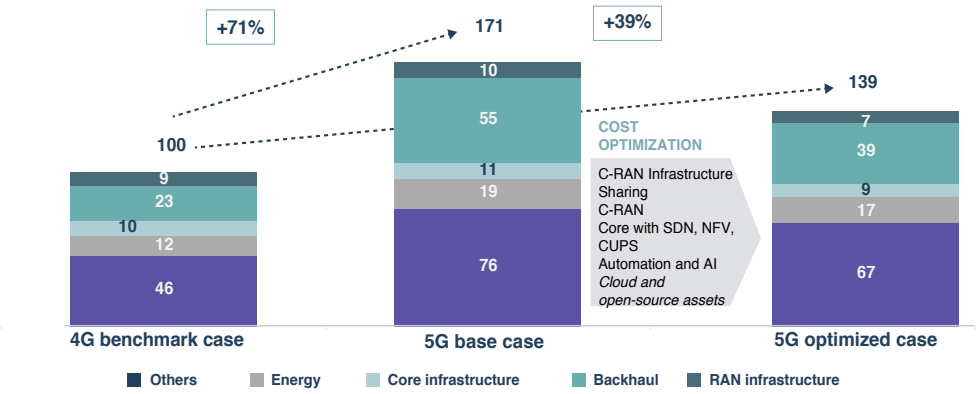


Source: SmC+

Infrastructure companies will play an increasingly important role in this value chain to enable and make available the resources with differential quality of service required upstream (with end service providers and end devices) and downstream (capacity and cloud providers).

According to a 2019 GSMA study on the networks of the future, cost reductions driven by infrastructure sharing applied to 5G, with virtualized and cloud-native access networks, software-defined automation, among other solutions, can be as much as 40%.

FIG 21.
Estimated 5G cost reduction as a result of infrastructure sharing



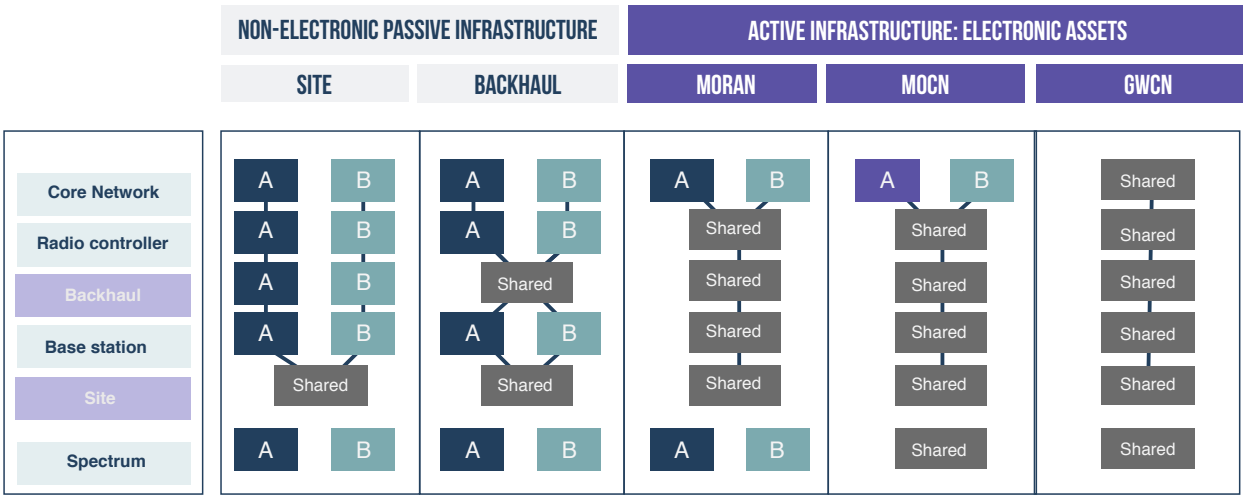
Source: GSMA (2019)

The evolution of the market with new services and associated densification needs, infrastructure sharing (passive, active, backhaul active indoor and outdoor, spectrum), and new models of arrangements and agreements among market players and others have become enablers to achieve the leap towards the new mobile connectivity generation.

In passive sharing, towers, masts, poles, ducts, channels, cameras, racks with variability in site usage and the backhaul network are shared among the parties. In active sharing, there are three ways of sharing Wireless Access Networks (RAN):

- **MORAN (Multi-Operator Radio Access Network)** where each operator keeps its own core network and spectrum, but where both networks can share the resources of access networks or RANs;
- **MOCN (Multi-Operator Core Network)** where both networks not only share the resources of access networks or RANs but also the spectrum; and finally,
- **GWCN (Gateway Core Network)** where all operators share not only access networks but also the core network, but where only one of them has control of this network, which reduces the flexibility of the rest.

FIG 22.
New sharing models



NOTES:
MORAN (Multi-Operator Radio Access Network)
MOCN (Multi-Operator Core Network)
GWCN (Gateway Core Network)
Source: GSMA

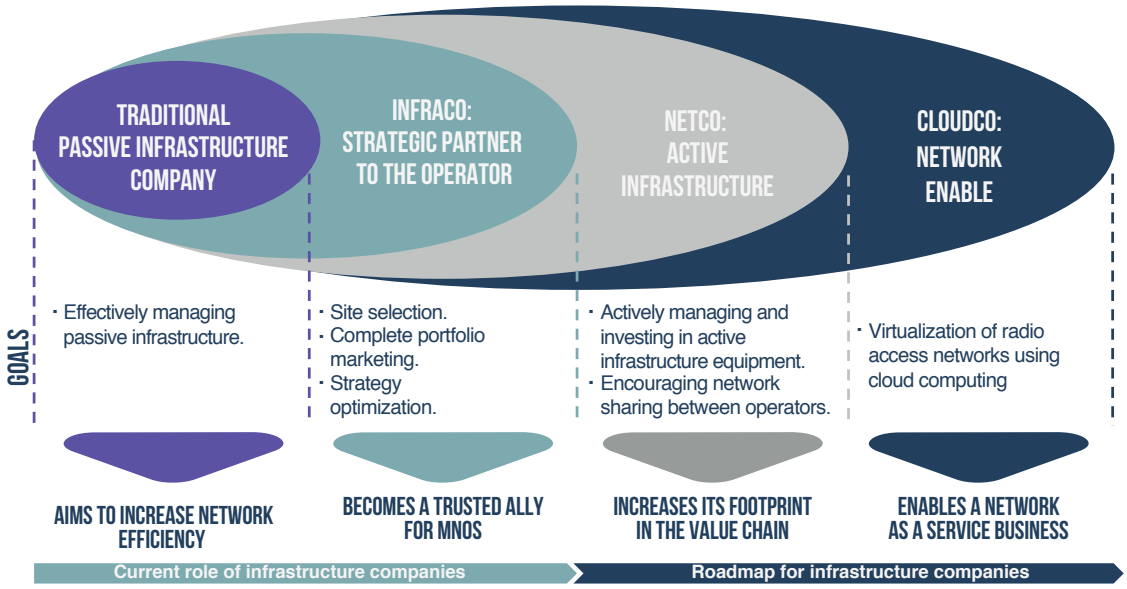
Infrastructure sharing is one of the most promising instruments for reducing deployment costs and thus making private sector investment feasible. This is because, to meet the new 5G demands, a radio frequency spectrum higher than 6 GHz will be offered, which has lower coverage per cell (e.g., a cell in the 20GHz band has one third of the coverage radius regarding one using 3.5 GHz; therefore, 9 cells in 20 GHz will be needed to replace one in 3.5 GHz[20]). For this reason, coordination between telecommunications and Internet companies, dedicated infrastructure companies, owners of street furniture, ducts and public spaces (both national and local) will be key for achieving higher levels of sharing.

Value chain conversion

Within this context of greater infrastructure sharing, including active components, new network infrastructure management models with a different vision from that of traditional operators will be necessary. This value chain shows a continuum that goes from the traditional tower companies —also called towercos, as neutral holders that would further diversify their business— to hyperscale companies —known as cloudcos— passing, from lesser to greater integration in the value chain, through the infraco and netco models.

In the current towerco model, network efficiency is sought, being the infrastructure company's objective to manage and operate the infrastructure. In a further step of integration, in the infraco model, the passive infrastructure company becomes a strategic partner of the communications service provider since the management and operation of the sites are outsourced and leased from them. The netco model includes the management objective and investment in active infrastructure equipment. Finally, and with full integration in the value chain, the cloudco model considers the network as a service; and the infrastructure company offers it as such, virtualizing the radio access network (RAN) to the cloud and deploying micro *datacenters*.

FIG 23.
New business cases for digital infrastructure



Source: SmC+ based on Barclays' data

20. Refer to GSMA (2019), Future Networks. Infrastructure sharing.

The need to promote both infrastructure deployment and sharing

Network infrastructure competition, which originally involved each operator relying on its own network, has been central to the policies to regulate the telecommunications sector in the Americas and in the European Union countries. However, under a high densification scenario, replicating networks can be economically inefficient, creating unbridgeable entrance barriers for new players and having an undesirable impact on the environment.

As players and their service rendering conditions change, regulations and public policies in the sector must be adjusted to effectively promote efficient uses of resources such as infrastructure sharing and co-investment agreements, as is the case of some new wholesale networks, like the renowned rural wholesale operator Internet for All in Peru.

Thus, passive infrastructure sharing regulation is a measure that seeks to solve an efficiency problem derived from the lack of competitive coordination and, especially, from the use of assets that are not easily divisible —mainly in urban areas— for the production of services. As noted by OECD/IDB (2016)[21] and regarding specific best practices to promote passive infrastructure sharing, the following are worth mentioning:

- To establish obligations for dominant operators that own ducts, masts and other passive infrastructure to share their use with alternative operators at regulated prices, even when the passive infrastructure belongs to a parent company (e.g., a power generation company).
- To Implement "one dig" policies that encourage various utilities (gas, electricity, telecommunications and water) to adhere to a common shared plan for excavation works. This can reduce the investment of the parties involved, minimize disruption and inconvenience to public spaces, and better organize deployment and future maintenance.
- Generally, when planning new public infrastructure —such as roads— it is worth investing in pipelines that can be used by any operator to deploy its own networks, under cost-based open access conditions. This is especially useful when backbone and backhaul infrastructures is missing.

It is important to note that a significant part of the passive infrastructure deployed by other utility companies, such as gas, water or electricity, can also be used for telecommunications services. In this regard, utility companies that carry out civil works financed in whole or in part by the State may be required to comply with reasonable requests from telecommunications companies for the coordination of civil works, in order to deploy high-speed broadband networks. This is the case in the European Union, where Directive 2014/61/EU on measures to reduce the cost of deploying high-speed electronic communications networks, addressed such obligations.

Along the same lines, ensuring that operators have access to accurate information on the availability of buildings, public spaces or sites is essential for efficient and shared use of passive infrastructure. This means developing IT systems that display geo-referenced data on such infrastructure, as well as supporting the processes for requesting its use, provision and maintenance. If the passive infrastructure to be shared belongs to a dominant operator, the implementation of these systems may be part of the imposed obligations for access. Whenever it also includes elements provided by other utility companies and/or other infrastructure, it may be advisable for the public administration to facilitate data consolidation management from various organizations to simplify the use of these assets.

21. OECD/IDB, Broadband Policies for Latin America and the Caribbean, A Digital Economy Toolkit, 2016, Chap. 4 Competition and Infrastructure Bottlenecks

Barriers to the development of the communications infrastructure market

Despite the expected growth in the number of sites, for many years, the industry has been facing several barriers that delay the deployment of infrastructure and, as it does not guarantee legal certainty to those who perform it, investments are hindered. The exponential densification needed to have an acceptable 5G and IoT experience necessarily requires municipal government alignment.

A common problem at a global level, and particularly in Latin America, has to do with the different competencies of government authorities regarding authorizations on elements that have an impact on service provision. In the case of telecommunications, local authorities or municipalities generally have constitutional autonomy to grant permits for the installation of antennas and rights-of-way for fiber laying. Thus, if they are not aligned with the national public policy, they may interfere with the rendering of telecommunications/internet services, which pertains to the national or federal competence (as the case may be)[22].

In most countries in the region, local regulations have prevailed over national or federal regulations, making them very restrictive, non-transparent, bureaucratic and even irrational when it comes to obtaining municipal permits. Local governments or municipalities exercise their authority by applying their own health regulations or set their own considerations for minimum distances and tower heights, the use of public spaces or the way environmental impact should be measured. This has led to the existence of countless legislations to regulate elements that are quite standard and common. This problem is widely known in Latin America. There are extreme cases of cities that are highly restrictive on infrastructure deployment. For example, in São Paulo (Brazil) in 2019 there were 700 unresolved antenna installation requests and 2 years passed without new authorizations. Other difficulties that the city of São Paulo presents for infrastructure deployment include the lack of differentiation for authorizations according to the type of infrastructure (for example, between small antennas and towers) and approval by neighbors in the case of dead-end corridors.

Such is the situation that in the ranking of "Internet-friendly cities" in Brazil, the city of São Paulo ranks 98th out of 100[23]. In the 2020 version of the ranking, the following problems have been highlighted for the bottom 10 cities.

However, recently, in 2021, and approved on first ballot, Bill 347/2021 defines the new São Paulo Antenna Act aimed at simplifying the authorization granting processes for antenna installations. The following are some of the most remarkable changes:

- Radio base stations may be placed on any street, regardless of width (previously installation on streets less than 10 meters wide was forbidden).
- Silence is consent. If a request exceeds 60 days without response, absence of response from competent authorities shall imply tacit approval for all purposes.
- Mini radio base stations and mobile radio base stations would be exempt from permits for structure deployment.

22. A detailed debate and proposals on the issue of federal and municipal competencies and incentives can be found in SmC+ (2020), Infrastructure Deployment and Municipal Conflicts. Some possible approaches to change the current paradigm, Expert Insight Series No.1, by Esteban Russell, July 2020.
23. Refer to Conexis Internet friendly cities.

FIG 24.
Brazil: main issues highlighted in the Internet Friendly Cities Ranking

TIMELINE	• 100% of cases require over 6 months to obtain a permit.
BUREAUCRACY	• 100% of cases must submit more than one document for approval in order to obtain an infrastructure deployment permit. • 70% require new licenses for new technology deployments. • 60% lack a timeline to respond to requirements.
RESTRICTIONS	• 70% demand a 16.4 ft (5 m) minimum distance on every side. • 70% set a minimum distance between antennas. • 60% have strong requirements regarding environmental permits and the distance between the antennas and buildings (such as hospitals and schools).
COSTS	• 90% require several reports/surveys (environmental surveys, structural reports, etc.) • 80% have permit renewals within less than 10 years.

Source: Conexis Internet friendly cities (2021).

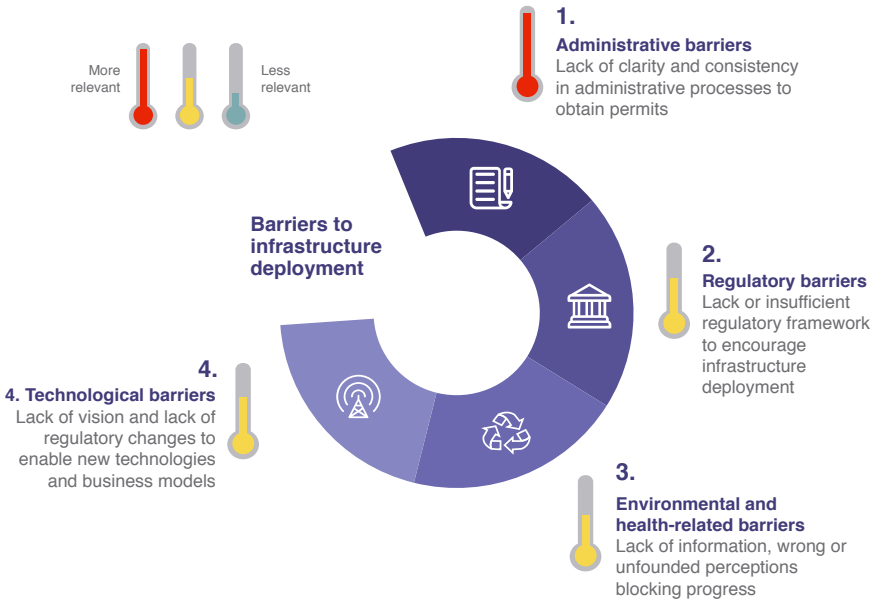
National governments have often felt restricted in implementing their plans of connectivity, deployment of new technologies, quality of service improvement or coverage requirements of a spectrum tender.

As stated, small cells will be fundamental to provide high-capacity and reliable connectivity; therefore, they will act as mechanisms for innovation, generation of start-ups and new high value-added services. However, as Webb (2019)[24] points out, the growth of these small cells has faced typical restrictions to obtain permits so far, especially when using public spaces administered by local authorities, which, in the absence of a special administrative channel, may require a right-of-way or lease similar to traditional antennas[25]. If small cell deployment requires fees similar to a macro cell or permits that take 2 years to be authorized, there exists a factor that negatively impacts the profitability of the business case against mobile expansion.

Following a classification provided by CAF in a 2017 paper[26], the barriers to infrastructure deployment have been grouped into: (i) administrative; (ii) regulatory; (iii) environmental and health; and (iv) technological. Administrative barriers are currently the most relevant and the greatest impediment to achieving deployments in line with market needs and timing.

24. Dr. William Webb: "Are we risking a Mobile Connectivity Crisis", June 2019.
25. While the value of one of these small cells can range from US$ 5 to US$ 12,000, the cost of the equipment will be just a very minor part of the total cost of procuring, maintaining and providing power and *back*haul to the new antenna sites.
26. Refer to CAF (2017) report "Mobile Broad Band Expansion" by Analysys Mason.

FIG 25.
Types of barriers for infrastructure deployment



Source: SmC+

ADMINISTRATIVE BARRIERS: The most relevant

- Lack of alignment between national and subnational agencies (for example, in Brazil there are approximately 5,700 municipalities, which means that there are at least 5,700 different administrative processes).
- Lack of consistency in the requirements (fees, maximum heights, etc.) and requests for documentation, even in the same municipality. Authorities do not understand the scope of competence of the municipality, thus adding more requirements than those actually required. This causes that, when applying for a permit, applicants are not clear about the documentation to be submitted, and opt, in practice, between the following alternatives: (i) submission of as much documentation as possible; or (ii) submission of the minimum documentation to initiate the process and receive a formal request for documentation to be submitted, which does not always end up happening.
- Even with their own administrative processes, different from those at the national level, municipalities often lack the capacity and knowledge to design efficient processes. There is a lack of understanding of the Code of Best Practices.
- Multiplicity of stakeholders. Request for information by multiple institutions (even requesting the same information/ documentation).
- No continuity of local decisions.
- Disproportionate or unequal fees.
- Lack of legal certainty in the appeals processes.
- Absence or extension of deadlines (different deadlines and lack of legal certainty, which makes planning very difficult). Current deadlines are pushing infrastructure companies away from the *time-to-market* to respond in due time and manner to operators. Many cases end up without approval (not necessarily due to rejection, but due to lack of response).
- Public consultation, whereby the approval of neighbors is required prior to the installation of a new network infrastructure.
- Participation of the community leader, who seeks to negotiate for his personal benefit.

ENVIRONMENTAL AND HEALTH BARRIERS
Connected to direct interests of neighbors

ENVIRONMENTAL

- Minimum distance between antennas.
- Minimum area requirement.
- Land use restriction.
- Identification of special locations.
- Excessive disguising measures.
- Authorization from aeronautical authorities.
- Prohibition in cultural and heritage conservation sites.

HEALTH

- Lack of regulations on exposure limits to non-ionizing radiation.
- Lack of dissemination of current regulations and international recommendations.
- Approval of different exposure limits and control procedures.
- Use of different exposure limits based on the area.
- Request for studies by multiple institutions.
- Frequent submission of radiation reports.

These barriers are mainly linked to neighbors' interests and perceptions or beliefs, generally groundless. One of the concerns expressed is related to irradiation and its impact on health, a concern that is mainly explained by the citizens' lack of technical knowledge and false news on the subject. A second concern is the impact on property values, with the misconception that properties lose value if they have connectivity infrastructure installed on them, which, given the rental income the property receives, could, in any case, be the opposite. Finally, it is also stated that the installation of infrastructure has a negative impact on the entire population when it is only a few who benefit economically. All impact measurements and their positive externalities for the entire economy prove otherwise.

This situation has led to demonstrations against the installation of new infrastructure, attacks against its integrity and even to the discrediting of politicians who promote the installation of such infrastructure. Such is the case that during campaign periods, many politicians take as a campaign strategy to "clean up" the city's infrastructure on account of the health, visual and environmental impact it produces.

REGULATORY BARRIERS
Absence of a comprehensive legal framework

- Lack of regulatory consistency among municipalities in the same country.
- Lack of regulations or awareness of them.
- Laws that hinder infrastructure deployments (e.g., the Antenna Act 2012 and the Real Estate Co-ownership Act that requires very high quorums, both in Chile).
- Lack of regulation regarding rights-of-way and RAN sharing.
- Lack of regulation regarding carrier neutral approach.
- Permits for the use of public spaces and property for the installation of infrastructure.
- Possible impact of the declaration of the Internet as an essential service.

TECHNOLOGICAL BARRIERS
Lack of adaptation to new technologies and business models

- Prohibition of infrastructure sharing, in some cases; and in others, as in Chile, obligation of operators to prepare their infrastructure for shared use.
- Lack of differentiation between macro and small cells, making the procedures for obtaining permits similar.
- Setting different fees based on technology.

Regulatory efforts to address the barriers have been varied and not entirely effective so far

Public policy and the regulatory framework can play a key role in extending infrastructure sharing. Nevertheless, in recent years, numerous efforts have been implemented by regulators or policy makers in the region to reduce administrative and technical barriers in municipalities, mainly by trying to harmonize regulations and improve transparency. Education campaigns and the implementation of positive incentives have also been attempted, for example, by promoting friendly municipalities.

Clearly, the desirable solution would be the implementation of one-stop shops at the national level, expedited facilitation for the use of public buildings and simplification of small cell installation[27].

This, together with a regulatory framework that encourages the entering into commercial agreements for the use of existing street infrastructure, as well as passive and then active infrastructure sharing between operators and new players in order to achieve cost reductions and efficient investments[28], should be the path to follow.

The following table shows the different existing regulations or promotional initiatives on the sharing of some element, whether passive or active. The practical application of these regulations and the existence of private agreements between operators or suppliers are not reflected.

FIG 26.
Infrastructure sharing: regulatory highlights in selected countries

REGULATIONS AND/OR COMMERCIAL AGREEMENTS DETAILS	Active and Passive Sharing	Passive sharing
ARG	• **Res. 105/2020[29].** The "Passive Infrastructure Sharing Regulation" sets forth parameters to boost sharing through agreements with freely defined conditions in accordance with the principles of the regulation. • **Decree 1060/2017[30].** It defines the legal concept of "Independent Passive Infrastructure Operator". It is therein stated that they do not require authorization or permit to lease infrastructure, notwithstanding the obligation to notify ENACOM of the commencement of their activities. • **Res. 4510 and 4656/2017[31]**. Active infrastructure sharing is allowed in active elements that make up the access, transport and switching networks for mobile communications to meet service obligations. Agreements must be notified to the regulator.	
BRA	• **Law 13.116/2015[32].** Passive infrastructure sharing is mandatory, except when there is technical justification; • **Res. 683/2017[33]**. It regulates the shared use of the infrastructure that supports the provision of telecommunications services. It promotes the optimization of resources and cost reduction to benefit end users. It avoids the duplication of infrastructure for the provision of services. • Active infrastructure sharing[34] is allowed under commercial agreements between parties and is monitored by competition authorities.	

27. The only precedent on record regarding the facilitation of small cell deployment in the region corresponds to Resolution ANE 774 dated December 27, 2018, which established in its Section 14 the installation of radio bases that do not require civil works or a land use authorization license. However, it is not clear how well this regulation is working in practice.
28. Refer to: Decree 1060/2017 of December 20, 2017 seeking multiple or shared access to passive infrastructure for consideration.
29. Refer to Resolution 105/2020
30. Refer to Decree 1060/2017
31. Refer to Resolution 2017/4510 and Resolution 2017/4656
32. Refer to Law 13.116 of 2015
33. Refer to Resolution 683/2017
34. Note: An example of this sharing is Vivo and Claro sharing their mobile networks and spectrum to increase rural coverage in Brazil. The approach they implemented is the Multiple Operators Core Network (MOCN) model.

CHL

- Public service concessionaires are required under the Telecommunications Act to share passive infrastructure[35].
- Active sharing is not regulated.

COL

- **Res. 5890/2020**[36]. Regulation for telecommunications operators to share passive infrastructure in power lines.
- **Res. 5283/2017**[37]. It provides for a new passive infrastructure sharing regime, including rules on the marking of ducts and poles, a new methodology for calculating prices.
- **4G Licenses.** Mobile operators that obtained the 4G license are required to share passive and active infrastructure.

CRI

- **Res. RJD-222-2017**[38]. It regulates infrastructure sharing for public telecommunications networks and makes passive infrastructure sharing mandatory.

ECU

- **Res. 0807/2017**[39]. It regulates the shared use of physical infrastructure and applies to all service providers under the general telecommunications regime.
- **Ministerial Agreement 017/2017**[40]. It approves the national technical standard for the setting of fees for the use of poles and ducts for the installation of telecommunication networks.

MEX

- Passive infrastructure sharing is mandatory for operators with significant market power[41].

PER[42]

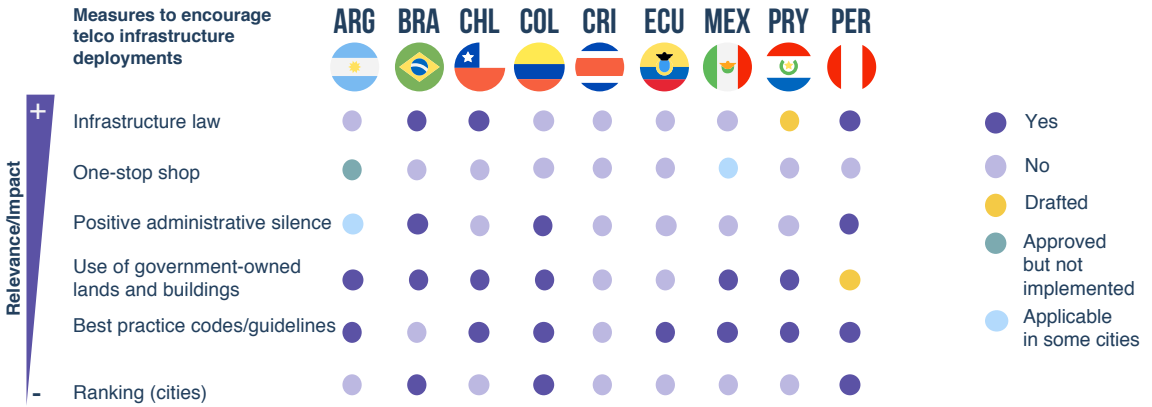
- **Legislative Decree Nº 1019**[43]. Provides for passive infrastructure sharing obligations for major public telecommunications services providers.
- **Ministerial Res. 136/2021**[44]. Draft Supreme Decree approving the rule regulating the sharing of active telecommunications infrastructure.

Notwithstanding the regulation that may exist regarding the sharing of active infrastructure, there is still no relevant experience in its development.

Finally, it should be noted that, although the results vary widely and are generally not very effective, the region's governments have adopted different measures to promote the deployment and sharing of connectivity infrastructure.

35. Refer to Law No. 18168
36. Refer to Resolution No. 5890/2020
37. Refer to Resolution No. 5283/2017
38. Refer to RJD Resolution No. 222/2017
39. Refer to ARCOTEL Resolution No. 0807/2017
40. Refer toMinisterial Agreement No. 017/2017
41. Refer to The Economist, article published in August, 2020: “Preponderance obligations also apply to Slim's Fibra Sites, according to the IFT (Federal Telecommunications Institute)”
42. In Peru there is a special regulation for Rural Mobile Infrastructure Operators The Internet for All (IpT) is the first operator of its kind, and uses Open RAN technology; its purpose is to allow mobile operators in Peru to extend their services to rural areas through the infrastructure and services offered by IpT. Any mobile operator could request to join its infrastructure. So this would be a special case of active infrastructure sharing.
43. Refer to Legislative Decree No. 1019
44. Refer to Ministerial Resolution No. 136-2021-MTC/01

FIG 27.
Some measures implemented to promote network deployment



Source: Prepared by SmC+ based on information from regulators

As it can be seen in the figure above, the countries in the region have explored and adopted multiple alternatives to address the problem. Within the regulatory framework, the main initiatives that are desirable for the industry are the one-stop shop, positive administrative silence, and the use of state-owned buildings or those of other infrastructure companies. Secondly, as regards their relevance, we can mention the publication of best practices and the ranking of cities with respect to their clarity in terms of processes and rules for infrastructure installation.

The cases of Brazil, Chile and Peru stand out as they have specific regulations on infrastructure deployments. Additionally, in Paraguay, in 2019, CONATEL has made a proposal to regulate the expansion of telecommunications infrastructure; however, to date, it has not yet been considered or enacted as a law.

In Argentina, the one-stop shop has been approved but has not yet been implemented. Although not nationwide, in Hidalgo[45], Mexico, a process similar to the one-stop shop procedure is in place for enabling telecommunications infrastructure.

Positive administrative silence is implemented in Brazil, Colombia and Peru, while in Argentina it is available in the city of Mendoza. In Brazil and Peru it derives from their laws (for example, in Brazil, the 2020 decree regulating the Antenna Law restores the positive administrative silence, whereby the automatic license is assigned in the event that municipalities do not grant it within 60 days). Peru represents a successful case in the implementation of positive administrative silence and automatic approval, subject to subsequent oversight.

The use of public buildings and land, such as the infrastructure of companies from other sectors, facilitates deployments, reducing costs and time and promoting connectivity capillarity. Similar initiatives have been evidenced in different countries and cities in the region.

Finally, there are also measures such as codes of good practice or guides to standardize their application among the different cities and municipalities in the country. Likewise, the publication of a ranking of cities that favor deployments seeks to highlight good practices and expose those that hinder the advancement of connectivity.

45. Refer to article published by the government of Hidalgo in July, 2020: Hidalgo, pioneer in telecommunications infrastructure deployment.

Infrastructure market projections to 2030

5G deployment in Latin America started slowly in 2019, in several small countries such as Uruguay, Puerto Rico, Trinidad and Tobago and Suriname. Deployments and adoption are expected to grow more strongly from 2022 onwards with specific spectrum bidding processes for this technology in the largest countries in the region, such as Brazil, which is expected by the end of 2021[46]. According to Ericsson's Mobility Report estimates, 216 million connections are projected by the end of 2026.

It is then expected that, once the spectrum is allocated, the industry will start with 5G *macro cell* and *small cell* deployments, in addition to the continuity of 4G[47] base station deployments, all resulting in an increase in the total number of connectivity sites. The demand for sites for the year 2030 was estimated based on the existing digital divide in the region, the growing trend in the demand for data and the upcoming 5G deployments, along with their new uses and applications.

As a requisite for this estimate, it was considered that in the main countries of the region, site deployments will continue at the same pace and, as 5G spectrum is assigned, deployments of macro cells and small cells will also begin. Regarding the former, it is considered that they will share existing infrastructure sites, or those to be deployed, with radio bases of other technologies (mainly 4G, but also 2G and 3G). On the other hand, in the case of small cells, due to their specific characteristics and the need for densification and proximity to users, the installation of new sites is expected.

Regarding the pace of deployment, an aggressive deployment is considered in the years following the spectrum licensing, in which 5G coverage will be sought in the main cities of each country within 3 years, after which a gradual growth is assumed with which, by 2030, 5G coverage will be achieved in all urban areas of each country.

The following table summarizes the main premises and assumptions used to make this estimate.

FIG 28.
Premises and assumptions for infrastructure industry forecasting

ASSUMPTIONS	CONDITION	COMMENTS
Small cell density	235 *small cells* per km2	Source: SCF [48] The deployment weighted average of different operators in the survey conducted by SCF is used.
Number of macro cells persmall cell	11 *small cells* per *macro cell* installed	Source: Delta Partners[49] In the referenced study, there is consensus on a requirement by MNOs of at least 10 *small cells* per macro cell.
Geographic scope	Latin America. For this purpose, projections were made based on the following countries: Argentina, Brazil, Chile, Colombia, México, Peru, Costa Rica, Paraguay	To complete the projection for the entire region, the expected deployments for the remaining countries were considered. For the sake of simplification, the expected deployments in these countries were calculated considering the population ratio between these countries and the countries considered.
Pace of deployment	• Initial: 5G coverage in major cities within 3 years • Continuity: achieving 5G coverage in the country's urban areas	For the initial stage, area was taken for the main cities. For the continuity stage, the percentage of the area with urban typology in each country was considered, based World Bank information.

46. The first 5G spectrum tender in the region took place in Chile in February 2021. It is estimated that the next 5G spectrum allocations would take place in the third quarter of 2021 in the Dominican Republic and Brazil; in 2022 in Colombia, Costa Rica and Mexico; and in 2023 in Panama, Argentina and others. For other countries in the region, although plans are not yet clear, deployment is expected to begin in 2024.
47. According to GSMA's 2020"The Mobile Economy in Latin America ", 4G penetration will increase from 49% in 2019 to 67% in 2025, when 5G penetration is expected to be 9%.
48. SCF (2017), Deployment plans and business drivers for a dense HetNet: SCF operator survey.
49. Delta Partners (2017), What you need to know about the rise of small cell infracos.

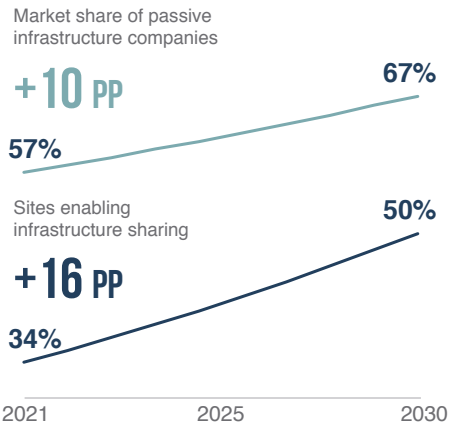
Infrastructure sharing	• The weighted average is considered based on the market share of infrastructure companies and mobile network operators (MNOs), and on each one's level of sharing. • In the case of infrastructure companies, the starting point is 45% in 2021, reaching 60% in 2030. • As for MNOs, they increase from 20% to 30% in the same period.	The values are based on market information gathered by the author. Considering the expected evolution of market share, in which infrastructure companies will reach 67% in 2030, the result is that infrastructure sharing for the entire sector will increase from 34% to 50%.
Investments	• Installation of new 4G sites with co-location of macro cells: current market values were used for each of the countries considered. • Micro cells: real values were measured from installations in Europe and adapted to the reality of each of the countries considered based on the purchasing power parity[50] (PPP) of each one.	Values from the Netherlands were used for the international comparison of investment costs of small cells for Europe. The exchange rate for each country with respect to the USD, inflation in the period in the country of calculation and, finally, the PPP coefficient (for which the IMF[51] was taken as a source) are considered. Only passive infrastructure deployment costs are contemplated, without considering either active infrastructure elements, site maintenance or operation costs.

Source: SmC+ analysis

In order to determine new sites to be deployed and thus analyze how infrastructure sharing may evolve, two situations are studied: (i) on the one hand, an increase in market share of passive infrastructure companies, which naturally have a higher level of sharing than mobile network operators -MNOs- and, (ii) on the other hand, an increase in their level of sharing (estimated to rise from a current rate of around 45% to reach 60% by 2030)[52]. The following figure shows the expected evolution of the infrastructure sharing level and market share of the base case and, on the right side, a sensitivity analysis of the sector's infrastructure sharing level under different scenarios of infrastructure company sharing and their market share. If the market share of infrastructure companies were to grow by 10 percentage points by 2030, the overall level of site sharing would likely surpass that, at 16 percentage points.

FIG 28.
Projected market share of infrastructure companies and sharing levels

BASE CASE

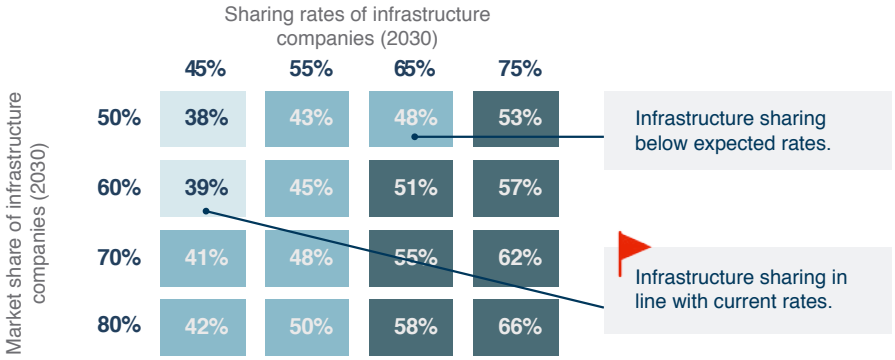


Source: SmC+

Assumes that passive infrastructure companies move from a current sharing level of around 45% to 60% by 2030 and that communications service providers, over the same period, move from 20% to 30%.

50. The PPP makes it possible to represent income and consumption data for each country for international comparison purposes. PPP is calculated based on price data from around the world. PPP exchange rates are established to ensure that the same quantity of goods and services are valued equivalently in all countries.
51. IMF: International Monetary Fund.
52. In the case of communications service providers, it is assumed that their level of infrastructure sharing will increase from the current 20% to 30% in 2030.

SENSITIVITY ANALYSIS ON INFRASTRUCTURE SHARING LEVEL



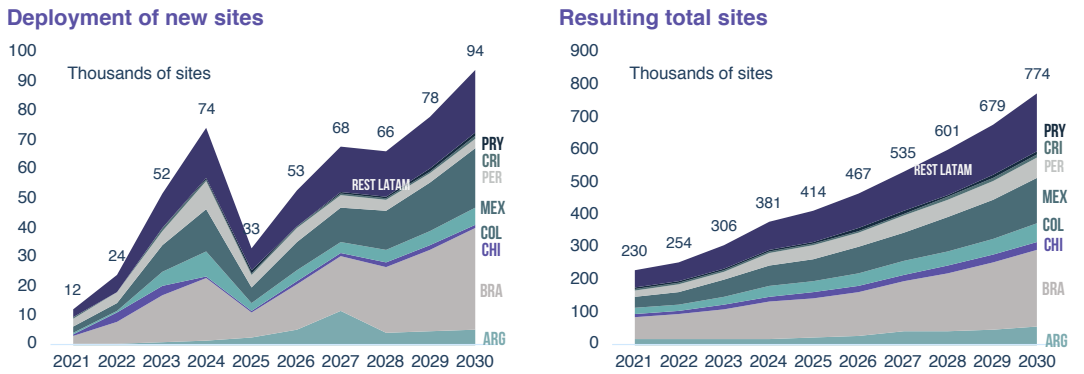
Supposes that communications service providers move from 20% to 30% infrastructure sharing level

Source: SmC+

Given different scenarios for the market share of infrastructure companies and their level of sharing, assuming that communications service providers will move from a current 20% sharing level to 30% in 2030, sharing could reach levels close to 70% (compared to the 50% considered in the base case).

By 2030, more than 550,000 sites are expected to be deployed throughout Latin America. This deployment involves small cells as well as sites to install macro cells (at these sites, base radios of different technologies, 2G and 3G legacy, and 4G radio bases and macro cells, will coexist). This deployment represents a 4.0 times increase in the number of current sites.

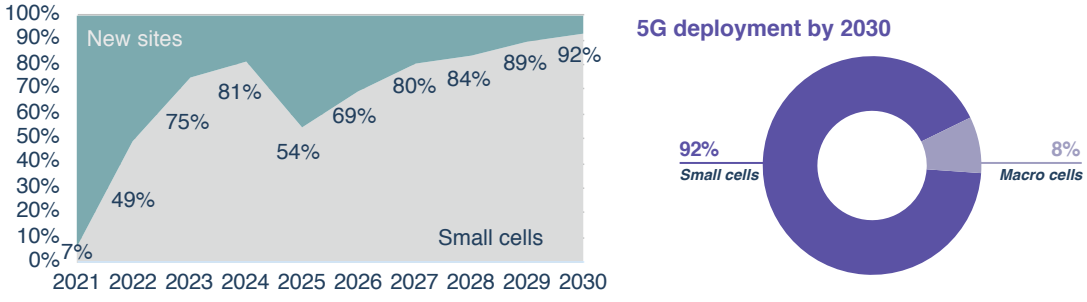
FIG 29.
Deployment of new sites by 2030



Source: SmC+

As mentioned above, the macro cells are considered to share locations with existing or to-be-deployed 4G base stations, while it is assumed that small cells will be installed at new sites.

FIG 30.
Deployment of new sites by 2030

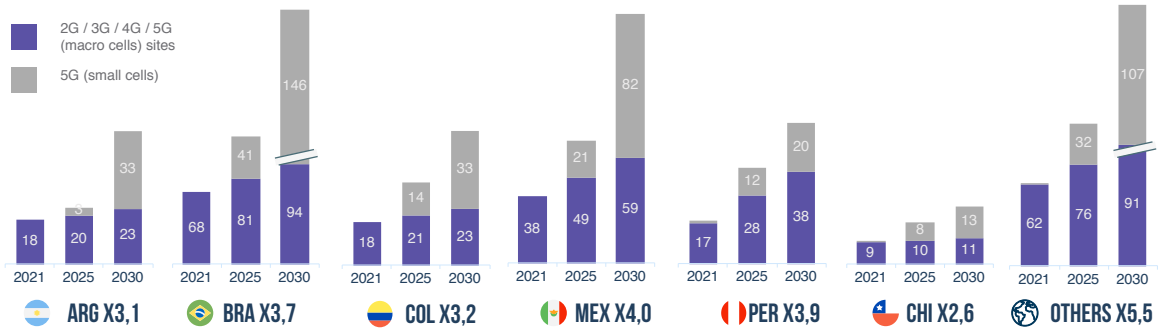


Source: SmC+

It is expected that most deployments will be made by passive infrastructure companies, thus increasing their market share from 57% to 67% by 2030.

The pace of deployment will be different in each of the countries considered, depending on the timing of 5G spectrum allocations, the starting site capacity, the deployment momentum in recent years, the population concentration in major cities and the percentage of urban population, among other variables.

FIG 31.
Deployments of new sites by country



Source: SmC+ analysis

Finally, based on the estimated deployment of sites, the amount of investment required has been calculated, for which different infrastructure investment values have been considered for each country.

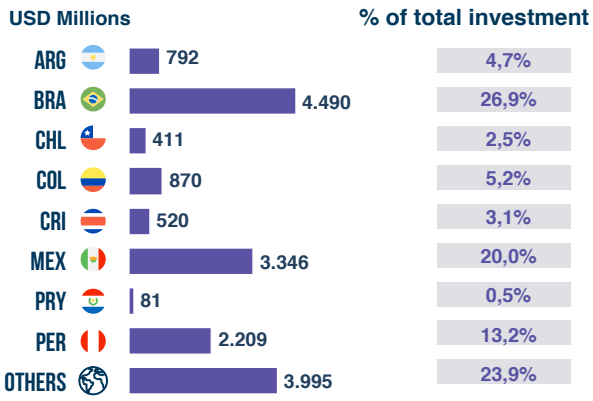
Estimated investment up to 2030 amounts to USD 17 billion, which is equivalent to 3% of the mobile operator industry's average annual revenues in that period. These estimates only consider investments related to passive infrastructure deployments, i.e. excluding active infrastructure, spectrum and operating costs, among others. Brazil and Mexico account for nearly 50% of the required investment (27% and 20%, respectively), while the remaining is distributed as follows: 13% in Peru, 5% in Colombia, 5% in Argentina and 30% in other countries in the region.

A 17 billion dollar investment up to 2030 is equivalent to 3% of Latin American operator's average annual revenue, so it would not be a significant figure if they are allocated to more efficient infrastructure models that can meet the demand for passive infrastructure in the face of 5G adoption and IoT growth.

Finally, it is important to note that 62% of this investment will likely be made by passive infrastructure companies, while mobile operators are expected to invest only 38%. The investment share of passive infrastructure companies will evolve along with their market share, starting under 60% in the first few years and reaching 67% in 2030.

Considering that these investments will be made within one year, and assuming an 8.4%[53] discount rate, their present value is USD 11 billion.

FIG 32.
Estimated investments by country for site deployment: 2021 to 2030



Source: American Tower, GSMA, World Bank, OECD, IMF, Central Banks and Statistics Institutes of the countries, Econstor, TowerXchange, SmC+ analysis

53. Cost according to NYU Stern's Aswath Damodaran for emerging markets and for the telecommunications equipment sector.

Summary and recommendations

The exceptional circumstances caused by the coronavirus pandemic (COVID-19) have highlighted the importance of the telecommunications infrastructure in providing continuity for communications, aiding security and prevention, sustaining economic, educational, health and social activities and the provision of public services.

In the current health emergency and considering the increased demand for connectivity by public and private institutions and by more people who work remotely or study from home, it is of utmost importance that authorities enable the necessary conditions to deploy new networks and effectively maintain existing ones, allowing the free movement of technical personnel and their access to sites.

The role of infrastructure companies, committed to investing in and maximizing the use of public space, must be considered now more than ever to offer more communication alternatives. Territorial integration, access to critical services such as health and public safety, and support for new forms of education and work will be fundamental to guarantee the well-being and prosperity of the future of our countries. All this begins with more antennas.

Clearly, passive infrastructure companies will have a key role to play in the deployments required for 5G development, as they will be responsible for about two thirds of the total USD 17 billion investment required due to a x4 increase in the number of sites demanded. All this, in a context in which infrastructure management and the participation of the different stakeholders are

changing, and where it is necessary to stimulate sharing.

Contextual changes mean that by 2030, independent passive infrastructure companies are expected to account for 67% of the infrastructure asset market in Latin America. These companies offer different advantages for the sector, both from the mobile operators' point of view and from the economic benefit for the sector as a whole and from an environmental perspective, leveraged by the specialization that infrastructure companies contribute to the complete process required for the deployment of connectivity infrastructure and by the generation of greater infrastructure sharing.

FIG 33.
Benefits for the sector resulting from the role of passive infrastructure companies

Operator specialization
Focus on their core business, without the need to dedicate economic and human resources to the deployment of new sites and their subsequent maintenance and administration.
Financial efficiency: transforming a cost from CAPEX to OPEX, use to invest in other business activities.

Economic benefits for the sector
Operators' resources in products and services for end customers, who ultimately benefit the most.
Cost reduction resulting from infrastructure sharing.

Infrastructure companies specialization
Know-how specific to the infrastructure deployment activity, even more relevant given the need for new sites and new stakeholders to interact with
Focus on business profitability, therefore, interest in promoting infrastructure sharing.

Environmental benefits
Reduced number of sites.
Less visual pollution and lower public concern.
Lower carbon footprint as a result of reducing the use of materials and site operation.

Partnering with all stakeholders on a forward-looking work agenda

Collaboration and coordination among authorities will be essential to stimulate this growing industry that needs predictability in the approval processes for site installation. Based on this, public policy recommendations are mainly aimed at providing predictability by local authorities in the approval processes for site installation.

Local governments have the opportunity to play a key role in digital transformation, serving the needs of citizens by improving connectivity services, security or street lighting. Becoming a smart city requires intelligent use of city resources (buildings, squares, roads, etc.) and those of utility concessionaires (ducts, poles and masts). These assets ultimately belong to the citizens, who increasingly demand more advanced and better quality connectivity to carry out their activities. Failure to use those assets efficiently represents a lost opportunity cost that developing countries cannot afford.

Public policy recommendations have been classified into those that are mainly related to regulatory issues and those that are of a strategic or commercial nature for the business.

FIG 34.

Public policy recommendations: regulatory

RECOMMENDATION	DESCRIPTION/ IMPACT	RELEVANT BACKGROUND
National-municipal coordination	• Currently, there are as many regulations as there are municipalities in the country. • Nationwide uniformity of rules, ensuring that they are adopted by the municipalities. • Eliminates discretionary power and ambiguity, thus ensuring uniform criteria and processes in addition to legal certainty. • Procedures manual.	• Argentina • Colombia • Costa Rica • Brazil
One-stop shop	• "One-stop" solution. • The result is an expedited process, through clear and unambiguous requirements. • No duplicate requirements by different agencies and reduces bureaucratic time.	• Colombia • Argentina • Mexico (in Hidalgo there is a comparable scheme)
Positive administrative silence	• Commencement of work against request for approval and submission of documentation. • Clarity in conditions and requirements is required, no discretionary power is tolerated. • No infrastructure company would risk disbursing money if what is presented does not meet the established requirements. • At present, in many cases there is denial by default, i.e.,the absence of a response must be considered as a rejection.	• Brazil • Peru • Chile (listed as provisional permit) • Argentina (Mendoza)
Active, passive and carrier neutral infrastructure sharing	• Cost efficiency for both the infrastructure company and the operator. • Ability to meet the demand for sites in a shorter period of time. • Extension of the carrier neutral concept to other assets (fiber, data center, RAN as a Service, active element).	
Expedited process for smaller infrastructure	• Differential requirements according to infrastructure size, reducing requirements, and therefore timeframes, in the case of smaller infrastructure. • Different standards in the case of antennas, small cells, micro data centers, etc.	

Source: SmC+

Fig 35.
Public policy recommendations: incentives/promotion

RECOMMENDATION	DESCRIPTION/ IMPACT	RELEVANT BACKGROUND
Use of existing infrastructure	• Public-private agreements with utilities and governments for the use of infrastructure and public buildings (e.g. electricity, highways, street lighting, etc.). • Requires continuous negotiation as well as reaching a significant number of agreements. • Economic savings in deployments by using existing infrastructure. • Accelerates deployment times and obtains immediate capillarity.	• Mexico • Chile • Costa Rica • Brazil • Argentina
Ranking of Internet-friendly cities	• Release of the ranking of cities based on their ability to develop Internet (including connectivity deployments). • Exposes those cities that do not promote infrastructure deployments, with consequent political impact for officials as well as on the feasibility to attract investments. • To be published by, or with the support of, a recognized body, such as the Ministry of Telecommunications.	• Brazil • Argentina • Colombia • Peru
Citizen perception	• Communication and education on those issues that citizens perceive as negative in the industry: health, environment, capital gains, etc. • Involvement of authorities from different sectors: medical, technical, environmental, real estate experts, etc. to clarify doubts about the industry and its impacts. • Communication campaigns.	• Peru • Colombia • Bolivia • Argentina • Mexico
Tax incentives	• Tax exemption given the high investment amounts. • Tax benefits for infrastructure sharing. • Advance tax refunds (e.g. VAT on fixed asset investments).	

Source: SmC+

It is clear that some of the recommendations made have already been attempted in the past with mixed results, although generally with little success due to implementation failures or a lack of real empowerment to carry them through. So far, all efforts have been difficult and not without obstacles, when outside the scope of the sector. This indicates that there is a need for real empowerment of those who drive the agenda at the national level in order to "discipline" the other national vertical and subnational stakeholders. The mandate should be clear and unambiguous from the plan to the policy maker within the Executive Power, and if possible, endowed with a normative and institutional framework so as to act in an institutionalized (not voluntary) manner in all senses. This approach is associated with the need to define a new paradigm in the management of authorizations and permits to support mobile expansion infrastructure deployment.

However, some of these initiatives have been undertaken on a temporary basis as a result of the effects of the COVID-19 pandemic. This exceptional circumstance enabled the incentives of jurisdictional actors observing different autonomies to be organized under the same objective.

Consequently, in order to achieve agreed-upon and more favorable results, it is essential for national authorities to set up an intersectoral roundtable, where various stakeholders would be invited to participate and contribute with measures to ensure the success of initiatives that support infrastructure deployments. Some of the players that should necessarily

be part of this intersectoral roundtable are the following: (i) national authority (Ministry of Telecommunications); (ii) municipal authority; (iii) infrastructure companies; (iv) mobile operators; (v) environment; (vi) municipal urban planning; (vii) Ministry of Health; and (viii) a citizen representative.

In the case of the health authorities, it is important to note that a considerable part of the restrictions are the direct result of neighborhood pressure on local political authorities. The underlying problem is social misinformation about the effects of non-ionizing radiation (NIR). Local authorities lack the technical training necessary to persuade, and are unwilling to take on this "pro-infrastructure" role. In turn, operators, and their unions, have the technical knowledge but not the social credibility. The national regulatory body, and the national health ministry, both have the technical knowledge and the social credibility to perform this fundamental task. It is therefore important that both governmental offices be obliged to deal with this issue on a permanent and mandatory basis and to set up teams and budgets to address this matter[54].

The objective is to have a group that deals with matters that promote infrastructure deployments considering the interests of all parties involved, seeking their approval and avoiding obstacles when implementing initiatives.

Participation of all parties is vital in order to have various visions and to consider the interests, not always convergent, of the different players and sectors involved, so that they all coincide in a common collaborative agenda.

The COVID-19 pandemic, coupled with the imminent need to deploy new sites for the use of 5G, make the issue a high priority that should not be neglected by authorities, which requires enormous coordination and collaboration efforts, but mainly leadership in pursuit of a very clear goal: sustainable economic development with equal opportunities for all Latin Americans.

54. Russell E. (2020).

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