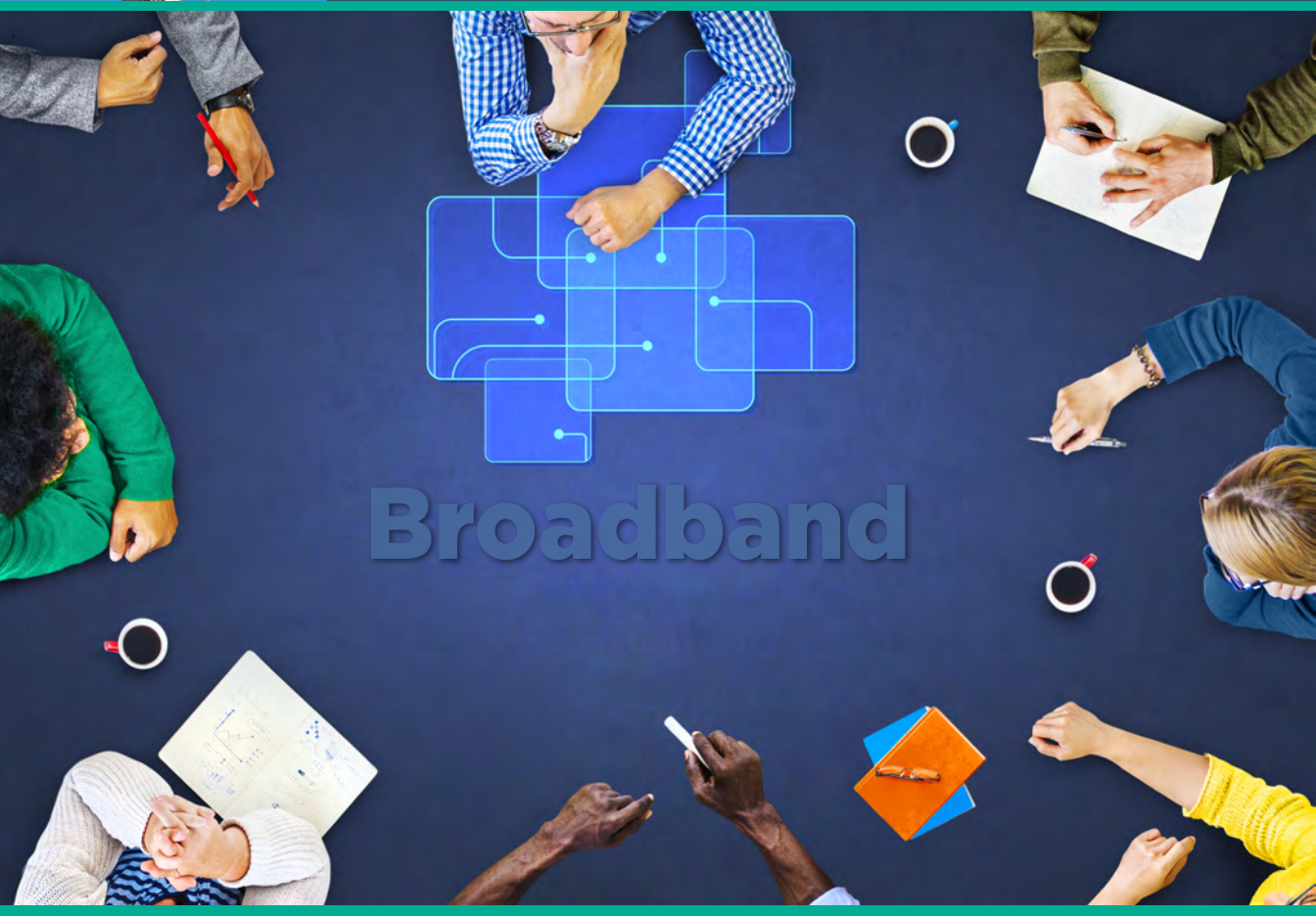
Development of National Broadband Plans

in Latin America and the Caribbean



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Abbreviations

3GPP	3rd Generation Partnership Project
BBGP	Broadband for the General Population
BSR	Bad session rate
CBRS	Citizens Broadband Radio Service
CIP	Crown Infrastructure Partners
DBO	Design-Build-Own
DNS	Domain name server
FCC	Federal Communications Commission (United States)
FTTP	Fiber to the premises
GAA	General Authorized Access
GB	Gigabyte
Gbps	Gigabits per second
GDP	Gross domestic product
GEO	Geostationary equatorial orbit
GHz	Gigahertz
GNI	Gross national income
GSMA	Global System for Mobile Communications Association
HAPS	High-altitude platform station
HSBB	High-Speed Broadband
HSDPA	High Speed Downlink Packet Access
ICT	Information and communications technology
IDB	Inter-American Development Bank
IEEE	Institute of Electrical and Electronics Engineers
IMT	International mobile telecommunications
IoT	Internet of Things
ISP	Internet service provider
ITU	International Telecommunication Union
ITU-D	ITU Telecommunication Development Sector
IXP	Internet exchange point

Kbps	Kilobits per second
LAC	Latin America and the Caribbean
LEO	Low earth orbit
LTE	Long Term Evolution
M2M	Machine to Machine
MB	Megabyte
Mbps	Megabits per second
MHz	Megahertz
MSAP	Mandatory Standard on Access Pricing
MSP	Managed Spectrum Park
NBP	National broadband plan
NFCP	National Fiberisation and Connectivity Plan (Malaysia)
NTIA	National Telecommunications and Information Administration (United States)
OECD	Organisation for Economic Co-operation and Development
PAL	Priority Access Licensee
PCAST	President's Council of Advisors on Science and Technology (United States)
PPP	Public-private partnership
PPP$	Purchasing power parity dollars
RSM	Radio Spectrum Management
SDG	Sustainable Development Goals
SME	Small and medium enterprise
SMME	Small, micro, and medium enterprise
SPV	Special-purpose vehicle
TIC A.C.	Telecomunicaciones Indígenas Comunitarias A.C. (Mexico)
TVWS	Television white space
UAS	Universal access and services
UFB	Ultra-Fast Broadband
UHF	Ultra High Frequency
UN	United Nations
U-NII	Unlicensed National Information Infrastructure
USD	United States dollar
VHF	Very High Frequency
WSIS	World Summit on the Information Society

Executive Summary

This publication details the benefits of and proposes a framework for national broadband plans in the Latin American and Caribbean (LAC) region. As the Broadband Commission for Sustainable Development has pointed out, a well-formed national broadband plan is a country's blueprint for addressing and reducing digital inequality (ITU and UNESCO, 2020). In addition, in its latest Affordability Report, the Alliance for Affordable Internet details the linkage between high-quality national broadband plans and progress toward affordability (Alliance for Affordable Internet, 2020a).

All LAC governments should have a national broadband plan (NBP) as a key pillar for any digital agenda. Most countries in the region have adopted them, with the exception of El Salvador, Haiti, Saint Kitts and Nevis, Suriname, and Venezuela (ITU and UNESCO, 2020). However, most plans are outdated and, in general, lack clear, ambitious, and achievable policy-related commitments and quantifiable targets. In addition, many lack effective monitoring and evaluation programs.

This work details six key elements common to NBPs in countries that have made the most progress in increasing the availability, adoption, and use of information and communications technologies (ICTs): (i) good governance, (ii) clear goals, (iii) regular assessment of broadband availability and adoption, (iv) supply-side interventions, (v) demand-stimulation activities, and (vi) monitoring and evaluation programs. To further inform the recommendations, the present work examines the national broadband planning and sectoral development efforts of four countries: (i) Malaysia, (ii) New Zealand, (iii) Spain, and (iv) the United States. It also incorporates references to successful policy-related innovations from other countries and identifies the full range of digital technologies that could be used to address national connectivity goals. The good news is that governments and network operators have a growing menu of options to deliver cost-effective and affordable connectivity to communities in need. The key to unlocking these opportunities is developing sound policies and regulations.

A key insight from available literature is that global efforts to close the digital divide are not ambitious or effective enough. Basic connectivity targets will lead to greater inequalities in basic and enhanced capabilities, and thus goals should be based on the future of technology and include specific targets for poorly connected areas such as rural and marginalized areas

or groups. While timescales will vary based on a country's stage of sectoral development, a well-considered NBP could achieve the following targets in the LAC region:

- 4G mobile networks covering 99 percent of the population
- 5G mobile coverage in major urban settlements and along major roads and railways
- All anchor institutions (primary and secondary health-care facilities, schools, centers for administrative service provision, postal offices, youth centers, etc.) with at least 1 Gbps symmetrical fiber connections
- All households with access to fixed broadband services delivering at least 100 Mbps download capacity and 20 Mbps upload capacity, with low latency and no data caps
- At least 70 percent of youth and adults having basic digital skills

In addition, LAC governments should consider alternative approaches to expanding broadband availability. Governments can promote competition from new entrants through wholesale open access networks, infrastructure sharing, and increasing licensed and unlicensed access to spectrum for fixed wireless and satellite solutions. This could also include funding new business models such as community networks and cooperatives. Demand-stimulation initiatives, such as digital skills training programs and the development of local applications and content, also need further development, even where affordable fixed and mobile broadband is available. Overall, a coordinated and concerted effort to achieve aggressive digital inclusion targets is needed that incorporates proven as well as new technological, financial, and regulatory approaches.

Introduction and Overview

This work provides a framework for Latin American and Caribbean (LAC) governments to develop national broadband plans (NBPs). This introduction gives a brief overview of the state of global broadband access and United Nations (UN) and International Telecommunication Union (ITU) goals and efforts to achieve global universal digital connectivity. It also briefly discusses the implications of the COVID-19 pandemic on global efforts to expand internet connectivity, and offers an overview and analysis of digital connectivity across the LAC region. The first section provides an introduction to NBPs, both from a substantive and procedural perspective. The second section summarizes key innovations from the NBPs and efforts of four countries—Malaysia, New Zealand, Spain, and the United States—and identifies key innovations that might be applicable to the LAC contexts. The third section gives an overview of digital technologies used to achieve connectivity goals, and the fourth section provides a detailed guide to building an NBP, including indicia of good governance, clear goals, assessing the current state of broadband, developing specific policy and regulatory goals inclusive of promoting competition, increased access to spectrum, supply-side interventions, demand-side interventions, providing ambitious but realistic goals, and implementing monitoring and evaluation programs. The appendices cover the contribution of digital infrastructure to the achievement of the UN's Sustainable Development Goals; provide more detail on the NBPs in Malaysia, New Zealand, Spain, and the United States; summarize different community networks around the world; and review different public-private partnership (PPP) models.

According to the latest ITU data, global internet user penetration is currently at 51 percent or about 4.0 billion people online, meaning that about 3.7 billion people around the world are still not accessing the internet (ITU, 2020d). Global internet user penetration is 44 percent in developing countries, and in least developed countries internet user penetration is at 19 percent (ITU, 2020d).

According to the World Bank, 65.90 percent of people in Latin America and 82.84 percent of people in Organisation for Economic Co-operation and Development (OECD) countries were internet users (World Bank, n.d., "World Development Indicators").[1]

[1] Note that the World Bank creates summaries based on ITU data and the ITU only has up-to-date data for most countries through 2018, when 212 out of 233 economies responded to surveys.

According to the ITU, the proportion of all women using the internet globally is 48 percent, compared to 55 percent of all men (ITU, 2020d). In the LAC region, a nearly equal proportion of men and women use the internet; however, there are some differences within the region (ITU, 2020d).[2]

Furthermore, the opportunities and education of children and young people have been severely limited by lack of internet access, especially during the COVID-19 crisis. According to a new report commissioned by UNICEF and the ITU Telecommunication Development Sector (ITU-D), 2.2 billion or 67 percent of children and young people under age 25 worldwide lack internet access at home (UNICEF and ITU, 2020). In Latin America and the Caribbean, the figure is 47 percent (130 million) (UNICEF and ITU, 2020).

Table 0.1 provides a breakdown of the number of children and young people in select LAC countries who have internet access at home. In the LAC region, there is a major urban-rural divide. The percentage of children and young people under age 25 with internet access at home is 62 percent in urban areas, but only 27 percent in rural areas (UNICEF and ITU, 2020). In addition, there are stark differences between the rich and poor: 75 percent of children and young people in the wealthiest quintile have internet access at home, compared to only 40 percent of children and young people in the poorest quintile (UNICEF and ITU, 2020).

The Broadband Commission for Sustainable Development was established in 2010 by the ITU and UN Educational, Scientific and Cultural Organization (UNESCO) with the aim of boosting the importance of broadband on the international policy agenda and expanding broadband access in every country as key to accelerating progress toward national and international development targets (Broadband Commission for Sustainable Development, 2020). The Broadband Commission has observed that lack of affordability, constrained access to infrastructure and devices, poor digital skills, and/or the absence of relevant online content mean that the 3.7 billion people around the world who are not online, and billions of other marginalized people struggling with poor connectivity, are unable to leverage the power of digital transformation in a way that could catalyze seismic shifts in development outcomes (Broadband Commission for Sustainable Development, 2020). The Broadband Commission has established seven advocacy targets seeking to expand broadband infrastructure and internet access and use by populations around the world (Table 0.2).

The Broadband Commission has observed that "achieving affordable universal connectivity is essential for achieving the 17 Sustainable Development Goals (SDGs) and making good on our pledge to Leave No-one Behind" (Broadband Commission for Sustainable Development, 2020). According to the Broadband Commission, four of the UN's 17 SDGs include targets related to information and communications technology (ICT) and at least 38 other sustainable devel-

[2] The Alliance for Affordable Internet has warned against premature abandonment of government programs targeted at closing the gender gap in connectivity (Alliance for Affordable Internet, 2020a). According to the GSMA (2020), while markets like Brazil and Mexico show near parity in smartphone device ownership and internet use between men and women, in markets like Guatemala a significant gender divide persists; moreover, in Guatemala, safety and security remain a greater barrier to connectivity for women than men.

TABLE 0.1 PERCENTAGE OF CHILDREN AND YOUNG PEOPLE IN SELECT LAC COUNTRIES WITH INTERNET ACCESS AT HOME

Country	School-age children 3–17 years old (%)	Youths 15–24 years old (%)	Children and youths 0–25 years old (%)
Argentina	40	45	41
Barbados	66	70	65
Bolivia	12	17	13
Brazil	83	83	86
Chile	86	88	87
Colombia	36	44	38
Costa Rica	72	78	74
Dominican Republic	24	27	24
Ecuador	42	47	42
Guatemala	9	12	9
Haiti	21	28	22
Mexico	43	41	49
Nicaragua	5	4	6
Panama	31	36	30
Peru	29	26	33
Saint Lucia	48	49	48
Suriname	50	55	52
Trinidad and Tobago	45	44	49
Uruguay	64	63	71

Source: UNICEF and ITU (2020). See Appendix 5 for specific survey and year used for each country.

opment targets rely on universal and affordable access to ICT and broadband to reach these targets (ITU and UNESCO, 2020).[3] Appendix 1 provides a table from an Inter-American Development Bank (IDB) report on the impact of digital infrastructure on the SDGs in the LAC region.

This work focuses on the Broadband Commission's first target (that all countries should have a funded national broadband strategy), which necessarily incorporates targets two, three, and four (focused on affordability, broadband-user penetration, and digital skills attainment).

[3] The four SDGs with ICT-related targets are SDG 4 on Quality Education (target 4b); SDG 5 on Gender Equality (target 5b); SDG 9 on Industry, Innovation and Infrastructure (target 9c); and SDG 17 on Partnerships for the Goals (target 17.8).

TABLE 0.2 BROADBAND COMMISSION'S ADVOCACY TARGETS

Advocacy targets	Description	Situation in LAC countries
Advocacy Target 1 (policy)	By 2025, all countries should have a funded NBP or strategy or include broadband in their universal access and services (UAS) definition.	Countries with NBPs: Argentina, Antigua and Barbuda, Bahamas, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Vincent and the Grenadines, Uruguay
Advocacy Target 2 (affordability)	By 2025, entry-level broadband services should be made affordable in developing countries, at less than 2 percent of monthly gross national income per capita.	In LAC, the bottom 40 percent of income earners would have to set aside an amount equal to 10 percent of their monthly income to subscribe to basic fixed broadband (with a capacity of 2 Mbps), compared to 3 percent of wages for the same population segment in OECD countries. Within LAC subregions, the bottom 40 percent of income earners would have to set aside the following amount of their monthly income to subscribe to basic fixed broadband: 13 percent in the Caribbean, 13 percent in Central America, 11 percent in the Andean countries, and 8 percent in the Southern Cone (Prats Cabrera and Puig Gabarró, 2017).
Advocacy Target 3 (connectivity)	By 2025, broadband-internet user penetration should reach 75 percent worldwide, 65 percent in developing countries, and 35 percent in least-developed countries.	Percentage of the population with internet access in 2020 by country (Statista, 2021):

Bahamas	85
Puerto Rico	84
Barbados	82
Chile	82
Argentina	78
Uruguay	78
Trinidad and Tobago	77
Dominican Republic	75
Costa Rica	74
Peru	73
Venezuela	72
Brazil	71
Ecuador	69
Colombia	69
Mexico	69
Paraguay	65
Bolivia	65
Guatemala	65
Cuba	63
Panama	62
El Salvador	59
Jamaica	55
Nicaragua	47
Honduras	42
Haiti	33

(continued on next page)

TABLE 0.2 BROADBAND COMMISSION'S ADVOCACY TARGETS *(continued)*

Advocacy targets	Description	Situation in LAC countries
Advocacy Target 4 (skills)	By 2025, 60 percent of youth and adults should have achieved at least a minimum level of proficiency in sustainable digital skills.	According to the World Bank (Cobo, Hawkins, and Rovner, 2020):[a] **Colombia:** The strategy combines online, offline, and broadcasting. Families with internet access can utilize Aprender Digital, a national platform with over 80,000 digital resources organized by grade. **Costa Rica:** To reach homes, a national emergency platform with educational resources was created (Aprendo en Casa). Costa Rica reaches its teachers through digital tools and resources such as a virtual classroom or a guide for autonomous work. **Dominican Republic:** There is a national education portal with content classified by grade, with public and private TV broadcasts. Over 1,000 free public Wi-Fi access points have been set up. WhatsApp groups are giving specific support to teachers and parents and provide helpful content. **Ecuador:** Ministry of Education has developed a set of guides for educators to ensure that learning is not interrupted, and to help build teacher capacity for remote delivery. A national information unit was created to provide guidance and critical information to teachers and parents. A national educational platform is available with over 800 pedagogical resources. **Nicaragua:** The government is implementing a multi-layer contingency plan to inform and implement to ensure that learning will continue if schools are closed. The country has pedagogical guides by grade and is organizing digital content to be shared in the educational platform. WhatsApp and social media are key coordination and communication channels. **Paraguay:** An agreement with a large tech company was reached to offer an educational package at zero cost to benefit 60,000 teachers and 1.2 million students. The administration has launched a national portal (adapted for users with limited broadband connectivity). **Peru:** The government is adopting a strategy to distribute content via internet, TV, radio, and phones. The actions include content aligned with the national curriculum. A national platform combines virtual classes with mobile messaging. **Uruguay:** Students from public schools have access to a computer, and the focus is on getting educational content for the devices to provide the needed pedagogical assistance to educators. A national learning management system was implemented where educators can have their own virtual classroom and/or improve their teaching skills.

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TABLE 0.2 BROADBAND COMMISSION'S ADVOCACY TARGETS *(continued)*

Advocacy targets	Description	Situation in LAC countries
Advocacy Target 5 (digital finance)	By 2025, 40 percent of the world's population should be using digital financial services.	According to an Inter-American Development Bank (IDB) report by Ballesteros, Navajas, and Gallagher (2020), of 21 countries in the region analyzed, 19 made emergency economic transfers to support vulnerable sectors of the population during the COVID-19 crisis. Of those, 11 countries distributed those funds mainly through financial accounts and digital wallets. Digital transfers made it possible to ensure that social assistance reached its recipients quickly and safely. Digital infrastructures have enabled governments to identify, register, and mobilize funds. An example is Brazil, where since April 2020 government aid to independent workers, microentrepreneurs, and the unemployed reached 67 million people. Other LAC countries also launched economic transfer programs for informal sector workers, reaching 75 percent of these workers in El Salvador, 38 percent in Chile, and 21 percent in Colombia.
Advocacy Target 6 (SME connectivity)	By 2025, un-connectedness of micro-, small-, and medium-sized enterprises should be reduced by 50 percent, by sector.	According to the World Bank Enterprise Surveys data on enterprises with websites and using email (World Bank, n.d., "Enterprise Surveys"): In LAC countries, 49.7 percent of firms have their own website and 84 percent use email to interact with clients/suppliers. In addition, according to an IDC study commissioned by Cisco (IDC, 2020), Latin America lags behind when it comes to digital maturity; 54 percent of small businesses in the region are at the lowest level of maturity (Stage 1: Digital Indifferent) on their digitalization journey, 1 percent are in Stage 2: Digital Observer, and 44 percent are in Stage 3: Digital Challenger, with none having reached Stage 4: Digital Native. Finally, countries like Argentina, Chile, Colombia, Ecuador, Mexico, Peru, and Uruguay are having progress in the OECD SME Policy Index assessment (OECD, 2019).
Advocacy Target 7 (gender equality)	By 2025, gender equality should be achieved across all targets.	In the LAC region, a nearly equal proportion of men and women use the internet; however, there are some differences within the region, such as in Central America (ITU, 2020d). Thus, further work is needed.

Source: ITU and UNESCO (2020), plus individual sources cited in table.
[a] For further details on digital skills in the region, see https://publications.iadb.org/publications/english/document/Sources-of-Data-on-Digital-Talent-in-Latin-America-and-the-Caribbean.pdf.

Overview of Connectivity in Latin America and the Caribbean

Universal fixed and mobile broadband availability would deliver huge economic benefits to the LAC region. In particular, digitalization furthers the UN's SDGs, and digital infrastructure can mitigate the impact of the COVID-19 pandemic and future events (García Zaballos, Iglesias,

and Adamowicz, 2019; García Zaballos, Iglesias et al., 2020). Each 10 percent rise in fixed and mobile broadband penetration would result in a 1.6 percent and 1.7 percent rise in the region's gross domestic product (GDP) respectively (Bamford, Hutchinson, and Macon-Cooney, 2021). Approximately US$51 billion would be needed to extend 4G mobile coverage to 100 percent of the population of Latin America and the Caribbean, but this investment would deliver approximately US$955 billion in economic benefit (Bamford, Hutchinson, and Macon-Cooney, 2021). The region could see a similar cost-benefit from investing in fixed broadband.

As shown in Table 0.3, the price of mobile data-only packages is affordable[4] in several economies of the LAC region, but such packages remain unaffordable in the majority of the region's countries, especially for the bottom 40 percent and 20 percent of income earners.

Table 0.4 shows that while the price of fixed broadband is affordable in four countries in the LAC region, the price of fixed broadband remains unaffordable in most markets, and in particular for the bottom 40 percent of income earners in all LAC countries. It is noteworthy that the Bahamas and Brazil are the only countries in the region where *both* mobile and fixed broadband is affordable for the average person (this is not the case, however, for the bottom 40 percent and 20 percent of income earners, for whom no countries in LAC have affordable fixed broadband).

[4] The Broadband Commission has set a target for entry-level mobile and fixed broadband services to be less than 2 percent of monthly gross national income (GNI) per capita. For mobile services, mobile broadband is considered affordable if 1 GB of data is available for 2 percent or less of GNI per capita (Alliance for Affordable Internet, 2018). Fixed broadband service is considered affordable if it provides at least 5 GB of monthly data consumption on a connection providing at least 256 Kbps for 2 percent or less of GNI per capita (ITU, 2020e).

TABLE 0.3 PRICE OF MOBILE DATA-ONLY PACKAGES IN LAC (PERCENTAGE OF GNI PER CAPITA FOR ENTIRE POPULATION AND BOTTOM 20 AND 40 PERCENT OF INCOME EARNERS)

Global Rank	Economy	% of GNI p.c.	% of GNI p.c. bottom 20%	% of GNI p.c. bottom 40%	USD	PPP$
26	Bahamas	0.58	N/A	N/A	14.55	12.84
33	Costa Rica	0.72	3.27	1.15	6.93	10.79
52	Chile	0.89	3.07	1.40	10.9	15.15
62	Mexico	1.02	3.78	1.61	7.79	14.75
70	Barbados	1.18	N/A	N/A	15.00	11.93
75	Argentina	1.31	5.57	1.90	13.53	N/A
84	Uruguay	1.61	5.55	2.28	20.99	25.19
85	Panama	1.67	9.28	2.74	20.00	34.87
86	Peru	1.68	6.46	2.44	9.13	17.37
90	Brazil	1.8	11.61	3.20	13.68	22.23
94	Suriname	1.93	N/A	N/A	8.04	N/A
100	Ecuador	2.2	9.78	3.38	11.2	19.28
104	Saint Kitts and Nevis	2.38	N/A	N/A	37.04	49.15
108	Bolivia (Plurinational State of)	2.58	10.12	3.75	7.24	14.49
109	Colombia	2.74	14.81	4.66	14.14	29.61
112	Antigua and Barbuda	2.81	N/A	N/A	37.04	45.57
113	Saint Lucia	2.82	18.19	4.76	22.22	29.08
118	Trinidad and Tobago	3.07	11.16	4.35	41.54	49.7
122	Dominica	3.39	11.30	5.02	20.37	28.42
123	Dominican Republic	3.42	N/A	N/A	21.01	45.62
124	Grenada	3.45	N/A	N/A	28.15	38.28
125	Guatemala	3.58	15.91	5.82	13.17	21.99
130	Haiti	3.97	14.44	5.80	2.65	5.66
134	El Salvador	4.4	13.97	6.24	14.00	27.85
136	Paraguay	4.42	18.42	6.83	20.93	44.86
138	Belize	4.45	27.81	7.88	17.5	N/A
140	Saint Vincent and the Grenadines	4.59	N/A	N/A	30.37	42.19
141	Guyana	4.61	21.95	7.23	18.29	29.36
148	Jamaica	5.6	21.13	8.62	23.28	36.35
156	Nicaragua	7.87	30.86	12.54	13.31	35.82
159	Honduras	8.62	47.89	13.21	16.73	32.83
N/A	Cuba	N/A	N/A	N/A	20	N/A
N/A	Venezuela	N/A	N/A	N/A	N/A	N/A

Sources: ITU (n.d., "Price Baskets") and World Bank (n.d., "World Development Indicators").
Note: For Global Rank, a lower number means more affordable and a higher number means less affordable.

TABLE 0.4 PRICE OF FIXED BROADBAND PACKAGES IN LAC (PERCENTAGE OF GNI PER CAPITA FOR ENTIRE POPULATION AND BOTTOM 20 AND 40 PERCENT OF INCOME EARNERS)

Global Rank	Economy	% of GNI p.c.	% of GNI p.c. bottom 20%	% of GNI p.c. bottom 40%	USD	PPP$
44	Bahamas	1.38	N/A	N/A	34.71	30.64
45	Brazil	1.43	9.23	2.54	10.92	17.74
51	Trinidad and Tobago	1.55	5.64	2.20	20.97	25.09
61	Costa Rica	1.79	8.14	2.85	17.16	26.72
71	Mexico	2.37	8.78	3.73	18.14	34.31
74	Uruguay	2.65	9.14	3.75	34.5	41.4
75	Panama	2.67	14.83	4.38	31.95	55.7
76	Chile	2.68	9.24	4.20	32.73	45.51
78	Saint Kitts and Nevis	2.76	N/A	N/A	42.9	56.94
89	Dominican Republic	3.21	N/A	N/A	19.69	42.77
90	Barbados	3.35	N/A	N/A	42.5	33.81
92	Peru	3.47	13.35	5.05	18.86	35.89
96	Antigua and Barbuda	3.65	N/A	N/A	48.15	59.24
103	Colombia	4.19	22.65	7.13	21.62	45.27
106	Saint Lucia	4.42	28.52	7.46	34.82	45.56
107	Ecuador	4.59	20.40	7.06	23.41	40.3
109	Paraguay	4.98	20.75	7.69	23.55	50.47
111	Grenada	5.45	N/A	N/A	44.44	60.44
112	Argentina	5.52	23.49	8.00	56.95	N/A
113	Dominica	5.86	19.53	8.68	35.19	49.1
114	Jamaica	6.41	24.19	9.86	26.67	41.64
115	Guatemala	6.48	28.80	10.54	23.81	39.76
119	Saint Vincent and the Grenadines	6.72	N/A	N/A	44.44	61.74
120	Suriname	6.77	N/A	N/A	28.14	N/A
121	Bolivia (Plurinational State of)	7.58	29.73	11.03	21.27	42.6
124	El Salvador	7.85	24.92	11.13	25	49.73
126	Guyana	8.01	38.14	12.56	31.77	50.99
132	Belize	8.77	54.81	15.52	34.5	N/A
145	Honduras	17.51	97.28	26.84	34	66.7
148	Nicaragua	19.03	74.63	30.33	32.19	86.63
168	Haiti	82.5	300.00	120.44	55	117.62
N/A	Cuba	N/A	N/A	N/A	50	N/A
N/A	Venezuela	N/A	N/A	N/A	N/A	N/A

Sources: ITU (n.d., "Price Baskets") and World Bank (n.d., "World Development Indicators").
Note: For Global Rank, a lower number means more affordable and a higher number means less affordable.

1 Introduction to National Broadband Plans

As the Broadband Commission has observed, digital inequality persists around the world, even in countries with high-speed connectivity infrastructure (ITU and UNESCO, 2020). The same is true in the LAC region, where digital inequality disproportionately impacts people who are: (i) low income earners, (ii) located in rural areas, and (iii) lacking literacy and digital skills. The COVID-19 pandemic has accentuated even further the connectivity and digitization lag in LAC countries (García Zaballos, Iglesias et al., 2020). As with other measures of human development, people at the bottom are catching up in terms of basic internet access but remain behind in enhanced capabilities (UNDP, 2019). In addition, the digital divide is widening, not narrowing, across many dimensions. With the rapid progress in technologies, digital inequality is at risk of widening at an accelerating pace over time (UNDP, 2019). Addressing digital inequality, therefore, should be at the top of any government's agenda, and a well-formed NBP can act as a government's blueprint for building greater digital equality.

The Broadband Commission for Sustainable Development's first advocacy target is for all countries to have a funded NBP or strategy or include broadband in their universal access and service (UAS) definition by 2025. All LAC governments should have an NBP as a key pillar for any digital agenda, and there are numerous resources available to assist them in developing such plans. The World Bank's Broadband Strategies Toolkit guides policymakers, regulators, and other relevant stakeholders as they address issues related to broadband development (World Bank Group, n.d.). In 2012, the ITU-D developed best practices for NBPs, digital agendas, and digital strategies (ITU, 2012). In addition, in 2013, the Broadband Commission published a report on NBPs (Broadband Commission for Sustainable Development, ITU, and Cisco, 2013). In its 2020 annual report, the Broadband Commission places a particular focus on what governments can be doing to reduce digital inequality (ITU and UNESCO, 2020). The Affordability Report 2020 from the Alliance for Affordable Internet details the linkage between high-quality NBPs and progress toward affordability and details key attributes of successful NBPs (Alliance for Affordable Internet, 2020a).

While each of these resources and reports takes a slightly different approach, they share many common themes such as using transparent processes involving input from a wide range of actors, setting clear targets, implementing both supply- and demand-side interventions, and conducting regular reviews and implementing policy changes based on those reviews (Alliance

for Affordable Internet, 2020a; World Bank Group, n.d.). Ultimately, the goal of any successful NBP is to significantly increase the availability, adoption, and use of ICTs, which in turn leads to improved social and economic inclusion and various indicia of human development.

Table 1.1 presents six key elements of successful NBPs, along with recommended actions.

TABLE 1.1	SIX KEY ELEMENTS OF A SUCCESSFUL NATIONAL BROADBAND PLAN AND RECOMMENDED ACTIONS
Good governance	• A country's NBP should be developed through an open and transparent process. • A single entity in government should lead, but inter-governmental coordination is key to gaining needed support and for successful implementation of the plan. • Allowing for limited trials of new regulatory models and technologies—"sandboxes"—can be a good way to try out new approaches prior to allowing them permanently countrywide.

Clear goals	• Develop a multi-year NBP with clear, ambitious, and achievable policy-related commitments and quantifiable targets.
	• Over a five-year period, supply-side targets could include:
	  • 4G mobile networks covering 99 percent of the population
	  • 5G mobile coverage in major urban settlements and along major roads and railways
	  • At least 1 Gbps symmetrical fiber connections for all anchor institutions
	  • Fixed broadband services delivering at least 100 Mbps download capacity and 20 Mbps upload capacity, with low latency and no data caps, available to all households
	  • A set of intermediate targets with escalating speeds each year (an increase of 10 percent per year for download speeds and 15 percent per year for upload speeds)
	  • Access for all citizens to at least 2 GB of mobile data per month or 5 GB of fixed data per month for less than 2 percent of the median income (with an increase in bandwidth of 20 percent per year)
	• Over a five-year period, demand-side targets could include:
	  • A program providing an affordable laptop or tablet to every low-income primary and secondary school student
	  • 70 percent of the country with basic digital skills to engage with government services, online education, and e-commerce
	  • A program providing discounted mobile and fixed broadband to marginalized groups, such as persons with disabilities
	• Resilience targets for internet infrastructure can include:
	  • Network/ISP Resilience: Targets for availability and stability of the physical links and logical/peering links, availability of multiple domain name servers (DNS) and intrusion detection systems
	  • Critical Infrastructure Resilience: Targets for resilience of power infrastructure and internet cables (terrestrial and undersea), number of internet exchange points (IXPs) and top-level domains in a country
	  • Market Resilience: Targets for affordability of access and level of market concentration (avoiding chokepoints)

Regular assessment of broadband availability and adoption	• For data on availability, combine mobile and fixed operator coverage and speed data with crowd-sourced data such as OpenSignal. • Ensure that fixed and mobile coverage is available on a publicly accessible broadband map for all operators in the country and ensure that the map is kept up to date. • For data on usage and adoption, combine a mix of survey data such as the ITU ICT Access questionnaire with crowd-sourced service data such as Ookla and data from online services such as Facebook and marketing platforms such as GlobalWebIndex. • Network measurement data from end-user devices should be overlaid on the publicly accessible broadband map.

(continued on next page)

TABLE 1.1	SIX KEY ELEMENTS OF A SUCCESSFUL NATIONAL BROADBAND PLAN AND RECOMMENDED ACTIONS *(continued)*

Supply-side interventions	• Implement clear and enforceable competition policies:
	  • Policies should maximize competition throughout the supply chain.
	  • Policies should both promote competition and protect against abuse of market power.
	• Open up spectrum:
	  • Allocate licensed spectrum for 5G mobile networks
	  • Below 6 GHz for coverage
	  • Above 24 GHz for capacity
	  • Allocate more unlicensed spectrum for Wi-Fi 6 and other technologies in the 5 GHz and 6 GHz bands
	  • Promote dynamic access to unused spectrum
	  • Unlicensed access to TV white spaces (TVWS)
	  • Consider spectrum-sharing models in other bands, such as
	  • 2.3 GHz and 2.6 GHz bands
	  • 3.3–3.8 GHz bands
	  • Enable next-generation satellite and high-altitude-platform communications
	• Investment in infrastructure:
	  • In the absence of private sector investment, governments should consider investing in core network infrastructure, with access sold on a non-discriminatory (wholesale open access) basis to:
	  • Backbone networks
	  • IXPs
	  • Submarine cables
	  • In instances of market failure (such as in high-cost rural areas), governments should subsidize deployment of fixed and mobile last-mile networks, in which case,
	  • Separate programs should be created for fixed and mobile services,
	  • Fund recipients should be required to deploy broadband throughout the concession area,
	  • Subsidies should be open to all qualified competitors and available on a technology-neutral basis,
	  • Subsidies should be determined through a competitive process, such as reverse auctions, and
	  • Fund recipients should be held accountable for meeting quantifiable targets and should be rewarded for beating build-out deadlines.
	  • Funds for universal service subsidies should be collected from as broad a base of contributors as possible, ideally through general tax revenues.
	  • Universal service funds should be independently administered.
	• Consider policies promoting community-based network operators, especially in rural areas.
	• Consider social-purpose spectrum licenses to support community networks in locations where licensed spectrum is not being used.
	• Ensure that citizens from traditionally disenfranchised groups—such as persons with disabilities, the elderly, children, youth, ethnic minorities, and women and girls—have equitable access to mobile and fixed broadband, as well as other digital technologies.

Demand-stimulation activities	• Ensure that low-cost mobile and fixed broadband services and devices are available to low-income individuals and households. • Enable discounted services for anchor institutions (schools and libraries, health-care centers, government offices, police and fire stations, and community centers) and marginalized groups (e.g., women and girls, persons with disabilities, and indigenous populations). • Implement both basic and advanced digital skills programming. • Support programs developing locally relevant applications and content.
Monitoring and evaluation programs	• Include a monitoring and evaluation program at the outset. • Perform an open and transparent assessment and review of progress at least every two years. • Be prepared to course correct and update the plan in response to changed conditions.

As the Broadband Commission has noted, the process of developing an NBP will depend on a country's unique political and economic characteristics, as well as legal constraints. However, the steps below—adapted from a 2013 report by the Broadband Commission, ITU, and Cisco (2013)—can be used as a guide to consider the various elements of an NBP:

1. *Determine the convening and implementing bodies:* Which governmental organization will convene stakeholders to develop and implement the plan? And, which governmental organization(s) will be responsible for implementing the plan?
2. *Identify the consultative approach:* Will you take an informal approach (limited input from groups associated with convening agency), a consultative approach (one or more open public consultations on the draft plan), or actively consultative approach (workshops, public consultations, and joint reviews of drafts)?
3. *Landscape assessment, benchmarking, and identification of binding constraints:* Will include an assessment of fixed and mobile broadband availability and adoption, competitive landscape, etc.
4. *Goal setting:* Establishment of goals and targets for the NBP (e.g., speed, coverage, and adoption targets).
5. *Identify possible policy and marketplace interventions:* What policy and marketplace interventions will ensure that goals can be met?
6. *Match and filter policy actions on the basis of impact and feasibility:* What policy actions are likely to have the greatest impact relative to effort?
7. *Plan launch and implementation:* Prepare the draft plan, conduct public consultation, publicly launch plan, and commence implementation.

Today, 174 countries worldwide have an NBP of some sort, with several countries currently in the process of adopting one (ITU and UNESCO, 2020). In the LAC region, most countries have adopted NBPs. Notable exceptions are El Salvador, Haiti, Saint Kitts and Nevis, Suriname, and Venezuela (ITU and UNESCO, 2020).

In addition, some regional broadband plans have been developed, such as in Southeast Asia.[5] While some countries have developed new or updated NBPs, many countries are instead now focused on upgrading their UAS definitions or terms of service or developing broader digital transformation strategies and plans that address connectivity among other major issues (ITU and UNESCO, 2020).

[5] The countries of the Association of Southeast Asian Nations (ASEAN) adopted an ASEAN ICT Masterplan in 2015 (AIM 2015) and subsequently updated that plan in 2020 to focus more on consumer choice, quality, and pricing. That plan seeks to move beyond focusing only on connectivity to identifying and supporting communities that are isolated or underserved and focusing on increasing the demand, usage, affordability, and connectivity of broadband services across the ASEAN region. See the ASEAN ICT Masterplan 2020 (https://www.asean.org/storage/images/2015/November/ICT/15b%20--%20AIM%202020_Publication_Final.pdf) and Final Review: ASEAN ICT Masterplan 2020.

2 National Broadband Planning Case Studies

The recommendations on NBPs presented in this work are informed by a review of the NBPs of four countries: Malaysia, New Zealand, Spain, and the United States. While some other countries' policies are highlighted, these four countries were spotlighted for several reasons. First, each of these four countries was early to adopt an NBP and each has done a good job following up on their origi-

MALAYSIA

Notable Innovations and Achievements

- Creation of the High-Speed Broadband (HSBB) Project, a national open access network, using a Design-Build-Own (DBO) PPP arrangement (see Appendix 4)
  - Network is designed, funded, built, and managed by publicly owned operator
  - Private retail ISP providers can purchase access from HSBB
  - Achieved the fastest end-to-end fiber rollout in the world between 2011 and 2013
- Strong demand-side programs to increase uptake
  - 1 Malaysia program aimed to provide one million netbooks to citizens who lack devices. By 2014, the program had distributed 1.7 million laptops.
  - Community access facilities such as 1Malaysia Wireless Villages set up in rural areas with free Wi-Fi and training facilities
- Pricing
  - Mandatory Standard on Access Pricing (MSAP) to regulate wholesale prices of broadband
  - Price per GB of data for prepaid and postpaid mobile broadband is less than 0.3 percent of the median individual monthly income
- Spectrum access
  - Spectrum-sharing arrangements allowed between service providers for an apparatus assignment spectrum class

nal commitments. They have also effectively measured and evaluated their progress. Each has made notable and unique innovations in areas of focus in this report (e.g., competition policy, spectrum policy, connectivity community anchor institutions, universal service programs, demand stimulation, etc.). Like the LAC region, these countries have widely variable population sizes, geographies, and demographics. One country—Spain—has been part of the European Union's regional approach to sectoral

NEW ZEALAND

Notable Innovations and Achievements

- Creation of a national wholesale access network, Ultra-Fast Broadband (UFB), using a joint venture PPP arrangement (see Appendix 4)
  - Mix of government (NZ$1 billion) and private sector (NZ$3.5 billion) funding
  - The UFB is co-owned by the four partners (main incumbent, Chorus, holds 69 percent, plus three other fiber companies)
  - Considered 100 percent complete, with an uptake of 60 percent as of December 2020
- Targets for general population (75 percent of population with 100 Mbps download and 50 Mbps upload in 10 years)
- Target for anchor institutions (all schools and public hospitals, most private health facilities, and most businesses connected to fiber in first six years)
- High level of accountability, with quarterly reports on the government's broadband and mobile program
- Focus on fiber to the premises (FTTP) policy has paid off
  - New Zealand's average broadband speed is 142.10 Mbps (23rd in the world) compared to Australia (58.76 Mbps)
- Created a specific plan for rural areas (Rural Broadband Initiative Phases 1 and 2)
- Created spectrum parks in the 2.5 GHz band to test technology-based or organizational-based spectrum sharing that does not depend on formal licensing
- Created an interim television white space (TVWS) licensing regime to allow TVWS trials to be deployed with a very light approach not requiring a spectrum database
- Māori Spectrum Working Group established in 2019
  - They received 50 MHz of 5G spectrum in the 3.5 GHz band in 2019

development while implementing some unique programs of its own. Many LAC countries also follow European Union models, and Spain is an OECD member along with Chile, Colombia, and Mexico.

This section summarizes each country's notable innovations and achievements in relation to the development and implementation of their NBP. Appendix 2 provides sources for the information in the following charts as well as more detailed summaries of each country's accomplishments, lessons learned, and challenges.

SPAIN

Notable Innovations and Achievements

- Development of a national strategy for ultra-fast networks
- Efficient use of the radio spectrum supporting the deployment of networks and technologies
- Promoting more dynamic and flexible use of the spectrum
- Actions to support public and private cooperation and joint venture capital investments through a strategy promoting:
  - Sustainable competition
  - Technological neutrality
  - Reduced deployment costs
  - Shared use of infrastructure
  - Voluntary agreements among operators
- Following a technology-neutral approach considering the full range of technologies to be used in rural areas
- Inviting all interested parties to participate and contribute to the NBP definition
- Launching a program to expand the deployment of broadband and the dissemination of high-speed networks and emerging technologies
- Minimizing the number of licenses that must be requested to provide services
- Promoting digital skills competencies for citizens in the general population, active population, and technology population
- Educa en Digital program created to support the digital transformation of the educational system

THE UNITED STATES

Notable Innovations and Achievements

- Global leader in spectrum policy
  - Auctioned 1,000s MHz of exclusive-use licensed spectrum for next-generation 5G mobile networks
  - Free access to 1,000s MHz of non-exclusive unlicensed spectrum for next-generation Wi-Fi and other wireless technologies
  - A leader in enabling spectrum sharing across a variety of low-, mid-, and high-band spectrum ranges (TVWS, CBRS, etc.)
- Broadband data collection
  - Granular data collection on fixed and mobile broadband availability and adoption
- Innovative universal service policies
  - All universal service programs now focused on broadband availability and adoption
  - Separate programs for mobile and fixed broadband connectivity
  - Technologically and competitively neutral reverse auctions to determine recipients of funding to extend broadband to unserved areas
  - Specific programs focused on stimulating demand for key verticals—education, health care, and agriculture
  - Additional incentives for extending access and increasing adoption for traditionally disenfranchised groups such as tribal communities, minority communities, and persons with disabilities

3 Digital Technologies to Achieve Connectivity Goals

Governments and network operators have a growing menu of options available to them to cost effectively deliver affordable connectivity to underserved and unserved communities around the world.This section identifies the full range of digital technologies that could be used to address both short-term and long-term national connectivity goals and assesses the pros and cons of different technology choices. Options explored include traditional fiber, coaxial cable and copper infrastructure, various fixed and mobile terrestrial wireless solutions, geostationary and low-earth-orbit (LEO) satellites, and other emerging and experimental technologies.

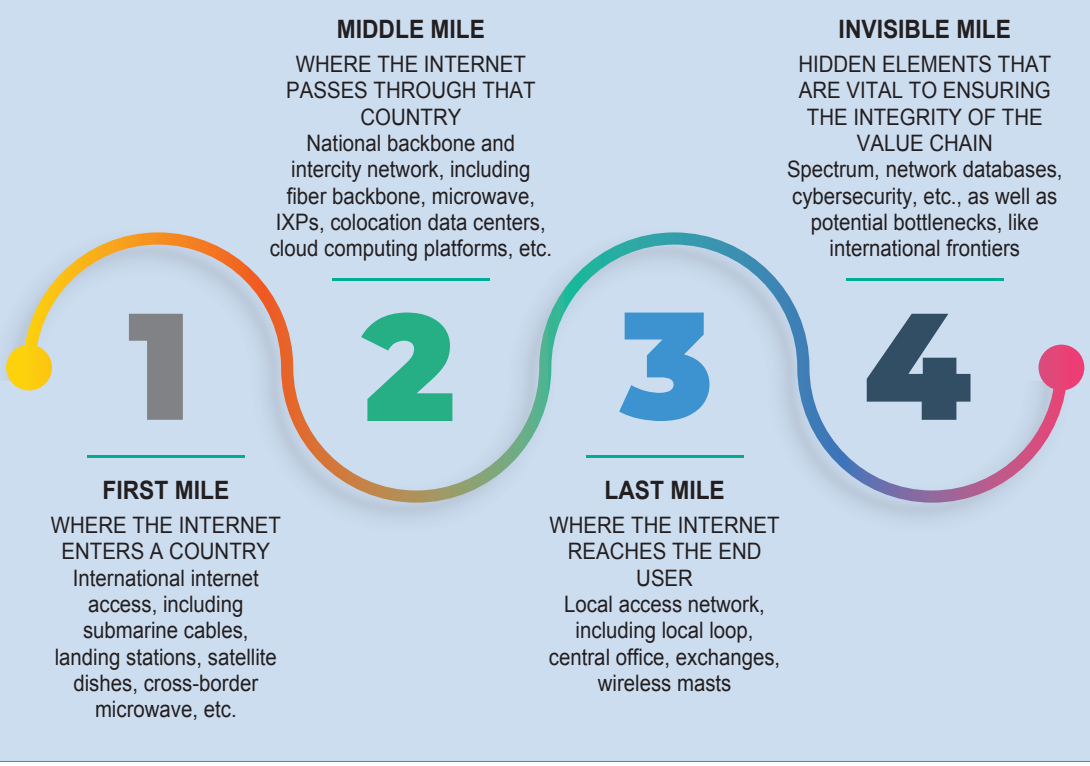
The broadband network value chain to develop universal, affordable, and high-quality broadband internet access comprises four broad segments or building blocks: first mile, middle mile, last mile, and invisible mile, as depicted in Figure 3.1, adapted from the Broadband Commission's "moonshot" report on Africa (Broadband Commission for Sustainable Development, 2019).

All four parts of the value chain need to be present to deliver fixed or mobile internet access. Equally important are supporting infrastructure (for example, data centers and a reliable electricity supply) and devices that are used to access the internet.

The first mile is where the internet enters a country (Broadband Commission for Sustainable Development, 2019). The network component of the first mile is international internet access, including submarine cables, landing stations, satellite dishes, cross-border microwave and fiber links, domain name registration, and so on. Countries need to be connected to undersea cables or via cross-border terrestrial links (particularly for landlocked countries). Most LAC countries have access to submarine cable systems, either directly through local landing points or through terrestrial connections (ITU, n.d., "Transmission Map").

The middle mile is where the internet passes through a country (Broadband Commission for Sustainable Development, 2019). The network components are the national backbone and intercity networks, including the fiber-optic cables or copper wires, microwave, satellite links, internet exchange points (IXPs), colocation data centers, cloud computing platforms, and so on. Once connected to high-speed internet at the border, LAC countries require fiber backbones to carry internet traffic from the border to urban and rural centers throughout the country and backhaul or metro networks to extend further. Satellite transmission remains important in some small island states and in rural and remote locations of the region that lack access to terrestrial first- or middle-mile networks. In addition, while most LAC countries have IXPs and

FIGURE 3.1 THE BROADBAND NETWORK VALUE CHAIN



Source: Broadband Commission for Sustainable Development (2019).

more IXP locations are being added, some of the island states, such as Antigua and Barbuda, Dominica, Haiti, Martinique, Montserrat, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines, along with French Guiana, Guatemala, Guyana, Nicaragua, Panama, and Suriname, do not have their own IXPs (TeleGeography, n.d.). In these countries, domestic internet traffic is exchanged through points outside the country, usually through fiber or satellite across international hubs to reach their destination.

The last mile is where the internet reaches the end user (Broadband Commission for Sustainable Development, 2019). Once high-speed internet arrives at a population center via the first and middle miles, network operators provide mobile or fixed internet access services to consumers, businesses, and governments. Network components of the last mile include the local loop, which historically was comprised of copper cables; now fiber is increasingly used for last-mile connections in urban or suburban areas. Wireless masts are used for mobile and fixed wireless connectivity, as well as satellite in remote locations where terrestrial networks cannot be economically deployed (ITU, 2020c). There are also new developments that enable network

operators to cost effectively deploy high-speed last-mile networks to locations outside of population centers. For example, new high-capacity terrestrial fixed wireless access (FWA) solutions, described in more detail later in this section, can be utilized in more places, and other innovative solutions (such as high-altitude platform stations [HAPS] using drones and balloons) are being piloted. In addition, new LEO satellite solutions promise to deliver lower latency and higher throughput internet connections to locations around the world (Broadband Commission for Sustainable Development, 2017).

Internet access is either fixed or mobile. The two primary benefits of mobile last-mile access for the end user are the ability to access the internet on the go and the ability to connect with a low-cost device. The primary benefit of fixed last-mile access is the ability for users to affordably consume large amounts of data on a connection with high throughput and low latency.

To deliver mobile connectivity, network operators deploy wireless technologies based on the 3rd Generation Partnership Project (3GPP) family of technology standards. A new generation of mobile wireless technologies is developed roughly once per decade; Fourth Generation (4G) mobile technologies were largely deployed from 2010 to 2020, and new Fifth Generation (5G) mobile technologies will be largely deployed from 2020 to 2030. Long Term Evolution (LTE), which was designed from the beginning to support data communications, was first introduced with 4G mobile technologies and is now the basis for 5G mobile technologies. 5G mobile technologies are designed to enable high-density, high-throughput, and low-latency use cases, supporting a range of industrial, enterprise, and consumer applications.[6] 5G network deployments have just begun in a few markets in Latin America and the Caribbean.[7]

While the introduction of 5G is exciting, it is important to remember that new communications technologies are designed for urban markets where demand and wealth concentrate. The economies of scale for these technologies make it difficult to deploy them profitably in rural areas with lower average incomes and population densities. Mobile wireless networks in rural areas with low population densities are often provisioned to provide basic coverage and are not designed to handle high throughput connectivity. This should be an important consideration as 5G wireless technologies are rolled out over the next decade (Hart, 2018).

To deliver fixed broadband access to prospective customers, a network operator considers a variety of available technologies, from satellite communications technologies to terrestrial fixed wireless technologies to fiber-optic connections. High-capacity fiber-optic and other wired technologies, along with emerging higher frequency wireless technologies, are typically the most cost-effective technologies for highly dense suburban and urban areas. Satellite communications

[6] One interesting development in the mobile wireless industry is the emergence of Open RAN Radio architectures that disaggregate hardware and software elements in 5G networks. By virtualizing network elements in the cloud, an Open RAN network architecture promises to introduce more competition, increase flexibility, and reduce costs for network operators, which will have implications for where 5G networks can be cost effectively deployed.

[7] For current information on 5G network deployments in LAC, see https://www.5gamericas.org/wp-content/uploads/2021/02/Latin-America-2.16.21.pdf.

technologies are typically the most cost-effective solution for the remotest rural areas. In areas with lower population densities than where fiber is most cost effective and higher population densities than where satellite is most cost effective, network operators will use terrestrial (i.e., non-satellite) fixed wireless technologies for last-mile access. These fixed wireless technologies operate on low-band (e.g., television white spaces [TVWS][8]), mid-band (e.g., 3.5 GHz and 5 GHz bands), and high-band spectrum (e.g., millimeter wave bands). The low bands are good for long-range connections in rural locations and the high bands are good for short-range high-throughput connections in urban locations. A good example of a project utilizing the low-band TVWS spectrum is being led by Telecaribe, a public broadcaster in Colombia, which deployed TVWS pilots to cover six schools in rural and marginalized areas (National Spectrum Agency, 2020b). Telecaribe has the legal authorization to provide both broadcasting services and internet access services. On this deployment, Telecaribe used the same tower for their broadcasting antennas and the TVWS antennas, showing that both signals can coexist without harmful interference. From the connectivity public policy and the social impact perspective, Telecaribe is currently recognized and supported by government authorities as an example of digital inclusion.

Table 3.1 summarizes different last-mile access technologies that a network operator could utilize to bring broadband access to its customers and their pros and cons.

One can see how an internet service provider would utilize different technologies and products for customers located in different urban, suburban, and rural areas. The mix of technologies used will depend on the area(s) of intended service. Internet service providers operating in urban areas will primarily deploy fiber-optic networks, complemented with wireless technologies using higher spectrum bands, offering more throughput and the ability to serve more customers simultaneously. Internet service providers operating in rural areas will rely more on fixed wireless technologies, using lower spectrum bands whose signals that can travel over longer distances. Pricing of technologies, the average income of prospective customers, and the availability of public subsidies also impact decision making on the technology mix to be used.

The invisible mile consists of the hidden elements vital to ensuring the integrity of the value chain (Broadband Commission for Sustainable Development, 2019). The network components of the invisible mile include not only the radio spectrum, network databases (for example, for numbering), cybersecurity, and so on, but also potential bottlenecks such as market concentration, multilayered taxation of activities, lack of access to rights-of-way, and inefficient regulations including transborder regulatory issues. The next section addresses an important aspect of the invisible mile: policy and regulation.

[8] The TV white spaces (TVWS) are frequencies that have not been assigned or are otherwise not being used by broadcasters and other licensees in the VHF and UHF broadcast bands.

TABLE 3.1 LAST-MILE ACCESS TECHNOLOGIES

Broadband Technology	Typical Throughput	Cost					Notes	Examples
		Speed	Latency	Reliability	Economics	Coverage		
Fiber to the Home	50 Mbps to 1 Gbps	🟢	🟢	🟢	🔴	🔴	Pros: Future proof Cons: High capital costs	AT&T, Comcast, Verizon
5G Fixed Wireless	5–500 Mbps	🟢	🟢	🟢	🟢	🟢	Pros: Mature technology ecosystem Cons: Requires licensed spectrum, high entry barriers	Mobile Operators
Other Fixed Wireless Solutions	5–500 Mbps	🟢	🟢	🟢	🟢	🟢	Pros: Lowest-cost options, low barriers to entry, can be non-line-of-sight Cons: Immature ecosystem	Wireless ISPs
LEO Satellite	5–100 Mbps	🟢	🟢	🟡	🟡	🟡	Pros: Low latency, high throughput Cons: Still in trials, tech & bus model unproven, expensive customer premises equipment	Starlink, OneWeb, Telesat, Amazon Kuiper
GEO Satellite	2–50 Mbps	🔴	🔴	🟡	🟡	🟢	Pros: Ubiquitous coverage Cons: High cost, low throughput, high latency	Hughes, Iridium

Source: Authors' elaboration.

4 A Guide to Building National Broadband Plans

This section highlights policy and regulatory aspects of NBPs that have been shown to accelerate availability and usage and promote competition in the industry. It then suggests approaches policymakers and regulators could take to improve their chances of closing the digital divide in their country. This discussion is organized around the six key elements to successful NBPs outlined earlier: (i) good governance, (ii) clear goals, (iii) regular assessment of broadband availability and adoption, (iv) supply-side interventions, (v) demand-stimulation activities, and (vi) monitoring and evaluation programs.

Practicing Good Governance

Key Recommendations

- The NBP should be developed through an open and transparent process.
- A single entity in government should lead, but inter-governmental coordination is key to gaining needed support and for successful implementation of the plan.
- Limited trials of new regulatory models and technologies—"sandboxes"—can be a good way to try out new approaches prior to allowing them permanently countrywide.

A prerequisite for good policymaking includes a stable, transparent, and impartial (and ideally independent) regulator, not subject to undue influence by particular market actors (Broadband Commission for Sustainable Development, 2014). A country's NBP should be developed through an open and transparent process that involves participation and input from all relevant stakeholders, including governmental organizations, the private sector, and civil society (World Bank Group, n.d., Section 2.2.). Prior to publishing its NBP, a government should conduct a public consultation in which a draft plan is made available for public comment. There might be multiple rounds of comments and separate consultations for different aspects of a draft NBP. In addition, a variety of other mechanisms can be used to stimulate stakeholder input, including field hearings, workshops, and the creation of advisory committees comprised of government, the private sector, and civil society focused on specific issue areas (e.g., spectrum policy) or industry verticals (e.g., agriculture).

A single focal point in government—such as the telecommunications ministry or regulator—should be the lead on the development of a country's NBP and coordinate its implementation. Inter-governmental coordination is critical to gain needed buy-in from other parts of the government that will be tasked with supporting and in some cases implementing aspects of the NBP. For example, the broadband policymaker might need to coordinate with the country's competition authority, consumer protection authority, financial regulator, ministry of education, ministry of health, ministry of agriculture, ministry of defense, energy regulator, and others.

Pilot projects (or regulatory "sandboxes") can play an important role in ongoing research and development (R&D) efforts related to broadband deployment. Such projects can help to demonstrate the viability of a new technology, service, or approach. A good example of a regulatory "sandbox" is the Managed Spectrum Park license in New Zealand (see Appendix 2 for more details).

Setting Clear Goals

National Broadband Plan Timeline

Key Recommendation

- Develop a multi-year NBP with clear, ambitious, and achievable policy-related commitments and quantifiable targets.

Successful NBPs are neither too short nor too long and are neither over-ambitious nor under-ambitious. As the World Bank advises, "[s]ustained, focused efforts with continual updates over a number of years contribute to the long-term success of any broadband strategy. Conversely, seeking a "one-shot" solution that can be achieved with minimal time and resources is not likely to produce the best long-term outcome" (World Bank Group, n.d., Section 2.2.). Moreover, according to Boutheina Guermazi, Director of Digital Development at the World Bank, a "critical aspect of a good national broadband plan is its ability to provide regulatory predictability for the private sector, particularly in areas such as spectrum policy, licensing, and tax policy" (Alliance for Affordable Internet, 2020a). Regulatory uncertainty (or a constantly changing regulatory environment) creates risk, discourages investment, and ends up undermining a government's broadband policy goals. In the countries surveyed for this work, the NBPs ranged from five to ten years, with regular reviews and updates. Follow-on plans tended to be shorter than the original NBP. A country's NBP, therefore, should be a multi-year initiative (e.g., about five years), with clear and ambitious yet achievable policy-related commitments and quantifiable targets.

Fixed and Mobile Broadband Definitions

As the applications we use for education, health care, business, entertainment, and interacting with the government become more media rich and bandwidth intensive, we need to ensure

Key Recommendations

- Over a five-year period, supply-side targets could include:
  - 4G mobile networks covering 99 percent of the population
  - 5G mobile coverage in major urban settlements and along major roads and railways
  - At least 1 Gbps symmetrical fiber connections for all anchor institutions
  - Fixed broadband services delivering at least 100 Mbps download capacity and 20 Mbps upload capacity, with low latency and no data caps, available to all households
  - A set of intermediate targets with escalating speeds each year (an increase of 10 percent per year for download speeds and 15 percent per year for upload speeds)
  - Access for all citizens to at least 2 GB of mobile data per month or 5 GB of fixed data per month for less than 2 percent of the median income (with an increase in bandwidth of 20 percent per year)

that definitions for broadband access move in step with these trends. A broadband speed target set for 2025 might be completely inadequate in 2030. These definitions are critical, as governments use broadband definitions to measure their progress in closing the digital divide and to develop and implement policies aimed at addressing areas where progress is lacking. For example, the ITU (2020e) defines entry-level broadband as at least 5 GB of monthly data consumption on a connection providing at least 256 Kbps (ITU, 2020e), but setting targets with this level of access is simply not adequate to become fully engaged with today's media-rich internet and will only widen the digital divide over time. In a simulation carried out by Nokia, the minimum bandwidth for comfortably working, learning, and playing online was estimated at 50 Mbps download (García Zaballos, Iglesias et al., 2020). We recommend aggressive targets for the LAC region, as outlined later in this section.

Broadband speed targets are usually specified in "megabits (or gigabits) per second" (Mbps or Gbps) or phrases such as "high-speed broadband" are used, as in the case of Ireland (Government of Ireland, 2020). In some cases, however, these phrases don't have a corresponding speed definition, and this should be avoided. Speed can also be broken up into download and upload speed; in cases where only one speed is provided, it is usually referring to download speed. In addition, latency and consumption allowances are used in broadband definitions, as is done by the Federal Communications Commission (FCC) in the United States. In many cases a specific technology is specified, such as the UK targeting 95 percent geographical coverage of LTE by 2022 (Hutton and Baker, 2019), but exclusive use of a specific technology to reach a coverage target is usually avoided. It's critical to make use of consistent definitions and targets in order to remove any ambiguity when checking if targets have been met.

Fixed broadband access speed targets and timelines should be well defined. In the countries examined, very aggressive targets were set almost a decade ago and remain relevant today. In Malaysia in 2010, the High-Speed Broadband (HSBB) network set a target of 100 Mbps for urban areas and 20 Mbps for rural areas (Razali Anuar, 2014). The current target is an aver-

age speed of at least 30 Mbps for 98 percent of the population by 2023. In New Zealand, the 2010 Ultra-Fast Broadband (UFB) plan set a target of 100 Mbps download and 50 Mbps upload by 2010 for 75 percent of New Zealand, and the new Rural Broadband Initiative has set a target of above 20 Mbps for 84,000 of the 90,000 rural households in New Zealand by 2022 (Crown Infrastructure Partners, n.d.). In addition, Chile has a very progressive approach that guarantees a minimum speed for internet access that increases by 10 percent each year, reducing the need for updates to the defined speed targets (Subsecretary of Telecommunications, 2020).

Judging by the success of New Zealand and Malaysia, it would be wise to set a starting baseline fixed broadband target close to their 2020 targets; we suggest a fixed broadband definition of 100 Mbps download and 20 Mbps upload. We also suggest following the example of Chile and setting an increase in the target of 10 percent per year. Due to the increased use of symmetrical internet technologies such as video conferencing, it would also be wise to escalate upload speeds for fixed wireless at a higher annual percentage (e.g., 15 percent annually). This will allow operators time to gradually modify spectrum or time slicing between the downlink and uplink for broadband connections.

Targets for population coverage of fixed broadband using fiber are typically less than 100 percent as infrastructure costs to reach very remote homes and businesses are high and technology such as LEO satellites are better suited to these edge cases.

Mobile broadband access is a best-effort technology and is highly dependent on the quality of the signal and the congestion at the base station, which depends on the number of users attached to the base station. Therefore, countries normally set mobile broadband targets for a specific level of technology and amount of coverage, such as 4G coverage for all major highways in five years. We suggest the following five-year targets for population coverage: 4G mobile networks covering 99 percent and 5G mobile coverage in major urban settlements and along major roads and railways.

Timelines should also be set for sunsetting older 2G and 3G technology and for upgrading technology to 4G and 5G. Maintaining legacy technology such as 2G and 3G on a tower with 4G and 5G radios adds to maintenance and running costs, while upgrading technology on towers allows the same tower infrastructure to be reused and, as many of the same frequency bands are used, coverage profiles are similar but often with an order of magnitude improvement in speed. Australia, Japan, and the United States stopped supporting 2G in 2018, 2011, and 2020, respectively, and Taiwan stopped supporting 3G in 2018 (EMnify, 2020). When setting timelines for sunsetting legacy technology and making upgrades, care should be taken to ensure that the ecosystem of devices used by the population supports the upgrade. For example, there are many legacy Machine to Machine (M2M) and Internet of Things (IoT) connections that still run on 2G, which is why Vodafone will support 2G in Europe until 2025 (Pearce, 2017). A countrywide survey of device support should be done before setting targets, and setting realistic targets using a cost-benefit exercise for 4G and 5G upgrades is critical. For example, Brazil had 4G and 3G population coverage of 97.3 percent and 99.9 percent respectively in December 2019 (Anatel, 2020b), yet only 74.2 percent of the population have devices that can access the 4G

network (Teleco, 2021). The remainder of the population accesses the network on 3G (14.2 percent) and 2G (11.5 percent), mostly due to lack of device support for 4G (Teleco, 2021).

Targets typically aim for 99 percent mobile coverage because targeting 100 percent population coverage significantly increases the infrastructure cost of covering the last 1 percent of the population, which can be accomplished with technology such as LEO satellite.

Goals for Education, Health Care, and Other Anchor Institutions

Key Recommendations

- Over a five-year period, demand-side targets could include:
  - A program providing an affordable laptop or tablet to every low-income primary and secondary school student
  - 70 percent of the country with basic digital skills to engage with government services, online education, and e-commerce

Anchor institutions such as schools, health-care facilities, and libraries form critical learning and health hubs for communities. Even when high-speed broadband access has not yet reached all homes, high-speed access at schools can improve learning outcomes. Similarly, it can increase the effectiveness and efficiency of health-care facilities, helping health-care workers automate records management and helping both health-care workers and patients access services such as telehealth to get advice from remote health experts. Schools can also run after-school programs that depend on high-speed broadband to offer supplementary education programs for learners and digital skills programs for adults. These anchor institutions can also act as connection points for spreading connectivity to the neighboring community.

Many NBPs in countries with successful broadband expansion programs have specific targets for schools, health-care providers, libraries, and priority community anchor institutions. In New Zealand's 2010 Ultra-Fast Broadband (UFB) plan, the target was to connect 75 percent of New Zealanders with "ultra-fast broadband" (100 Mbps download, 50 Mbps upload) over 10 years, concentrating on priority broadband users such as businesses, schools, and health services (Wikipedia, 2021b). In Malaysia, the 2019 National Fiberisation and Connectivity Plan (NFCP) aims to provide fiber connections at 70 percent of schools, hospitals, libraries, police stations, and post offices by 2022 (Government of Malaysia, n.d.). In the FCC's National Broadband Plan, Goal 4 states that every anchor institution such as schools, hospitals, and government buildings should have affordable access to at least 1 Gbps of broadband service (FCC, 2010).

Supplying high-speed broadband access to anchor institutions should be tightly coupled with demand-side interventions that also address affordability and digital skills. Several governments have set goals for device access and digital skills. These will vary by country and by need. The Government of Malaysia created the 1Malaysia program focused on low-cost devices

for schoolchildren (FMT Reporters, 2021). The Digital Education Action Plan of the European Commission states that students who are currently in primary or secondary school or vocational training must have guarantees that they will acquire, in the educational system, the digital skills demanded by society (European Commission, n.d.).

We recommend a goal of reaching 100 percent of schools and other anchor institutions with 1 Gbps broadband service, coupled with digital skills development programs at anchor institutions as well as programs to provide an affordable laptop or tablet to every low-income primary and secondary school student. This will ensure that the future generation have the digital skills to participate in the Fourth Industrial Revolution. This capacity will also provide the option for small local operators to use anchor institutions to spread connectivity to the surrounding community.

Addressing Marginalized Groups

Key Recommendation

- Over a five-year period, demand-side targets could include:
  - A program providing discounted mobile and fixed broadband to marginalized groups, such as persons with disabilities

According to the Broadband Commission, a good NBP should address groups with low rates of mobile and fixed broadband adoption such as those with diverse languages, minorities, or people with specific needs (Broadband Commission for Sustainable Development, ITU, and Cisco, 2013). Each country will handle this issue differently depending on cultural and social norms. For example, the U.S. FCC has broadsband programs specifically focused on tribal areas (FCC, 2016).

An example of a traditionally disenfranchised population present in every country is persons with disabilities. According to the United Nations, persons with disabilities form the world's largest minority. According to a report by the World Health Organization (WHO, 2011), it is estimated that more than one billion people worldwide—15 percent of the global population—are living with a disability (WHO, 2011), 80 percent of whom live in developing countries (UN, n.d.). Around the world, people with disabilities face challenges that prevent them from equally participating in social or economic life. They may face inaccessible physical environments, barriers to vital services and information, and a lack of basic assistive technologies. Individuals with disabilities also face higher poverty rates (WHO, 2011). This makes it more likely that the costs of internet subscriptions and electronic devices will be prohibitive for them.

A good example of an NBP that addressed access for people with disabilities is Colombia's 2010 Plan Vive Digital (Scalise, 2016). The plan aimed to increase both availability and usage of the internet and ICTs, particularly for vulnerable and low-income populations. It also paid special attention to persons with disabilities, drawing a clear link between access to ICT and important success factors such as education and employability.

Considering the vast potential of internet technology to improve the lives of persons with disabilities, wider internet access should be considered imperative. The following aspects of access for persons with disabilities can be embedded in NBPs:

- Subsidize internet access for people with disabilities**.** Focus should be placed on increasing high-speed internet adoption by persons with disabilities, especially those who qualify for other programs targeting low-income citizens.
- Provide statistical data on disability, internet access, and personal income. Introduce questions in household expenditure surveys that would allow measuring and analyzing the link between disability status/prevalence, internet access, and income.
- Localization of software and devices for existing programs (in education, health, business, government) for certain more vulnerable populations to suit the needs of people with disabilities.

Ensuring Internet Resilience

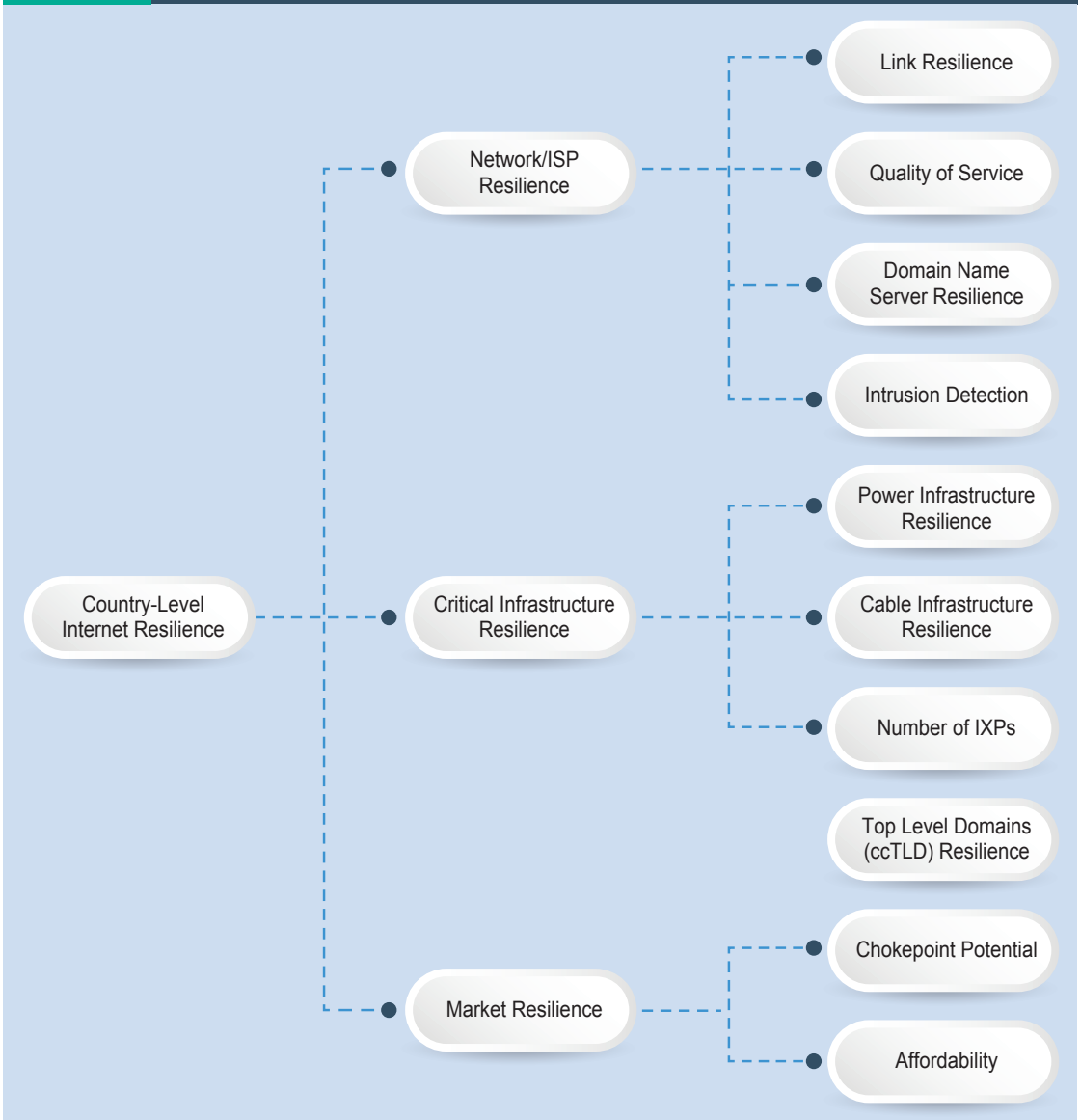
Key Recommendations

- Resilience targets for internet infrastructure can include:
  - Network/ISP Resilience: Targets for availability and stability of the physical links and logical/peering links, availability of multiple DNS and intrusion detection systems
  - Critical Infrastructure Resilience: Targets for resilience of power infrastructure and internet cables (terrestrial and undersea), number of IXPs and top-level domains in a country
  - Market Resilience: Targets for affordability of access and level of market concentration (avoiding chokepoints)

There are many threats and obstacles (both internal and external) that impact internet infrastructure and the mechanisms for increasing the overall resilience of internet services. Resilience is related to the ability of a network to maintain an acceptable level of service in the event of an outage or during a crisis. A study by Facebook (Böttger, Ibrahim, and Vallis, 2020) using traffic from its edge network showed that during the COVID-19 crisis, North America and Europe were very resilient to the shifting demand in network access from home and the increase in video conferencing traffic (Böttger, Ibrahim, and Vallis, 2020). However, some developing countries with fewer IXPs and lack of home access showed an increase in packet loss and a degradation of network performance (Böttger, Ibrahim, and Vallis, 2020)._According to the same report, developing countries experienced different degrees of impact. Colombia's bad session rate (BSR)—a "bad session" is a video session with a slow start or frequent stalls—increased from 10 percent to 13.5 percent as the lockdown started in late March 2020. However, Brazil, Peru, and Ecuador had no noticeable change in BSR (Böttger, Ibrahim, and Vallis, 2020).

As shown in Figure 4.1, "internet resilience" encompasses many underlying components ranging from the resilience of physical internet infrastructure and power infrastructure to market resilience and quality of service aspects such as uptime, available bandwidth, and latency.

FIGURE 4.1 TAXONOMY OF INTERNET RESILIENCE



Definitions:

- *Country-Level Internet Resilience*: The ability of a country to provide internet services to its citizens at an acceptable level of service in the face of faults and challenges to normal operations.
- *Network/ISP Resilience*: The ability of a network to continue providing an acceptable level of service in the event of an outage or during crises. This aspect of resilience is made up of various components such as the resilience of physical links, logical/peering links, performance/quality of service of links, and availability of multiple domain name servers (DNS) and intrusion detection systems to detect security threats such as denial-of-service attacks.
- *Critical Infrastructure Resilience*: Comprises the resilience of the power infrastructure, the internet cables infrastructure (both terrestrial and undersea), the availability and efficiency of IXPs, as well as the country code Top Level Domain (ccTLD) infrastructure—this is in-country hosted infrastructure using a top-level domain reserved for a country.
- *Market Resilience*: The ability of the market to self-regulate and provide affordable prices to end users by maintaining a diverse and competitive market.

An NBP should consider the following resilience aspects:

- The availability and stability of the physical infrastructure, which includes power stations, undersea or terrestrial fiber, landing stations, and last-mile access networks
- The quality of service of the network from the end user's perspective and the stability of the network in terms of reachability, throughput, and latency to selected target servers
- The availability and performance of internet service components, the most critical being the DNS ecosystem and intrusion detection systems
- The presence and efficiency of IXPs and the local peering fabric
- The resilience of the internet service provider (ISP) market; i.e., the level of concentration toward specific autonomous systems (AS) and affordability

Regular Assessment of Broadband Availability and Adoption

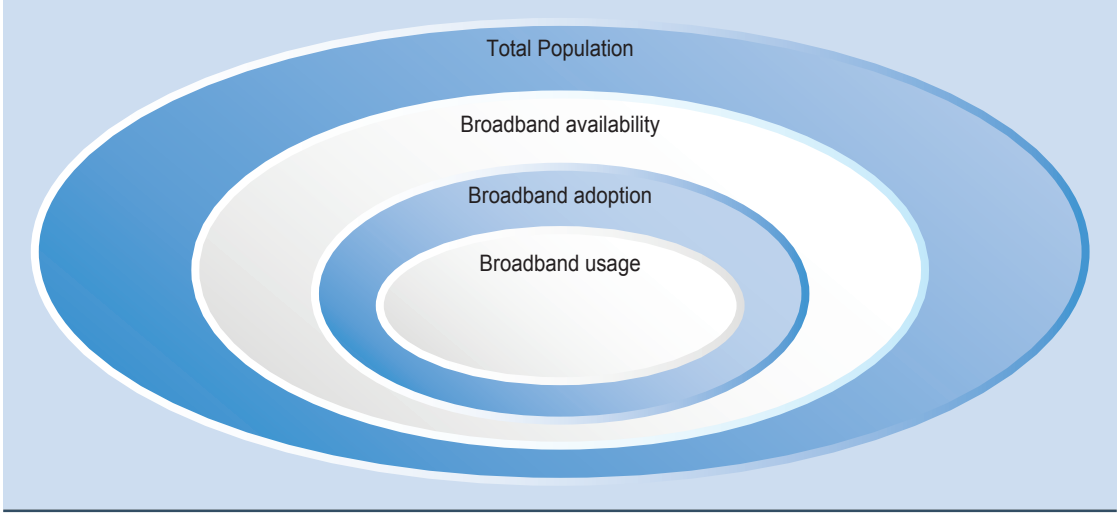
Key Recommendations

- For data on availability, combine mobile and fixed operator coverage and speed data with crowd-sourced data such as OpenSignal.
- For data on usage and adoption, combine a mix of survey data such as the ITU ICT Access questionnaire with crowd-sourced service data such as Ookla and data from online services such as Facebook and marketing platforms such as GlobalWebIndex.

In its 2020 report on rural connectivity in LAC during the COVID-19 pandemic (Ziegler et al., 2020), the IDB highlights that there is limited information on the gaps in rural connectivity. The lack of ways to measure rural connectivity is a core problem exacerbating the rural digital divide in the region (Ziegler et al., 2020). More broadly, the Broadband Commission has identified data collection as a key challenge, especially in developing countries (ITU and UNESCO, 2020). Most of the data series for advocacy targets such as affordability, penetration rates, and target population groups come from national statistical agencies, and collecting this data is a labor-intensive process. The Broadband Commission acknowledges that there may be other methodologies to collect similar or proxy datasets to supplement this data (ITU and UNESCO, 2020). This section suggests a methodology for collecting data on mobile and fixed broadband availability, adoption, and usage.

For a visual representation of the terms "availability," "adoption," and "usage," see Figure 4.2. Within the total population, a certain fraction of the population will have broadband *availability* (this means they have a broadband operator who can provide them with a fixed broadband connection, or they are covered by a mobile broadband signal). Within the fraction of the population with broadband available to them, a certain fraction will *adopt* a broadband service (e.g., subscribe to a fixed broadband service or purchase a mobile broadband package). Then, within the population that has adopted broadband, there will be a certain level of broadband *usage*. This usage level could be described in terms of the frequency of the usage (e.g., daily or hourly), in terms of the amount of data used (e.g., measured in GB or MB) or in terms of the type of services used (e.g., for video conferencing or email).

FIGURE 4.2 VISUALIZING BROADBAND AVAILABILITY, ADOPTION, AND USAGE



Data Collection on Availability

Key Recommendations

- For data on availability, combine mobile and fixed operator coverage and speed data with crowd-sourced data such as OpenSignal.
- Ensure that fixed and mobile coverage is available on a publicly accessible broadband map for all operators in the country and ensure that the map is kept up to date.

Governments and an array of third parties collect data and report on fixed and mobile broadband availability with different levels of geographic precision (i.e., on whether broadband is actually available in a particular location). Each data source has some degree of inherent limitations and in order to develop a more balanced picture that combines information from suppliers and consumers, a collection methodology should ideally cross-reference data from multiple sources. Data collection on availability is usually sourced directly from mobile and fixed broadband providers and collected either by the ministry, regulator, or a designated third-party data administrator. Consumer groups, technology companies, and other organizations also increasingly collect data on fixed and mobile broadband availability.

Broadband availability is measured as either geographic (percentage of landmass covered) or population (percentage of population covered). For fixed broadband access, such as fiber, availability is expressed as a percentage of households, businesses, or facilities served across the whole country, or it can be defined as a percentage of geographic area or users serviced in an area, such as a census area. For mobile broadband, availability is usually expressed as the percentage of a geographic area or population covered with a specific technology such as 3G or 4G.

Averages often hide the truth about specific target groups that are underserved. For example, in a city with high levels of inequality, there could be 80 percent fixed or mobile broadband availability overall but 100 percent availability in wealthier areas and only 20 percent availability in low-income areas. Geographically precise or granular population coverage can help prevent these distortions. The U.S. FCC, for example, collects broadband data based on census blocks, which can be as small as a high-rise apartment building in a major city (FCC, 2021e). Even with this geographic precision, however, distortions can occur, especially in rural areas where people are spread over large tracts of land. To address this concern, the FCC is moving to shape files in which network operators draw polygons around coverage areas (FCC, 2021a).

Mobile broadband wireless coverage has additional complexity due to the need to define an acceptable performance at the edge of the network. Operators usually define their network edge using a receive sensitivity level (the signal strength value where a certain bit error rate is achieved). There are a number of guidelines that can be used to measure this, including 3GPP free space, GSMA free space, and beside hand and head (BHH). For example, GSMA free space defines 4G receive sensitivity (edge of the cell) in band 20 as –93.5 dBm with a Block Error

Rate (BLER) of less than 5 percent (Ofcom, 2015). The challenge is that different operators and regulators use different standards and definitions for defining this network edge, which makes understanding the ground truth challenging. Creating universal definitions of what comprises a network edge is an ongoing worldwide problem that needs to be addressed by international bodies such as the ITU.

In order to create a more complete picture of network availability for mobile broadband, crowd-sourced tools such as Opensignal can play a complementary role. Opensignal is an independent mobile analytics company specializing in "quantifying mobile network experience" (Opensignal, n.d.). Opensignal's objective is to report as accurately as possible the real-world mobile experience as recorded by mobile network users. Opensignal records signal strength, data speed, and reliability over multiple georeferenced points as the user moves. This data is then made available to users or organizations as maps with multiple georeferenced signal strength measurements. Crowd-sourced tools like Opensignal rely on widespread user adoption across a wide geographic area to provide a complete picture across the country. Higher-income users tend to use Opensignal more to check the quality of their link and compare this with competitors, whereas low-income areas tend to use tools like Opensignal less. Regulators or government-contracted service providers could complement these data sets with drive tests and use tools like Opensignal or customized testing software in areas with less data to verify the coverage maps provided by operators.

Fixed broadband providers usually publish availability maps that describe what kinds of services (i.e., fiber, cable, or DSL) are currently available or will be made available in the future. Verifying if these maps are accurate can be done by the regulator or a consultant that creates a representative sample set of points around the country and phones the supplier asking to install the promised service. If the supplier promises to install the service within a short time frame, the data point is marked as true; if the supplier mentions that it's not available, the data point is marked as false. In the United States, BroadbandNow conducted such a study and determined that more than twice as many Americans lack access to broadband than the network operators have reported to the FCC (Busby, Tanberk, and BroadbandNow Team, 2020). The FCC has now established a challenge process for third-party groups to challenge network operators' data submissions (FCC, 2021b). Publicly accessible broadband maps of fiber and mobile coverage from all operators in a country, such as the Interactive Transmission Map produced by the ITU,[9] help ensure that network plans are directed where intervention is required most.

NBPs should specify that measurements of progress to achieve coverage targets need to be verified by complementary data sources. Mobile broadband targets can be verified by tools such as Opensignal or drive tests and fixed broadband targets can be verified by random phone calls requesting the installation of a service. This will provide more trustworthy progress reports rather than only relying on coverage maps provided by operators. Coverage targets should also

[9] https://www.itu.int/itu-d/tnd-map-public/.

provide both population and geographic coverage and study specific target groups or areas where current internet availability is lacking.

Data Collection on Adoption and Usage

Key Recommendations

- For data on usage and adoption, combine a mix of survey data such as the ITU ICT Access questionnaire with crowd-sourced service data such as Ookla and data from online services such as Facebook and marketing platforms such as GlobalWebIndex.
- Network measurement data from end-user devices should be overlaid on the publicly accessible broadband map.

Measuring adoption and usage is critical to understanding uptake of available broadband services. One could use qualitative methods such as household surveys or quantitative methods such as collecting data from specialized crowd-sourced testing services or popular applications such as Facebook.

Many governments and regulators conduct household adoption and usage surveys. The ITU, in turn, collects adoption and usage data from member states on an annual basis. The ITU questionnaire—used by many member states—has a wide set of questions on internet adoption and computer ownership, such as access to a computer or tablet, internet always available in a household, use of the internet from home or work, and what household members use the internet for (e.g., seeking health or education information, looking for a job, purchasing goods or services). There are two versions of the ITU questionnaire, one short questionnaire with five indicators and a comprehensive questionnaire with 18 indicators. Each of the indicators have a list of associated sub-questions.

Many countries don't have the human capacity to do comprehensive semiannual or annual surveys and may opt for longer intervals or do annual surveys using the ITU's short questionnaire. Indicators that are binary, such as "access to a computer," are useful, but many other statistics gathered are too general to expose the level of engagement and usage of internet services. For example, "using the internet for education" could capture a user viewing Khan Academy videos every day with an affordable 10 Mbps connection or a frustrated user who has slow, expensive access and occasionally views Wikipedia.

Another very crude yardstick of adoption for mobile broadband is the number of mobile cellular subscriptions and internet subscriptions. The core challenge with this indicator is that many users have multiple sim cards and statistics agencies need to estimate the number of multiple subscriptions per user. In addition, sim cards can become dormant, or a subscription may have very low usage—not enough to be considered a broadband user. As a result of all these limitations, it is suggested that surveys and subscription data be supplemented with data available from crowd-sourced services as well as online services such as Facebook and marketing sites.

Speedtest.net, also known as Speedtest by Ookla, is a web service that provides free analysis of internet access performance metrics, such as connection data rate and latency. The service measures the data throughput (speed) and latency (connection delay) of an internet connection against one of 14,698 geographically dispersed servers (as of June 2021).[10] Each test measures the data rate for download (i.e., from the server to the user's computer) and upload (i.e., from the user's computer to the server). The tests are performed within the user's web browser or the Speedtest app. As of January 2021, over 30 billion speed tests have been completed. Speedtest users usually want to know if they are getting speeds promised by their supplier and they are typically advanced engaged users of internet services. Data from Speedtest can also be used to check the general performance of access in a country, which is more applicable to the previous section on measuring availability and helping create maps with network performance across the country.

Data on users' level of engagement on social media platforms such as Facebook is available in the form of Facebook quarterly reports per country on daily active users. The general level of engagement on different websites, in terms of share of total website traffic by age and gender, is collected by a number of different marketing sites such as Semrush[11] and GlobalWebIndex[12] at a country level. These sites also provide data such as the most common search terms and e-commerce activity. This data is also gathered for annual country reports on internet activity by DataReportal.[13] This user data can complement in-country survey data that asks binary questions like "do you use the internet for streaming video" and provide a richer view of the level of user engagement across the country.

To provide a more complete picture of adoption and usage of broadband services, NBPs should specify a monitoring and evaluation process that combines surveys and complementary data sources. Governments can use a combination of surveys (such as those designed and used by the ITU) complemented by crowd-sourced tools such as Speedtest by Ookla and data available from marketing statistics–gathering platforms such as Semrush or GlobalWebIndex. Results from crowd-sourced tools on network performance should be overlaid on the publicly accessible national broadband map.

Supply-Side Interventions

Clear and Enforceable Competition Policies

A key element of any successful NBP is promoting competition. Markets with high rates of fixed and mobile broadband availability and adoption also tend to be markets with high rates of competition. This competition is seen throughout the supply chain and within and between

[10] See https://www.speedtest.net/speedtest-servers for the latest data.
[11] https://www.semrush.com/.
[12] https://www.globalwebindex.com/.
[13] https://datareportal.com/.

Key Recommendations

- Policies should maximize competition throughout the supply chain.
- Policies should promote competition, for example:
  - Market liberalization
  - Universal licensing
  - Non-discriminatory wholesale access to competing operators' facilities (ducts, poles, colocation facilities), networks (including unbundling and interconnection), and services (e.g., backhaul)
  - Accounting and structural separations for vertically integrated network operators
  - Promotion of passive and active infrastructure sharing (e.g., at towers, data centers, etc.)
  - Non-discriminatory and low-cost access to rights-of-way (for example, roads, railways, pipelines, or electricity transmission lines)
  - Dig-once policies, ensuring that construction projects include the installation of fiber
- Policies should also protect against abuse of market power, such as:
  - Predatory pricing
  - Undue price discrimination
  - Excessive pricing
  - Margin squeeze
  - Refusal to supply

technology platforms—in the first mile, middle mile, last mile, and even the invisible mile. As observed by the World Bank, "liberalization and promotion of competition among facilities are the best ways to guarantee lower costs" (World Bank Group, n.d., Section 2.2.4). A wide range of laws and regulations can promote competition, including: (i) market liberalization; (ii) universal licensing; (iii) non-discriminatory wholesale access to competing operators' facilities (ducts, poles, colocation facilities), networks (including unbundling and interconnection), and services (e.g., backhaul); (iv) accounting and structural separations for vertically integrated network operators; (v) promotion of passive and active infrastructure sharing (e.g., at towers, data centers, etc.); (vi) non-discriminatory and low-cost access to rights-of-way (for example, roads, railways, pipelines, or electricity transmission lines); and (vii) dig-once policies, ensuring that construction projects include the installation of fiber. As discussed below, regulators can also use spectrum policy to promote competition and design universal service programs to avoid marketplace distortions and harness the power of competition.

Effective competition also needs effective protection, particularly when the market is still nascent (Broadband Commission for Sustainable Development, 2014). Competition rules that offer protection from anticompetitive behavior by a dominant incumbent or a collusive group need to be established and enforced before an investor decides to enter a market. Effective competition requires two main elements: clear rules and effective enforcement by the appropriate authorities. The anti-competitive practices likely to be proscribed either by general competition (if it exists) or by telecommunication legislation usually include, among others, predatory pricing, undue price discrimination, excessive pricing, margin squeeze, or refusal to supply, or

other strategies to foreclose the market (Broadband Commission for Sustainable Development, 2014).

Opening Up Spectrum

Key Recommendations

- Allocate licensed spectrum for 5G mobile networks
  - Below 6 GHz for coverage
  - Above 24 GHz for capacity
- Allocate more unlicensed spectrum for Wi-Fi 6 and other technologies in the 5 GHz and 6 GHz bands
- Promote dynamic access to unused spectrum
  - Unlicensed access to TVWS
  - Consider spectrum-sharing models in other bands, such as
    - 2.3 GHz and 2.6 GHz bands
    - 3.3–3.8 GHz bands
- Enable next-generation satellite and high-altitude-platform communications

As discussed previously, most of the world's population is accessing the internet on a mobile or fixed wireless connection, utilizing devices communicating over available radio frequencies or spectrum. For this reason, spectrum policy or the way in which regulators manage their national radio frequencies is critically important for achieving universal connectivity goals. Smart spectrum policy can literally change the cost economics of deploying wireless networks[14]—expanding access to underserved and previously unserved communities, increasing competition, and reducing costs for consumers (Oughton et al., 2021). To support network operator deployments, it is important that regulators make spectrum available across a range of low-band, mid-band, and high-band frequencies to support fixed and mobile terrestrial- and satellite-based communications. This diversity is key to addressing connectivity gaps and improving affordability.

Sufficient spectrum should be made available on an exclusive-use basis for mobile operator 5G networks. To maximize 5G use cases and deliver both capacity and coverage to users, spectrum above 24 GHz and below 6 GHz should be allocated on a licensed basis for 5G deployments.[15] As noted in a recent IDB report, the millimeter wave bands above 24 GHz, with ample unallocated, unassigned, or otherwise unused contiguous spectrum, are ideal for the deployment of 5G technologies capable of delivering up to 20 Gbps connections. These bands are

[14] By opening up more large swaths of spectrum across complementary low-, mid-, and high-band spectrum, a regulator will enable a wireless network operator to optimize the placement of towers and other network infrastructure, thereby allowing the operator to serve more customers in more places at lower costs.

[15] 5G Americas provides recommendations on a variety of spectrum bands that it believes could be made available for IMT licensing. See https://www.5gamericas.org/wp-content/uploads/2019/07/5G_Americas_5G_Spectrum_Vision_Whitepaper-1.pdf.

ideal for "securing transmission capacity in hotspot areas where users are concentrated, such as urban centers, stadiums, stations, and airports, but it is not appropriate for nation-wide 5G networks" (García Zaballos, Iglesias Rodríguez et al., 2020). 3GPP, the 5G standardization body, has also recommended that spectrum below 6 GHz be made available for 5G networks, to support use cases requiring wide-area coverage (García Zaballos, Iglesias Rodríguez et al., 2020). Spectrum below 2 GHz and between 6 GHz and 24 GHz is less attractive for 5G because these bands are heavily utilized by other licensed users.[16] As discussed above, the United States is an example of a country that has successfully made spectrum bands above 24 GHz and below 6 GHz available for 5G licensing. Likewise, Asian countries such as China, Japan, and South Korea are allocating both bands to 5G (García Zaballos, Iglesias Rodríguez et al., 2020). LAC regulators can follow the lead of these countries.

At the same time, sufficient spectrum should also be made available on a non-exclusive unlicensed or license-exempt basis for Wi-Fi, Bluetooth, and a variety of other technologies used for providing fixed wireless last-mile access. Wi-Fi 6, based on the IEEE 802.11ax industry standard, can deliver a maximum data rate of up to 9.6 Gbps and allows new and existing Wi-Fi networks increased speed and capacity to support multiple devices utilizing next-generation applications that require high throughput and low latency. Wi-Fi 6 is well suited to supporting high-definition (HD) video streaming, Wi-Fi calling, smart home devices, hotspot access, automation of citywide services, augmented reality (AR) and virtual reality (VR) applications, health monitoring devices, wearables, and seamless roaming, as well as off-load for 4G and 5G mobile networks (Policy Impact Partners and Dynamic Spectrum Alliance, 2020). The economic benefits of opening up these bands is well documented (Dynamic Spectrum Alliance, 2020). As discussed above, the U.S. FCC recently adopted a decision to open up 1200 MHz of spectrum (5925–7125 MHz) in the 6 GHz band to enable use of wider channels and meet growing demand for unlicensed spectrum. Several Latin American regulators, including in Argentina, Brazil, Colombia, and Mexico, have commenced consultations on opening up some or all of the 5925–7125 MHz bands for unlicensed access (Secretary of Public Innovation, 2020; Anatel, 2020c; National Spectrum Agency, 2020a; Eleos Compliance, 2020). Other LAC regulators should follow this lead.

While it is clear more licensed and unlicensed spectrum is needed to support next-generation wireless applications, it is becoming increasingly difficult for regulators to move incumbent users from their existing assignments and clear that spectrum for new uses and users. Fortunately, the emergence of various types of spectrum-sharing technologies enables regulators to allow wireless network operators access to new spectrum bands without displacing incumbent government users and commercial licensees. These spectrum-sharing regimes are made pos-

[16] Spectrum below 2 GHz is being used by mobile operator 4G networks, as well as a variety of other uses, thereby constraining the amount of contiguous spectrum that could be made available for 5G. Spectrum between 6 GHz and 24 GHz is being used for other purposes, such as satellite and point-to-point microwave connections.

sible by the emergence of spectrum-sensing capabilities and cloud-based spectrum-sharing databases that can dynamically assign unused frequencies while protecting incumbent users from harmful interference. The U.S. FCC has leveraged these dynamic spectrum-sharing systems to allow access to TVWS, 3.5–3.65 GHz Citizens Broadband Radio Service (CBRS), and 6 GHz spectrum.[17] Along with about a dozen other countries, the Colombian regulator, ANE (the National Spectrum Agency), and the Trinidadian regulator, the Telecommunications Authority, already allow access to the TVWS and several other regulators including Anatel, the national telecommunications agency in Brazil, have conducted consultations to open up the TVWS in their countries (Anatel, 2020a). In addition, in 2019, the Dynamic Spectrum Alliance published a paper proposing that regulators in Latin America enable spectrum sharing between primary and secondary users in the 2.3 and 2.6 GHz bands, which have been identified to support international mobile telecommunications (IMT) spectrum and, therefore, could allow for service providers to deploy infrastructure quickly and take advantage of the large and competitive LTE device market (Policy Impact Partners and Dynamic Spectrum Alliance, 2019). In addition, the Ministry of Transport and Communications in Peru has proposed allowing tiered access to some or all of the 3.3–3.8 GHz spectrum (Ministry of Transport and Communications, 2020). Local conditions will dictate which spectrum bands can be shared in a particular country.

In addition, regulators should consider licensing for spaced-based satellite communications, as well as experimental HAPS. These technologies promise higher throughput and lower latency connectivity than is available from traditional geostationary satellite constellations. They are suitable in remote locations where terrestrial connectivity cannot be cost effectively deployed, providing direct connectivity to consumers and IoT devices as well as backhaul connectivity to last-mile mobile and fixed wireless networks. As discussed in Appendix 2, the U.S. FCC has made a series of decisions paving the way for high-speed broadband to be provided by numerous non-geostationary orbit satellite constellations, including OneWeb, SpaceX, Kuiper, Telesat, and others. HAPS providers, like HAPSMobile, have conducted their first test flights (HAPSMobile Inc., 2020). These providers' connectivity solutions are in varying stages of development, but each of the companies is committed to deploying global offerings, with a focus on helping to close the global broadband gap.

Investment in Infrastructure

Making mobile and fixed broadband available to all of the world's population is, "above all, an infrastructure investment challenge" (ITU, 2020b). A recent ITU report estimates that US$428 bil-

[17] The terminology and complexity of allowing dynamic spectrum access varies by spectrum band. To protect incumbent users and others with licensed spectrum rights, TVWS utilizes a TV White Space Database, the CBRS band utilizes a Spectrum Access System (SAS), and the 6 GHz band utilizes an Automatic Frequency Coordinator (AFC) (for outdoor transmissions). The Dynamic Spectrum Alliance has published an interesting paper on automated frequency coordination; see http://dynamicspectrumalliance.org/wp-content/uploads/2019/03/DSA_DB-Report_Final_03122019.pdf.

Key Recommendations

- In the absence of private sector investment, governments should consider investing in core network infrastructure, with access sold on a non-discriminatory (wholesale open access) basis to:
  - Backbone networks
  - IXPs
  - Submarine cables
- In instances of market failure (such as in high-cost rural areas), governments should subsidize deployment of fixed and mobile last-mile networks, in which case,
  - Separate programs should be created for fixed and mobile services,
  - Fund recipients should be required to deploy broadband throughout the concession area,
  - Subsidies should be open to all qualified competitors and available on a technology-neutral basis,
  - Subsidies should be determined through a competitive process, such as reverse auctions, and
  - Fund recipients should be held accountable for meeting quantifiable targets and should be rewarded for beating build-out deadlines.
- Funds for universal service subsidies should be collected from as broad a base of contributors as possible, ideally through general tax revenues.
- Universal service funds should be independently administered.

lion in additional investment is required over 10 years to extend 4G-equivalent mobile connectivity to 90 percent of the world's population aged 10 years and above (ITU, 2020b). Excluding the United States and Canada, approximately US$47 billion in additional investment is required over 10 years to extend 4G-equivalent mobile connectivity to 90 percent of the population of the Americas aged 10 years and above (ITU, 2020b). Approximately US$51 billion would be needed to reach 100 percent of the population. These investment estimates include the cost of metro and backbone infrastructure, network operation and maintenance, mobile infrastructure capital expenditure, satellite coverage in rural areas not feasibly served by 4G, policy and regulation, and ICT skills and content. A recent paper reports that this level of investment would return US$955 billion in economic benefit to the LAC region (Bamford, Hutchinson, and Macon-Cooney, 2021).

The ITU estimates do not include the cost of extending fixed broadband directly to homes and businesses. According to the World Bank, there are approximately 14.78 fixed broadband subscriptions per 100 people around the world (World Bank, n.d., "World Development Indicators"). In the LAC region, there were approximately 84 million fixed broadband subscriptions in 2019, in a region with over 650 million people (ITU, n.d., "Fixed-Broadband"). That means that there are approximately 12.9 fixed broadband subscriptions per 100 people in LAC.[18] Significant investment will be required to make fixed broadband universally available in LAC, and one can expect a significant return from investing in universal fixed broadband.

As discussed above, the broadband network value chain (or building blocks) to develop universal, affordable, and high-quality broadband internet access comprises four broad segments:

[18] Based on an estimated population of 650 million people in LAC.

first mile, middle mile, last mile, and invisible mile. The first mile and middle mile are infrastructure that is often shared by providers of mobile and fixed broadband connectivity. The first mile is comprised of submarine cables, landing stations, satellite dishes, cross-border microwave and fiber links, domain name registration, and so on, and the middle mile is comprised of national backbone and intercity networks, including the fiber-optic cables or copper wires, microwave, satellite links, IXPs, local hosting of content, and so on. While countries in the LAC region already have first-mile infrastructure in place, there are instances in which middle-mile infrastructure, such as national backbone and intercity links, as well as IXPs, has not been deployed on a nationwide basis (i.e., it only interconnects larger population centers). Investment in middle-mile infrastructure has taken on renewed importance as network operators look to "densify" their networks for 5G mobile networks, alongside higher-capacity fixed networks.

In instances in which the private sector cannot, in whole or in part, raise the capital needed to develop a country's first-mile and middle-mile infrastructure, governments have a role to play in spurring that investment.[19] As discussed in Appendix 2, Malaysia is an example of a country that has successfully directed public investment toward the deployment of first-mile and middle-mile infrastructure. Indeed, there are numerous examples of governments investing in national fiber-optic networks and other shared infrastructure. Governments award a contract to one or more private sector entities, selected through a transparent and competitive process. The middle-mile network operator is required to provide access to its network on a non-discriminatory basis.

Lack of ubiquitous last-mile infrastructure is a problem for nearly every country. In particular, fixed and mobile last-mile infrastructure cannot be profitably deployed in many rural and economically depressed areas. Various forms of marginalization, such as a low rate of adult literacy and high percentages of households without sewage, drainage facilities, or electricity, often correspond with lower broadband availability (García Zaballos, Iglesias et al., 2020). The IDB recently reported that rural localities with low levels of marginalization had almost 70 percent coverage of broadband networks, while their urban counterparts had 100 percent coverage (García Zaballos, Iglesias et al., 2020). For localities with high levels of marginalization, broadband networks cover less than 10 percent of rural localities, compared to 90 percent of urban localities (García Zaballos, Iglesias et al., 2020).

High-quality data is key to identifying those areas lacking access to mobile and fixed broadband—ideally with a high level of geographic granularity. Absent availability data, network operators and communities can identify areas lacking availability on an ad hoc basis. Armed with this information, the regulator can determine which areas might benefit from subsidies and at what amounts. As discussed in Appendix 2, the U.S. FCC has implemented a system of reverse auctions for determining support amounts. These auctions are conducted on a com-

[19] "Particularly in situations where the service demand does not yet exist to justify private investment, public money frequently serves as a risk guarantee for network development while internet use continues to grow" (Alliance for Affordable Internet, 2020a, 25).

petitively and technologically neutral basis and bidders are given preferences based on speed, latency, and usage allowances. Auction winners are required to serve all customers within a defined geographic area and must build out their networks in a specified period of time. Other regulators, such as New Zealand, require subsidy recipients to prioritize higher bandwidth (e.g., 1 Gbps+ fiber) connections to anchor institutions, such as schools and libraries, health-care clinics, government offices, police and fire stations, and other community institutions (Mosby and Purre, 2010).

One note of caution is that many governments' universal service funds have proven unsuccessful (World Bank, 2021). To increase their likelihood of success, it is important that universal service funds include appropriate guardrails. Separate programs should be created for fixed and mobile services. Fund recipients should be required to deploy broadband throughout the concession area. Subsidies should be open to all qualified competitors and available on a technology-neutral basis. Subsidies should be determined through a competitive process, such as the U.S. FCC's reverse auctions mechanism. Fund recipients should be held accountable for meeting quantifiable targets and should be rewarded for beating build-out deadlines. Funds for universal service subsidies should be collected from as broad a base of contributors as possible, ideally through general tax revenues. Finally, universal service funds should be independently administered, with appropriate fiscal oversight.

Explore Community-Based Network Operators

Key Recommendations

- Consider policies promoting community-based network operators, especially in rural areas.
- Consider social-purpose spectrum licenses to support community networks in locations where licensed spectrum is not being used.

While they remain small in size and geography, there are now a growing number of community networks or social-purpose operators that show promise for connecting communities where traditional operators cannot cost effectively provide coverage or affordable access. Community networks operate on the following core principles:

- Collective ownership: network infrastructure managed as a common resource
- Social management: network infrastructure is operated by community members
- Open design: the network implementation and management details are public
- Open participation: anyone can extend the network if they follow the network principles
- Promotion and development of local content in local languages

Community networks can be operationalized, wholly or partly, through individuals and local stakeholders, NGOs, private sector entities, and/or public administrations. They are mostly

structured as a cooperative where any surplus is reinvested in the network or pays dividends to cooperative members. Some markets, such as the United States, have a deep history of community networks going back to the early days of electrification and telephony. In the United States, these network operators—still numbering close to 1,000—grew up in rural agricultural communities and adopted a cooperative business model leveraging existing farmers' cooperatives. The U.S. National Telecommunications Cooperative Association still has 850 independent, community-based telecommunications company members leading innovation in rural and small-town America (NTCA, n.d.).

While community networks are well known in some markets like the United States, one of the main barriers to the adoption of an enabling regulatory framework for community networks or social-purpose operators is that few people know they exist. This applies not only to the rural communities that are most likely to benefit, but also to policymakers, regulators, and development organizations. Lack of awareness is compounded by the view that access markets can be sufficiently well served only by a handful of large-scale national mobile and fixed network operators competing to provide services of sufficient coverage and quality, and at an affordable price. The experience of the United States has shown the opposite to be the case—some of these rural markets can only be served by non-profit community-based network operators.

There is an increasing body of evidence, as shown in the 43-country Community Networks report by GisWatch (APC and IDRC, 2018), that support for expanding the telecommunications operator ecosystem to include community networks and embedding this in NBPs could help provide affordable access to more vulnerable communities. Two successful recent cases of community networks—one providing fixed connectivity and the other providing mobile connectivity—are highlighted below.

Spain's Guifi.net, which received the European Broadband Award for the best innovative model of financing, business, and investment in 2015, supports thousands of individual participants and 26 local for-profit and non-profit telecom operators sharing infrastructure in common, with a fiber/wireless backbone and multihoming internet links with Wi-Fi and fiber-to-the-home (FTTH) fixed broadband connectivity. The nodes of the network are contributed by individuals, companies, and administrations that freely connect to an open network of telecommunications and extend the network wherever the infrastructure and content might not otherwise be accessible. Guifi.net allows for a wide set of different business models to exist around an infrastructure commons and this flexibility has been the secret of its success. As of June 2021, Guifi.net had 36,881 active nodes and 70,135 kilometers of wireless links.[20]

Community Cellular Networks in Oaxaca, Mexico, nominated for a World Summit on the Information Society (WSIS) award in 2019, is an example of a community-based mobile network. In 2013, because of the joint efforts between Rhizomatica, REDES A.C., and those in charge of a community radio station in a small village called Talea de Castro in the state of Oaxaca, it was possible to create an indigenous mobile telecommunications network completely operated,

[20] See https://guifi.net/en for the latest data.

owned, and managed by the community itself. The community decides who is responsible for managing the network, how it will operate, and even how much service costs. Currently, the service is licensed through a cooperative called Telecomunicaciones Indígenas Comunitarias A.C. (TIC A.C.), comprised of 14 operating communities, which cover 63 localities. TIC A.C. also has an operational team that accompanies individuals and communities seeking to build, manage, and operate their own communication networks.

As of July 2020, Community Cellular Networks has provided daily service to more than 3,500 people despite some of the harshest conditions for building communications networks in Mexico. In 2021, Community Cellular Networks, which has been allocated 10 MHz in the 850 MHz band, won a court case that exempts it from paying spectrum fees. In addition, the government regulations provide low-cost satellite capacity to local operators like those that are part of TIC A.C. Rhizomatica now functions as a local and international organization to support communities who want to build and maintain self-governed and -owned telecommunication infrastructure. They are involved in policy and regulatory advocacy, open-source technology development for GSM networks, and capacity building.

Other community network models have received global, regional, and national recognition, as documented in Appendix 3.

Digital Inclusion

Key Recommendation

- Ensure that citizens from traditionally disenfranchised groups—such as persons with disabilities, the elderly, children, youth, ethnic minorities, and women and girls—have equitable access to mobile and fixed broadband, as well as other digital technologies.

Over the last few decades, an increasing number of national governments have enacted laws and regulations increasing access to technology. This includes ensuring that all citizens, including those from traditionally disenfranchised groups, such as persons with disabilities, the elderly, children, youth, ethnic minorities, and women and girls, have equitable access to broadband.

Laws, policies, and regulations in many countries now ensure that devices, products, and services are usable by everyone on an equal basis, regardless of their gender, age, ability, or location. In addition, standards have been developed and harmonized to secure accessible, scalable, and affordable ICTs. Moreover, technology companies have implemented features in their products that increase access to their products.

The ITU has developed a toolkit and self-assessment entitled "Towards building inclusive digital communities," which helps policymakers and stakeholders build inclusive digital communities globally by providing a holistic understanding and knowledge of ICT and digital accessibility principles and implementation requirements (ITU, 2021). The toolkit details guidelines and best practices encompassing laws and regulations, political buy-in, standards, public pro-

curement, training, monitoring, and e-government. It also enables countries and organizations to run a self-assessment and obtain an immediate overview on the level of their ICT accessibility implementation.

Demand-Stimulation Activities

Even when mobile and fixed broadband is available, many people do not subscribe to it. According to the Global System for Mobile Communications Association (GSMA), for mobile broadband services, 3.3 billion people around the world live in areas covered by mobile broadband networks but do not use mobile internet. This usage gap is more than four times greater than the coverage gap (GSMA, 2019). According to the GSMA, affordability, low levels of literacy and digital skills, a perceived lack of relevance, and safety and security concerns are the most important barriers to mobile internet use from a consumer point of view (GSMA, 2019). Even in places like the United States, about one-quarter of consumers do not subscribe to home broadband, even when it's available to them, and rates of subscription are lower for consumers who are older, lower-income, and ethnic minorities (Pew Research Center, 2021). Addressing these barriers is critical to further reducing the adoption and usage gap and driving digital inclusion (GSMA, 2019). Below, we discuss how governments are stimulating demand for mobile and fixed broadband services.

Addressing Affordability

Key Recommendations

- Ensure that low-cost mobile and fixed broadband services and devices are available to low-income individuals and households.
- Enable discounted services for anchor institutions (schools and libraries, health-care centers, government offices, police and fire stations, and community centers) and marginalized groups (e.g., women and girls, persons with disabilities, and indigenous populations).
- Implement both basic and advanced digital skills programming.
- Support programs developing locally relevant applications and content.

The Broadband Commission has set a target for entry-level mobile and fixed broadband services to be less than 2 percent of monthly gross national income (GNI) per capita. For mobile services, mobile broadband is considered affordable if 1 GB of data is available for 2 percent or less of GNI per capita (Alliance for Affordable Internet, 2018).[21] Fixed broadband service is considered affordable if it provides at least 5 GB of monthly data consumption on a connection

[21] The ITU's measure for mobile broadband affordability requires 1.5 GB of data for 2 percent or less of GNI per capita (ITU, 2020e).

providing at least 256 Kbps for 2 percent or less of GNI per capita (ITU, 2020e). As discussed above, we have proposed more aggressive connectivity targets for LAC, but mobile and fixed broadband services should also be made more affordable.

While mobile and fixed broadband is affordable in some LAC markets, in most markets of the region fixed and mobile broadband remains unaffordable for the average person. As the data in Table 0.3 shows, mobile broadband is unaffordable for the average person in a majority of countries in LAC (ITU, n.d., "Price Baskets"). With the exception of the Bahamas, Brazil, Costa Rica, and Trinidad and Tobago, fixed broadband is unaffordable throughout LAC (ITU, n.d., "Price Baskets"). The Bahamas, Brazil, and Costa Rica are the only countries in the LAC region for which *both* mobile and fixed broadband is affordable for the average person.

Averages can mask inequality, which means that these countries will also have consumers with below-average GNI for whom current fixed and mobile broadband services are unaffordable. As detailed in Tables 0.3 and 0.4, a look at the bottom 40 percent and 20 percent of income earners across LAC shows that mobile and fixed broadband connectivity is considerably less affordable. A good example of this can be seen in Brazil, where both fixed and mobile broadband are considered affordable for the average income earner. However, Brazil is ranked as the 9th most economically unequal country in the world (Wikipedia, 2021a). According to the OECD, the average monthly income in Brazil was US$1,598 in 2013 and the median income was US$1,095 (OECD, n.d.). In 2015, the country's richest 5 percent had the same income as the remaining 95 percent (Oxfam, n.d.). Even though both its fixed and mobile broadband is considered affordable by the Alliance for Affordable Internet, Brazil has segments of its population for which broadband is still unaffordable. As shown in Tables 0.3 and 0.4, the bottom 20 percent of income earners in Brazil pay 11.6 percent of their income for mobile access and 6.5 percent of their income for fixed access.

It has been determined that NBPs correlate positively with greater internet affordability (Alliance for Affordable Internet, 2020a). According to the Alliance for Affordable Internet, "[t]he Central American region is unique for its endemic lack of NBPs. Among the six countries in the region, only Costa Rica, where access is the most affordable and average incomes are nearly triple anywhere else in the region, has a National Telecommunications Development Plan. In all other countries, the market lacks an effective national broadband plan" (Alliance for Affordable Internet, 2020a). While the cost of fixed and mobile data in Costa Rica is well below the Broadband Commission's target for entry-level mobile broadband services, entry-level mobile and fixed broadband services are unaffordable in Belize, El Salvador, Guatemala, Honduras, and Nicaragua (Alliance for Affordable Internet, 2020a).

In addition to implementing the supply-side efforts discussed above, which will reduce the cost of network inputs and enable operators to deliver more affordable services to more people, governments also implement programs to make mobile and fixed broadband service more affordable for low-income consumers. For example, the United States has implemented universal service programs that enable qualified low-income consumers (those that qualify for federal income-based programs, such as food stamps, free and reduced lunches for schoolchildren,

subsidized housing, etc.) to receive discounted mobile and fixed broadband services. The discounts are set by the FCC and people in tribal (indigenous) areas can receive larger discounts. Mobile and fixed broadband providers participating in this program are reimbursed for the cost of providing these monthly service discounts. A similar idea is to provide low-income households with vouchers enabling them to receive discounted or free broadband service installations and monthly services from their provider of choice. In addition, as part of its response to the COVID-19 pandemic, the U.S. Congress passed legislation and the FCC is implementing a program to provide discounted broadband service and devices to a broader cross-section of low-income households impacted by the current economic recession (Wu, 2021).

Governments also have implemented programs funding connectivity for anchor institutions. For example, as discussed in Appendix 2, the Government of Malaysia has a program to connect schools and community centers to high-speed broadband. In addition, the U.S. FCC has programs enabling schools, libraries, and health-care providers to receive discounted connectivity, with discounts based on the level of poverty in the community and whether it is a rural community.

The cost of devices is also a well-recognized barrier to broadband adoption. The Alliance for Affordable Internet's new study of device costs in low- and middle-income countries estimates that nearly 2.5 billion people live in countries where the cost of a smartphone is a quarter or more of the average monthly income (Alliance for Affordable Internet, 2020b). Several countries have implemented programs to ensure that low-income consumers—especially school children—can have access to low-cost devices. For example, the 1Malaysia program provided 1.7 million low-cost netbooks to citizens who lacked devices. In addition, as discussed above, the U.S. FCC is in the process of implementing a program to enable fixed and mobile network operators to provide low-cost devices to low-income households. In addition, Spain's Educa en Digital program provides low-cost devices to educational systems.

Digital Skills

Lack of digital skills remains a significant barrier to technology adoption. In a survey of the top barriers to mobile internet use in low- and middle-income countries, the GSMA found that "lack of literacy and skills" and "safety and security" ranked slightly higher than "affordability" for consumers surveyed in Latin America (GSMA, 2019). One can expect the same to be true for fixed broadband.[22] Lack of digital skills impacts both youth and adults (especially older adults). As discussed above, the COVID-19 pandemic has deeply impacted children, many of whom lack internet access at home. The digital skills gap for older people also has been exacerbated by the pandemic as they are forced to make vaccine and other medical appointments online, often without the skills to do so (Browning, 2021; Humana Foundation and OATS, 2021).

[22] According to a Pew Research Center Survey (Pew Research Center, 2013), about a third of U.S. non-internet users (34 percent) did not go online because they had no interest in doing so or did not think the internet was relevant to their lives. Another 32 percent of non-users said the internet was too difficult to use.

Therefore, basic digital skills—in essence, understanding how to use technology—are critical for people to be able to fully benefit from digital services. The Broadband Commission's Advocacy Target 4 is for 60 percent of youth and adults to have achieved at least a minimum level of proficiency in sustainable digital skills by 2025 (GSMA, 2019). The European Commission's goal is for 70 percent of adults to have basic digital skills by 2025 (Stolton and Valero, 2020). We propose that LAC governments follow the European Commission's lead and set a goal of at least 70 percent of youth and adults having basic digital skills in the next five years.

The World Bank has observed that "[d]igital literacy programs with higher chances of sustainability are either sponsored by a private company, the partnership of an NGO and a private company, a public-private partnership, or a public-private partnership including an NGO; on the other hand, if a project is exclusively sponsored by the public sector, chances are that it will not be sustainable" (World Bank Group, n.d.). Such partnerships will be critical for LAC governments to ensure that more of their citizens have the digital skills they need to participate online.

Local Content

Finally, it is important that consumers have access to content that is relevant to them and in their first language. The World Bank has observed that "users purchase broadband services and devices in order to gain access to the complementary services and content. In fact, for the population at large, the network infrastructure is less important on a day-to-day basis than the availability of relevant and useful online services and applications that allow them to access, create, and share content" (World Bank Group, n.d.). According to the GSMA, consumers who are not online often report that there is not enough content in their own language or that the internet is not relevant enough for them (GSMA, 2019).

Numerous efforts are underway to encourage the development of relevant content in more local languages. Governments can play an important role in developing local content and local applications by requiring that e-government applications are locally developed and available in local languages. In addition, there are examples of governments funding technology incubators.[23] An increasing array of online tools (YouTube, TikTok, etc.) are also available that enable the creation of user-generated content in local languages. As internet content becomes more relevant, consumers will be more willing and able to productively use their internet access.

Effective Monitoring and Evaluation Programs

The successful implementation of broadband rollout programs, guided by an NBP, depends heavily on monitoring and evaluation programs being in place, on regular public reviews, and on

[23] For example, the Government of Colombia's Apps.Co program (https://www.apps.co/) promotes digital entrepreneurship through training and mentorship.

Key Recommendations

- Include a monitoring and evaluation program at the outset.
- Perform an open and transparent assessment and review of progress at least every two years.
- Be prepared to course correct and update the plan in response to changed conditions.

a willingness to make policy changes when necessary to keep the plan on track. While at least 174 countries now have an NBP, more work must be done to monitor and evaluate the current state of implementation of these national plans (ITU and UNESCO, 2020). In some cases, even after publishing and endorsing a national plan, government transitions and competing priorities lead to situations where national plans are no longer effectively being implemented and/or targets need to be revised in order to have an impact on broadband availability and adoption (ITU and UNESCO, 2020).

The most effective NBPs have regular reviews and iterations. According to the Alliance for Affordable Internet in its annual affordability survey, three leading emerging-market countries—Malaysia, Colombia, and Costa Rica—demonstrate the impact of NBPs on internet affordability and the importance of iterative reviews in achieving excellence in this space (Alliance for Affordable Internet, 2020a). In 2020 these three countries earned the highest scores of any countries on the Alliance for Affordable Internet indicator for the quality of targets within their NBPs and the widespread impact of these targets. In these three countries, their NBPs set targets, led the sector, and provided evidence of impact. In Costa Rica, the NBP details a procedure for reviewing progress over the duration of the plan's lifespan, including biennial updates published by the ministry. These activities ensure that the NBP is not a one-off event in these countries but rather is the launching point for further and continued activity in the sector (Alliance for Affordable Internet, 2020a). As a result, the Alliance for Affordable Internet recommends that an NBP should have a stated plan for transparent assessment and review that occurs at least every other year (Alliance for Affordable Internet, 2020a). We agree that such a review should happen at least every two years.

5 Conclusion

This work has shown that global and regional efforts to close the digital divide are not ambitious or effective enough. Digital inequality is widening and at an accelerating pace, including in the LAC region. This work proposed a framework for NBPs in the LAC region. A well-formed NBP is a country's blueprint for addressing digital inequality. To reverse the trend toward greater inequality, there needs to be a coordinated and concerted effort to achieve aggressive digital inclusion targets that incorporates proven as well as new technological, financial, and regulatory approaches. NBPs should ensure that both mobile and fixed broadband is universally available and affordable. By reviewing prevailing literature and using four countries as reference points, this work detailed six key elements common to successful NBPs: (i) good governance, (ii) clear goals, (iii) regular assessment of broadband availability and adoption, (iv) supply-side interventions, (v) demand-stimulation activities, and (vi) monitoring and evaluation programs. Table 5.1 provides a review of the recommended actions for each of these elements.

One area that warrants greater attention by governments at every stage of broadband sectoral development is demand stimulation, addressing affordability, skills, and relevancy. With so much at stake, governments also need to more aggressively promote alternative technologies and business models to expand broadband availability.

TABLE 5.1	RECOMMENDED ACTIONS FOR A SUCCESSFUL NATIONAL BROADBAND PLAN
Good governance	• A country's NBP should be developed through an open and transparent process. • A single entity in government should lead, but inter-governmental coordination is key to gaining needed support and for successful implementation of the plan. • Allowing for limited trials of new regulatory models and technologies—"sandboxes"—can be a good way to try out new approaches prior to allowing them permanently countrywide.

Clear goals	• Develop a multi-year NBP with clear, ambitious, and achievable policy-related commitments and quantifiable targets.
	• Over a five-year period, supply-side targets could include:
	  • 4G mobile networks covering 99 percent of the population
	  • 5G mobile coverage in major urban settlements and along major roads and railways
	  • At least 1 Gbps symmetrical fiber connections for all anchor institutions
	  • Fixed broadband services delivering at least 100 Mbps download capacity and 20 Mbps upload capacity, with low latency and no data caps, available to all households
	  • A set of intermediate targets with escalating speeds each year (an increase of 10 percent per year for download speeds and 15 percent per year for upload speeds)
	  • Access for all citizens to at least 2 GB of mobile data per month or 5 GB of fixed data per month for less than 2 percent of the median income (with an increase in bandwidth of 20 percent per year)
	• Over a five-year period, demand-side targets could include:
	  • A program providing an affordable laptop or tablet to every low-income primary and secondary school student
	  • 70 percent of the country with basic digital skills to engage with government services, online education, and e-commerce
	  • A program providing discounted mobile and fixed broadband to marginalized groups, such as persons with disabilities
	• Resilience targets for internet infrastructure can include:
	  • Network/ISP Resilience: Targets for availability and stability of the physical links and logical/peering links, availability of multiple domain name servers (DNS) and intrusion detection systems
	  • Critical Infrastructure Resilience: Targets for resilience of power infrastructure and internet cables (terrestrial and undersea), number of internet exchange points (IXPs) and top-level domains in a country
	  • Market Resilience: Targets for affordability of access and level of market concentration (avoiding chokepoints)

Regular assessment of broadband availability and adoption	• For data on availability, combine mobile and fixed operator coverage and speed data with crowd-sourced data such as OpenSignal. • Ensure that fixed and mobile coverage is available on a publicly accessible broadband map for all operators in the country and ensure that the map is kept up to date. • For data on usage and adoption, combine a mix of survey data such as the ITU ICT Access questionnaire with crowd-sourced service data such as Ookla and data from online services such as Facebook and marketing platforms such as GlobalWebIndex. • Network measurement data from end-user devices should be overlaid on the publicly accessible broadband map.

Supply-side interventions	• Implement clear and enforceable competition policies:
	  • Policies should maximize competition throughout the supply chain.
	  • Policies should both promote competition and protect against abuse of market power.
	• Open up spectrum:
	  • Allocate licensed spectrum for 5G mobile networks
	  • Below 6 GHz for coverage
	  • Above 24 GHz for capacity

(continued on next page)

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TABLE 5.1	RECOMMENDED ACTIONS FOR A SUCCESSFUL NATIONAL BROADBAND PLAN

Supply-side interventions *(cont.)*	• Allocate more unlicensed spectrum for Wi-Fi 6 and other technologies in the 5 GHz and 6 GHz bands
	• Promote dynamic access to unused spectrum
	  • Unlicensed access to TV white spaces (TVWS)
	  • Consider spectrum-sharing models in other bands, such as
	  • 2.3 GHz and 2.6 GHz bands
	  • 3.3–3.8 GHz bands
	• Enable next-generation satellite and high-altitude-platform communications
	• Investment in infrastructure:
	  • In the absence of private sector investment, governments should consider investing in core network infrastructure, with access sold on a non-discriminatory (wholesale open access) basis to:
	  • Backbone networks
	  • IXPs
	  • Submarine cables
	  • In instances of market failure (such as in high-cost rural areas), governments should subsidize deployment of fixed and mobile last-mile networks, in which case,
	  • Separate programs should be created for fixed and mobile services,
	  • Fund recipients should be required to deploy broadband throughout the concession area,
	  • Subsidies should be open to all qualified competitors and available on a technology-neutral basis,
	  • Subsidies should be determined through a competitive process, such as reverse auctions, and
	  • Fund recipients should be held accountable for meeting quantifiable targets and should be rewarded for beating build-out deadlines.
	  • Funds for universal service subsidies should be collected from as broad a base of contributors as possible, ideally through general tax revenues.
	  • Universal service funds should be independently administered.
	• Consider policies promoting community-based network operators, especially in rural areas.
	• Consider social-purpose spectrum licenses to support community networks in locations where licensed spectrum is not being used.
	• Ensure that citizens from traditionally disenfranchised groups—such as persons with disabilities, the elderly, children, youth, ethnic minorities, and women and girls—have equitable access to mobile and fixed broadband, as well as other digital technologies.

Demand-stimulation activities	• Ensure that low-cost mobile and fixed broadband services and devices are available to low-income individuals and households. • Enable discounted services for anchor institutions (schools and libraries, health-care centers, government offices, police and fire stations, and community centers) and marginalized groups (e.g., women and girls, persons with disabilities, and indigenous populations). • Implement both basic and advanced digital skills programming. • Support programs developing locally relevant applications and content.
Monitoring and evaluation programs	• Include a monitoring and evaluation program at the outset. • Perform an open and transparent assessment and review of progress at least every two years. • Be prepared to course correct and update the plan in response to changed conditions.

Appendix 1

Contribution of Digital Infrastructure to the Achievement of the Sustainable Development Goals (SDGs)

SDG	IMPACT
SDG 1: End Poverty	An increase of 1 percent in mobile investment reduces the percentage of the population living below the poverty line by 0.0135 percent. An increase of 1 percent in investment in fixed telecom infrastructure leads to a reduction of the poverty headcount ratio by 0.0045 percent. Overall increase of 1 percent of total telecom investment is associated with a reduction in poverty of 0.0132 percent.
SDG 2: Zero Hunger	An increase of 1 percent in total telecom investment is associated with a reduction in the percentage of undernourished people of 0.011 percent, while an increase of 1 percent in mobile investment is associated with a reduction in the same variable of 0.014.
SDG 4: Quality Education	An increase of 1 percent in mobile investment increases the secondary net enrollment rate by 0.031 percent.
SDG 5: Gender Equality	A 1 percent increase in investment in fixed telecom infrastructure increases the proportion of seats held by women in national parliaments by 0.0221 percent. A 1 percent increase in total telecom investment increases women's presence in parliament by 0.0642 percent. A 1 percent increase in mobile investment increases the percentage of girls in secondary school by 0.0294 percent.
SDG 7: Affordable and Clean Energy	In relation to smart grids and smart logistics, an effective metering and monitoring system can generate an immediate energy savings of 10 percent, and 30 percent over the long run.
SDG 8: Decent Work and Economic Growth	Frontier (Frontier Economics, 2018) estimates that a 10 percent increase in M2M connections would generate an increase in GDP of US$370 billion in Germany and US$2.26 trillion in the United States between 2018 and 2032. Similarly, 5G is expected to enable a global output of US$12.3 trillion globally by 2035.
SDG 9: Industry, Innovation, and Infrastructure	An increase of 1 percent in total telecom investment increases trademark applications by 0.12 percent. Moreover, an increase of 1 percent in investment in fixed telecom infrastructure increases trademark applications by 0.06 percent.
SDG 10: Reduced Inequalities	An increase of 1 percent in mobile telecom investment increases the income share held by the lowest 10 percent by 0.001 percent and the lowest 20 percent by 0.0019 percent. A 1 percent increase in fixed telecom investment leads to an increase in the income share held by the lowest 10 percent by 0.0004 percent. Finally, a 1 percent increase in investment in telecom infrastructure is associated with an increase in the income share held by the lowest 10 percent of 0.0014 percent and the lowest 20 percent by 0.0027 percent.
SDG 13: Climate Action	An increase of 1 percent in investment in mobile technology reduces CO_2 per capita by 0.09 percent, while a 1 percent increase in the investment in fixed telecom sector reduces CO_2 per capita by 0.015 percent.

Source: García Zaballos, Iglesias, and Adamowicz (2019).

Appendix 2

National Broadband Plans

MALAYSIA

Notable Innovations and Achievements

- Creation of the High-Speed Broadband (HSBB) Project, a national open access network, using a Design-Build-Own (DBO) PPP arrangement (see Appendix 4)
  - Network is designed, funded, built, and managed by publicly owned operator
  - Private retail ISP providers can purchase access from HSBB
  - Achieved the fastest end-to-end fiber rollout in the world between 2011 and 2013
- Strong demand-side programs to increase uptake
  - 1 Malaysia program aimed to provide one million netbooks to citizens who lack devices. By 2014, the program had distributed 1.7 million laptops.
  - Community access facilities such as 1Malaysia Wireless Villages set up in rural areas with free Wi-Fi and training facilities
- Pricing
  - Mandatory Standard on Access Pricing (MSAP) to regulate wholesale prices of broadband
  - Price per GB of data for prepaid and postpaid mobile broadband is less than 0.3 percent of the median individual monthly income
- Spectrum access
  - Spectrum-sharing arrangements allowed between service providers for an apparatus assignment spectrum class

Basic Statistics

Malaysia's population is currently 32.16 million with an urbanization rate of 76 percent. The most recent ITU data on Malaysia states that 83 percent of the country's population were internet users as of 2020. Internet users grew by 3.6 percent between January 2019 and Janu-

ary 2020. Data from Ookla (December 2019) shows that the average speed of a fixed internet connection is 78.03 Mbps and the average speed of a mobile connection is 23.8 Mbps (Kemp, 2020a).

National Broadband Strategy

The Malaysian government has considered broadband connectivity a key national strategic issue since 2002 when discussions on its first National Broadband Strategy commenced. The first NBP was approved in 2004. Since then, a number of evolving strategies and initiatives have emerged (Razali Anuar, 2014) and Malaysia has been seen by many leaders, such as the European Commission, as a pathfinder for broadband expansion. Between 2011 and 2013, it achieved the fastest end-to-end fiber rollout in the world and over the same period had one of the fastest and lowest-cost high-speed broadband deployments worldwide (Razali Anuar, 2014).

The Malaysian High-Speed Broadband (HSBB) Project was created as a Design-Build-Own (DBO) PPP in 2008 (see Appendix 4 for a description of DBO PPPs) and is a key component of the National Broadband Implementation Strategy. In 2008 it aimed to achieve 50 percent broadband penetration by 2010; this target was exceeded and stood at 57 percent by the end of 2010 (Salman and Safar Hasim, 2011).

The National Broadband Implementation Strategy focuses on both supply- and demand-side components:

Supply Side

- Broadband for the General Population (BBGP)
  - Create incentives and facility-based competition based on major technologies (xDSL, WiMAX, 3G/HSDPA)
  - Universal Service Provision (USP) programs to roll out collective and individual access
  - Average speeds of 2 Mbps
- High-Speed Broadband (HSBB)
  - Target capitals, industrial areas, and development regions
  - Open access network for other service providers
  - PPP arrangement for infrastructure rollout
  - Speeds exceed 10 Mbps

Demand Side

- Awareness
  - Continuous government and private sector awareness initiatives
- Attractiveness

    - Enhance and promote e-government, e-education, and e-commerce initiatives
    - Improve and align online content strategies and activities
    - Leverage the development of traditional information resources
- Affordability
    - Develop initiatives to reduce/improve broadband access costs (PCs, subscriptions, etc.)
        i. In 2010, the government started an initiative to distribute one million free computers through the 1Malaysia program.
    - Widen community access facilities and deployment
- Deployment plans are customized for three different zones:
    - Zone 1: Urban
    - Zone 2: Suburban
    - Zone 3: Rural

The HSBB Network is focused on Zone 1, urban deployments (currently 76 percent of the population). The HSBB aimed to achieve speeds of up to 100 Mbps by 2020 for 410,000 premises. The BBGP is focused on connectivity for Zone 2 (suburban areas) and Zone 3 (rural areas). The BBGP aims to provide backhaul fiber with speeds up to 1 Gbps by 2020 and end-user speeds of up to 20 Mbps. Universal Service Provision initiatives are focused on rural areas and include building Pusat Internet Centers for connectivity and training, constructing cellular towers, distributing netbooks, and building an additional submarine cable from Peninsular Malaysia to Sabah and Sarawak.

The regulatory framework used for the HSBB project has the following key aspects:

- Services provided are based on fair and equitable access
- Open access that allows other service providers to use the HSBB Network

The most recent ICT policy, the National Fiberisation and Connectivity Plan (NFCP) 2019–2023 (Government of Malaysia, n.d.), is aimed at enabling wider service coverage, delivering faster broadband speeds, providing more choice to consumers, and leveraging the opportunities afforded by the digital economy. Key targets identified under the NFCP include:

- Affordable entry-level fixed broadband packages;
- Provision of an average speed of 30 Mbps in 98 percent of populated areas;
- Availability of 1 Gbps speeds in selected industrial areas by 2020 and all state capitals by 2023; and
- Fiber connections at 70 percent of schools, hospitals, libraries, police stations, and post offices by 2022.

In 2018, the Malaysian regulator created a policy called Mandatory Standard on Access Pricing (MSAP) to regulate wholesale prices of broadband. As a result of MSAP's implementa-

tion, demand for fixed residential and commercial broadband services rose by between 18 and 22 percent from August 2018 to August 2019 (Bernama, 2019). In addition, the price reductions caused by MSAP led the number of fixed broadband subscribers with an upload speed of more than 100 Mbps to rise eight-fold to 1.2 million subscribers in 2018 (Bernama, 2019).

Spectrum Access

From as early as 2002, the Malaysian Communications and Multimedia Commission (MCMC) encouraged industry players to be open to infrastructure and network sharing in order to ensure efficiency and better optimization of scarce resources such as spectrum. To use radiofrequency spectrum, an entity has to be granted the appropriate rights and permission to use it. This assignment has three possible options:

- *Spectrum Assignment:* This is a full authorization that enables a network operator to use specified frequency bands for any purpose consistent with the assignment conditions. The assignment is for a longer period of time (generally 10–20 years). It is akin to an exclusive license, subject to terms and conditions of the grant.
- *Apparatus Assignment:* This confers rights to use the spectrum to operate a network of a specified kind at a specified frequency band or bands. Typically, this permission is valid for 1–5 years, subject to terms and conditions of use.
- *Class Assignment:* This provides a general authorization to any network operator for use of a specified frequency band for a specific purpose subject to terms and conditions of use. For example, some user devices such as cordless telephone devices, Wireless LAN, Bluetooth, Radio Frequency Identification (RFID) and wireless microphone devices fall into this category.

In the 2.3 GHz and 2.6 GHz bands, service providers with apparatus assignments have entered into spectrum-sharing arrangements on a commercial basis. The 2.3 GHz band is used for WiMAX and the 2.6 GHz band is used for LTE. However, these assignments are likely to be replaced with long-term spectrum assignment licenses; there are ongoing public inquiries (MCMC, 2019) on the best method to assign this spectrum in the coming years, with some in the industry open to spectrum-sharing arrangements in these and future bands like 3.5 GHz.

Measuring Success

The implementation of the NBP in Malaysia has been fairly successful. In 2010, 56.3 percent of Malaysians were using the internet. In 2019, 84.2 percent of Malaysians were using the internet (World Bank, n.d., "World Development Indicators"). Broadband subscriptions increased from 17 percent in 2010 to 131 percent in 2019. In 2019, the price per GB of data for prepaid and postpaid mobile broadband was less than 0.3 percent of the state's median individual monthly

income. By August 2010, 123,000 netbooks had been distributed under the 1Malaysia program. By 2014, the program exceeded its one million target and had distributed 1.7 million laptops.

Challenges

The proportion of women who are internet users declined over time from 43.6 percent to 41.0 percent between 2012 and 2018. This is a worrying trend but is not unique—data from the Economist Intelligence Unit in 2020 showed that men remain 21 percent more likely to be online than women (Iglesias, 2020). Malaysia is addressing this challenge with specific gender targets in their latest broadband policy.

There were complaints about the quality of the 1Malaysia netbooks (Diew, 2012), with issues such as poor keyboard, touchpad, hard disk drive, and general build quality.

NEW ZEALAND

Notable Innovations and Achievements

- Creation of a national wholesale access network, Ultra-Fast Broadband (UFB), using a joint venture PPP arrangement (see Appendix 4)
  - Mix of government (NZ$1 billion) and private sector (NZ$3.5 billion) funding
  - The UFB is co-owned by the four partners (main incumbent, Chorus, holds 69 percent, plus three other fiber companies)
  - Considered 100 percent complete, with an uptake of 60 percent as of December 2020
- Targets for general population (75 percent of population with 100 Mbps download and 50 Mbps upload in 10 years)
- Target for anchor institutions (all schools and public hospitals, most private health facilities, and most businesses connected to fiber in first six years)
- High level of accountability, with quarterly reports on the government's broadband and mobile program
- Focus on fiber to the premises (FTTP) policy has paid off
  - New Zealand's average broadband speed is 142.10 Mbps (23rd in the world) compared to Australia (58.76 Mbps)
- Created a specific plan for rural areas (Rural Broadband Initiative Phases 1 and 2)
- Created spectrum parks in the 2.5 GHz band to test technology-based or organizational-based spectrum sharing that does not depend on formal licensing
- Created an interim television white space (TVWS) licensing regime to allow TVWS trials to be deployed with a very light approach not requiring a spectrum database
- Māori Spectrum Working Group established in 2019
  - They received 50 MHz of 5G spectrum in the 3.5 GHz band in 2019

Basic Statistics

New Zealand's population is currently 4.8 million with an urbanization rate of 87 percent. The most recent ITU data on New Zealand states that 93 percent of the country's population were internet users as of 2020. Internet users grew by 2.4 percent between January 2019 and January 2020. Data from Ookla (December 2019) shows that the average speed of a fixed internet connection is 103.38 Mbps and the average speed of a mobile connection is 54.72 Mbps (Kemp, 2020b).

National Broadband Plan

The drivers for creating New Zealand's NBP were identified by the New Zealand Institute in 2008 as follows:

- The national economic benefits of broadband would be in the range of NZ$2.7 to NZ$4.4 billion per year.
- New Zealand needed to shift from penetration to increasing broadband speeds so there was an investment focus in fiber.

New Zealand created an NBP in 2010 called the Ultra-Fast Broadband (UFB) Initiative. The plan had the following key elements:

- Rollout of fiber to the premises (FTTP) as opposed to Australia's mixed-access approach
- Connect 75 percent of New Zealanders with "ultra-fast broadband" (100 Mbps download, 50 Mbps upload) over 10 years, concentrating on priority broadband users such as businesses, schools, and health services, plus greenfield developments and certain tranches of residential areas in the first six years
- Creation of a price-regulated investment vehicle offering open-access "dark fiber" wholesale services (called FibreCo)
- A mix of government (NZ$1 billion) and private (NZ$3.5 billion) sector funding
- Structural separation of TelecomNZ (now known as Spark) and government investment in Chorus (in 2008, TelecomNZ was operationally separated into three divisions under local loop unbundling initiatives by the central government: Telecom Retail, Telecom Wholesale, and Chorus, the network infrastructure division)

The plan was revised in 2019 (denoted UFB2+) and set a new target of reaching 87 percent of the population with "ultra-fast broadband" (defined as 100 Mbps download and 50 Mbps upload) by 2022 and providing fiber to more than 190 new towns. As of November 2019, the original UFB project was considered 100 percent complete, with an uptake of 60 percent as of December 2020.

The UFB is a PPP with government and four other companies with a total government investment of US$1.08 billion. Crown Fibre Holdings Limited,[24] a Crown-owned company,[25] was set up to oversee the implementation and delivery for UFB. The main partner company is Chorus, which won 69 percent of the rollout area. The other three partner companies are local fiber companies Ultrafast Fibre (13.7 percent), Northpower Fibre (1.6 percent), and Enable Networks (15.3 percent).

Chorus or the local fiber companies wholesale services to ISPs who offer retail services to customers. This is analogous to the model in Australia and Malaysia where the national broad-

[24] https://www.crowninfrastructure.govt.nz/.

[25] A Crown entity (from the Commonwealth term "Crown") is an organization that forms part of New Zealand's state sector established under the Crown Entities Act 2004, a unique umbrella governance and accountability statute. The Crown Entities Act is based on the corporate model where the governance of the organization is split from the management of the organization.

band network offers wholesale services. Currently, there are 89 retail providers offering services over the UFB. The contract with UFB states that two speed options should be offered: 30 Mbps download and 10 Mbps upload or 100 Mbps download and 50 Mbps upload.

The new Rural Broadband Initiative Phase 2 (RBI2) (Centre for Public Impact, 2016) program plans to provide improved broadband access to over 84,000 rural households and businesses. This program was established in 2017 when Crown Infrastructure Partners (CIP) assessed 90,000 rural households and businesses and discovered that they cannot access broadband speeds of at least 20 Mbps. CIP was contracted to provide fast broadband above 20 Mbps to 64,000 of these 90,000 households and businesses commencing in 2018 and to be completed by 2022. CIP is partnering with the Rural Connectivity Group (RCG), a joint venture between Spark, Vodafone, and 2 Degrees, as well as nine regional wireless internet service providers (WISPs).

Spectrum Policies

New Zealand encourages innovative ideas to use spectrum more efficiently as well as create new methods or opportunities for connecting the unconnected. To this end, New Zealand has created Managed Spectrum Park (MSP) licenses and interim TVWS licenses, and allocated spectrum to the Māori Spectrum Working Group.

MSP licenses were created in 2008. The licensed band consists of 40 MHz of spectrum from 2575 MHz to 2620 MHz. In this regime, the licensee agrees to share the block of spectrum by means of licensing or employing compatible equipment capable of sharing the same spectrum (this could be using techniques such as antenna polarization, careful site selection, power control, databases, etc.). MSP licenses are allocated following an "expression of interest" process, which may involve a ballot if applicants can't agree to share spectrum. To ensure the spectrum is efficiently utilized, services must be implemented within two years of allocation.

TVWS are unassigned broadcast frequencies and are particularly useful for creating long-range links in rural areas. New Zealand has taken a wait-and-see approach to TVWS and has created an interim licensing scheme to allow TVWS trials to operate in the UHF television band (510–606 MHz). Radio Spectrum Management (RSM) will investigate a long-term regime for New Zealand, once international frameworks and regulatory regimes are mature. FCC- and Ofcom-certified devices can operate on up to four contiguous or non-contiguous channels in New Zealand without further certification and without the use of a spectrum database. When a service provider applies to RSM for TVWS spectrum, an approved radio engineer must do calculations to check for interference in the area where the deployment will occur. If RSM is satisfied with the application and the calculations, the license will be approved.

Established in 2019, the Māori Spectrum Working Group advocates for Māori interests in radio spectrum and spectrum auctions in the future. A recent deal was signed that allocated a significant slice of 5G spectrum to the Māori (Pullar-Strecker, 2019). 50 MHz of unused spectrum in the 3.5 GHz band, currently supported by smartphones, would be made available to the

Māori in 2020. Māori interests in radio spectrum date back to 2004, when the Māori Television Broadcasting service was established (currently they own two digital TV channels).

Measuring Success

Although slow at first, the implementation of the NBP has resulted in accelerated uptake of broadband services. The focus on FTTP from the start of the plan is now paying off. This is seen when you compare the average fixed broadband speed (142.10 Mbps) of New Zealand to Australia (58.76 Mbps), which chose to use a mixed-access method.

Measurement of the plan's success includes the following:

- Each quarter, a Quarterly Connectivity Update is published reporting on the progress of the government's broadband and mobile programs.[26]
- The wholesale providers that are part of the UFB supply data on a voluntary basis to Broadband Map NZ,[27] a broadband mapping service built by non-profit InternetNZ. This can be used by individuals and businesses to find out what services are available in their area.
- In 2010, 80.46 percent of New Zealanders were using the internet. In 2019, 90.81 percent of New Zealanders were using the internet (World Bank, n.d., "World Development Indicators").
- In 2020, fiber broadband uptake stood at just below 50 percent (IT Brief New Zealand, 2020) of the country (one of the highest among OECD countries and much higher than Australia's 20 percent).
- New Zealand's mobile plan prices are below the OECD average for all plan types. For instance, a medium-use plan of 100 calls and 2 GB of data costs NZ$28, 24 percent below the international average (Williams, 2020).
- As of April 2021 the average mobile download speed was 76.47 Mbps (23rd in the world) and average fixed broadband download speed was 153.88 Mbps (24th in the world) (Speedtest.net, 2021).

Challenges

Prices for a medium-use fixed broadband plan (up to 150 GB of data on a 30 Mbps connection) and voice bundle remained at NZ$75 (US$54) in 2019 (Williams, 2020). As the OECD average price has dropped since 2018, New Zealand is now more expensive than the international average.

[26] See https://www.mbie.govt.nz/science-and-technology/it-communications-and-broadband/fast-broadband/quarterly-updates-on-broadband-deployment/.
[27] https://broadbandmap.nz/about-us.

SPAIN

Notable Innovations and Achievements

- Development of a national strategy for ultra-fast networks
- Efficient use of the radio spectrum supporting the deployment of networks and technologies
- Promoting more dynamic and flexible use of the spectrum
- Actions to support public and private cooperation and joint venture capital investments through a strategy promoting:
  - Sustainable competition
  - Technological neutrality
  - Reduced deployment costs
  - Shared use of infrastructure
  - Voluntary agreements among operators
- Following a technology-neutral approach considering the full range of technologies to be used in rural areas
- Inviting all interested parties to participate and contribute to the NBP definition
- Launching a program to expand the deployment of broadband and the dissemination of high-speed networks and emerging technologies
- Minimizing the number of licenses that must be requested to provide services
- Promoting digital skills competencies for citizens in the general population, active population, and technology population
- Educa en Digital program created to support the digital transformation of the educational system

Basic Statistics

Spain's population is currently 46.75 million with an urbanization rate of 80 percent. The most recent ITU data on Spain states that 91 percent of the country's population were internet users as of 2020. Internet users grew by 4.3 percent between January 2019 and January 2020. Data from Ookla (December 2019) shows that the average speed of a fixed internet connection is 122.71 Mbps and the average speed of a mobile connection is 35.05 Mbps (Kemp, 2020c).

Digital Agenda

As with all European Union member countries, the Spain's Digital Agenda tracks the EU's Digital Agenda for Europe. Some of the key components of Spain's broadband strategy are:

- The Digital Agenda,
- The National 5G Plan,
- The funding program PEBA-NGA 2019–2021,
- Digital Spain 2025, and
- The National Plan for Digital Skills.

Digital Spain 2025 includes a set of measures, reforms, and investments, articulated in ten strategic axes, aligned with the digital policies established by the European Commission.[28] The following strategic goals are relevant:

- Guarantee adequate digital connectivity for 100 percent of the population, promoting the elimination of the digital divide between rural and urban areas (2025 goal: 100 percent of the population with 100 Mbps coverage).

  Broadband communications infrastructure is the cornerstone of the digitization strategy. In addition to being key to fighting the COVID-19 pandemic, the improvement of digital infrastructure is an important engine to economic recovery and social inclusion.
- Continue to lead the deployment of 5G technology in Europe, encouraging its contribution to increasing economic productivity, social progress, and territorial structuring (2025 goal: 100 percent of the radio spectrum prepared for 5G).

  Spain set the goal to establish itself as a leader in the development and deployment of 5G networks. The evaluation carried out in May 2020 by the European Observatory confirms Spain's leadership in the development of 5G networks and services in Europe (30 cities and 31 pilot experiences), leadership that should not be held back by the impact of the COVID-19 pandemic.
- Digital Competencies: The measures developed in this area seek to provide digital skills to specific target groups.

  The core program to achieve this is Educa en Digital. It consists of a set of actions to support the digital transformation of the educational system through the provision of devices, digital educational resources, digital skills for teachers, and actions that involve the application of artificial intelligence to personalized education (Ministry of Education and Professional Training, 2020).

  The National Plan for Digital Skills is a comprehensive plan that aims to: (i) substantially increase the level of basic digital skills of the currently worst-off groups (seniors, people with low income and education, non-urban populations, women); (ii) guarantee the advanced digital skills of students at the end of secondary education; (iii) train the workforce with the digital knowledge necessary in their jobs and for future employability,

[28] See https://www.lamoncloa.gob.es/presidente/actividades/Documents/2020/230720-Espa%C3%B1a Digital_2025.pdf.

increasing their productivity and also promoting remote work; and (iv) respond to demand for general and advanced digital specialists in the Spanish economy, paying special attention to reducing the existing gender gaps in all of them (Government of Spain, 2021; Jākobsone, 2021).

Spectrum Policies

According to Spain's Digital Agenda, a national strategy for ultra-fast networks, 95 percent of the population will have an ultra-fast connection of 300 Mbps by 2021. As part of this plan, it is also essential to achieve efficient use of radio spectrum in order to encourage the deployment of new networks and technologies and to increase the value of the services provided (Ministry of Economic Affairs and Digital Transformation, n.d., "España Digital 2025"). The use of the spectrum has been critical for achieving the goals imposed by the Digital Agenda for Europe, both for making broadband available to the entire population and for achieving 100 percent coverage of households.

The country has also been working to remove regulatory and administrative barriers to ensure dynamic and flexible use of spectrum to promote the deployment of ultra-fast broadband networks. Actions have been taken to support public-private cooperation and joint venture capital investments (Ministry of Economic Affairs and Digital Transformation, n.d., "España Digital 2025").

According to Digital Spain 2025 (Ministry of Economic Affairs and Digital Transformation, n.d., "España Digital 2025"), spectrum best practices include the following:

- Bringing forward the date for making spectrum blocks available to telecommunications operators for electronic communications services.
- Promoting more efficient use of the spectrum while simplifying access to it through: (i) facilitating flexible use of spectrum by permitting secondary markets; (ii) use of general authorization, only requiring prior notification and payment of fees; (iii) analysis of alternatives to promote the shared use of the radio spectrum; (iv) assessment of innovative technologies, such as smart radio systems.
- Identifying spectrum bands that are underutilized and can be made available for higher-value services on a technologically neutral basis.
- Assessing the spectrum requirements for the development of ultra-fast broadband networks and identify the frequency bands that can be used to fulfill this demand.

The National 5G Plan (Ministry of Economic Affairs and Digital Transformation, n.d., "Plan Nacional 5G") also addresses spectrum access. Some of the key highlights are:

- Issuing a tender for the 3.6–3.8 GHz band and definition of the scenarios for the rearrangement of the 3.4–3.8 GHz band.

- Issuing a tender for the 1452–1492 MHz band and adoption of measures for the future release of the extended L-band.
- Defining the national roadmap for the release of the 700 MHz band (second digital dividend).
- Analyzing the possibility of rearranging the 26 GHz band and establishing technical rules prior to tender.
- Facilitating the use of the different frequency bands identified for the delivery of 5G services in pilot projects carried out within the scope of the national plan.

Measuring Success

As a consequence of the Digital Agenda, many mechanisms for improving the experience of broadband service users were put into place, increasing the demand of digital services and promoting the production and distribution of digital content over the internet. At the outset, the objectives of the agenda were to reach 100 percent coverage at 30 Mbps and 50 percent take-up of 100 Mbps services by households by 2020 (European Commission, 2020).

The national ultra-fast network strategy promoted sustainable competition, technological neutrality, reduced deployment costs, and shared use of infrastructure and investments through voluntary agreements among operators. Particularly in those areas in which deployments by private companies are limited because of lack of profitability, the strategy addresses the use of public-private cooperation mechanisms, allowing the extension of coverage of new networks as established by European legislation.

Several actions were taken to assess and report on fixed and mobile broadband service quality and make terms and conditions of service more transparent for users (European Commission, 2020).

Spain also created PEBA-NGA 2019–2021, a next-generation broadband funding program for 2019–2021. The objective of the program is to expand the deployment of broadband and the dissemination of high-speed networks and support the adoption of emerging technologies, networks for the digital economy, and the deployment and adoption of networks and services to guarantee digital connectivity (Ministry of Economic Affairs and Digital Transformation, n.d., "Programa de extensión").

The purpose of the National Plan 2018–2020 is also to adopt standards, identify practical use cases, experiment with technology, and develop the relevant ecosystems in the 5G domain. One key lesson learned from the development of this plan was the challenge of digitally transforming various stakeholders like network operators, the manufacturers and vendors of cutting-edge technological solutions, entrepreneurs, the scientific and research community, public administrations and users, and particularly companies from different economic sectors.

Challenges

The main challenges to Digital Spain 2025 and the National Plan for Digital Skills (Ministry of Economic Affairs and Digital Transformation, n.d., "España Digital 2025") are as follows:

- Guaranteeing adequate digital connectivity for 100 percent of the population and eliminating the digital divide between rural and urban areas (2025 goal: 100 percent of the population with 100 Mbps coverage).
- Boosting economic activity from the development of digital infrastructures.
- Providing digital skills to three large target groups, aligned with those identified by the Coalition for Digital Skills and Jobs: (i) citizens in general; (ii) the active population, which includes working and unemployed people; and (iii) technology professionals from all sectors of the economy.
- Increasing the level of basic digital skills of the currently worst-off groups (seniors, people with low income and education, non-urban populations, women).
- Guaranteeing the advanced digital skills of students by the end of secondary education.
- Training the workforce with the digital knowledge necessary for their jobs and for future employability, increasing their productivity and also promoting remote work.
- Responding to the demand for general and advanced digital specialists in the Spanish economy, paying special attention to reducing the existing gender gaps in all of them.

THE UNITED STATES

Notable Innovations and Achievements

- Global leader in spectrum policy
  - Auctioned 1,000s MHz of exclusive-use licensed spectrum for next-generation 5G mobile networks
  - Free access to 1,000s MHz of non-exclusive unlicensed spectrum for next-generation Wi-Fi and other wireless technologies
  - A leader in enabling spectrum sharing across a variety of low-, mid-, and high-band spectrum ranges (TVWS, CBRS, etc.)
- Broadband data collection
  - Granular data collection on fixed and mobile broadband availability and adoption
- Innovative universal service policies
  - All universal service programs now focused on broadband availability and adoption
  - Separate programs for mobile and fixed broadband connectivity
  - Technologically and competitively neutral reverse auctions to determine recipients of funding to extend broadband to unserved areas
  - Specific programs focused on stimulating demand for key verticals—education, health care, and agriculture
  - Additional incentives for extending access and increasing adoption for traditionally disenfranchised groups such as tribal communities, minority communities, and persons with disabilities

Basic Statistics

The population of the United States is currently 330 million with an urbanization rate of 82 percent. According to the most recent ITU data on the United States, 87 percent of the country's population were internet users as of 2020. Internet users grew by 0.6 percent between January 2019 and January 2020. Data from Ookla (December 2019) shows that the average speed of a fixed internet connection is 130.79 Mbps and the average speed of a mobile connection is 41.00 Mbps (Kemp, 2020d).

Overview of National Broadband Plan

The U.S. government's National Broadband Plan, released by the Federal Communications Commission (FCC) on March 17, 2010, set out a roadmap for initiatives to stimulate economic growth, spur job creation, and boost America's capabilities in education, health care, homeland security, and more (FCC, 2010). A comprehensive 376-page document, the FCC's plan included

over 200 recommendations in sections focusing on economic opportunity, education, health care, energy and the environment, government performance, civic engagement, and public safety. The FCC's plan was not self-effectuating; rather, it was a set of recommendations requiring further actions by the FCC and other regulatory and legislative bodies. While much of the plan could be accomplished by the FCC through its rulemaking proceedings, many of the recommendations required action by Executive Branch agencies and, in some instances, required new legislation from Congress.

The FCC's National Broadband Plan was organized into four parts:

1. *Establishing competition policies:* Design policies to ensure robust competition and, as a result, maximize consumer welfare, innovation, and investment.
2. *Ensuring efficient allocation and use of government-owned and government-influenced assets:* Ensure efficient allocation and management of assets the government controls or influences, such as spectrum, poles, and rights-of-way, to encourage network upgrades and competitive entry.
3. *Creating incentives for universal availability and adoption of broadband:* Reform current universal service mechanisms to support deployment of broadband and voice in high-cost areas, ensure that low-income Americans can afford broadband, and support efforts to boost adoption and utilization.
4. *Updating policies, setting standards, and aligning incentives to maximize use for national priorities:* Reform laws, policies, standards, and incentives to maximize the benefits of broadband in sectors the government influences significantly, such as public education, health care, and government operations.

The FCC's National Broadband Plan also included six long-term goals to serve as a compass over the next ten years (by March 2020):

- *Goal No. 1:* At least 100 million U.S. homes should have affordable access to actual download speeds of at least 100 Mbps and actual upload speeds of at least 50 Mbps.
- *Goal No. 2:* The United States should lead the world in mobile innovation, with the fastest and most extensive wireless networks of any nation.
- *Goal No. 3:* Every American should have affordable access to robust broadband service, and the means and skills to subscribe if they so choose.
- *Goal No. 4:* Every American community should have affordable access to at least 1 Gbps broadband service to anchor institutions such as schools, hospitals, and government buildings.
- *Goal No. 5:* To ensure the safety of the American people, every first responder should have access to a nationwide wireless, interoperable broadband public safety network.
- *Goal No. 6:* To ensure that America leads in the clean energy economy, every American should be able to use broadband to track and manage their real-time energy consumption.

More than 10 years from publication of its first National Broadband Plan, the FCC has been the subject of some fair criticism for failure to meet these ambitious goals (Terry, 2019). In addition, legislation has been proposed that would require the FCC to update its National Broadband Plan.[29] Nonetheless, the FCC and other parts of the U.S. government have made significant progress on many of the National Broadband Plan's recommendations. The following sections highlight some of the FCC's more noteworthy recommendations and actions in relation to the four sections of the FCC's National Broadband Plan.

Establishing Competition Policies

In its 2010 National Broadband Plan, the FCC put forth several recommendations aimed at increasing broadband competition. The FCC committed to collect, analyze, benchmark, and publish detailed market-by-market information on broadband pricing and competition, which will likely have direct impacts on competitive behavior (e.g., through benchmarking of pricing across geographic markets). The FCC argued that this information will also enable it and other agencies to apply appropriate remedies when competition is lacking in specific geographies or market segments. The FCC also committed to develop disclosure requirements for broadband service providers to ensure consumers have the pricing and performance information they need to choose the best broadband offers in the market. The FCC argued that increased transparency will incentivize service providers to compete for customers on the basis of actual performance. Moreover, the FCC committed to undertake a comprehensive review of wholesale competition rules to help ensure competition in fixed and mobile broadband services. Finally, the FCC committed to free up and allocate additional spectrum for unlicensed use, fostering ongoing innovation and competitive entry.

The FCC has followed through on many of these recommendations. While the jurisdictional theory that underpins the regulation of broadband internet access providers has been the subject of considerable debate over the last decade, the FCC has required internet service providers to disclose information about their practices to consumers, entrepreneurs, and the Commission, including any blocking, throttling, paid prioritization, or affiliated prioritization, but fell short of requiring broadband providers to provide information on pricing, which is not regulated (FCC, 2018f, 2020h; Mozilla Corporation v. Federal Communications Commission and United States of America, 2019). The FCC has also taken several steps to eliminate and modernize outmoded regulations that it concluded might stifle investment, including: (i) removing unnecessary transport and facilities pricing regulation (FCC, 2019b); (ii) removal of unbundling and resale requirements (FCC, 2019d, 2020g); (iii) eliminating the filing of paper tariffs (FCC, 2019c); and (iv) eliminating a requirement that carriers maintain separate books of accounts, one for regulatory accounting and one for financial accounting (FCC, 2017).

[29] See https://www.markey.senate.gov/imo/media/doc/Update%20to%20National%20Broadband%20Plan.pdf.

The Commission also took additional steps to foster competition in the market. This included a series of decisions paving the way for high-speed broadband to be provided by numerous non-geostationary orbit satellite constellations, including OneWeb, SpaceX, Kuiper, Telesat, and others.[30] In addition, the FCC imposed merger conditions on network operators in an effort to help close the digital divide and bring robust 5G deep into rural areas. Moreover, as discussed in detail below, the FCC opened up huge swaths of licensed and unlicensed spectrum for use by both incumbent and new fixed broadband providers.

Ensuring Efficient Allocation and Use of Assets

Opening Up More Spectrum for Next-Generation Networks

In its 2010 National Broadband Plan, the FCC made several spectrum policy recommendations. The FCC recommended that 500 MHz of spectrum be made newly available for broadband within 10 years, of which 300 MHz should be made available for mobile use within five years. The FCC recommended innovative approaches to reallocating spectrum from various types of government and private sector users to high-demand commercial uses. The FCC also committed to expand opportunities for innovative spectrum access models by creating new avenues for opportunistic and unlicensed use of spectrum and increasing research into new spectrum technologies. Notable requests for authorization from the U.S. Congress included funding for a nationwide public safety mobile broadband communications network and auction of several bands of spectrum for next-generation mobile networks. This included a request that the U.S. Congress give the FCC authority to establish a new form of "incentive auctions" to compensate TV stations for relocating to UHF spectrum below 600 MHz.

Following the issuance of the plan, President Barack Obama set a goal to make 500 MHz of spectrum available for mobile and fixed wireless broadband by 2020. In support of this goal, the U.S. Department of Commerce's National Telecommunications and Information Administration (NTIA) identified several bands that could be repurposed for shared or exclusive use by nonfederal users. NTIA formally recommended or otherwise identified 335 MHz of spectrum allocated to federal agencies for potential reallocation (Strickling, 2015). In addition, the U.S.

[30] See, for example, WorldVu Satellites Limited Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb NGSO FSS System, Order and Declaratory Ruling, FCC 17-77, released June 23, 2017 (https://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0623/FCC-17-77A1.pdf); Space Exploration Holdings, LLC, Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System, IBFS File No. SAT-LOA-20161115-00118, Memorandum Opinion, Order and Authorization, FCC 18-38, released March 29, 2018 (https://docs.fcc.gov/public/attachments/FCC-18-38A1.pdf); and Kuiper Systems, LLC Application for Authority to Deploy and Operate a Ka-band Non-Geostationary Satellite Orbit System, IBFS File No. SAT-LOA-20190704-00057, Order and Authorization, FCC 20-102, released July 30, 2020 (https://docs.fcc.gov/public/attachments/FCC-20-102A1_Rcd.pdf). See also "FCC Boosts Satellite Broadband Connectivity and Competition in the United States," November 15, 2018 (available at https://docs.fcc.gov/public/attachments/DOC-355102A1.pdf).

President's Council of Advisors on Science and Technology (PCAST) conducted an in-depth study on the future of spectrum use and concluded that the future spectrum needs of consumers and federal agencies could only be met by the sharing of spectrum between government and commercial interests (PCAST, 2012).

The FCC has been a leader in making spectrum available for 5G mobile services. Building upon a successful 700 MHz auction, which preceded the 2010 National Broadband Plan, the FCC freed up more sub–1 GHz spectrum in the 600 MHz band by relocating television stations to new channel assignments below 600 MHz (FCC, 2014a). The FCC concluded successful 5G auctions in the 24 GHz and 28 GHz bands, raising more than $2.7 billion in gross bids (FCC, 2019a). Together, the FCC made 1,550 MHz of spectrum available for 5G connectivity through these auctions. In addition, the FCC auctioned 3,400 MHz of millimeter wave spectrum in the upper 37 GHz, 39 GHz, and 47 GHz bands, garnering over $7.5 billion in net bids (FCC, 2020e). Most recently, the FCC conducted a historic auction to reallocate the lower 280 MHz of the 3.7–4.2 GHz band, commonly called the "C-band," for advanced wireless services, including 5G (FCC, 2020b). This auction garnered over $80.9 billion in bids primarily through licenses awarded to telecom companies Verizon, AT&T, and T-Mobile, shattering the prior FCC auction record of $44.9 billion and becoming by far the highest-grossing auction in U.S. history (FCC, 2021d). The FCC has also opened up proceedings to allow access to a variety of other mid-band and high-band spectrum ranges.

The FCC conducted the first-ever mid-band 5G auction in the United States, auctioning 70 MHz of Priority Access Licenses in the 3.5 GHz CBRS band and raising more than $4.54 billion in net proceeds (FCC, 2018e, 2020d). This is part of a unique three-tiered access and authorization framework—first recommended in the 2012 PCAST Report—to coordinate shared federal government and commercial use of the band. Incumbents comprise the first tier (Incumbent Access) and receive protection from all other users, followed by Priority Access Licensees (PALs) in the second tier, and General Authorized Access (GAA) in the third tier. Over half of the band—a minimum of 80 MHz—is reserved for GAA use. PALs receive protection from GAA operations but must protect and accept interference from Incumbent Access–tier users. GAA is licensed by rule and must avoid causing harmful interference to higher-tier users and (like unlicensed users) accept interference from all other users, including other GAA users. GAA users can operate throughout the entire 150 MHz of the 3.5 GHz band on any frequencies not in use by PALs. To enable full commercial deployment across the entire band, the FCC authorized several Spectrum Access Systems and Environmental Sensing Capabilities.

The FCC has also freed up massive amounts of unlicensed spectrum. The FCC adopted new rules to make 45 MHz of 5.9 GHz spectrum available for unlicensed services such as Wi-Fi. The new band plan designated the lower 45 MHz (5.850–5.895 GHz) for unlicensed uses and the upper 30 MHz (5.895–5.925 GHz) for enhanced automobile safety using Cellular Vehicle-to-Everything (C-V2X) technology (FCC, 2020k). Earlier in the decade, the FCC opened up other 5 GHz bands for unlicensed access, including the 5.47–5.725 GHz band (the U-NII-2C band) and

the 5.825–5.850 GHz band (in the U-NII-3 band).[31] In addition, the FCC recently opened up the entire 1,200 MHz of spectrum in the 6 GHz band for unlicensed use, increasing the amount of mid-band spectrum available for Wi-Fi by almost a factor of five (FCC, 2020c). Moreover, the FCC adopted rules to expand access to a total of 21.2 GHz of spectrum above 95 GHz (so-called Spectrum Frontiers) for unlicensed use (FCC, 2019e). Finally, the FCC revised its rules allowing opportunistic unlicensed access to TVWS (i.e., unassigned and unused VHF and UHF broadcast spectrum), which are plentiful in rural areas and areas where fewer broadcast television stations are on the air, giving network operators more flexibility to utilize both broadband and narrowband radios on TVWS spectrum (FCC, 2020j).

Enabling Access to Facilities

In its 2010 National Broadband Plan, the FCC also made several recommendations to facilitate access to various government-owned and government-influenced assets that play an important role in the economics of broadband networks, such as poles, conduits, rooftops, and rights-of-way. Recommendations to optimize access to infrastructure use included the following:

1. *Pole Attachments:* Establishing low and more uniform rental rates for access to poles and simplifying and expediting the process for service providers to attach facilities to poles.
2. *Access to Rights-of-Way:* Improving rights-of-way management for cost and time savings, promoting use of federal facilities for broadband, expediting resolution of disputes and identifying and establishing best practices guidelines for rights-of-way policies and fee practices that are consistent with broadband deployment.
3. *Dig-Once Policies:* Facilitating efficient new infrastructure construction, including through "dig-once" policies that would make federal financing of highway, road, and bridge projects contingent on states and localities allowing joint deployment of broadband infrastructure.

In furtherance of these goals, the FCC has promoted broadband deployment and competition by speeding up the process and reducing the costs of attaching new network facilities to utility poles (FCC, 2018b). The FCC has also streamlined discontinuance rules and eliminated unnecessary network change rules that impede the deployment of next-generation networks (FCC, 2018a). In addition, the FCC established a Broadband Deployment Advisory Committee, comprised of industry stakeholders, which produced model codes to help guide state and local governments as they seek to accelerate broadband infrastructure deployment and investment (FCC, n.d.).

The FCC also took several steps to facilitate the deployment of 5G mobile wireless networks: they streamlined rules for wireless infrastructure modifications to facilitate 5G deploy-

[31] See FCC (2003), which establishes the 5.47–5.725 GHz (U-NII-2C) band, and FCC (2014b), which adds 5.825–5.850 GHz to the 5.725–5.825 GHz (U-NII-3) band and defers a decision on whether to allow unlicensed devices to use the 5.350–5.470 GHz U-NII-2B and 5.850–5.925 GHz U-NII-4 bands.

ment (FCC, 2020f) and adopted new rules speeding federal environmental and historical preservation review of 5G small-cell placements and help to expand the reach of 5G for faster, more reliable wireless service (FCC, 2018c). Among other things, the reforms ban municipal roadblocks that have the effect of prohibiting deployment of 5G networks and give cities a reasonable deadline to approve or disapprove small-cell siting applications (FCC, 2018b; City of Portland v. the FCC, 2020).

Incentives for Universal Availability and Adoption of Broadband

In its 2010 National Broadband Plan, the FCC recognized that three elements must be in place to ensure all Americans have the opportunity to reap the benefits of broadband: (i) all Americans should have access to broadband service with sufficient capabilities, (ii) all should be able to afford broadband, and (iii) all should have the opportunity to develop digital literacy skills to take advantage of broadband. To achieve these goals, the FCC proposed phasing out subsidies for telephone service over a 10-year period and replacing those programs with new universal service programs ensuring that fixed and mobile network operators can deploy broadband in high-cost rural areas. In addition, the FCC recommended transitioning its Lifeline program—which subsidizes the cost of telephone service for qualified low-income consumers—to a program focused on broadband. They also recommended the creation of various digital skills training programs across federal agencies. The FCC concluded that these changes did not require new legislation from Congress, and over the last decade the FCC has taken a number of steps to reform its universal service programs.

Adopted in 2015, the FCC's current definition for fixed broadband is 25 Mbps download and 3 Mbps upload (FCC, 2015). The FCC had concluded that this definition was justified considering "advances in technology, market offerings by broadband providers and consumer demand" (FCC, 2015). At that time, the FCC reported that approximately 83 percent of Americans had access to 25/3 Mbps[32] broadband, but that less than half of rural Americans had such access.

A government's efforts to increase broadband availability and adoption start with good data. Over time, the FCC has made several changes to its collection of data from fixed and mobile network operators. The FCC recently created a twice-yearly Digital Opportunity Data Collection to help ensure that it collects precise and accurate broadband deployment data, used to determine which areas qualify for universal service subsidies (FCC, 2021a). Among other things, the FCC's rules specify which fixed and mobile broadband ISPs are required to report availability and/or coverage data and requires fixed broadband providers to report speed and latency information. The FCC also requires fixed broadband ISPs to report whether broadband services are offered to residential and/or business customers. Mechanisms are also in place for the public to challenge data submitted by network operators.

[32] When broadband speeds are presented in this form, the first number (e.g., 25) refers to the download speed and the second number (e.g., 3) is the upload speed.

The FCC has reformed all of its universal service programs so that they now focus on broadband availability and adoption; for example, one subsidizes the cost of both fixed and mobile network deployments in high-cost rural areas. The FCC has several programs focused on extending fixed broadband services in unserved rural areas (discussed in more detail below) and also recently established a 5G Fund, which will make up to $9 billion in universal service fund support available to mobile operators deploying advanced 5G mobile wireless services in rural America (including $680 million specifically set aside for deployment on tribal lands) (FCC, 2020a). The 5G Fund also would set aside at least $1 billion specifically for deployments facilitating precision agriculture needs. In 2016, the FCC began modernizing its Lifeline program to enable network operators to provide discounted broadband services to qualified low-income consumers (FCC, 2016). As part of the U.S. government's COVID-19 response, the FCC has also implemented a $3.2 billion emergency broadband benefit program to support broadband service and connected devices to help low-income consumers impacted by the pandemic access the internet (FCC, 2021c). The FCC also took numerous other steps to address the COVID-19 pandemic such as securing voluntary commitments from service providers,[33] temporarily waiving certain regulations,[34] and granting special temporary authority to use spectrum.[35]

One interesting innovation the FCC has now implemented is making universal service funding for deployment of fixed broadband services available through a system of reverse auctions. Under this competitively and technologically neutral system, competing broadband providers—irrespective of the technology they use to provide services—bid down the cost of subsidies needed to deliver broadband services to unserved communities.[36] Unserved locations are identified through granular broadband availability data, now gathered from network operators via the Digital Opportunity Data Collection. Reserve prices are set based on the cost of deploying a fiber-to-the-home network and bidding credits are given to bidders committing to provide service with higher throughputs (e.g., 50/5 Mbps, 100/20 Mbps, and 1 Gbps/500 Mbps services) than the baseline broadband speed (i.e., 25/3 Mbps). Each speed tier also has minimum usage allowances and maximum latency limits. Auction winners have six years to build out their networks and are required to serve all customers across the entire geographic area they have committed to serve.

[33] See, for example, the Keep Americans Connected Pledge (https://www.fcc.gov/keep-americans-connected).

[34] See, for example, Lifeline and Link Up Reform and Modernization order (https://docs.fcc.gov/public/attachments/DA-20-1357A1.pdf).

[35] See, for example, "FCC Provides T-Mobile Temporary Access to Additional Spectrum to Help Keep Americans Connected During Coronavirus Pandemic," March 15, 2020 (available at https://docs.fcc.gov/public/attachments/DOC-363051A1.pdf) and "FCC Grants Wireless ISPs Temporary Access to Spectrum In 5.9 GHz Band to Meet Increase in Rural Broadband Demand During Pandemic," March 27, 2020 (available at https://docs.fcc.gov/public/attachments/DOC-363358A1.pdf).

[36] See https://www.fcc.gov/auction/904/factsheet. The auction used a multi-round, descending clock auction format in which bidders indicated in each round whether they would commit to provide service to an area at a given performance tier and latency at the current round's support amount.

In 2020, the FCC completed Phase One of its Rural Digital Opportunities Fund auction, which makes available $9.2 billion in 49 states and the Commonwealth of the Northern Mariana Islands to deploy high-speed broadband to over 5.2 million unserved homes and businesses (FCC, 2020i).[37] Even though the FCC set as a baseline providing connectivity that delivers 25 Mbps download and 3 Mbps upload, nearly every location won in the auction (99.7 percent) will receive 100/20 Mbps broadband, with the vast majority (85 percent) receiving 1 Gbps/500 Mbps service. In addition, auction participants bid down the cost of the subsidies from the reserve price of $26 billion down to $9.2 billion such that $6.8 billion in unused Phase I funding will be added to funds available in a Phase II auction focused on additional areas lacking access to broadband. Moving to a technologically and competitively neutral bidding regime has resulted in many more network operators utilizing a full range of last-mile access technologies—including fiber, coaxial cable, fixed wireless, and satellite connectivity—winning universal service subsidies.

[37] The FCC conducted a previous reverse auction in 2018, the Connect America Fund Phase II reverse auction, which allocated $1.488 billion to expand broadband to more than 700,000 rural homes and businesses in 45 U.S. states (FCC, 2018d).) Also see the FCC's Rural Broadband Auctions page at https://www.fcc.gov/auctions/ruralbroadbandauctions.

Appendix 3

Community Networks: Global, Regional, and National Recognition

This appendix provides global-, regional-, and national-level references that support the use of community networks in broadband policy and regulation.

Global Recognition

- ITU-D: Telecommunications for rural and remote areas – Recommendation 19 from the World Telecommunication Development Conference includes the following (ITU, 2018, 648):
  10. that it is important to consider small and non-profit community operators, through appropriate regulatory measures that allow them to access basic infrastructure on fair terms, in order to provide broadband connectivity to users in rural and remote areas, taking advantage of technological advances;

  11. that it is also important that administrations, in their radio-spectrum planning and licensing activities, consider mechanisms to facilitate the deployment of broadband services in rural and remote areas by small and non-profit community operators;
- UN ECOSOC Resolution 2019/24 Numeral 54 includes "Community Networks" as an emerging topic (ECOSOC, 2019).
- The Report of the UN Secretary-General's High-level Panel on Digital Cooperation (UN, 2019) states that:
  Governments have an important role to play in creating a policy framework to enable private sector enterprise, innovation, and cooperative, bottom-up networks (p. 12).

  And concludes in its recommendation that:

  Second, investments should be made in both human capacity and physical infrastructure. Creating the foundation of universal, affordable access to electricity and the internet will often require innovative approaches, such as community groups operating rural networks, or incentives such as public sector support (p. 29).
- The Annual Deliverable 2019–2020 from ITU-D Study Groups Question 5/1: Telecommunications/ICTs for Rural and Remote Areas states (ITU, 2020f, 8):
  the following recommendations can be made for now:
  Ease regulatory requirements for community network operators.

- ITU produced documents in 2020 that mention community networks, such as the ITU Smart Villages blueprint (ITU, 2020a).

Regional Recognition

- In Africa, the Specialized Technical Committee on Communications and Information Technologies (STC-CICT) of the African Union included in its 2019 Sharm El Sheikh Declaration (STC-CICT, 2019) the following text directing the African Union Commission to:
  PROMOTE the formulation of strategy and pilot projects for Unlocking Access to Basic Infrastructure and Services for Rural and Remote Areas including Indigenous Community Networks, and develop guidelines on legislation on deployment of technologies and ICT applications, to accelerate infrastructure role [sic] out in collaboration with [African Telecommunications Union] and other regional institutions;
- The Broadband Commission's "Connecting Africa through Broadband: A strategy for doubling connectivity by 2021 and reaching universal access by 2030" (Broadband Commission for Sustainable Development, 2019) recognizes the role of community networks in three of the seven objectives of its action plan. Of particular interest is Objective 5:
  Provide direct funding support for extending affordable broadband access to commercially challenging rural and remote areas, to women, and low-income users
  and the recommendations under Objective 1, "Ensure that the commercial broadband ICT market is open and structurally prepared for competitive private investment":
  Adopt open wholesale and retail telecommunications market entry policies, especially competitive and unified licensing regimes, and liberal, dynamic spectrum policies. Such policies should also accommodate community and non-profit focused network operators who offer services in underserved areas.
- In the Americas, the Inter-American Telecommunication Commission tracks the implementation of resolution ITU D-19 regarding small not-for-profit and community operators through resolution 268-PCC1. A 2018 report shows the development of inclusive regulation for small and community operators in each of the countries (Inter-American Telecommunication Commission, 2018, 29).
- In the Asia Pacific region, community networks are a relatively new topic. Still, they were discussed in 2019 at the Third Session of the Asia-Pacific Information Superhighway Steering Committee and WSIS Regional Review and included in its deliberations (ESCAP, 2019).

National Recognition

Some countries such as Kenya and South Africa include in their policy documents references to community networks, small operators, and cooperatives as a vehicle for digital inclusion.[38]

[38] See Kenya's National Broadband Strategy 2018 (https://ca.go.ke/wp-content/uploads/2018/02/National-Broadband-Strategy.pdf); South Africa Connect: South Africa's Broadband Policy

Kenya highlights the need to provide for an enabling policy and regulatory framework for community-based operators in their National Broadband Strategy. South Africa not only mentions community-based operators in their National Broadband Plan and includes them as part of the Telecommunications Value Chain in their SMME Strategy, but the development and promotion of "SMMEs and cooperatives" is part of the objectives of the Electronic Communications Act, the main act of the telecommunications sector in the country. In the particular case of community networks, specific support for their development was articulated in the Budget Speech 2018 from the Department of Telecommunications and Postal Services. Unsurprisingly, South Africa is the country with the most local operators in Africa.

In the Americas during the last few years, Brazil has implemented a strong policy and regulatory strategy for facilitating the participation of small operators in serving rural and remote areas, including a recent note on how to regulate community networks (INSEIT, 2020). In Mexico, community and indigenous operators are specifically recognized in the Telecommunications Act, and it specifies that spectrum planning activities should always take into consideration the specific needs of these operators. Mexico's 2020–21 Social Coverage Program specifically refers to them as important allies in addressing unconnected areas (Secretary of Communications and Transport, 2019).

(https://www.ellipsis.co.za/wp-content/uploads/2013/10/NBP-2013.pdf); South Africa's Draft Information and Communication Technology Small, Medium, and Micro-Enterprise Support Strategy (https://www.dtps.gov.za/images/phocagallery/Popular_Topic_Pictures/40756_31-3_TeleComPostServ.pdf); South Africa's Electronic Communications Act, 2005 (https://www.dtps.gov.za/index.php?option=com_phocadownload&view=category&download=34:electronic-communications-act-2005&id=2:legislation&Itemid=142&start=20); and South Africa's Deputy Minister Stella Ndabeni-Abrahams: Telecommunications and Postal Services Dept Budget Vote 2018/19 (https://africanewswire.za.com/deputy-minister-stella-ndabeni-abrahams-telecommunications-and-postal-services-dept-budget-vote-2018-19/).

Appendix 4

Public-Private Partnership Models

Malaysia and New Zealand have created PPPs to build out their broadband networks, but each country has used a different PPP organizational structure. Malaysia makes use of a Design-Build-Own (DBO) arrangement where the network is designed, funded, built, and managed by a publicly owned operator and where multiple private providers partner with the public operator to offer retail services. New Zealand makes use of a joint venture where the new entity is co-owned by the partners to design, finance, build, and manage the network. This joint venture entity then sells wholesale access to retail ISPs.

There are a number of advantages and disadvantages of these different structures.

Private Design-Build-Own Model

The private DBO model involves a private sector organization receiving some level of public funding (often a grant) to assist in its deployment of a new network offering open wholesale access. Critically, in this model the public sector has no specific role in ownership or the running of the network, but it may impose obligations relating to the ownership structure or network coverage obligations in return for the funding.

Advantages of the private DBO model:

- This approach imposes only a limited burden on the public sector, which is not involved in running the network. This in turn can lead to faster deployments than other investment models.
- It has a number of advantages for the private operator, particularly because ownership of the network assets is likely to prove valuable in the long term.

Disadvantages of the private DBO model:

- It is essential that sufficient funding is available to attract interest from private operators, as significant investment may be required to make a viable business case, especially in rural areas.

- As the managing authority has limited ongoing control, the social benefit that the public sector is looking to create may be restricted if the private operator has little interest in delivering this and instead focuses on generating a financial return. (This issue can be addressed to some extent by the terms of the agreement.)

Joint Venture Model

A joint venture is an agreement where ownership of the network is split between the public and private sectors. Construction and operational functions are likely to be undertaken by a private sector organization.

Advantages of the joint venture model:

- Both parties can maintain a long-term financial stake in the network. This is attractive to managing authorities that are reluctant to relinquish full ownership of the network as they see long-term strategic value in owning the assets.
- The joint venture approach has the ability to broadly balance the interests of the public and private sectors; it can also balance the sharing of risk—some forms of joint ventures required the private partner to increase its stake in the project when certain key performance indicators (such as take-up) are achieved, which is a form of risk-sharing arrangement.
- This model often features the creation of special-purpose vehicles (SPVs)—subsidiary companies that are formed to undertake a specific business purpose or activity. These SPVs can be of almost any size, which makes the model very scalable (i.e., able to address local communities as well as subnational regions). The SPV mechanism also allows investment to be gathered from comparatively innovative sources, such as institutional investors.

Disadvantages of the joint venture model:

With two stakeholders (private and public) in the network, each with different interests, it may be difficult to align those interests and set up the joint venture, or to continue it over a long period.

Appendix 5

Data Sources for Table 0.1

The data for Table 0.1 comes from 2011–2019 survey data reported in UNICEF and ITU (2020). See below for specific survey and year used for each country listed in Table 0.1.

Country	Survey	Year
Argentina	Multiple Indicator Cluster Survey	2011–2012
Barbados	Multiple Indicator Cluster Survey	2012
Bolivia	EDSA	2016
Brazil	Brazil Continuous National Household Sample Survey (Continuous PNAD) 2018, IBGE	2018
Chile	Casen	2017
Colombia	Demographic and Health Survey	2015–2016
Costa Rica	Multiple Indicator Cluster Survey	2018
Dominican Republic	Multiple Indicator Cluster Survey	2014
Ecuador	ENSANUT	2018
Guatemala	Demographic and Health Survey	2014–2015
Haiti	Demographic and Health Survey	2016–2017
Mexico	ENSANUT	2018
Nicaragua	Nicaragua National Demographic and Health Survey 2011–2012	2011–2012
Panama	Multiple Indicator Cluster Survey	2013
Peru	ENDES	2019
Saint Lucia	Multiple Indicator Cluster Survey	2012
Suriname	Multiple Indicator Cluster Survey	2018
Trinidad and Tobago	Multiple Indicator Cluster Survey	2011
Uruguay	Multiple Indicator Cluster Survey	2012

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