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Development Sector

Global Connectivity Report 2022

Global Connectivity Report

2022

International Telecommunication Union
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Foreword

I am pleased to present the *Global Connectivity Report 2022*. The launch of this important publication coincides with the World Telecommunication Development Conference and the 30th anniversary of the establishment of the ITU Telecommunication Development Sector in 1992. The conference represents a unique opportunity to take stock of progress, celebrate our achievements, reflect on our shortcomings, and set the digital development agenda for the coming years. It offers a global stage to showcase initiatives and solutions and mobilize resources to implement both ongoing and new initiatives. In this context, the report provides the facts and the evidence that we need.

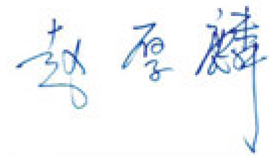
Over the past three decades, the number of Internet users went from a few million in 1992 to almost five billion in 2021. The ITU family can take pride in having contributed so significantly to this development. Indeed, ever since it was founded in 1865, ITU has enabled connectivity. We manage the radio-frequency spectrum and satellite orbit resources for the world, develop the technical standards that ensure networks and technologies interconnect seamlessly, and strive to improve access to information and communication technologies to underserved communities worldwide. Every time you go online, make a call, or send an e-mail, you are benefiting from the work of ITU.

However, despite the important progress made, we cannot rest on our laurels. Humanity is facing unprecedented global challenges (including the prospect of its own extinction). In 2015, the United Nations adopted the 2030 Agenda for Sustainable Development with the Sustainable Development Goals (SDGs) at its core.

In most areas, progress is either too slow, stalled, or being reversed. We need to step up our efforts in this 2020-2030 Decade of Action to deliver on the SDGs. Connectivity is not a panacea, but an important catalyst, an enabler for every single Goal.

As the *Global Connectivity Report 2022* highlights, the potential of the Internet for social and economic good remains largely untapped: one-third of humanity remains offline and many users only enjoy basic connectivity. The COVID-19 pandemic has increased dramatically the cost of digital exclusion. In this Decade of Action, we must achieve universal and meaningful connectivity so that everyone, everywhere can enjoy a safe, satisfying, enriching, productive, and affordable online experience.

I would like to thank the ITU family around the world, including Member States, Sector Members, and the staff, for the relentless efforts in carrying out the ITU mission. Our dedication and commitment to connecting the world are stronger than ever.



Houlin Zhao
Secretary-General
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Preface

Welcome to ITU's *Global Connectivity Report 2022*, which presents a unique and comprehensive global assessment of digital connectivity and its enablers.

Forty years ago, in 1982, ITU set up the Independent Commission for World-Wide Telecommunications Development, chaired by Sir Donald Maitland. In its seminal report, *The Missing Link*, that Commission called for bringing "all mankind within easy reach of a telephone" by the early part of the twenty-first century, noting that: "It cannot be right that in the latter part of the twentieth century a minority of the human race should enjoy the benefits of the new technology while a majority live in comparative isolation."

It was clear that it was no longer enough for ITU to simply accompany the development of telecommunications through spectrum management and technical standardization. We needed to actively *promote* connectivity as part of our role as a United Nations specialized agency working towards a more equal and equitable world.

The result was the establishment of the ITU Development Sector in 1992. When that Sector was set up, 30 years ago, there were fewer than 10 million Internet users. When the very first World Telecommunication Development Conference was held, two years later, there were only 20 million, or about 0.3 per cent of the world's population.

Over the intervening years, we have made tremendous progress in connecting humanity. The Internet is now woven into the entire fabric of our societies, and the minority has become the majority: two-thirds of humanity now accesses the online world.

And yet, to a large extent, the link is still missing. A full one-third of the world's population remains *totally* offline, and many among the online population are not "meaningfully connected" because of connectivity that is too slow, or unreliable, or costly, or because they lack the digital skills needed to get the most out of devices and services.

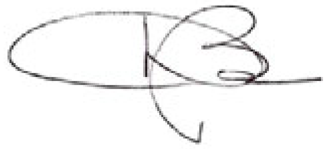
At the same time, the "missing link" has morphed into multiple divides: across and within countries; between men and women; between youth and older people; between cities and rural areas; between those linked to fibre and those who struggle on an intermittent 3G connection; and between the technology savvy and those who risk falling victim to the Internet's dark side.

The Internet offers a world of truly extraordinary possibilities. With digital now at the heart of every country's socio-economic development and prosperity, it is simply not acceptable that vast swaths of humanity remain digitally excluded.

Universal and meaningful connectivity – defined as the possibility for everyone to enjoy a safe, satisfying, enriching, productive, and affordable online experience – has become the new imperative in the 2020-2030 Decade of Action.

In everything we do, people must be at the centre. As Sir Donald and his colleagues acknowledged, "telecommunication is not an end itself". Connectivity must be "for the people" – a principle illustrated so beautifully in the cover of this report.

We, in ITU, are committed to working ever more closely with our partners and to using all our experience, expertise, creativity, and passion to bring universal and meaningful connectivity to everyone, everywhere. We look forward to working with you!



Doreen Bogdan-Martin
Director,
ITU Telecommunication Development Bureau

Table of contents

List of boxes, figures and tables

Boxes

Figures

Tables

Abbreviations

A4AI	Alliance for Affordable Internet
AI	artificial intelligence
AIS	automatic identification system
CDN	Content Delivery Network
CO:RE	Children Online: Research and Evidence
DCM	Disaster Connectivity Map
DE-CIX	Deutscher Commercial Internet Exchange
DRT	Digital Realty Trust
EGH	Expert Group on Household Indicators
EGTI	Expert Group on Telecommunication/ICT Indicators
FTTH	fibre-to-the-home
GDP	gross domestic product
GNI	gross national income
GPS	Global Positioning System
GSMA	GSM Association
GSR	Global Symposium for Regulators
ICT	information and communication technology
IEA	International Energy Agency
IoT	Internet of Things
ISP	Internet service provider
ITU	International Telecommunication Union
IXP	Internet exchange point
KIXP	Kenya Internet Exchange Point
MeitY	Ministry of Electronics and Information Technology (India)
MICT	Ministry of ICT Innovation and Youth Affairs of Kenya
MTDC	multi-tenant data centre
NBP	National Broadband Plan
NGO	non-governmental organization
NSA	Non-Standalone
NSO	national statistical office
OECD	Organisation for Economic Co-operation and Development
PPP	purchasing power parity
SDGs	Sustainable Development Goals
SIDA	Swedish International Development Cooperation Agency
SIM	subscriber identity module
SMEs	small and medium-sized enterprises
SMS	Short Message Service
TVWS	television white space
UAS	Universal Access and Service
UN-CEBD	United Nations Committee of Experts on Big Data and Data Science for Official Statistics
UN DESA	United Nations Department of Economic and Social Affairs
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNSC	United Nations Statistical Commission
USAID	United States Agency for International Development
USF	universal service fund
UTC	Coordinated Universal Time
VNIX	Viet Nam National Internet eXchange
VNNIC	Viet Nam Internet Network Information Center
WHO	World Health Organization
WTO	World Trade Organization

Executive summary

In the 30 years since the creation of the ITU Telecommunication Development Sector in 1992, the number of Internet users surged from a few million to almost five billion. This trend has enabled a digital transformation that has been, and is, transforming our societies and our economies. Yet the potential of the Internet for social and economic good remains largely untapped: one-third of humanity (2.9 billion people) remains offline and many users only enjoy basic connectivity. *Universal and meaningful connectivity* – defined as the possibility of a safe, satisfying, enriching, productive, and affordable online experience for everyone – has become the new imperative for the 2020-2030 Decade of Action to deliver on the Sustainable Development Goals (SDGs).

The *Global Connectivity Report 2022* takes stock of the progress in digital connectivity over the past three decades. It provides a detailed assessment of the current state of connectivity and how close the world is to achieving universal and meaningful connectivity, using a unique analytical framework. It goes on to showcase solutions and good practices to accelerate progress. The second part of the report consists of seven thematic deep dives on infrastructure, affordability, financing, the pandemic, regulation, youth, and data.

Chapter 1: Universal and meaningful connectivity: The new imperative

In 1984, the Independent Commission for World-Wide Telecommunications Development convened by ITU published *The Missing Link* – a seminal report that for the first time identified the social and economic benefits of telecommunications and promoted connectivity as a right and a priority for all countries. The report noted that it was "not right" that only a minority of the world benefits from "remarkable new technologies".

Since the publication of that report, there has been tremendous progress in connecting the world. The Internet – a remarkable technology that did not exist in 1984 – is now woven into the entire fabric of our daily lives. And the minority has become the majority: two-thirds of humanity use the Internet. Yet despite this progress, "the link is still missing": one-third of the world's population remains offline and many among the online population are not meaningfully connected. The "missing link" has morphed into multiple digital divides, across and within countries, between men and women, between youth and older persons, between cities and rural areas, between those who enjoy a fibre connection and those who struggle on a spotty 3G connection.

Linking everyone is no longer enough. Universal and meaningful connectivity, the possibility for everyone to enjoy a safe, satisfying, enriching, productive, and affordable online experience, has become the new imperative for the 2020-2030 decade.

Depriving vast swaths of humanity from the possibilities offered by the Internet is unacceptable and costly, as it stunts economic development and deepens inequalities. The COVID-19 pandemic has led to a sharp uptake in usage of the Internet. For those privileged enough to be connected, the Internet allowed a measure of continuity. However, for others, the pandemic exacerbated the cost of digital exclusion.

Connectivity has a profound and far-ranging impact. The catalytic and enabling role of connectivity for sustainable development is recognized in the Sustainable Development Goals. The Internet offers significant economic benefits and the potential to enhance welfare for individuals throughout their lives. It enables new forms of communication, entertainment, expression, and collaboration. It enables access to services where traditional services are lacking, access to an enormous amount of knowledge, learning resources, and job opportunities. The benefits of connectivity are considerable for everyone, including marginalized and vulnerable groups, who are often the least connected.

In this Decade of Action, three challenges have emerged:

- Closing the coverage gap: Even though 95 per cent of the world population is now within range of a mobile broadband network, at least 390 million people have no possibility to connect to the Internet.
- Closing the usage gap: One in three individuals who could go online choose not to, mainly due to prohibitive costs,

lack of access to a device, and/or lack of awareness, skills, or purpose.

- Achieving universal and meaningful connectivity: This means upgrading connectivity from basic to meaningful for all.

As the use of the Internet increases, so too does the exposure to the downsides of connectivity such as privacy infringements, cybercrime, harmful content, and the outsized power of large companies. Addressing these issues is part of the journey to universal and meaningful connectivity. Finally, digital connectivity alone cannot solve any of the global challenges the world is facing. It is only one of many enablers of sustainable development. "Analogue complements", including governance, security, health, education, transport infrastructure, and entrepreneurship are needed.

Chapter 2: The journey to universal and meaningful connectivity

Chapter 2 relies on the framework for universal and meaningful connectivity and the associated targets for 2030, developed by ITU and the Office of the Secretary-General's Envoy on Technology, to analyse the current state of digital connectivity globally and progress towards reaching the targets by 2030. The framework considers usage by various stakeholders (universal dimension of connectivity) and the five enablers of connectivity (meaningful dimension of connectivity): infrastructure, device, affordability, skills, and safety and security.

The assessment reveals that the world is still far from universal and meaningful connectivity. Infrastructure needs to be rolled out or improved to bridge the coverage gap. There are still significant differences between and within countries in network availability and quality. Fixed broadband is a costly investment and is not available or is unaffordable for many. Mobile broadband offers greater flexibility and is less expensive, and most rely on this technology to go online. But in many rural areas of developing countries, only 3G is available, when meaningful connectivity requires 4G.

The coverage gap, currently at 5 per cent, is dwarfed by the usage gap: 32 per cent of people who are within range of a mobile broadband network and could therefore connect, remain offline. Data compiled by ITU make it possible to classify the offline population based on who they are and where they live. These data reveal five divides:

- Income divide: The level of Internet use in low-income countries (22 per cent) remains far below that of high-income countries, which are close to universal usage (91 per cent).
- Urban-rural divide: The share of Internet users is twice as high in urban areas as in rural areas.
- Gender divide: Globally, 62 per cent of men are using the Internet, compared with 57 per cent of women.
- Generation divide: In all regions, young people aged between 15 and 24 are more avid Internet users (71 per cent of them are online) than the rest of the population (57 per cent).
- Education divide: In nearly all countries where data are available, rates of Internet use are higher for those with more education, far higher in many cases.

Understanding why people and households do not use the Internet is critical for designing effective, targeted interventions. The main reasons cited by people for not using the Internet are the lack of affordability, of awareness about the Internet, of need, as well as the inability to use the Internet.

Globally, connectivity became more expensive in 2021 due to the global economic downturn triggered by the COVID-19 pandemic. After years of steady decline, the share of income spent on telecommunication and Internet services increased in 2021. The global median price of an entry-level broadband plan in the majority of countries amounts to more than 2 per cent of the gross national income per capita, which is the affordability threshold set by the Broadband Commission for Sustainable Development.

People should not be forced to use the Internet. However, evidence suggests that introducing people to the Internet usually entices them to stay online. Based on activities people reported, use of the Internet leads to an improved social life, with the use of social networks, making Internet calls and streaming video the most common activities.

Beyond awareness about the merits of the Internet, making meaningful use of it requires specific skills. In the countries where data are available, they suggest that many people, sometimes the majority, do not have such skills.

Chapter 3: Accelerating progress towards universal and meaningful connectivity

This chapter explores options to accelerate progress towards universal and meaningful connectivity. Expanding broadband networks is needed to eliminate the remaining blind spots and improve the quality of connectivity. Measures include reducing constraints on foreign direct investment to attract capital for upgrading and expanding digital infrastructure; ensuring sound ICT sector regulation to help build competitive markets and enhance predictability; promoting infrastructure sharing to reduce costs; ensuring the supply of adequate, inexpensive spectrum to help reduce coverage gaps; and ensuring sufficient capacity and a shift to new generations of mobile broadband. Solutions to ensure an adequate energy provision to power ICT infrastructure include policy incentives, reducing duties and taxes on green power equipment and allowing independent power producers. Recalibrating universal service funds (USFs) can help deployment of infrastructure in unserved areas to reduce gaps among vulnerable groups such as women and girls, persons with disabilities and older persons.

Overcoming digital illiteracy is critical in bridging the usage gap. Effective and large-scale programmes are needed to address the challenge, including providing digital literacy as part of the school curriculum. Funding school connectivity remains a challenge, however. In many low- and middle-income countries where equipping schools with electricity is already a struggle, Internet access and digital skills are often after-thoughts. The cost of devices and Internet service is a significant barrier that stops many people from using the Internet. Countries have limited options, but eliminating import duties and reducing taxes on services will make them more affordable. Governments should encourage operators to offer a variety of plans that cater to different income levels and circumstances. Other measures to improve affordability include the provision of unlimited broadband access to community centres and schools; maintaining the temporary COVID-19 concessions that were put in place by operators in many countries; subsidizing data use for the poorest; and applying zero ratings for critical services such as e-government, education and health sites.

Meaningful connectivity implies safety of use. Threats include a breach of data privacy, misinformation and harmful content, and overuse of digital technology. It is important to know how to mitigate risks to preserve trust in the use of the Internet. Countries need to enact better data protection laws to safeguard privacy, social media companies need to moderate content to detect false and inciteful content, and media literacy must be part of any digital skills training.

To achieve universal connectivity, disadvantaged groups such as women and girls, persons with disabilities, older persons, those with low incomes and people living in remote areas, require special attention. Greater collaboration is needed across governments, agencies, advocacy organizations and digital companies to accelerate the acquisition of digital skills. To reduce the gender gap, non-governmental organizations should be supported in providing mentoring and digital skills training for women and girls. Technology companies, too, can play a role, not only by supporting skills initiatives but also by setting their own gender equity targets. Digital products and services should be customized to the needs of women in terms of design, safety and security. Training of older persons is necessary if they are to access online public services. Measures to reduce the digital disability gap include raising awareness, enacting laws that require online public services to be accessible to persons with disabilities, adapting products by adhering to international design guidelines, and supporting entrepreneurs in the development of contextually relevant digital assistive technologies. Since data are often lacking, there is a need to ensure that the scope of ICT surveys addresses disadvantaged groups as well.

Among the challenges posed by increased digital connectivity, e-waste continues to grow, and what happens to over four-fifths of e-waste is unknown. As a minimum, the recycling process should be made easier for consumers. Connectivity will help reduce carbon emissions across the economy, for example video conferencing for work and education will reduce travel while the greater use of sensors will generate energy efficiencies across many sectors. Furthermore, there is considerable untapped renewable potential from solar, wind, hydro and geothermal sources in many low- and middle-income countries. As major energy users, ICT companies can provide the scale of investment to make renewable energy economically feasible. Governments can help enormously by creating climate friendly energy strategies and liberalizing markets, particularly by welcoming independent renewable power producers.

Chapter 4: The critical role of middle-mile connectivity

Middle-mile infrastructure is essential for connectivity. It is composed of Internet exchange points (IXPs), data centres and cloud computing and is a critical link between international connectivity (first mile) and the infrastructure that connects users (last mile). IXPs enable Internet service providers (ISPs) and content providers to exchange their data traffic, which offers substantial advantages, including reduced cost, increased reliability through redundancy, improved quality, and reduction in time needed to retrieve data.

Data centres play a fundamental role in the digital economy by providing space for data storage of domestic content and processing of large datasets. Despite their crucial role, few data centres are found in low- and middle-income economies due to a range of elements including lack of demand, low income, natural disasters, political instability, energy supply, and ease of doing business.

Cloud computing offers computing power, on-demand infrastructure, competitive cost, maintenance, and advanced big data technologies. While it is attractive to store data on the cloud, cost, latency, and national security remain important considerations for countries.

For a country to improve its middle-mile connectivity, investment is crucial. The building blocks of an attractive data ecosystem include liberalization of the telecommunication market; putting in place data protection laws to help attract investment on data centres and cloud computing; addressing energy supply by allowing independent renewable power producers and suppliers to enter the market; and collaboration between governments, IXPs, ISPs, data centre operators, and investors.

Chapter 5: Meaningful connectivity for all: The affordability factor

Millions of people remain offline, or are not meaningfully connected, because of the high cost of the device and/or subscription. The global picture of affordability is one of many stark contrasts. Connecting to the Internet remains prohibitively expensive for many in low- and lower-middle-income economies while it is relatively cheap in richer countries. There are also less-visible divides within countries due to income inequalities. Even in countries where the average earner can afford an entry-level broadband service, poorer segments of the population often cannot. The "value-for-money" is also uneven across countries. Not only are entry-level fixed broadband connections out of reach in lower-income economies, but connection speeds are also far lower there than in high-income economies.

The past decade has seen significant improvements in affordability of broadband access, especially mobile broadband, but the majority of low- and middle-income economies fall short of the global affordability target. The economic crisis triggered by the COVID-19 pandemic has set back progress.

Affordability and connectivity go hand in hand. The critical challenge for policies with a digital development focus is to release countries trapped in a vicious cycle of unaffordable broadband prices that perpetuate low subscription rates. These are countries where factors such as physical geographic conditions, uneven population distribution or low levels of disposable income deter investments, where market size does not drive down prices, while unaffordable prices deter new subscribers.

Evidence suggests that affordability and the maturity of the regulatory environment go hand in hand. Countries showing the highest readiness levels in collaborative digital regulation and with tailored competition policy have the most affordable broadband service prices. This offers scope for countries to increase affordability as they improve their regulatory policy environment. Governments wishing to reduce the cost of broadband access can resort to a variety of measures, from conditioning regulatory approval on the provision of low-cost services, to negotiating public-private partnerships balancing investment incentives for network deployment with price capping. Governments may also consider reducing taxes or subsidizing access to free or low-priced devices, as well as free connection in public administration facilities such as libraries, hospitals, or schools or at other public hot spots. Measures to ensure affordable access to universal meaningful connectivity will ideally form part of more comprehensive broadband strategies.

Chapter 6: Financing universal and meaningful connectivity

Universal connectivity holds significant development opportunity but many areas, especially rural areas, remain unserved or underserved. However, current investment models for broadband connectivity are not commercially viable for uncovered areas due to the high cost of deployment and low demand. Policy and regulation can shrink the connectivity gap to some extent by removing obstacles to network deployment and by raising demand for broadband, but these are both inadequate and too slow in responding to the urgent need to close the gap. Both the base of contributors and the scope of investment to support deployment and adoption need to be broadened.

Several options are available to broaden the base of contributors:

- Identifying new contributors: New contributors can include digital companies, such as those with an e-commerce or other online focus, along with other companies deriving benefits from broadband, multilateral development banks, corporate social responsibility funds, and philanthropic donors. Contributions can come in a variety of forms, including investments and in-kind contributions such as digital skills training.
- Earmarking existing contributions: These contributions from ICT sector participants to support connectivity and adoption include mandatory contributions such as operator licence fees, spectrum licence fees, digital taxes, fees to access rights of way for infrastructure, and equipment import duties. Further contributions could include digital taxes and other regulatory levies.
- Reforming USFs: Reform can be achieved by setting clear objectives, implementing regulations, and providing a sound governance structure. Further changes in focus could include adding coverage obligations in spectrum licences and enabling direct operator investment rather than USF payments.

Several options are available to broaden the scope of investments:

- Operating expenditure: In addition to capital expenditure, contributing to operating expenditure can make a business plan more sustainable. These can include direct subsidies or incentives such as tax reductions and can include in-kind contributions.
- Risk protection: Governments and international institutions can offer guarantees and loss-guarantee schemes or insurance that limit risks beyond the investor's control, for example, political or currency risks.
- Demand-side support: Governments can ensure demand by becoming an "anchor tenant" with a future contract for connectivity in an underserved region. Indirect support for demand can be provided by subsidizing the cost of a device or data plans, increasing digital literacy, and developing locally relevant content.

Chapter 7: Policy and regulatory strategies that drive digital transformation

The need to redefine policy priorities, the roles of stakeholders, and to identify new tools has never been more pressing. Tensions, nevertheless, persist between established and emerging approaches to policy and regulation and new strategies will need to prove themselves.

Five strategies are at hand for policy-makers and regulators to navigate the digital transformation and connect the unconnected.

1. Build ambidextrous leadership: Policy leadership is built around embracing ambiguity and uncertainty with a growth mindset and out-of-the-box thinking, so when new challenges emerge, policy-makers and regulators can combine the 'tried-and-tested' with a new approach, and with equal ease.

2. Bridge silos and break through insularity: Silos are still common in national institutions and policy implementation. Adopting a whole-of-ecosystem approach to policy inception, design, prototyping and implementation is an issue in many countries – where these issues persist, they hinder digital market development, innovation and value-creation.
3. Develop a common language: Building a common language across stakeholder groups is essential to avoid policy implementation getting lost in translation. Leveraging stakeholder dialogue and data to guide decisions will co-create more diverse and resilient regulatory solutions.
4. Reframe and operationalize policy agendas: In the wake of recovery from COVID-19, governments have an opportunity to reframe their policy agendas and mainstream new priorities along with a broad development perspective. The circular economy, digital innovation, and gender empowerment have moved to the forefront of a new systemic approach where new legal instruments will redefine the focus for global action in the face of economic, technological, and climate disruption.
5. Skill up, and up again: In the "new normal", the speed of learning provides a competitive edge in business and technology. Problem-solving is impossible without building new skills and competences, formulating strategic thinking around new issues in digital markets and implementing novel regulatory approaches. A focus on emerging skills is key to building adequate institutional capacity and preparing for current and future challenges.

As digital markets grow and move towards everything-as-a-service, an agile and iterative, lean approach to policy and regulation has started to develop. The agency of regulators and policy-makers and their agility will be the keys to making the implementation of digital policies more impactful.

Chapter 8: Connectivity and the pandemic: Building resilience for future crises

While the COVID-19 pandemic triggered fundamental disruptions to the economy and our way of life, it also accelerated the pace of digitalization and connectivity for many. However, the impact of the pandemic on the connectivity landscape has been uneven, due to the interplay of positive and negative factors on different time horizons.

In the immediate emergency phase, lockdown restrictions generated demand for connectivity and digital services, ranging from home delivery to government services. They also helped change people's preferences for digital solutions such as using electronic payments or teleworking. At the same time, demand was tempered in many countries where connectivity was conditioned on physical presence, for example, in-person purchases or renewals of pre-paid SIM-cards or devices.

In the short- and medium-term, operators boosted connectivity supply by increasing capacity limits and the availability of zero-rated content, while government policies helped speed up investments in network infrastructure or access to spectrum. However, the pandemic also took a toll on the financial capacity of governments and operators, created problems in the availability of a skilled labour force and the functioning of global supply chains, while the uncertain economic environment deterred and sometimes distorted investments.

The pandemic highlighted the indispensable role of connectivity and serves as a wake-up call for policy actions to better prepare for future shocks. Closing the digital divide, improving the quality of connectivity, and driving digital deepening are essential to improving resilience. Among other benefits, such actions will protect already disadvantaged children against the loss of learning experienced in the pandemic due to no or poor connectivity and avoid the shocks felt by many as remote interactions were forced on often poorly prepared governments, institutions and populations.

Chapter 9: The digital lives of children and young people

Globally, 71 per cent of young people aged between 15 and 24 use the Internet, far more than any other age group, and in every country for which data are available they are more connected than the rest of the population. At the same time, only 40 per cent of school-age children have access to the Internet at home, with stark disparities across and within countries. While young people in middle-income countries drive the digital transformation, accessibility and affordability remain key constraints in low-income countries.

Access does not determine the value that children and young people gain from the Internet. A second level of the digital divide emphasizes the role of digital skills in mediating both the opportunities and risks of ICT use and digital engagement. Overall, young people have greater ICT skills than adults, and while there is gender parity for basic and intermediate skills, gender imbalances still exist for advanced skills such as programming.

Opportunities and risks tend to be correlated: more access and higher digital skill levels are associated with more exposure to online risks, making it challenging to increase the former without increasing the latter. Access and digital skills are key to ensure that children and young people enhance their prospects, however, stakeholders must collaborate effectively to protect them from online risks and harm.

As the digital environment becomes more complex, children and young people need to critically understand the digital world in which they are increasingly immersed. Many initiatives are underway to support and enhance digital learning and engagement. Online learning platforms can provide opportunities for children and young people to learn and develop new skills in many areas.

Improving evidence on access, use, skills and outcomes of children and young people will require international cooperation to ensure comparable definitions and measures and establish benchmarks enabling us to measure progress, examine problems and identify good practice.

Chapter 10: Measuring meaningful connectivity: The case for more and better statistics

Data are vital to universal and meaningful digital connectivity. While data volumes have grown exponentially, for many countries reliable statistics on digital connectivity remain surprisingly scant.

To assess progress, data on the deployment and uptake of digital technologies are essential. ITU collects, analyses and disseminates statistics from administrative sources and household surveys conducted by national statistical offices. While much progress has been made in recent years, large data gaps remain, especially on indicators collected from household surveys. These gaps are symptomatic of wider data gaps elsewhere. Unequal development has disadvantaged lower-income countries, which lack the infrastructure, the financial resources, and the skills necessary to produce data and subsequently extract value from them.

Big data, driven by data harvested by technology companies, has attracted much attention and sparked interest in a range of subjects owing to the timeliness and volume of such data. Many organizations, including ITU, are leveraging the potential of big data, particularly from mobile networks and open-source data from social media, crowdsourcing platforms, and online search engines. ITU has devised methodologies for using big data to complement traditional ICT statistics and has carried out pilot projects in several countries. Progress to date is promising, with guidelines prepared on how mobile phone data can be used to measure the information society.

Closing the data gaps is crucial for closing the digital divides and achieving universal connectivity. More and better data are needed to understand and remove the barriers to meaningful connectivity, especially for the marginalized people who are still offline. Data cultures, funding and improving the collection, processing and use of data are integral to development.

Chapter 1:
Universal and meaningful connectivity: The new imperative

Chapter 1. Universal and meaningful connectivity: The new imperative

In 1983, ITU established the Independent Commission for World-Wide Telecommunications Development and tasked it with identifying ways of stimulating the expansion of telecommunications across the world. Chaired by Sir Donald Maitland, the Commission published its recommendations in December 1984 in the seminal report *The Missing Link* (ITU 1984). The Commission recognized several disparities in the worldwide distribution of telecommunications. Notably, it estimated that three-quarters of the 600 million telephones in the world were concentrated in just nine industrialized countries.

The report underlined that it "cannot be right that in the latter part of the twentieth century a minority of the human race should enjoy the benefits of the new technology while a majority lives in comparative isolation". How has this situation changed and what has been the response to the recommendations of the Commission?

Since the publication of that report, there has been tremendous progress in connecting the world (for an overview, see Box 1.5 at the end of the chapter). The Internet a technology that did not exist in 1984, is now woven into the entire fabric of our daily lives. The minority has become the majority: two-thirds of humanity use the Internet. Yet to a large extent "the link is still missing". A third of the world's population remains offline and many among the online population are not meaningfully connected. Their connection may be too slow, unreliable, or costly. Lack of skills may compromise their ability to get the most out of devices and services. This limited connectivity is simply not sufficient to change the basic blueprint of their lives.

The "missing link" has morphed into multiple gaps and divides across and within countries, between men and women, between youth and older persons, between cities and rural areas, between those who enjoy a fibre connection and those who struggle on a spotty 3G connection, between the technology savvy and those who fall victims of the Internet's dark side.

The Internet offers formidable possibilities. Depriving vast swaths of humanity from such possibilities is becoming less acceptable and more costly, as it is deepening social and economic inequalities. And the COVID-19 pandemic has magnified the costs of digital exclusion.

Connecting everyone is no longer enough. The possibility of making meaningful use of the Internet, leveraging it to its full extent depends on a myriad of factors. The connectivity challenge has become even more arduous. Championed by ITU, the United Nations specialized agency for ICTs *universal and meaningful connectivity* is the possibility for everyone to enjoy a safe, satisfying, enriching, productive, and affordable online experience. Only by achieving universal and meaningful connectivity will the world fully realize the promise connectivity holds for digital transformation and for socio-economic development.

The COVID-19 pandemic has led to a sharp uptake in usage and reliance on the Internet for many individuals, businesses, schools, and governments. The Internet has enabled continuity during periods of lockdown, quarantine, and social distancing. Those who had fast, reliable, and affordable connectivity also had access to education, health care, shopping, social life, and entertainment. For others, the pandemic increased the cost of digital exclusion. School closures affected millions of students, and an estimated two-thirds of all school children were deprived of essential education services because they had no fixed broadband access at home (UNICEF and ITU 2020). In addition, jobs in sectors not conducive to telework tend to be at the bottom of the pay scale and are held disproportionately by lower-skilled, younger, and less educated workers. The pandemic profoundly disrupted those sectors with a high proportion of such jobs in tourism, logistics, and services, thus contributing to a deepening of social inequalities.

1.1 The promises of connectivity

The impact of connectivity is profound and far-ranging, extending to individuals, businesses and governments. The Internet has significant economic benefits and the potential to enhance welfare for individuals throughout their lives. The Internet enables access to online services where traditional services are lacking and to new forms of entertainment, expression, collaboration, and communication. It enables access to knowledge, learning resources, job opportunities, and drastically reduces search costs.

The Internet enables businesses to expand their customer base and to integrate global value chains. It improves efficiency and reduces transaction costs (World Bank 2016). It provides access to online resources for upskilling and reskilling, enables remote working and gives access to a larger pool of talent. The Internet enables innovation, leading to new business models. By generating productivity gains and innovation, the Internet contributes to job creation and economic development.

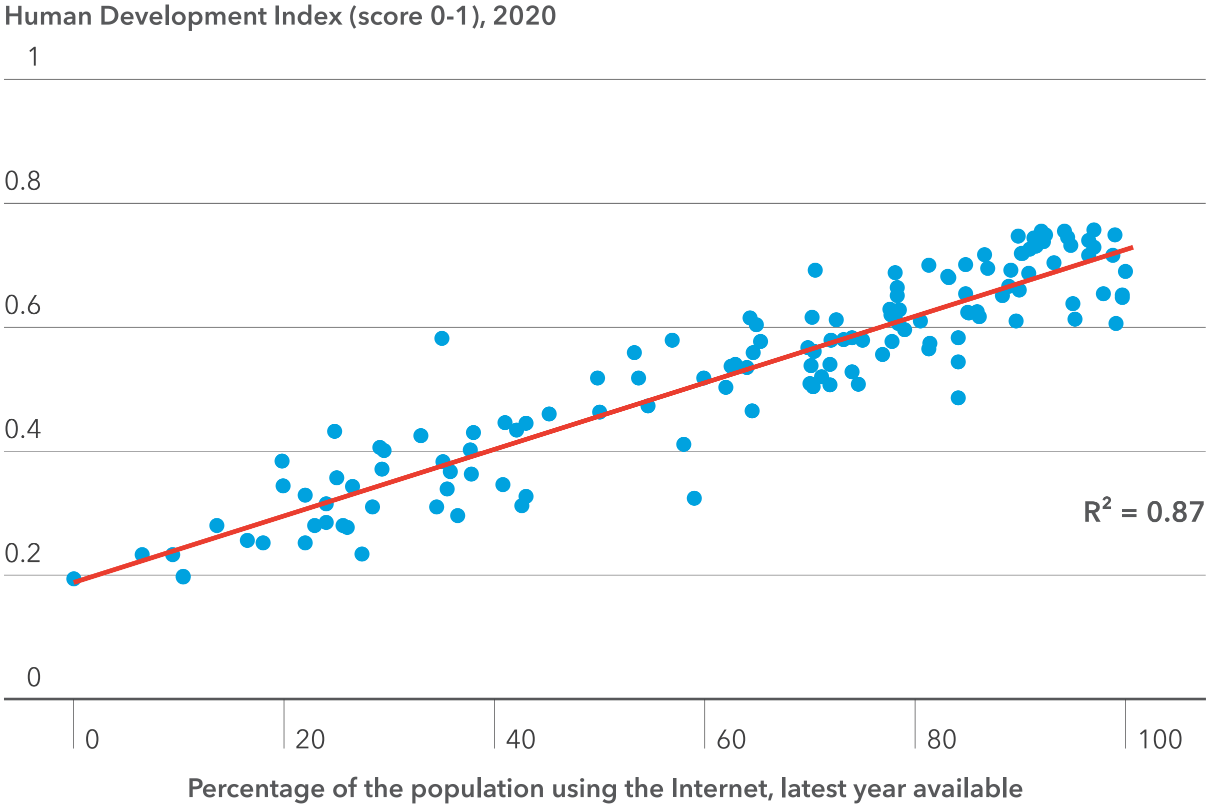
Governments use the Internet to deliver essential public services such as education and health care – and not just during the pandemic – and some services are available at reduced cost and with greater reach. The Internet can also be used for other government services such as business registration and tax collection, and to deliver benefits, especially useful in areas of a country where there are few traditional government offices.

An ITU study shows that a 1 per cent increase in fixed broadband penetration increases gross domestic product (GDP) in a country by 0.08 per cent, while a 1 per cent increase in mobile broadband penetration increases GDP by 0.15 per cent (ITU 2018[1]). While the economic impact of fixed broadband is greater in more developed countries, mobile broadband benefits are maximized in developing countries, where mobile tends to be the way most people access the Internet. In Africa, a 1 per cent increase in mobile penetration is estimated to increase GDP by 0.25 per cent (ITU 2019). Mobile broadband penetration in Africa increased from just under 30 per cent in 2018 to just over 40 per cent in 2021 (ITU 2021), and this 10 percentage-point increase corresponds to an increase of 2.5 percentage points in GDP.

The Internet: a lifeline for the marginalized and the vulnerable

In addition to economic advantages, the benefits of connectivity are considerable for society. There exists a very close relationship between connectivity and human development (Figure 1.1), although the relationship works both ways, connectivity drives development and more development leads to more connectivity.

Figure 1.1: Connectivity and human development



Note: N = 138.
Sources: ITU estimates and UNDP 2020.

The benefits of connectivity are considerable for the marginalized and vulnerable. Such groups are typically the least connected populations. For refugees for example, connectivity will keep them in touch with their communities, and will provide them with online services including education, employment, and financial support (see Box 1.1).

The role of connectivity in sustained, sustainable, and inclusive development and growth is recognized in the SDGs (Table 1.1). Target 9.c focuses specifically on connectivity to "*Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020*".

Table 1.1 highlights additional indicators related to connectivity under Goals 4, 5, and 17. The benefits of connectivity and its applications extend to the achievement of virtually every SDG. This table also shows ITU initiatives contributing to the SDGs and lists relevant ITU initiatives that contribute to specific goals.[11] Box 1.3 shows how one specific application, digital financial services, can contribute to multiple goals.

Box 1.1: Connectivity for refugees

"Connectivity is not a luxury for refugees. It is a lifeline."

– *Filippo Grandi, United Nations High Commissioner for Refugees*[2]

There are 84 million forcibly displaced people worldwide, of which 48 million are internally displaced and more than 26 million are refugees.[3] This number will rise in the mid- to long-term, as climate change impacts agriculture and sea levels, and as other disruptive events force people to migrate. This will add to the number of displaced people fleeing civil war, sectarian violence, and poverty. For these people, connectivity is an absolute lifeline, and the challenges to its delivery are considerable.

Once displaced, people need connectivity to communicate with family and friends, to let them know they are safe. As they move, they need to remain connected. They need information about their situation and options, and some of them will be able to continue with their livelihoods online. Connectivity is core to delivering a humanitarian response, such as cash transfers via mobile phone, education, and other essential digital services. People sacrificing food for connectivity and buying connectivity by the minute with precious cash to send messages (UNHCR 2016) are striking examples of how important connectivity is to them in their hour of need.

Connectivity challenges in hosting countries

It is a challenge to stay online for displaced people. According to the United Nations High Commissioner for Refugees (UNHCR), 85 per cent of refugees are hosted in developing countries. More than a quarter (27 per cent) are hosted in least developed countries,[4] often in rural areas where connectivity is typically below the average for the country. In addition, displaced people may not only lack the necessary papers to obtain a mobile phone, but their difficult financial circumstances means that help will be needed if affordable and accessible coverage is to be provided.

Focus on tackling connectivity challenges

Key organizations are addressing the connectivity challenge of displaced people. For example, UNHCR has a *Connectivity for Refugees* initiative to bring refugees online with available, affordable, and usable connectivity.[5] The Broadband Commission for Sustainable Development (2019) reported on broadband connectivity for refugees in 2019, and experts developed a Global Broadband Plan for Refugees in 2016.[6]

The GSM Association (GSMA) Mobile for Humanitarian Innovation project develops research, creates partnerships for new services, advocates for enabling policy environments, and evaluates performance.[7] The GSMA published a Humanitarian Connectivity Charter in March 2015 that was signed by 159 mobile operators in 111 countries, and endorsed by members of the international humanitarian community, including UNHCR.[8] GSMA forecasts that it is on track to reach 7 million people with access to mobile services by early 2022.

Box 1.2: The Sustainable Development Goals and the Decade of Action

The United Nations 2030 Agenda for Sustainable Development sets 17 Sustainable Development Goals (SDGs) for humanity. They address deep-seated challenges, such as ending poverty and hunger, protecting the planet, and fostering peaceful, just, and inclusive societies. Progress towards achieving many of the SDGs has been slow, and in 2019, the UN Secretary-General declared 2020-2030 the Decade of Action.[9] While the COVID-19 pandemic has made progress all the more critical, it has also made it harder to gain ground in achieving the SDGs, and progress continues to stall.[10]

Table 1.1: The contribution of connectivity and the SDGs

SDG	Description	Role of connectivity **Related connectivity indicator (if relevant)** **Selected relevant ITU initiatives**
1 NO POVERTY	*End poverty in all its forms everywhere*	Digital financial inclusion helps to lift individuals out of poverty by reducing transaction costs, providing access to loans, and reducing theft (see below). ITU has worked to accelerate digital financial inclusion in developing countries.
2 ZERO HUNGER	*End hunger, achieve food security and improved nutrition and promote sustainable agriculture*	Connectivity can help to make agriculture more data-driven to increase crop yields. It can also enable farmers to check the prices of their crops to increase their income. ITU and the Food and Agriculture Organization of the UN have a partnership to help promote ICT innovation in agriculture.[12]
3 GOOD HEALTH AND WELL-BEING	*Ensure healthy lives and promote well-being for all at all ages*	Health services can be delivered over the Internet, to enable interactions with patients among other benefits. For instance, reminders can be sent to patients to take their medication, and data can be gathered from individuals about their symptoms and from entire populations to track diseases. ITU has several partnerships with the World Health Organization to help deliver health services, including Be He@lthy Be Mobile.[13]
4 QUALITY EDUCATION	*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*	Connectivity can provide access to online education in general, as well as helping to develop the digital skills needed to work online and find jobs. Indicator 4.a.1: Proportion of schools offering basic services, by type of service, includes 'Internet' and 'computers' among the services Indicator 4.4.1: Proportion of youth and adults with ICT skills, by type of skills ITU is partnering with the International Labour Organization (ILO) to develop digital skills for youth to promote employment.[14] See also the Giga initiative under SDG 16.
5 GENDER EQUALITY	*Achieve gender equality and empower all women and girls*	The benefits of connectivity should be available to all equally, but currently there is a digital gender gap. Indicator 5.b.1: Proportion of individuals who own a mobile telephone, by sex ITU is involved in a number of gender equality initiatives, including EQUALS, a global network to improve women's access to technology, and that promotes female leadership in the tech sector.[15]
6 CLEAN WATER AND SANITATION	*Ensure availability and sustainable management of water and sanitation for all*	Internet of Things (IoT) devices can facilitate smart water and sanitation management, for instance to measure consumption and for quality monitoring. The ITU Focus Group on Smart Sustainable Cities examines key trends in urban smart water management.[16]
7 AFFORDABLE AND CLEAN ENERGY	*Ensure access to affordable, reliable, sustainable and modern energy for all*	Smart power grids can build more efficient energy systems with fewer emissions, for instance by enabling consumers to monitor and moderate their usage. ITU has addressed smart power grids, along with helping develop greener ICT equipment.

Table 1.1: The contribution of connectivity and the SDGs (continued)

SDG	Description	Role of connectivity **Related connectivity indicator (if relevant)** **Selected relevant ITU initiatives**
8 DECENT WORK AND ECONOMIC GROWTH	*Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*	Internet connectivity can offer opportunities for innovation and entrepreneurship to create jobs and companies, and digital transformation can generate economic growth. ITU has a Digital Innovation Framework to help accelerate these impacts, and established I-CoDI, the International Centre of Digital Innovation, to work with partners to develop strategies to accelerate digital transformation.[17]
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	*Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*	The Internet is a key enabler of digital infrastructure, the digital economy and innovation. Target 9.c addresses connectivity specifically. Indicator 9.c.1: Proportion of population covered by a mobile network, by technology ITU works to close the digital divide, including as part of the Broadband Commission for Sustainable Development in partnership with UNESCO (see Chapter 5).
10 REDUCED INEQUALITIES	*Reduce inequality within and among countries*	Access to technologies and the knowledge that can be reached through connectivity can provide jobs and enable remote work to help reduce inequalities. ITU's work to reduce the digital divide can contribute.
11 SUSTAINABLE CITIES AND COMMUNITIES	*Make cities and human settlements inclusive, safe, resilient and sustainable*	Smart technologies can help to make cities more sustainable, helping to manage traffic, trash collection, and air quality. ITU has a partnership with the UN Economic Commission for Europe (UNECE) and UN-Habitat to help with the transition to smart sustainable cities.[18]
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	*Ensure sustainable consumption and production patterns*	e-waste from ICTs is significant and increasing. ITU has initiatives to address the challenge of sustainable management of e-waste, including the Global E-waste Monitor, a collaborative effort with other partners to monitor and reduce e-waste.[19]
13 CLIMATE ACTION	*Take urgent action to combat climate change and its impacts*	ICT products and services consume energy. ITU has been developing standards on green data centres and power feeding systems to reduce the energy footprint of connectivity. On the other hand, as highlighted during the pandemic, Internet services can reduce the need for commuting to work or traveling for business.

Table 1.1: The contribution of connectivity and the SDGs (continued)

SDG	Description	Role of connectivity **Related connectivity indicator (if relevant)** **Selected relevant ITU initiatives**
14 LIFE BELOW WATER	*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*	Satellite imagery plays a significant role in monitoring oceans and terrestrial ecosystems. ITU allocates the use of spectrum needed to operate the satellites and coordinates the satellite orbits.
15 LIFE ON LAND	*Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*	
16 PEACE, JUSTICE AND STRONG INSTITUTIONS	*Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels*	Connectivity can be used to deliver government services to all, particularly underserved citizens, including for schools and hospitals, and it can also be used for general social inclusion and to assess the delivery of services. ITU is working with UNICEF on a programme called Giga to deliver connectivity to schools (as described below).
17 PARTNERSHIPS FOR THE GOALS	*Strengthen the means of implementation and revitalize the global partnership for sustainable development*	Public-private partnerships are key to delivering connectivity to all, particularly in un- or underserved areas. Indicator 17.6.1: Fixed Internet broadband subscriptions per 100 inhabitants, by speed Indicator 17.8.1: Proportion of individuals using the Internet ITU is partnering with the International Labour Organization (ILO) to develop digital skills for youth to promote employment.[20] See also the Giga initiative under SDG 16. ITU works on such partnerships, including the ones in this table, to help to achieve the SDGs.

Box 1.3: Impact of mobile money: achieving the SDGs[21]

Mobile financial services are important in developing countries, where the level of fixed connectivity is low, and the number of unbanked individuals is high. At the end of 2019, there were 2.3 billion users of mobile financial services, including more than 1 billion registered mobile money accounts. The most famous of these services is M-PESA in Kenya, offered by Safaricom, which now generates 11 billion transactions a year, and has clearly helped address pandemic restrictions.[22]

Greater financial inclusion lowers the cost of transactions, eliminates risk from handling cash, allows full and fair wage and social payments, and facilitates savings and loans. One study showed that women particularly benefited in developing countries, moving out of agriculture and into business, with increased financial resilience and savings. This same study (Suri and Jack 2016) showed that 194 000 households were lifted out of poverty as a result, some 2 per cent of all households in Kenya.

How is mobile money helping across the SDGs?

SDG 1: No Poverty. In Burkina Faso, mobile money users are three times more likely to save for unpredictable events and emergencies, shielding them from economic shocks. In Uganda, a study showed that mobile money helped small businesses to save and make payments, benefiting owners and workers.

SDG 2: Zero Hunger. Mobile money can help farmers increase their productivity by demonstrating creditworthiness to buy equipment and can help to reduce food insecurity by providing financial services used to purchase food.

SDG 3: Good Health and Well-Being. Mobile money allows individuals and households to save for health emergencies, to purchase health insurance, and to pay their bills, enabling increased access to health services.

SDG 4: Quality Education. Mobile money helps households to manage their savings for education and make school payments efficiently, also lowering cost for providers. It can also lower the cost and risks of schools making payments to teachers.

SDG 5: Gender Equality. Mobile money empowers women by giving them control over their money and reducing cash insecurity. In Côte d'Ivoire, men are twice as likely to have a traditional account with a financial institution as women, but there is no such gap with mobile money accounts. Mobile money also helps women to get credit to start businesses.

SDG 6: Clean Water and Sanitation. Pay as you go (PAYG) solutions enable users with mobile money accounts to pay for water, including a loan for their initial water connection, allowing users to pay in small instalments and have access to services.

SDG 7: Affordable and Clean Energy. PAYG solar panels enable the use of mobile money to pay for electricity in small amounts, when it is needed, thereby also purchasing the solar panel over time. As a result, children can study and businesses can operate after dark. Around 4.2 million panels were sold in Africa in 2019, increasing access to a clean source of power.

SDG 8: Decent Work and Economic Growth. In addition to using mobile money for payments, individuals earn income by becoming mobile money agents – there were 7.7 million in 2019. Small businesses use mobile money to efficiently and safely receive payments from their customers and pay their vendors, thereby increasing their revenues.

SDG 10: Reduced Inequalities. Financial remittances are important for migrants and their families, and the cost of sending them is significantly lower using mobile money. The average cost is actually below the 3 per cent target of SDG 10.C. These remittances, in turn, contribute to progress across many of the SDGs with increased income and resources.

SDG 11: Sustainable Cities and Communities. Mobile money enables easy access to public transportation and enables payments for ride-sharing platforms to lower the cost of commuting.

SDG 16: Peace, Justice and Strong Institutions. Mobile money transfers help reduce fraud and theft. For instance, when the Afghan National Police began to be paid with M-PESA instead of cash, salaries increased up to a third for some officers, while payments to ghost workers were stopped.

In order to promote digital payments, ITU works as part of the Financial Inclusion Global Initiative (FIGI) with the World Bank Group and the Committee on Payments and Market Infrastructure of the Bank for International Settlements.[23]

Digital financial services offer broad benefits for development, and mobile money is especially powerful given its availability, the convenience it brings, and its usefulness. Mobile money is a platform for a wealth of services that help progress in achieving the SDGs.

1.2 The downsides of connectivity

As the range of Internet uses continues to increase, exposure to the downsides of connectivity also increases. Concerns have intensified in recent years as Internet access has proliferated, such as privacy, cybersecurity, harmful content, and the outsize power of large companies.

The data protection balance

Privacy and data protection regulations are important in determining how personal data is used and protected. On the other hand, countries have to enable official access for law enforcement to counter terrorism and to prevent money laundering. This tension generates difficult policy discussions on the use of encryption and access to data stored in other countries.

Online harm: the world is struggling with an array of issues

The focus on protecting individuals – especially children – has intensified in recent years. How can we best ensure adults' and children's safety, while at the same time protecting freedom of expression?

There are challenges even with non-harmful content: many channels exist where only one viewpoint is expressed – an "echo chamber" – where views, sometimes extreme, are reinforced and unchallenged. Excessive amounts of time spent online, particularly for the young in their formative years, can impact adversely on their personal relationships and on the wider community (see Chapter 9 on connectivity among the young). Events where misinformation and disinformation have been injected into this void are well documented, sometimes with long-term, far-reaching political consequences.

During the pandemic, greater use of sensitive services has added to privacy concerns, while more access from home, with lower cybersecurity, has seen higher levels of attacks (see Box 1.4). In addition, harmful content has had serious consequences, not least life and death consequences as COVID-19 misinformation and conspiracy theories have flourished.

Online platforms: the role of regulation is still unclear

Recently, the tide has begun to turn against harmful content on online platforms, in part to prevent misinformation about the pandemic.

Online platforms such as Twitter provide a medium for direct communications between politicians, officials, voters and other users, generally staying clear of editorial decisions and allowing for endless points of view and broad discussion.

Platforms in many countries are allowed to operate with no editorial responsibility other than an obligation to remove illegal content when notified. Platforms can develop their own policies to guide decisions on how to moderate content. However, these policies have proven difficult to formulate and enforce due to the subjectivity and sheer quantity of uploaded content.

Some platforms are increasing controls on misinformation

One consequence of a lack of regulation on social platforms has been the rise of populist politicians using these platforms to make direct appeals to voters. Evidence has emerged that organized misinformation and disinformation campaigns have impacted outcomes in the 2016 elections in the United States and United Kingdom. In the light of such evidence, platforms have begun to address such issues by flagging, blocking, and banning some users. For example, a number of platforms now have in place policies that prohibit the posting of conspiracy theories and remove anti-vaccination content.

Box 1.4: The impact of digital distrust

Digital distrust was highlighted during the pandemic by the public's response to contact tracing applications. Countries where manual contact tracing was used to isolate those who came into contact with people infected with COVID-19 were soon overwhelmed and attention quickly turned to the use of smartphones in automating contact tracing.

In April 2020, an Oxford study suggested that if 60 per cent of the population used contact tracing apps, the pandemic could end earlier, and that surveys had indicated people would use them.[24] Concerns quickly emerged about data privacy however as apps traced individuals' location and proximity to others. And while Google and Apple collaborated in developing an 'Exposure Notification' application that addressed these concerns, take-up remained far below 60 per cent. While studies showed contact tracing apps did indeed prevent infections, their efficacy fell short of expectations.

Connectivity both contributes to, and helps mitigate, emissions

Connectivity and data centres require increasing amounts of power and contribute to the generation of greenhouse gases. Bitcoin "mining" is estimated to consume enough energy per year to power a country such as Malaysia or Sweden (Carter 2021). More positively though, digital connectivity facilitates working from home and online meetings, thereby reducing the environmental impact of travel, a trend that exploded during the pandemic and is likely to endure (Pearson *et al*. 2021). Moreover, connectivity contributes across a wide range of fronts that help mitigate climate change.

A balanced view: connectivity is not an end in itself

Addressing the downsides of connectivity is a balancing act and will become more so as meaningful connectivity becomes universal. The challenge is to harness the potential of online interaction and open a world of connections, while mitigating the harms, a particularly difficult challenge given the borderless nature of communications and the freedom of online platforms to devise their own content policies.

However, connectivity is a means to an end, not an end in itself. For instance, to achieve SDG 2 (zero hunger), connectivity can help increase agricultural production with an ICT application designed specifically for a particular crop and region. To have full effect however, such an application needs the support of crucial elements such as a skilled farm workforce, transport, and well-functioning markets.

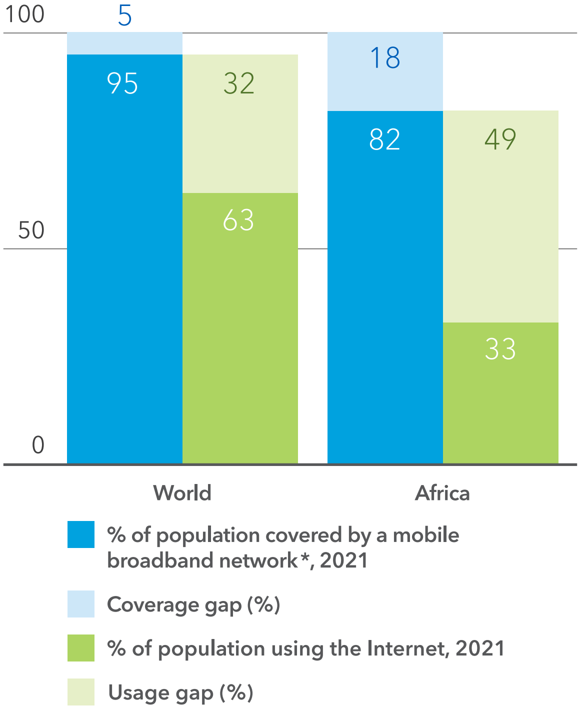
A dual approach is needed to support a balanced development. First, the Internet must be made universally accessible. Second, stronger "analogue complements" are needed to ensure that the Internet provides for economic and social development (World Bank 2016). These analogue complements then ensure that there is a strong policy and regulatory framework, inclusive skills training, and accountable institutions.

1.3 Charting a path to universal, meaningful connectivity

There are three clear challenges in this Decade of Action:

1. Closing the coverage gap. Ninety-five per cent of the world population is within range of a mobile broadband network (3G or above). However, lack of infrastructure and services in the poorest areas of the world mean that blind spots remain (Figure 1.2).

Figure 1.2: Coverage gap and usage gap



Note: *3G or more recent.
Source: ITU.

2. Closing the usage gap. ITU estimates that one in three individuals (33 per cent) who *could* go online today, choose *not* to do so.
3. Achieving universal and meaningful connectivity. Closing the digital divide means much more than getting everybody online. Meaningful connectivity allows for a safe, satisfying, enriching, and productive online experience at an affordable cost. Increasingly, the digital divide is defined as the ability to make meaningful use of connectivity and to enjoy the full benefits of the digital age.

How the usage gap is closed and universal and meaningful connectivity is achieved depends on a number of elements that are covered in the following chapters of this report:

- Infrastructure. Coverage, speed, reliability in infrastructure underwrites the possibility of connecting and the quality of online experience (see Chapters 3 and 4 for further discussion).
- Affordability. More affordable services will enable many people to come online, while those already online will be able to extend their usage (see Chapters 3 and 5).
- Digital skills. Improving digital literacy is essential. Many people do not use the Internet because they do not know what it is or how to use it, while many users fear or are unable to navigate cyberattacks, scams, fake news, or harmful content (Chapters 3 and 9).
- Devices. Internet-enabled devices need to be affordable, taking into account that device sharing is limiting and that basic devices will make for a less enriching online experience (Chapters 3 and 5).
- Safety and security. We need to strive for an Internet that is safe and secure, one that will engender trust when people go online (Chapter 3).

Addressing any one of these elements is a considerable challenge, and incremental improvements are required for *all* of them. If just one is neglected, meaningful connectivity will not be achieved. Policy-makers and other stakeholders can intervene using a number of tools at their disposal and further chapters in this report showcase examples of successful policies, regulation, and investments across all areas.[25]

The pandemic has not only magnified the importance of connectivity but also the heavy cost of its absence. It has also highlighted the need to strive beyond universal connectivity towards meaningful connectivity that enables remote work, education, health care, and entertainment. To achieve this goal, the work needed to counter the downsides of connectivity should be fully recognized. Meaningful connectivity will help advance the achievement of the SDGs and ensure that the Decade of Action delivers tangible social and economic benefits for all.

Box 1.5: A history of digital connectivity

Connectivity has gone through three main stages over the past decades. Understanding these stages helps understand how the digital divide has developed and how to address it.

Since the 1990s, the Internet has grown beyond its academic roots in user numbers and in the depth of online use. Access has migrated from dial-up fixed access to broadband, while mobile broadband was introduced with continuous upgrades of generations. Devices moved from static personal computers to smart devices and to the Internet of Things (IoT). And finally, services morphed from text-based serial communications and downloads to real-time multimedia interactions.

The Internet of today is unrecognizable compared to the one that existed when Tim Berners-Lee conceived the World Wide Web in 1989 in Geneva. The commercialization of the web brought the Internet into popular view. The Internet has increased steadily from almost zero users in 1990 to an estimated 4.9 billion users within three decades (see Figure 2.2 in Chapter 2).[26]

Stage 1: 1990s dial-up, fixed broadband, and the emergence of mobile

In the 1990s, connectivity used fixed infrastructure. Fixed telephone networks were fairly universal in developed countries, enabling early analogue dial-up services – slow access speeds and a phone call was needed to go online. The introduction of integrated services digital network (ISDN) provided a digital connection at speeds that could exceed those offered by dial-up connections, but take-up was relatively low.

Towards the end of the decade came the introduction of fixed broadband. Fixed telephone networks were upgraded to offer broadband using digital subscriber line (DSL) technology, while some countries also had widespread cable television networks that were upgraded to offer broadband. Increased fixed-broadband bandwidth enabled new multimedia content and was always-on connectivity and spawned new services. However, many developing countries had limited fixed-telephone networks, with long waiting lists, offering few opportunities for Internet access.

As a result, the connectivity focus in developing countries was necessarily on extending fixed networks, which is costly and slow, and limited the promise of connectivity. At the same time, mobile-cellular networks were emerging, leap-frogging cumbersome fixed networks and offering voice services to users in more and more countries. Mobile Internet services did nothing less than transform the connectivity landscape.

Stage 2: The rise of mobile broadband in the new millennia

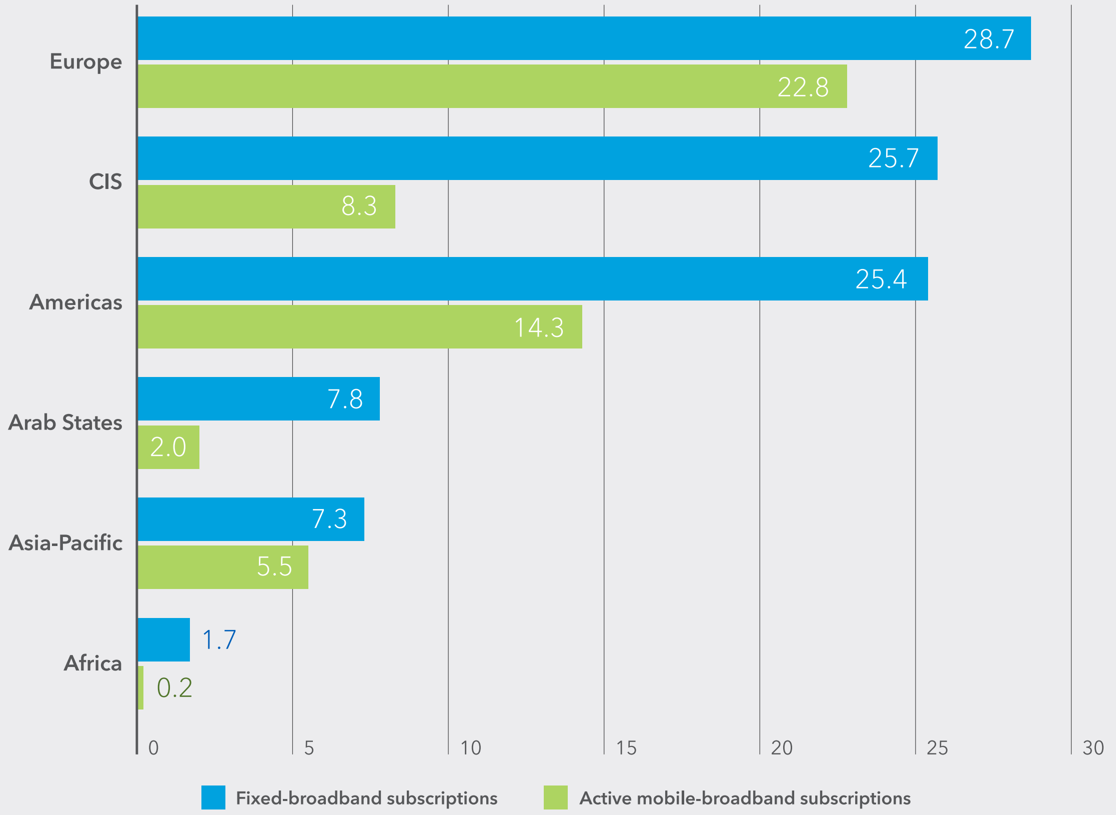
In the 2000s, mobile broadband emerged as the primary means for many to go online, beginning with 3G services. Mobile broadband had three advantages. First, the cost of upgrading existing mobile cellular networks to offer broadband was relatively low. Second, the deployment cost of mobile networks was significantly lower than deploying fixed networks and adding mobile Internet to voice revenues made it financially viable. Third, while fixed networks have many attributes of a natural monopoly, mobile services could be offered competitively, as was the case in most countries.

Early uses of mobile Internet were restricted by the device. Either a device captured the signal for use with a personal computer, effectively turning mobile into a fixed service, or it was used with basic devices that enabled e-mail and rudimentary web services. The release of the iPhone in 2007 and the Android phone in 2008 coupled with the launch of third-party apps accelerated adoption and the mobile Internet revolution.

The smartphone transformed use of the Internet. Not only did it give access to existing services where there was no fixed coverage, it also enabled new services based on features such as location-awareness. By the end of the decade, the penetration of mobile Internet had significantly outpaced fixed broadband, particularly in regions where there was little fixed connectivity, notably in Africa. It was clear that the future of connectivity in those regions was to be built on mobile (Figure 1.3).

Figure 1.3: Broadband penetration, 2010

Fixed- and active mobile-broadband subscriptions per 100 inhabitants



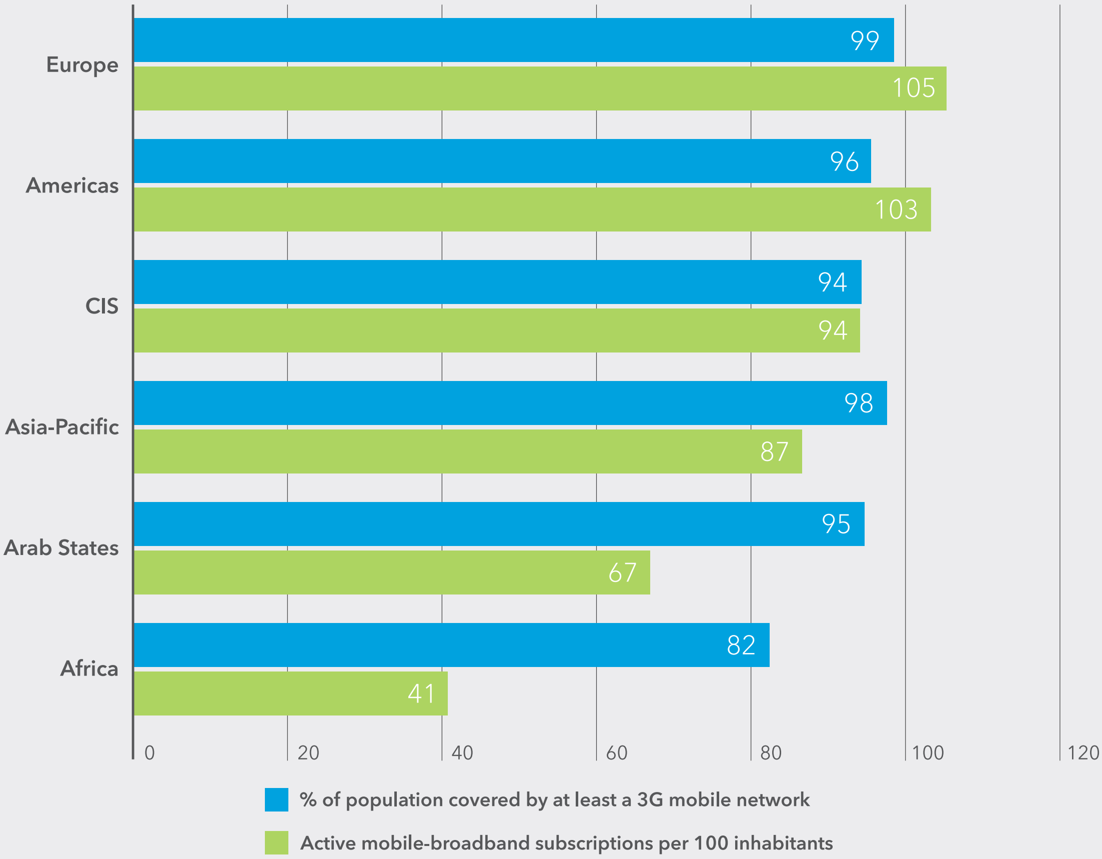
Note: CIS = Commonwealth of Independent States.
Source: ITU.

Stage 3: Global dominance of mobile broadband from 2010

From 2010 onwards, mobile broadband spread throughout the world, building on existing cellular networks and then expanding and upgrading to new generations of networks. As a result, the connectivity challenge in developing countries was fully – and positively – turned on its head. In the 1990s, the challenge had been the supply of connectivity. In the following decades, the population coverage of mobile broadband networks quickly overtook demand. And since it was inexpensive to upgrade mobile networks to offer broadband, the supply of mobile broadband was able to come on-stream at high volume. Furthermore, as mobile broadband networks expanded, they did so with 3G technology, offering mobile broadband, and then 4G as it began to be rolled out.

Figure 1.4 compares the population coverage of mobile broadband with the uptake of mobile broadband services in 2021. Mobile broadband coverage is nearing 100 per cent in many regions of the world, and in many countries within those regions it is at 100 per cent. But there is a big usage lag in certain regions, even allowing for multiple subscriptions, and with adoption lower than availability, particularly in Africa. This reveals a major shift: the connectivity challenge is shifting from the supply-side, where fixed broadband deployment lags, to the demand-side, where mobile broadband nears ubiquity, in most parts of the world.

Figure 1.4: Mobile-broadband coverage and subscriptions, 2021



Notes: The number of subscriptions can exceed 100 as individuals can have subscriptions for multiple devices. CIS = Commonwealth of Independent States.
Source: ITU.

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14 See: https://www.itu.int/en/ITU-D/Digital-Inclusion/Youth-and-Children/Pages/Digital-Skills.aspx

15 See: https://www.equalsintech.org

16 ITU. Focus Group on Smart Sustainable Cities. https://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx

17 ITU. I-CoDI – ITU's International Centre of Digital Innovation. https://www.itu.int/en/ITU-D/Pages/I-CoDI.aspx

18 ITU. United 4 Smart Sustainable Cities. https://www.itu.int/en/ITU-T/ssc/united/Pages/default.aspx

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25 The report does not consider broader factors, such as economic development and technological innovation, which also have significant impact on the level of connectivity – and the relationship runs both ways, as explained above.

26 See: http://www.itu.int/factsandfigures2021

Chapter 2
The journey to universal and meaningful connectivity

Chapter 2. The journey to universal and meaningful connectivity

This chapter introduces the framework for universal and meaningful connectivity and assesses where the world is today on the road to reaching this goal by 2030. The framework follows on from the United Nations Secretary-General's Roadmap for Digital Cooperation[1] and has been developed by ITU and the Office of the Secretary-General's Envoy on Technology (OSET). The framework includes aspirational targets to be met by 2030 (ITU and OSET 2022).

2.1 Measuring digital connectivity

Universal connectivity means connectivity for all, measured across four categories: people, households, communities, and businesses. Meaningful connectivity is a level of connectivity that allows users to have a safe, satisfying, enriching, and productive online experience at an affordable cost and with a sufficiently large data allowance. Meaningful connectivity is reliant on the "connectivity enablers" of infrastructure, affordability, device, skills, and safety and security (see Figure 2.1). Much of what is set out in this chapter builds from this framework.

This chapter uses this framework and its targets to assess the state of digital connectivity around the world and how close the world is to achieving universal and meaningful connectivity. Table 2.1 shows the targets and where the world currently stands on these targets.

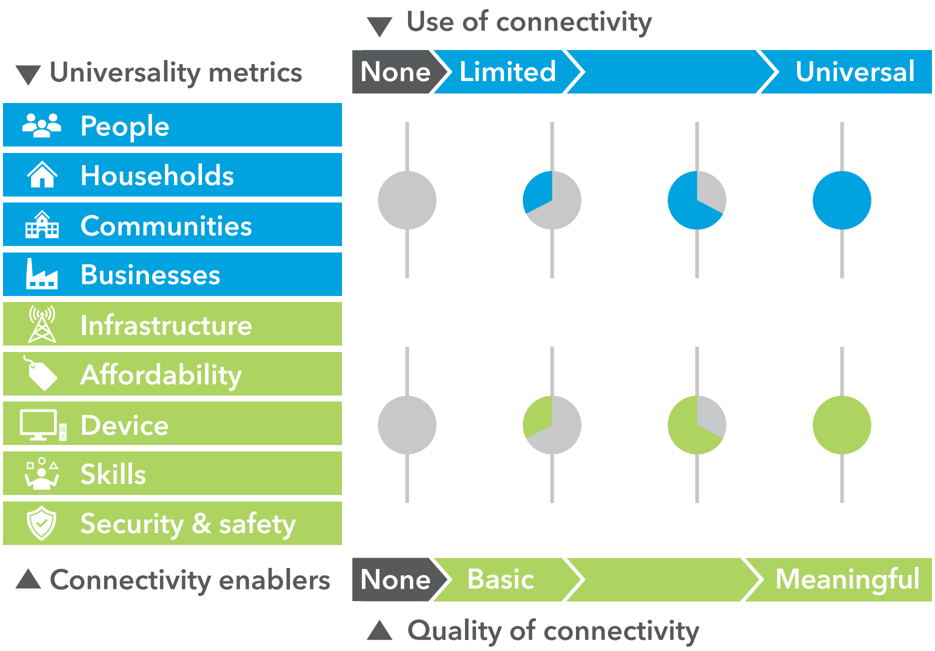
2.2 The state of digital connectivity

This section provides an overview of Internet use, broken down into three categories: individuals, households, and schools.

Individuals' use of Internet

The headline indicator to assess universal connectivity is the percentage of individuals using the Internet. Some individuals however choose *not* to use the Internet – so while the universality target in this context is a penetration rate of 100 per cent for the population aged 15 and above,[2] this is

Figure 2.1: Framework for universal and meaningful connectivity



Sources: ITU and UN OSET 2022.

Table 2.1: Aspirational targets for 2030 and current situation

Indicator	Target	Current situation globally[a]	Number of countries meeting the target[b]
Internet users (% of population)			
Aged 15 and above	100%	63%[c]	13/151[c]
Gender parity ratio (1 = parity)	1	0.92	40/112
Households with Internet access (%)	100%	66%	13/126
Schools connected to the Internet (%)	100%	40% (primary)	42/93
		51% (lower sec.)	50/94
		66% (upper sec.)	50/97
Businesses using the Internet (%)			
0 employees or more	100%	n.a.	6/24
> 10 employees	100%	n.a.	23/47
Mobile network coverage (% of population)			
3G	100% for the most advanced technology already in use in the country with minimum coverage of 40%	95%	2/29[d]
4G		88%	66/157
5G		n.a.	n.a.
Fixed-broadband speed (% of subscriptions)			
>10 Mbit/s	100%	91%	25/150
School connectivity			
Min. download speed (Mbit/s per school)	20	n.a.	8/24
Min. download speed (kbit/s per student)	50	n.a.	n.a.
Minimum data allowance (GB)	200	n.a.	n.a.
Entry-level broadband subscription price			
% of gross national income per capita	2%	1.9% (mobile)	96/185
		3.5% (fixed)	64/174
% of average income of bottom 40 percent of earners	2%	2.5% (mobile)	50/110
		6.0% (fixed)	21/106
Individuals using a mobile phone			
Gender parity ratio (1 = parity)	1	n.a.	29/56
Individuals owning a mobile phone (% of population)			
Aged 15 and above	100%	n.a.	22/78
Gender parity ratio (1 = parity)	1	n.a.	30/72
Population aged 15+ with basic digital skills (%)	70%	n.a.	8/77
Gender parity ratio (1 = parity)	1	n.a.	5/70
Population aged 15+ with intermediate digital skills (%)	50%	n.a.	11/76
Gender parity ratio (1 = parity)	1	n.a.	5/70

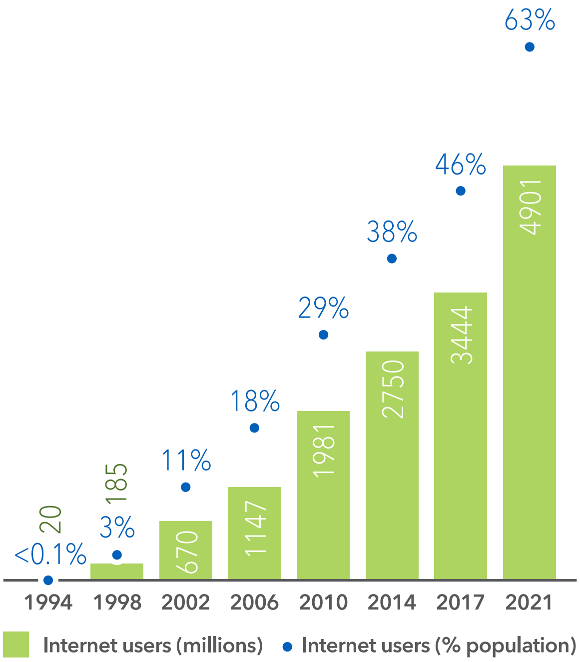
Notes: n.a. = not available (global situation cannot be assessed due to limited data coverage).
a: Data are either for 2021, 2020, or the latest year available in the last four years; more details are provided in this chapter.
b: Among countries for which data is available. *x/y* means that in *x* out of *y* countries for which data are available the target has been achieved or almost achieved (see text for details).
c: Percentage of total population instead of population aged 15 and above.
d: Number of countries where coverage of 4G has not reached 40 per cent of the population.
See ITU and OSET (2022) for details.
Sources: ITU; UNCTAD (retrieved May 2022); UNESCO-UIS database (retrieved February 2022).

considered "met or nearly met" when the share is 95 per cent or higher.

The World Wide Web was invented in 1989 and the Internet is a relatively young technology.[3] In 1994, an estimated 20 million people browsed the Internet, less than half a per cent of the world population. Penetration grew at double-digit rates until 2010, when it reached a 29 per cent penetration rate. Growth continued gradually until the effects of the COVID-19 pandemic sparked a surge in Internet use and in 2020 an estimated 466 million people began using the Internet for the first time, an increase of 10.3 per cent in penetration. By the end of 2021, 4.9 billion people were online, some 63 per cent of the world population. Figure 2.2 shows growth in the number of people using the Internet from 1994, the year when the first ITU World Telecommunication Development Conference (WTDC) was held.[4]

Figure 2.2: Growth of Internet use between 1994 and 2021

Number of individuals (millions) using the Internet

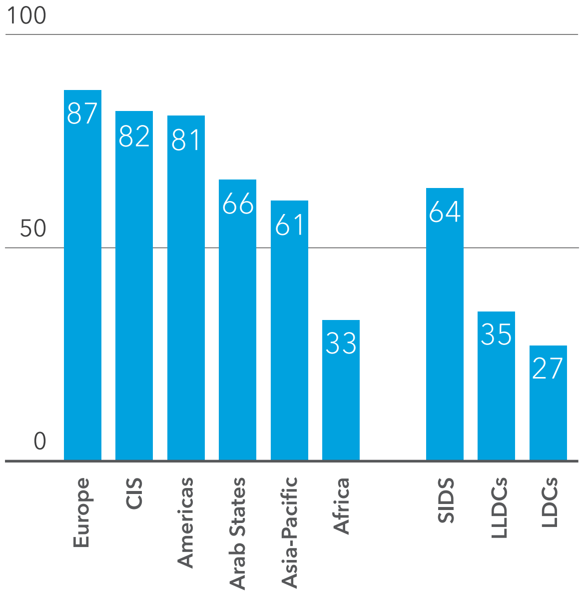


Source: ITU.

Global usage rates in Figure 2.2 hide the disparities between regions. Figure 2.3 shows that Europe, the Commonwealth of Independent States (CIS), and the Americas are close to achieving 95 per cent usage. The Arab States and Asia-Pacific are also on a clear path to universal usage. Africa, however, has only 33 per cent of the population online. In the least developed countries (LDCs), only 27 per cent of the population use the Internet and in landlocked developing countries (LLDCs) the share is 35 per cent. These low rates fall far short of Target 9.c of the Sustainable Development Goals that called for significantly increased access to information and communication technologies and for universal and affordable access to the Internet in least developed countries by 2020.[5]

Figure 2.3: Internet penetration around the world

Percentage of the population using the Internet, 2021



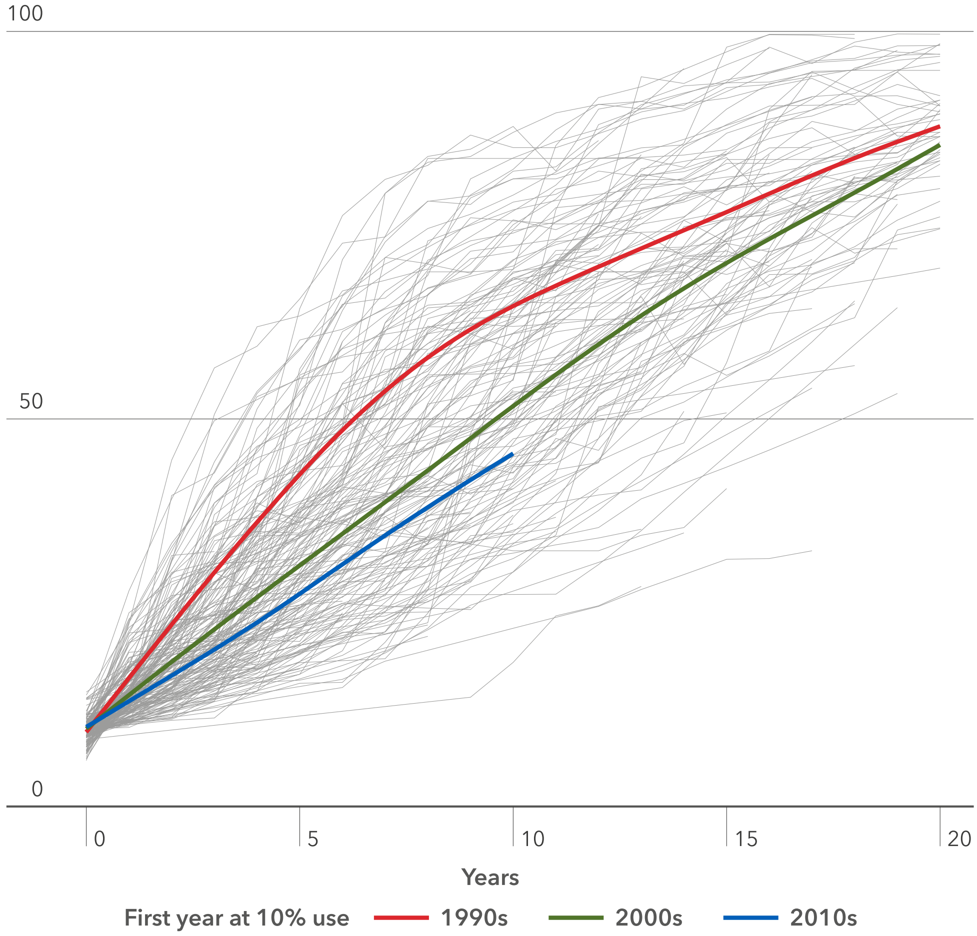
Note: CIS = Commonwealth of Independent States.
Source: ITU.

Figure 2.4 shows how Internet use progressed in all countries, using the year in which each country first reported 10 per cent Internet use as the starting point. The figure shows that most countries reached 50 per cent usage after ten years (from the 10 per cent starting point) and 75 per cent after 16 years. At the 20-year point, 93 per cent of countries had reached 75 per cent usage.

It is often hoped that countries that are late adopters of a technology will catch up by taking advantage of newer technologies, however, this is not always the case. Analysis shows that countries that were first to reach 10 per cent Internet use in the 1990s grew at a faster rate on average than in subsequent decades.

Figure 2.4: Internet use speed of diffusion

Share of individuals using the Internet starting from when a country reached 10 per cent Internet use



Note: Gray lines represent progression of Internet usage rates in individual countries.
Source: ITU.

In contrast, Internet use in countries that reached this level in the 2010s grew at a much slower rate. This highlights the challenges related to lack of resources in these less wealthy late adopting countries. New technology and lessons learned from early adopters may help, but do not fully compensate for the late adoption in less wealthy countries.

Survey data[6] show that the bulk of Internet users (91 per cent) connect at home. Half use the Internet when commuting and about a third connect at work or at another person's home. The rise of smartphones has reduced the need to use schools or community facilities to access the Internet, and only a small share of users connects through such locations. Nevertheless, these locations have a role to play in getting people online who otherwise would not know about the Internet or cannot afford access.

Household access to the Internet

The growth of the percentage of households with Internet access evolves in parallel with the percentage of individuals using the Internet. However, having Internet access at home does not mean that all household members are able to use the Internet with a quality connection, if at all. For example, when schools were closed in many countries, around two-thirds of children and young people aged 25 years or less (about 2.2 billion) did not have fast and reliable, fixed Internet access at home (UNICEF and ITU 2020).

Many households with broadband Internet access rely on a mobile-broadband connection at home, often inadequate for data-intensive activities such as remote schooling. For instance, in Morocco, Thailand, and Uzbekistan, over 70 per cent of households accessed Internet via mobile broadband only. Interestingly, in the 27 countries that provide data on Internet access by service, there is no link between income levels or the rate of Internet access and the choice of subscribing to a mobile-broadband connection only. This implies that there are other factors influencing the choice of service used to access the Internet. In some areas, for example, a mobile-broadband connection may be faster than a fixed-broadband connection, and therefore the preferred option.

Access to the Internet in schools

It is essential that schools have access to the Internet. Young people need digital skills to enter the labour market as many jobs involve working with ICTs and schools play a crucial role in teaching students these skills. Teaching can also be enhanced by the multitude of resources available on the Internet, including open educational resources[7] – of critical importance for children who do not have adequate Internet access at home. Moreover, schools without Internet access were unable to move their teaching online when forced to close during the pandemic. With these benefits in mind, the target for connected schools is set to 100 per cent.[8] Data collected by UNESCO for 2020 show that around the world, 40 per cent of primary schools and 66 per cent of secondary schools had access to the Internet in 2020. In LDCs, these numbers were 28 per cent and 35 per cent, respectively. In 42 of 93 countries for which data were available, the target has been met for primary schools. For secondary schools, the target has been met in 50 countries (available data from 94 countries for lower secondary and 97 countries for upper secondary).

Giga is a joint ITU-UNICEF initiative that seeks to connect every school to the Internet and every young person to information, opportunity and choice.[9] Giga maintains a real-time map of school connectivity to identify demand for infrastructure and funds, measure progress towards increasing Internet access, and continuously monitor global connectivity.[10] So far, 1 million schools in 42 mostly lower-income countries have been mapped by Giga from an estimated 6 million schools worldwide. Data from UNESCO show that 43 per cent of those schools do not have any connectivity. For 24 countries, the average download speed per school is available as well. In eight of those countries, seven small island developing States (SIDS) in the Caribbean plus Brazil, the average download speed was above 20 Mbit/s.

2.3 Divides in connectivity

Since 1994, the Internet has developed from a collaboration network for academics[11] to an indispensable tool for work, communication, education, entertainment and more. For most people, it is hard to imagine life without the Internet. The COVID-19 pandemic has highlighted how important it is to have access to fast and affordable Internet. Indeed, in the first year of the pandemic, growth in the percentage of Internet users was the highest in a decade (see Chapter 8 for more on connectivity and the pandemic).

In 2021, an estimated 2.9 billion people were still offline. The bulk of the global offline population, 1.7 billion people, lives in Asia-Pacific and was concentrated in China and India, followed by Africa with 738 million people offline. The combined offline population in the other four regions was 470 million people.

As the map in Figure 2.5 shows, in percentage terms, Africa was the least connected region in 2020, with 67 per cent of the population offline, followed by Asia-Pacific (39 per cent) and the Arab States (34 per cent).

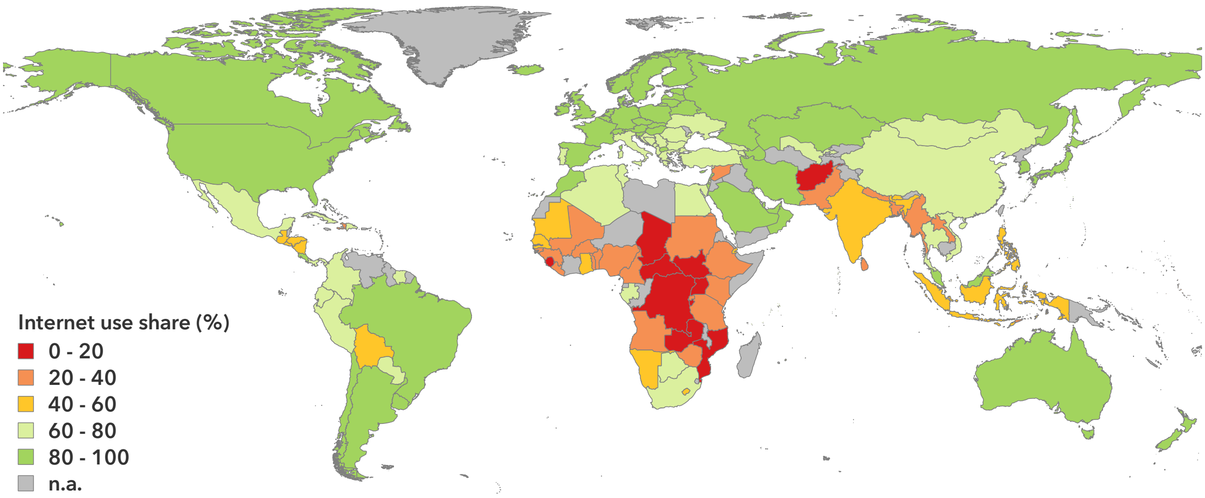
The income divide

Several gaps emerge when looking at the socio-economics of the offline population. A country's level of development, proxied by its gross national income per capita, strongly correlates with Internet penetration (see Figure 1.1 in Chapter 1). As further illustration of the digital divide across countries, Figure 2.6 shows the breakdown of the 2.9 billion people still offline by income group and by country. High-income countries (blue tiles) account for 16 per cent of the world's population, but they account for only 4 per cent of the total offline population. Low-income countries (orange tiles) account for just 7 per cent of the world's population, yet they account for 14 per cent of the offline population.

Despite an estimated sevenfold increase in Internet use in low-income countries since 2005, Internet use in these countries remains far below that of higher-income countries, reaching only 22 per cent in 2021. In contrast, high-income

Figure 2.5: The global digital divide

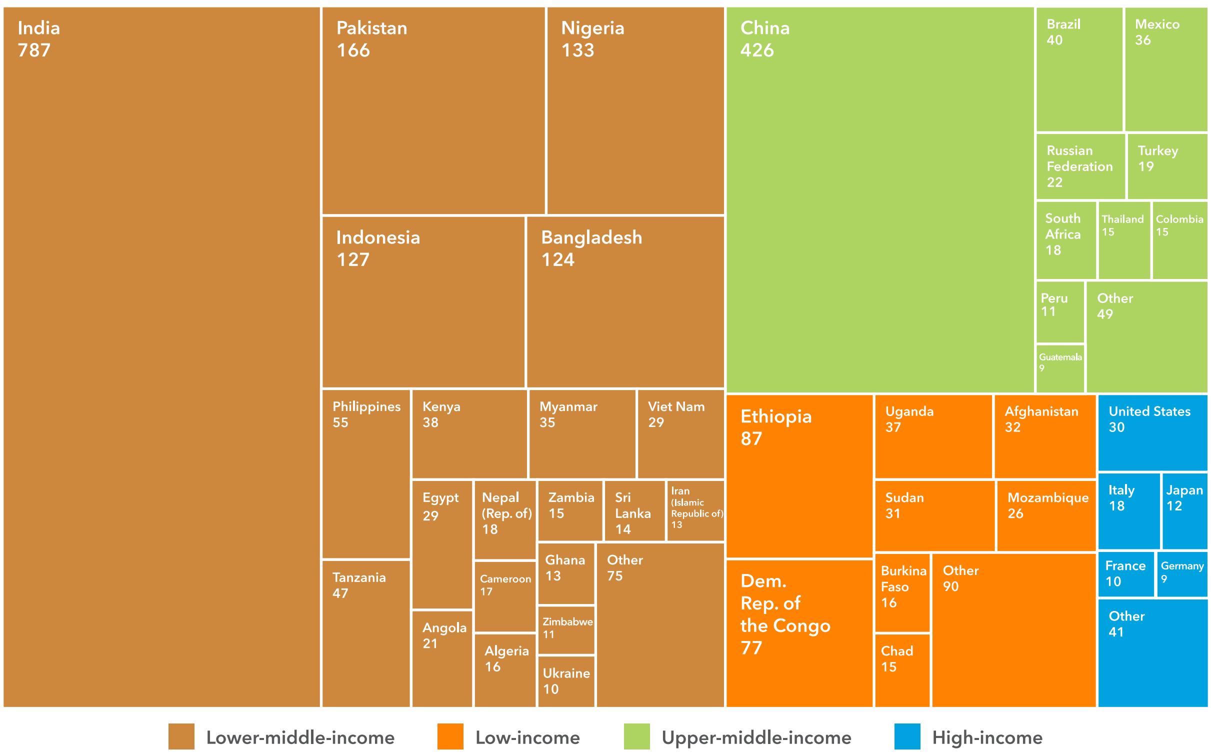
Percentage of the population using the Internet, 2020



Note: The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of ITU and of the secretariat of ITU concerning the legal status of the country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. The base map is the UNmap database of the United Nations Cartographic Section.
Source: ITU.

Figure 2.6: Development level and the offline population

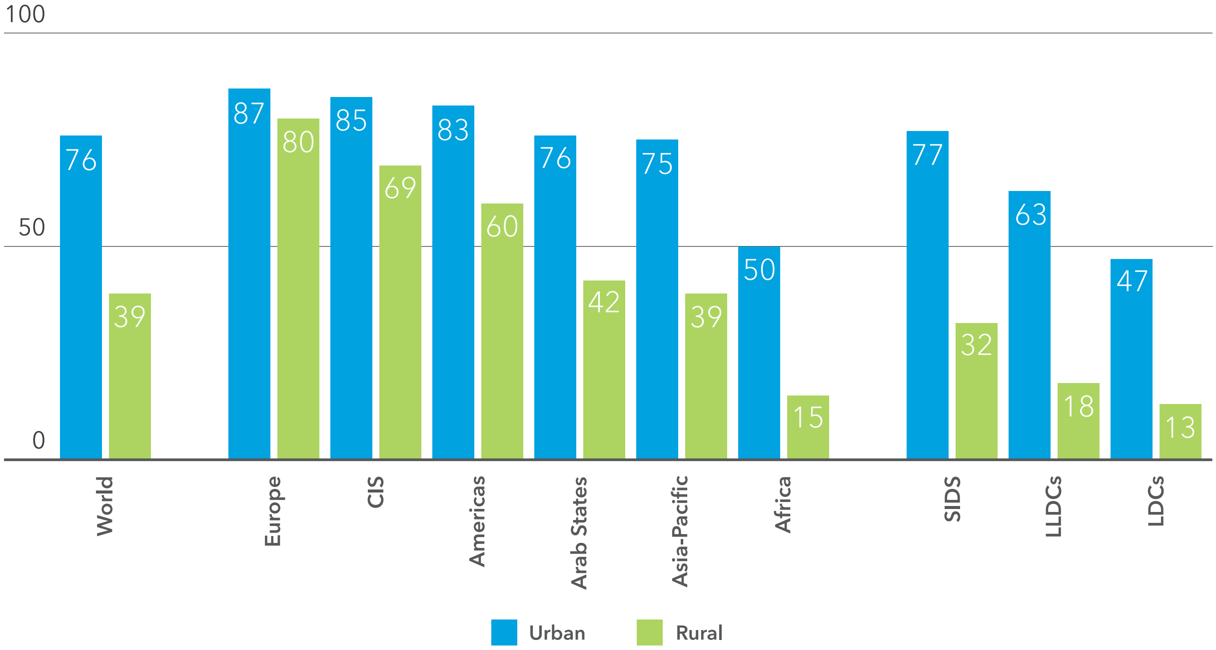
Individuals not using the Internet (millions), by income group, 2020



Note: Size of the tiles represent the country's share in the world's offline population.
Source: ITU.

Figure 2.7: The urban-rural divide

Percentage of the population using the Internet in urban and rural areas, 2021



Note: CIS = Commonwealth of Independent States.
Source: ITU.

countries, at 91 per cent penetration, are close to universal usage[12] and the gap between upper-middle-income countries and high-income countries is closing rapidly. While the difference was 41 percentage points in 2005, by 2021 this gap had shrunk to 15 percentage points. Internet use in lower-middle-income countries nearly doubled from 2017 to 2021, reaching 50 per cent.

The urban-rural divide

Globally, the share of Internet users is estimated to be twice as high in urban areas as in rural areas in 2020 (see Figure 2.7). An urban-rural divide exists in all regions but the higher the overall Internet use, the smaller the urban-rural gap. In Europe, for example, which is close to universal usage, urban use was less than 10 per cent higher than rural use. This contrasts sharply with Africa where Internet use in urban areas was almost 3.5 times as high as use in rural areas. Lower rural usage is partly a result of a lack of infrastructure, but there are additional factors at play. Rural areas usually have lower income levels, and the population often has lower levels of education and lower levels of ICT skills, all of which are negatively correlated with Internet use.

The gender divide

Globally, more men (62 per cent) were using the Internet in 2020 than women (57 per cent). Men were more likely to use the Internet than women in all regions, except the Americas.

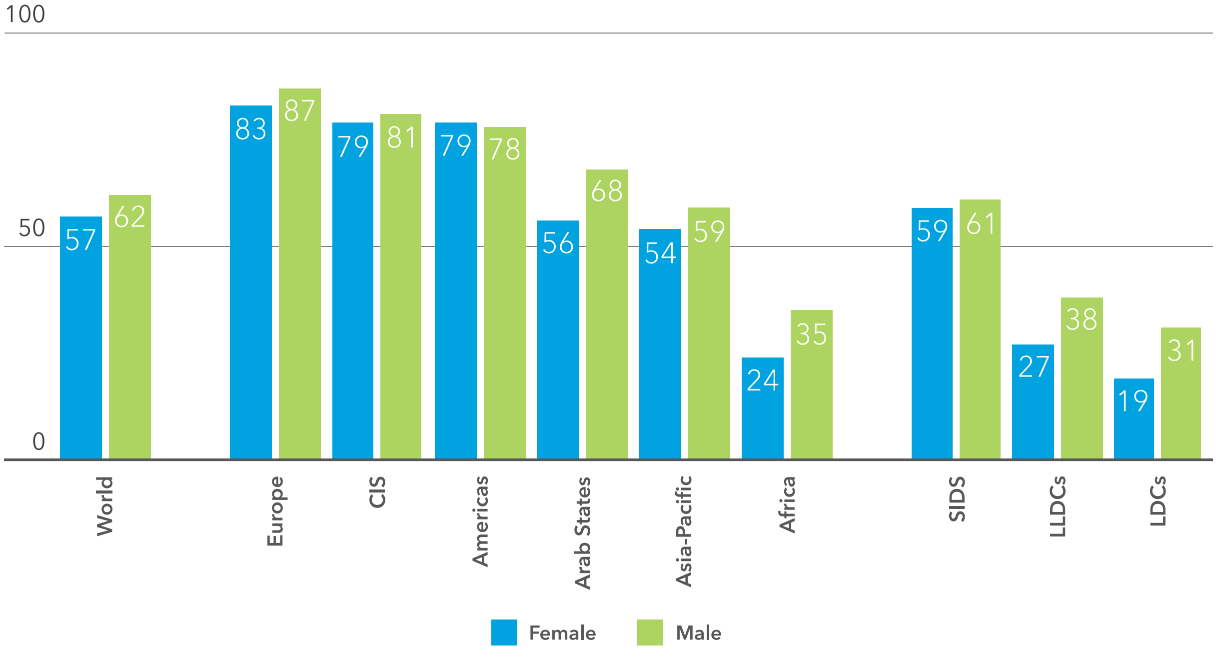
The gender gap is significantly smaller in countries where a higher proportion of the population uses the Internet, and a higher gender gap exists in countries with low Internet use. In countries where everyone is using the Internet, by definition there must be gender parity.

The gender parity ratio (GPR) is calculated as the proportion of women using the Internet divided by the proportion of men using the Internet. A value smaller than 1 indicates a larger proportion among men than among women. A value greater than 1 indicates the opposite. Values between 0.98 and 1.02 reflect gender parity as established in the 2030 targets.

Lower GPR values are most pronounced in LDCs and LLDCs, illustrating that low levels of Internet use are strongly correlated with low income levels. In the map in Figure 2.9, countries shaded in red have the largest gender gap and are mostly low-income countries. However, in line with increasing

Figure 2.8: The gender digital divide

Percentage of men and women using the Internet, 2020



Note: CIS = Commonwealth of Independent States.
Source: ITU.

Internet use rates, the number of low GPR values has been shrinking in recent years.

The age divide

In all regions, young people (between 15 and 24 years old) are more active on the Internet than other age groups. Figure 2.10 shows the huge divide when comparing the Internet uptake of people of 75 years old and above, and of those between 15 and 24. Greater uptake among the young bodes well for future connectivity, particularly in countries with a young demographic profile. In LDCs for example, where half the population is less than 20 years old, the workforce will become more connected and digitally skilled as this young generation joins its ranks. This in turn will improve the development prospects of these countries. See Chapter 9 for more on connectivity and the digital lives of children and youth.

The education divide

Education is another important determinant of Internet use. For those countries for which data were available, 94 per cent of people with a completed tertiary education were using the Internet, about 9 percentage points higher than those with completed upper secondary or post-secondary non-tertiary education. In contrast, those with a primary or lower secondary education are much less likely to use the Internet than those who have reached a higher level of education.

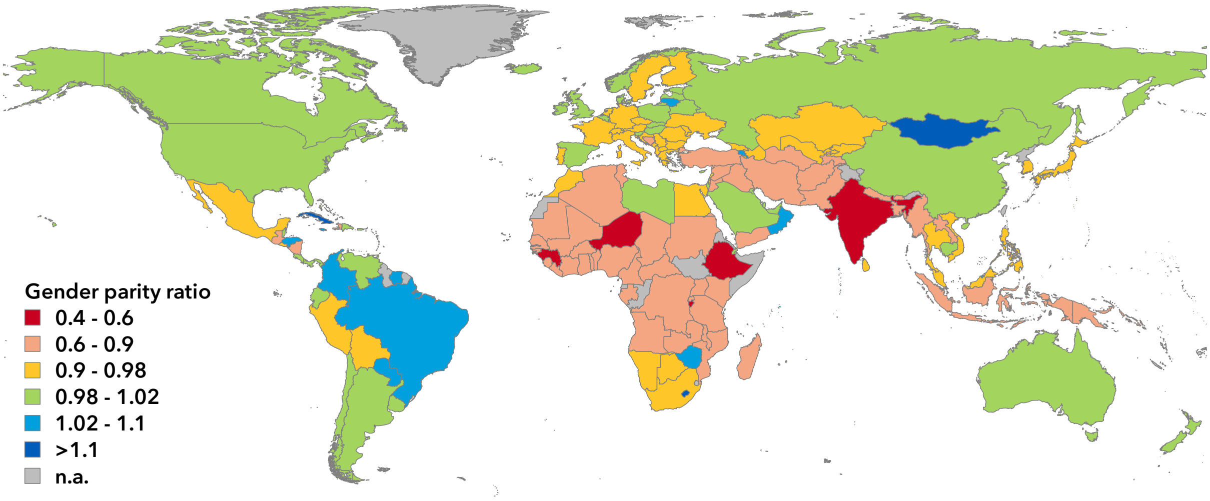
2.4 Barriers to connectivity

Understanding why people and households do not use the Internet is critical for designing effective, targeted interventions. In this context, household ICT surveys provide invaluable insight. Figure 2.11 plots the importance of each of the nine main reasons preventing household Internet access. Since the pertinence of some of the reasons depends on the level of Internet access in countries, the results are plotted against the share of households without Internet access.

The most cited barriers in the 49 countries providing data included: *Do not need the Internet*; *Cost of the equipment is too high*; or *Cost of the service is too high*. Thirty-three countries cited *Do not need the Internet* as the main reason as did more than 50 per cent of

Figure 2.9: The Internet use gender gap

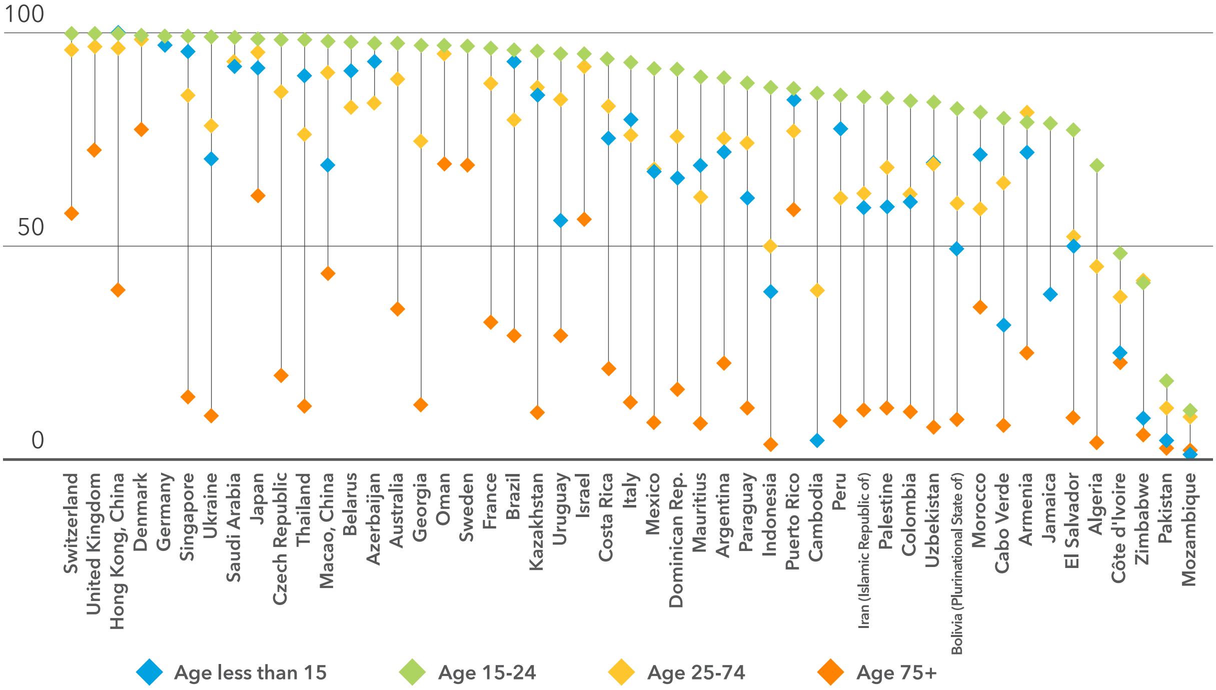
Gender parity ratio (1 = parity), latest year available[13]



Notes: The gender parity ratio is calculated as the proportion of women who used the Internet divided by the proportion of men who used the Internet. A value smaller than 1 indicates a larger proportion among men than among women. A value greater than 1 indicates the opposite. Values between 0.98 and 1.02 reflect gender parity. The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of ITU and of the secretariat of ITU concerning the legal status of the country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. The base map is the UNmap database of the United Nations Cartographic Section.
Source: ITU.

Figure 2.10: The age divide

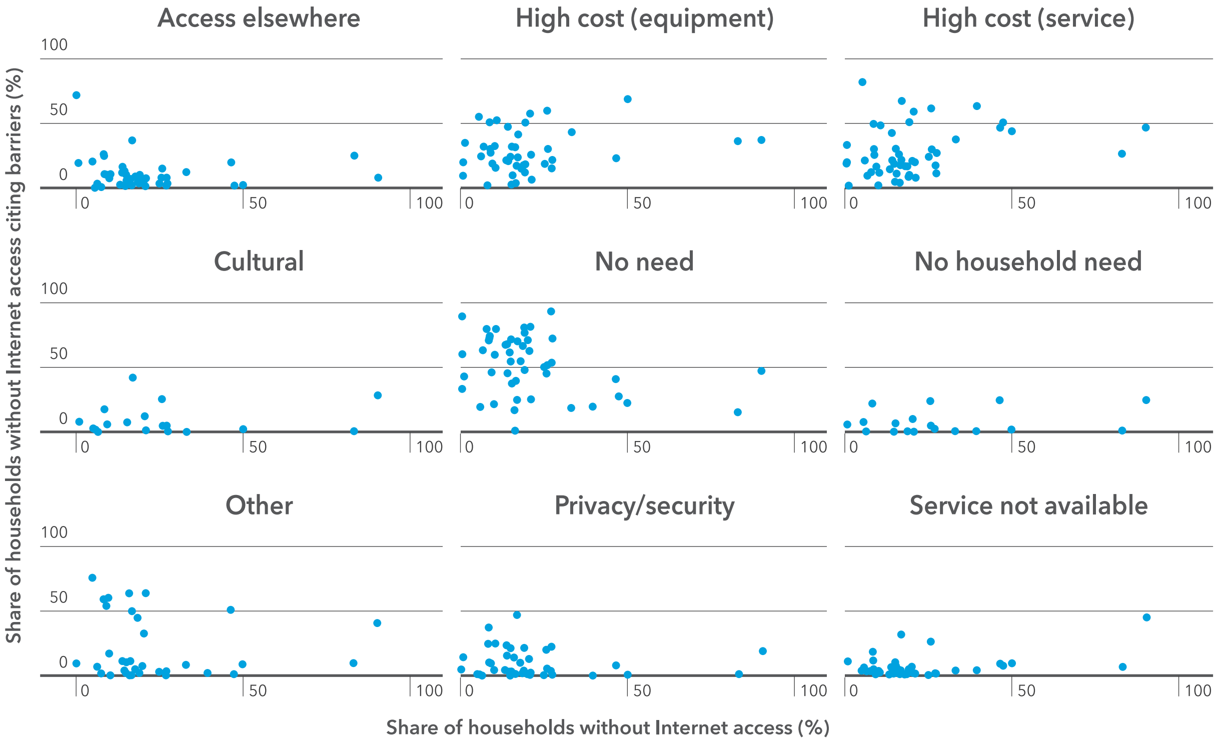
Percentage of individuals using the Internet, by age, latest year available



Source: ITU.

Figure 2.11: Connectivity barriers

Share of households without Internet access citing various barriers (vertical axis) versus share of households without Internet access (horizontal axis), by barrier, latest year available



Note: Full description of household barriers (indicator HH14) available in the Manual for Measuring ICT Access and Use by Households and Individuals (ITU 2020a). Includes countries with data for 2018 or more recent data.
Source: ITU.

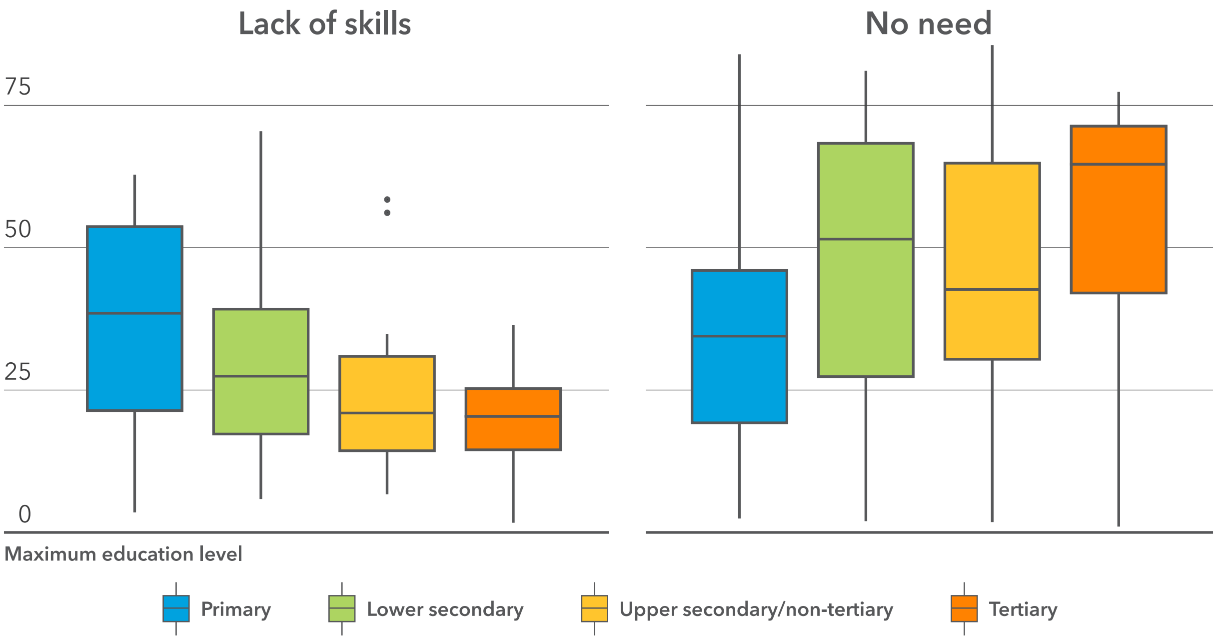
respondents in 27 countries. More than 80 per cent cited this reason in the Czech Republic, Egypt, Republic of Korea, and Ukraine. Fifty per cent of respondents in seven countries cited both the high cost of equipment and the high cost of service. Not exempt from such concerns, 55 per cent of high-income countries also cited the high cost of equipment and services as well as 82 per cent of households without Internet access in those countries. Several countries such as Brazil and the United Arab Emirates featured a large share of respondents who cited having access elsewhere as a reason for not having access at home. Privacy and security concerns as well as cultural reasons also play a part in countries such as Brazil and Switzerland.

Figure 2.11 also reveals there is no strong relationship between the level of household Internet access and the barriers cited by those without Internet access. This may highlight similarities between households in countries with high levels of Internet access and those in countries with low levels of access. As noted above, lack of Internet access is associated typically with rural areas and lower levels of education. It is therefore logical that similar conditions are to be found both in the few households without Internet access in countries with high overall Internet access, and the many households without Internet access in countries with low overall access.

Despite less available data, similar conclusions can be drawn about barriers faced by individuals who do not use the Internet. In the 28 countries reporting data since 2018, *Do not need the Internet* was most cited as a barrier in 15 countries, and it was cited as a reason by more than half of the responders in 14 of those countries. Examining barriers at the level of the individual provides insight into barriers that cannot be identified at the household level. For example, *Do not know how to use it* points to a lack of digital literacy, and was cited most frequently in nine countries and by over half of non-users in ten countries. In some countries, lack of relevance, lack of knowledge of what the Internet is, as well as high cost, were also reported by many. Privacy and security reasons were less often cited, suggesting that although they represent growing concerns, they currently

Figure 2.12: Level of education and reasons for not using the Internet

Share of individuals not using the Internet citing various barriers, by maximum education level attained, latest year data available



Notes: Full description of individual barriers (indicator HH19) available in the Manual for Measuring ICT Access and Use by Households and Individuals (ITU 2020a). Includes countries providing data in 2018 or later. *Primary* refers to ISCED 0-1, *Lower secondary* to ISCED 2, *Upper secondary/non-tertiary* to ISCED 3-4, *Tertiary* to ISCED 5+. The bars indicate the 25th, median and 75th percentile of all country values. The bottom and top lines indicate the minimum and maximum values (excluding outliers). Outliers are marked with a dot.
Source: ITU.

do not represent a major deterrent to Internet use.

As with household access, there is no clear relationship between the share of individuals using the Internet in countries and the share of individuals not using the Internet citing different barriers. Again, this points to similarities in individuals not using the Internet across countries regardless of countries' overall rates of Internet use among individuals.

Conversely, differences in barriers cited by individuals with varying levels of educational attainment within countries are evident (see Figure 2.12). Individuals with a primary or lower secondary education tend to cite lack of skills more frequently. Conversely, those not using the Internet with high education levels tend to cite *No need* more frequently, though there is a wide variation between countries and this tendency is less pronounced.

These findings are consistent with the results of a survey of 22 low- and middle-income countries (Chen 2021). The study found that for those who did not use the Internet at all, the most cited reasons were related to digital literacy, including *do not know what Internet is* (59 per cent) and *do not know how to use the Internet* (10 per cent). *No access to a device* (computer or mobile phone) was another barrier (11.5 per cent). Other factors such as lack of local language content or data privacy concerns did not appear to be key obstacles.

2.5 Enablers of connectivity

To achieve universal usage, all barriers to connectivity need to be overcome. Figure 2.1 shows that barriers can be transformed into connectivity enablers. For example, replacing a slow and expensive connection with a fast and affordable one will enable people to go online as often and for as long as they wish, and teaching the necessary ICT skills will enable meaningful use of the Internet as a satisfying, enriching, and productive experience.

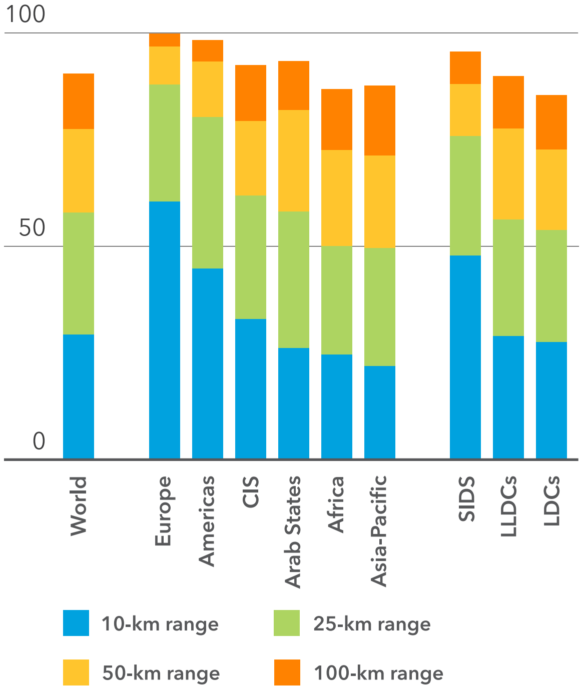
Infrastructure

The network is a precondition for Internet use. For decades, Internet access has been available over the fixed line telephone network. Originally using a modem to access the Internet, which incidentally would block the telephone line from making or receiving calls, people today use technology and network infrastructure that have improved the experience immeasurably, enabling high-speed fixed and mobile broadband networks that deliver always-on Internet access in most countries.

Although more people use mobile networks than fixed networks to connect to the Internet, the latter remains important. For example, fixed-broadband networks generally have a higher data capacity than mobile networks, and download limits are higher than similarly priced mobile-broadband plans. They are faster and are more reliable than 3G or 4G networks, making them more suited for high-bandwidth activities such as games and video calls. However, fixed-broadband networks are very expensive to roll out, maintain and upgrade, depending on the geography and extension of the territory to be covered.

Figure 2.13: Fixed-network coverage

Percentage of population within reach of operational fibre-optic transmission network, 2021



Note: CIS = Commonwealth of Independent States.
Source: ITU.

The topology of many fixed-broadband networks consists of fibre-optic rings with access points from which homes and businesses are connected.[14] In this case, for network deployment to be efficient and profitable, there needs to be a high geographic concentration of households and businesses.

However, Figure 2.13 shows that the vast majority of people do not have access to fibre-optic networks because of their location, in fact only 2.3 billion people (29 per cent) lived within 10 kilometres of a fibre-optic network in 2021.[15] It is worth noting too that living within 10 kilometres of a fibre-optic network is no guarantee of a connection for many reasons, not least being the absence of a point of presence (PoP), optical-line terminal or fibre-optic drop to connect the network to the home or office (ITU 2020b).

In Europe, more than 60 per cent of the population lives within 10 kilometres of a fibre-optic network, while the reach of fibre-optic networks in the Asia-Pacific region is only 22 per cent, Africa is 25 per cent, and the Arab States is 26 per cent.

See also Chapter 4, which explores the importance of middle-mile connectivity.

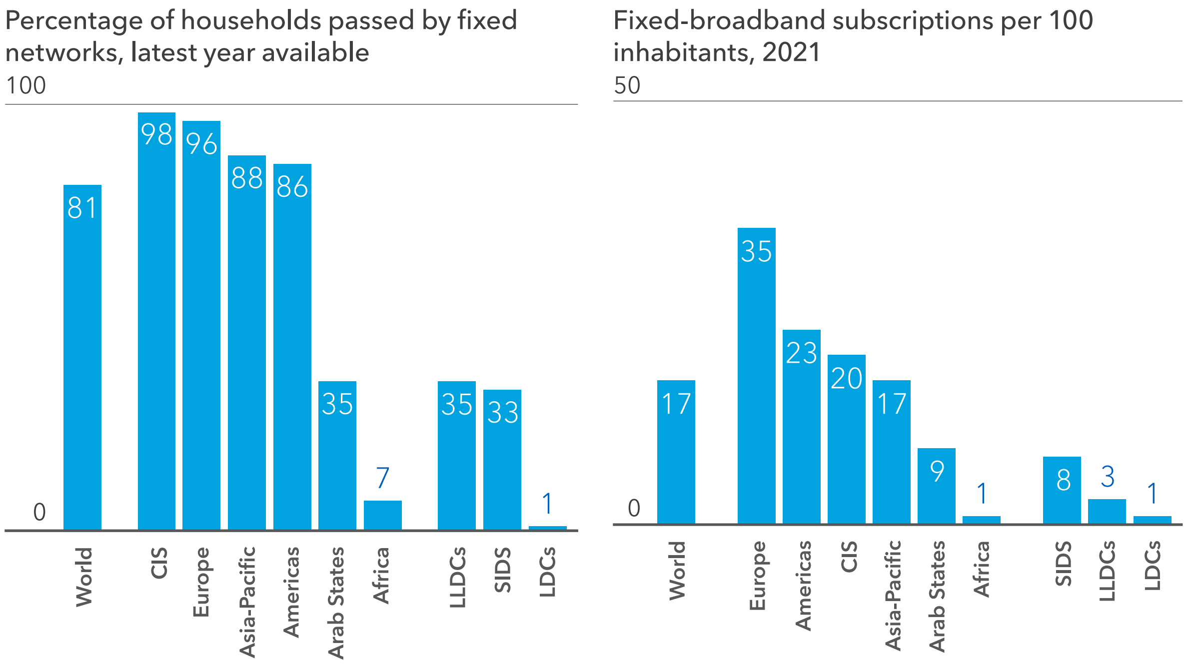
For a household to access a fixed network, a "last mile" connection is needed to bring that network to the home. For the past few years, ITU has collected data on the number of households covered by a fixed network. Figure 2.14 (left-side panel) shows that in Africa only 7 per cent of households can potentially subscribe to a fixed network (for LDCs this figure is just over 1 per cent), whereas in other parts of the world almost all households have access to a fixed network.

No access to a fixed network obviously impacts the number of fixed-broadband subscriptions (Figure 2.14, right-side panel). In Africa and in LDCs and LLDCs, few subscribe to fixed broadband services. In the Arab States, where only 40 per cent of homes are served by fixed-network services, only 9 out of every 100 inhabitants subscribe to fixed broadband. The highest proportion of fixed-broadband subscriptions is found in Europe, where 35 out of every 100 inhabitants subscribe to fixed broadband, and since fixed broadband is usually shared with all family members, this means that most households have a fixed-broadband connection.

The breakdown by speed provides an indication about the quality of the subscription, although it might also reflect cost. The framework for universal and meaningful connectivity sets a target of at least 10 Mbit/s for all fixed-broadband subscriptions by 2030. In Asia-Pacific and Europe, this target has almost been met, with respectively

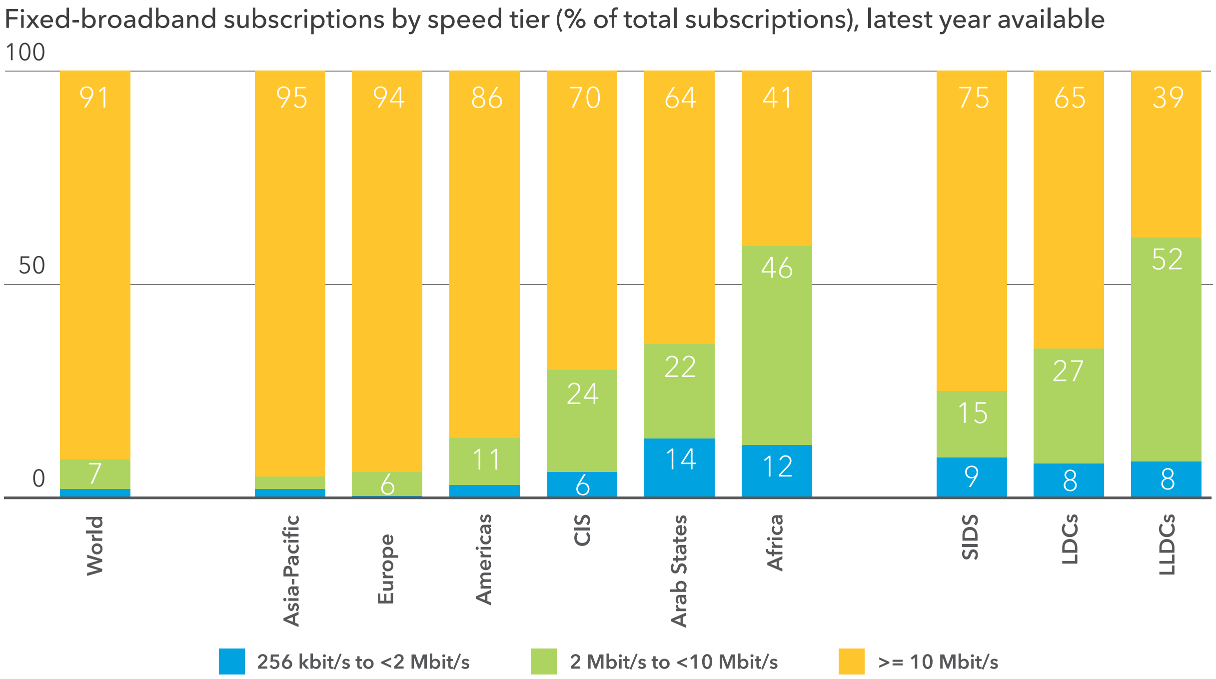
95 and 94 per cent of fixed-broadband subscriptions reaching 10 Mbit/s or faster. In LLDCs, only 39 per cent of subscriptions were high speed, and although in LDCs the situation was better, this was mainly because 70 per cent of fixed-broadband subscriptions were high speed connections in Bangladesh, which has a very high weight in the group aggregate (Figure 2.15).

Figure 2.14: Fixed-broadband coverage



Note: CIS = Commonwealth of Independent States.
Source: ITU.

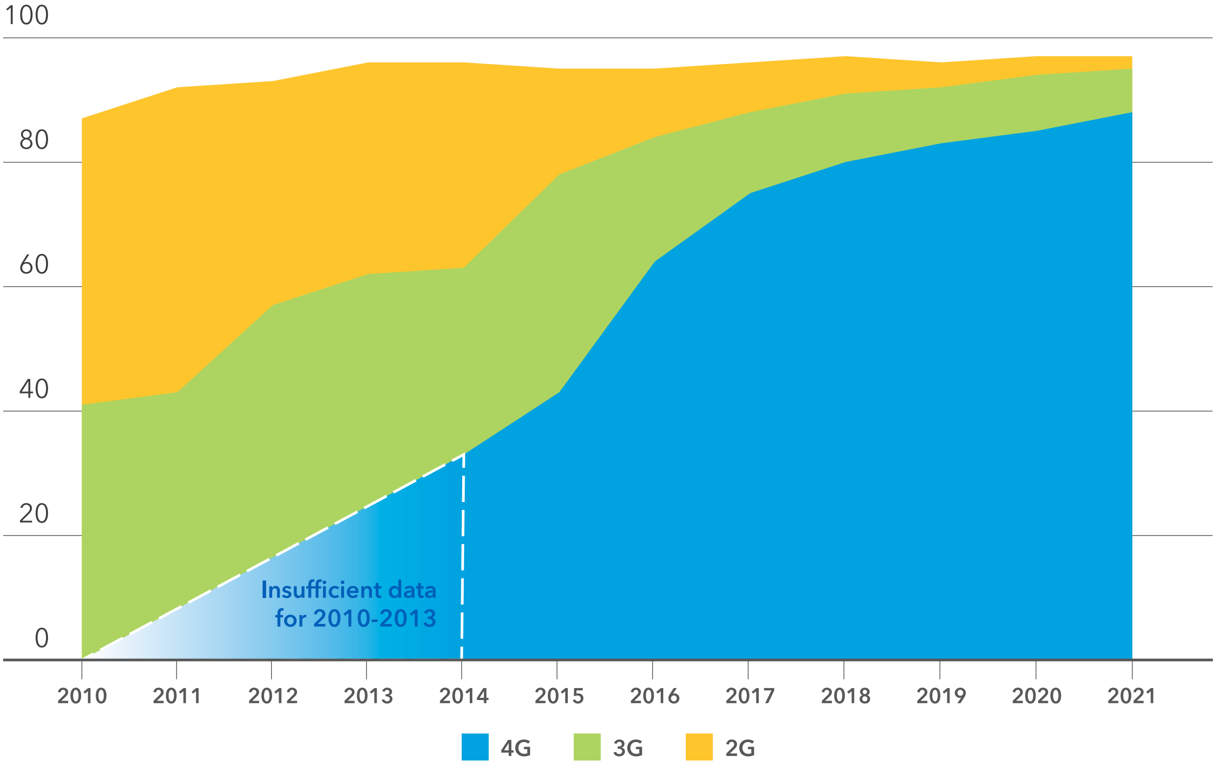
Figure 2.15: Fixed broadband speed



Notes: Values equal to or less than 3 are not labelled due to space considerations. CIS = Commonwealth of Independent States.
Source: ITU.

Figure 2.16: Mobile network coverage

Percentage of the population covered by a mobile network, by generation of mobile network



Notes: The values for 2G and 3G networks show the incremental percentage of population that is not covered by a more advanced technology network (e.g. 95 per cent of the world population is covered by a 3G network in 2021, that is 7 per cent + 88 per cent). There are insufficient data from 2009 to 2013 to show the evolution of 4G coverage from when the technology was introduced commercially in 2009.
Source: ITU.

Mobile broadband networks are not just a supplement to fixed networks but are the main gateway to the Internet for many users, given the availability and cost issues associated with fixed-broadband networks. Except for optical fibre, 4G can offer average download and upload speeds equivalent to fixed-broadband connections.

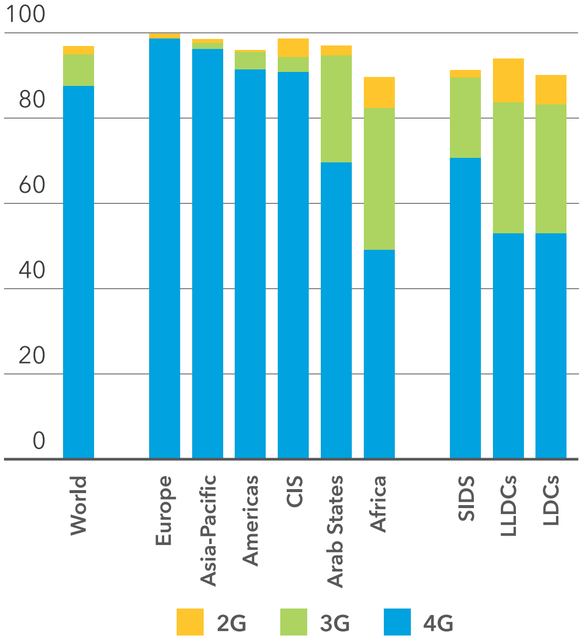
Another framework target for universal and meaningful connectivity aims to extend coverage of the mobile-broadband network to the world's population.[16] Globally, 95 per cent of the population is within reach of a mobile broadband network (at least 3G) and 88 per cent has access to a 4G network (Figure 2.16). The flattening curve in the evolution of 3G coverage underlines the challenge of connecting the rest of the population: 3G coverage doubled from 40 to 80 per cent between 2010 and 2015 but has increased only by 15 percentage points since, and has barely changed in the past three years. Even coverage by 2G technology, which is being phased out, never exceeded 97 per cent of the world's population.

Similar to SDG Target 9.c, which aimed to significantly increase access to ICTs and provide universal and affordable access to the Internet in least developed countries by 2020, the target set out in the framework for universal and meaningful connectivity intends to extend coverage to the entire world population by a mobile network of the latest technology (currently 4G) by 2030.

Although the SDG indicator does not specify a technology, Asia-Pacific and Europe have already met the target of universal 4G coverage, and the Americas and CIS regions are close to meeting it. However, Africa (49 per cent) and the Arab States region (70 per cent) are struggling to reach universal coverage for 4G (Figure 2.17).

Figure 2.17: Regional mobile network coverage

Percentage of the population covered by a mobile-cellular network, 2021



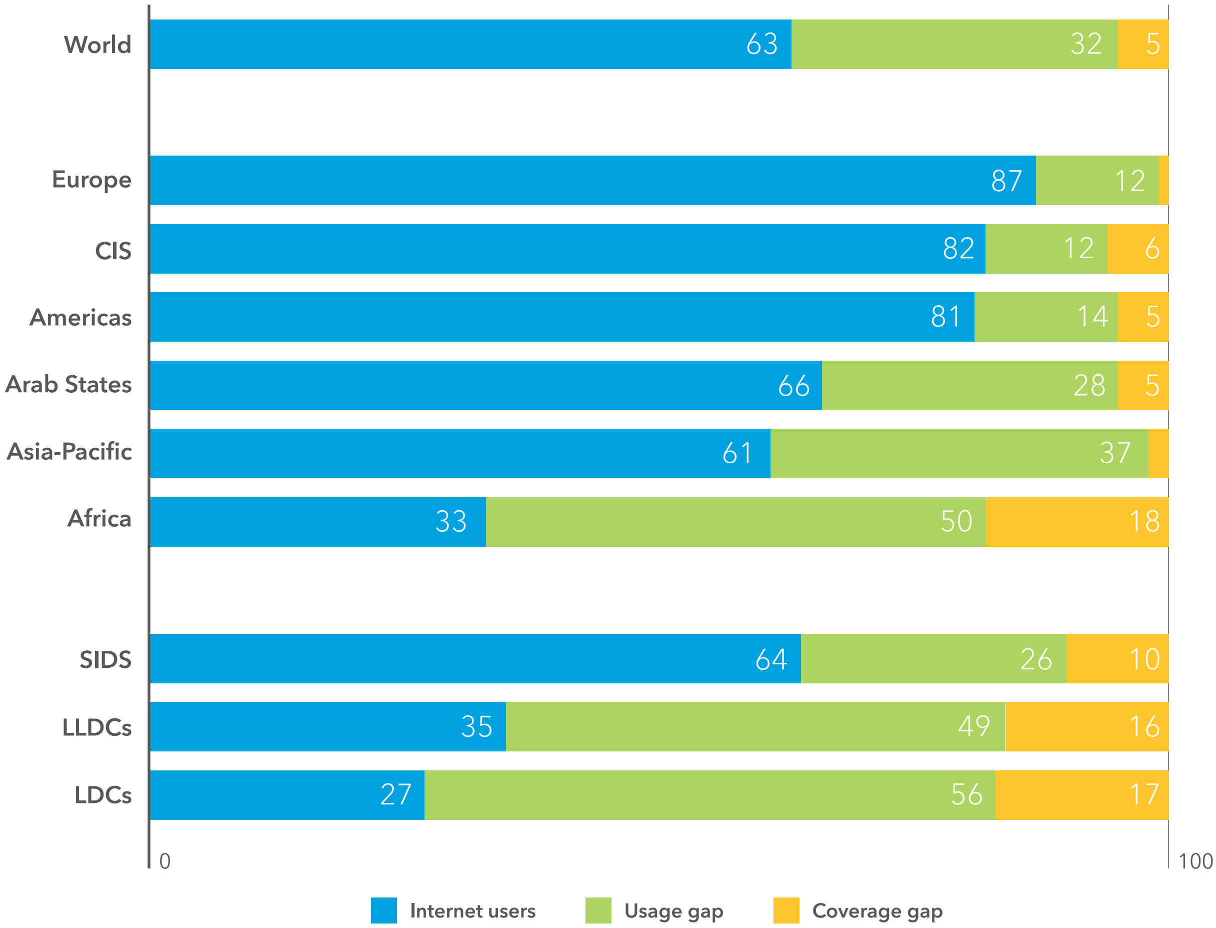
Notes: The values for 2G and 3G networks show the incremental percentage of population that is not covered by a more advanced technology network (e.g. 95 per cent of the world population is covered by a 3G network in 2021, that is 7 per cent + 88 per cent). CIS = Commonwealth of Independent States.
Source: ITU.

Combining data on coverage and Internet usage makes it possible to distinguish between those who are not using the Internet because of a lack of infrastructure,[17] and those not using the Internet for other reasons (see Chapter 1 and section 2.4 on barriers). Figure 2.18 highlights the persistent and significant coverage gap and significantly wider usage gap in some regions. The coverage gap refers to the lack of access to a mobile or fixed network, and the usage gap refers to the number of people not using the Internet minus those without access to a network (coverage gap). For example, in Asia and the Pacific, the coverage gap affects only 2 per cent of the population, whereas the usage gap concerns 37 per cent. This is consistent with the findings that affordability and skills are bigger barriers to connectivity than the lack of Internet availability.

While most urban areas in the world are covered by a mobile-broadband network, gaps persist in rural areas (Figure 2.19). In Africa, almost 30 per cent of the rural population cannot access the Internet, 18 per cent of the rural population has no mobile-network coverage, and another 11 per cent has only access to a 2G network. The coverage gap is almost as significant in the Americas, where 22 per cent of the rural population is not covered at all and another 4 per cent is covered only by a 2G network. This disaggregation underlines how much usage and coverage gaps vary depending on location. This has important implications for policy prioritization. For example, in rural areas of the CIS region, the usage gap is negligible, almost everyone uses the Internet. In rural Africa, only 15 per cent of the population uses the Internet and the coverage and usage gaps are almost the same size, whereas in Africa's urban areas, mobile-broadband coverage is almost universal and only a usage gap exists.

Figure 2.18: Coverage gap and usage gap

Percentage of the population using the Internet, not using the Internet and not covered by a network, 2021

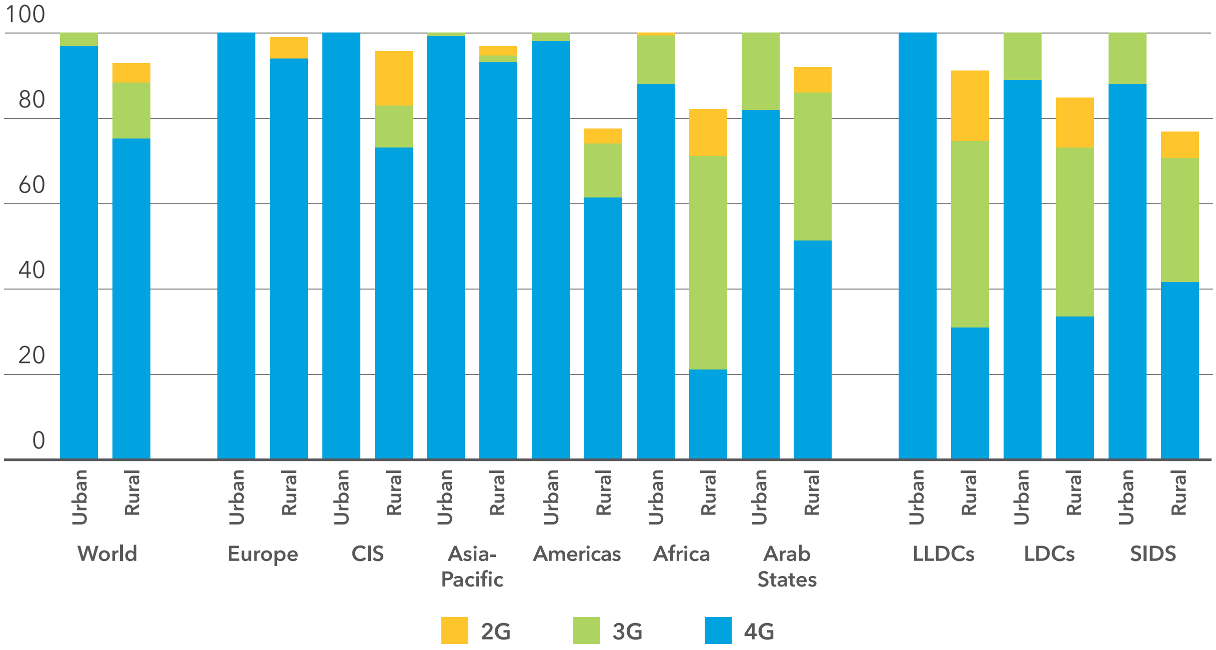


Notes: The coverage gap is the percentage of the population that does not have access to a mobile or fixed network. The usage gap is the percentage of the population not using the Internet *minus* the coverage gap. Values equal to or less than 3 are not labelled due to space considerations. CIS = Commonwealth of Independent States.
Source: ITU.

Despite the lack of access to a mobile-cellular network in some parts, the world has witnessed tremendous growth in the use of the mobile phone. In 1994, there were 56 million mobile-cellular subscriptions worldwide, less than one for every 100 inhabitants. In 2021, there were more mobile-cellular subscriptions than people on the planet (Figure 2.20, left-side panel). Mobile-broadband subscriptions have grown from 4 per 100 inhabitants in 2007 to 83 per 100 inhabitants in only 14 years (Figure 2.20, right-side panel).

Figure 2.19: The urban-rural digital access divide

Percentage of the population covered by a mobile-cellular network, by location, 2021

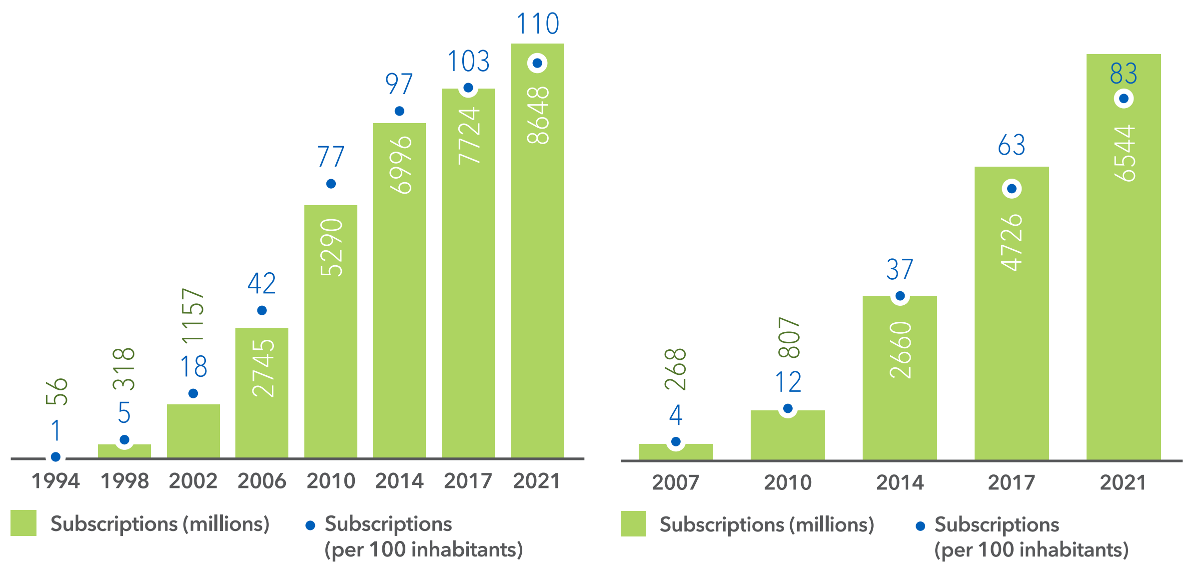


Note: CIS = Commonwealth of Independent States.
Source: ITU.

Figure 2.20: The rise of mobile telephony and mobile broadband

Mobile-cellular subscriptions at times of WTDC

Active mobile-broadband subscriptions at times of the WTDC

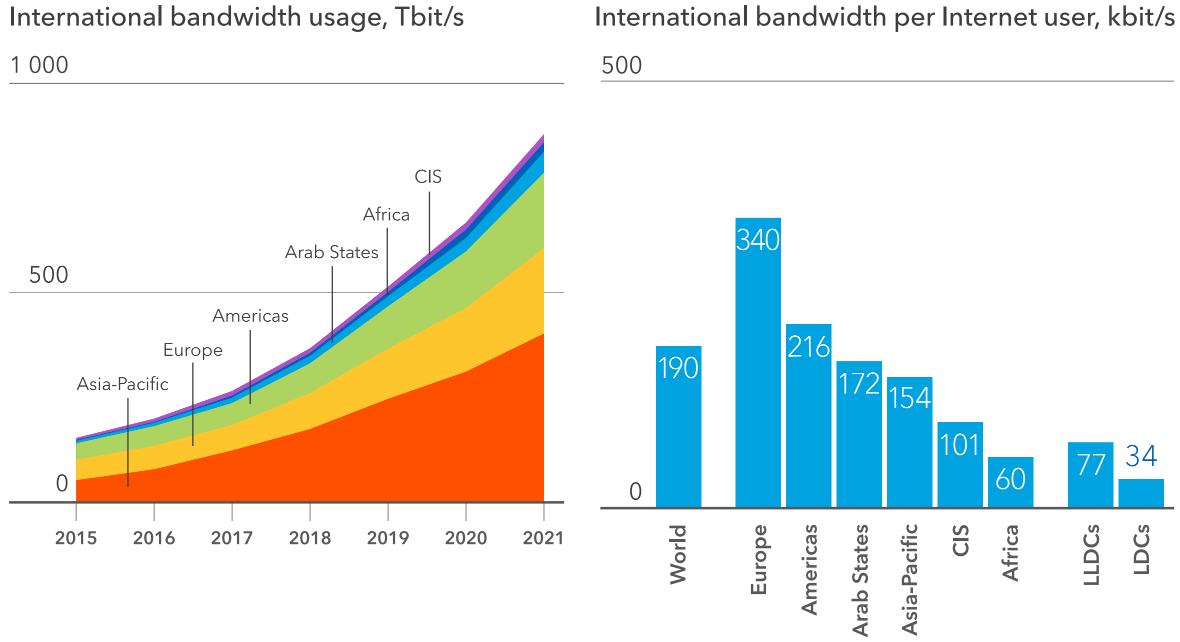


Source: ITU.

The rise in Internet use has been accompanied by an explosion in data usage, but this has been unevenly distributed (Figure 2.21, left-side panel). For example, international bandwidth usage saw a 30 per cent increase from 719 Tbit/s in 2020 to 932 Tbit/s in 2021. The highest regional total for international bandwidth use was in the Asia-Pacific region at over 400 Tbit/s, twice as high as in Europe (204 Tbit/s) and in the Americas (180 Tbit/s).

However, it is on a per-user basis that the digital divide becomes apparent (Figure 2.21, right-side panel). In Europe, bandwidth usage stood at 340 kbit/s per Internet user, followed by the Americas at 214 kbit/s and the Arab States region at 174 kbit/s. In Africa, on the other hand, international bandwidth usage was 60 kbit/s. In the LDCs, it was just 34 kbit/s per Internet user.

Figure 2.21: Growth in international bandwidth



Note: CIS = Commonwealth of Independent States.
Source: ITU.

Box 2.1: The global speed divide

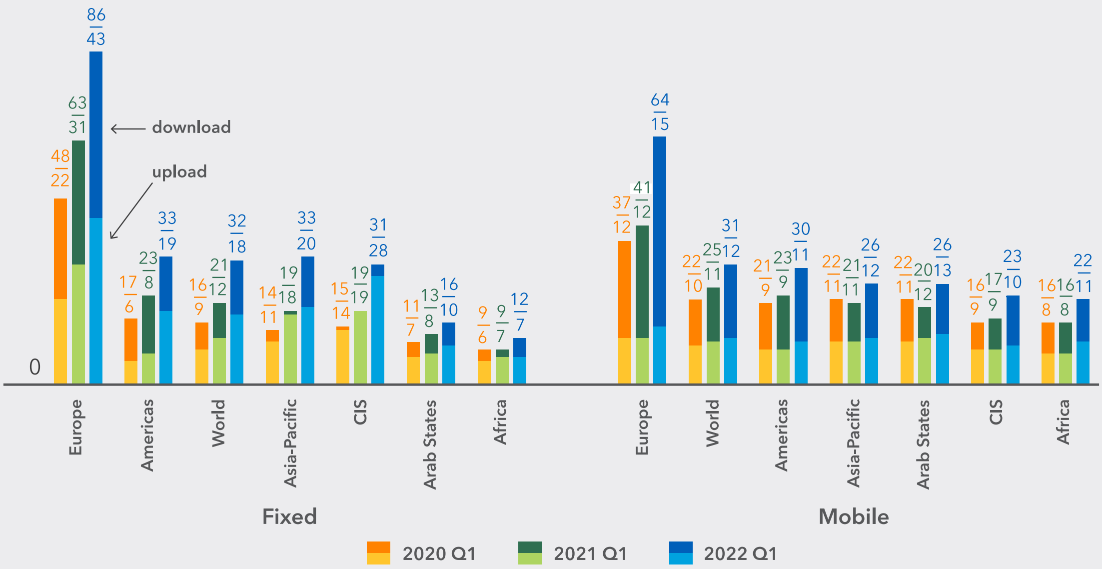
Users generally judge their broadband quality on their experience of connection speeds. Figure 2.22 illustrates user-generated speed test data collected by Ookla. It reveals that speed is another dimension of the digital divide, which is reflected by the median download and upload speeds across regions.

The three time points (2020, 2021, and 2022) in the chart refer to the emergency, recovery, and 'new normal' phases of the Covid-19 pandemic (see Chapter 8) and reflect, through the median upload and download speeds, differences in connection quality experienced by consumers as well as revealing how the gaps have evolved across regions over that time. The widest connection quality gap is between Europe (and high-income economies in general) and the rest of the world in both fixed and mobile networks. Interestingly, there is a divide between countries depending on which network provides faster speeds. In low- and lower-middle-income economies, mobile broadband offers the faster alternative (this is the case across African countries), while in high-income economies, fixed-broadband speeds are 30-50 per cent faster. Two years after the start of the pandemic, as networks adapted capacity, speeds measured on fixed networks overtook those on mobile – this global trend has been driven by the Americas, the CIS, and the Asia-Pacific regions.

While mobile networks provide a comparable alternative to fixed networks in most parts of the world concerning download speeds, there is a clear gap between the upload speeds provided by the two technologies. Mobile upload speeds measured in the different regions are surprisingly similar, remaining around the global median of 10-12 Mbit/s (highest in Europe at 15 Mbit/s in 2022, lowest in Africa at 8 Mbit/s in 2020). Users on fixed networks, on the other hand, could benefit from 2-3 times faster upload speeds than those in the same region using mobile networks. This difference is particularly important when it comes to using cloud computing or video conferencing services.

Figure 2.22: Upload and download speeds in the pandemic period

Median upload and download speeds, Mbit/s



Notes: The data are collected via the Speedtest by Ookla applications for Android and iOS. "Mobile" refers to tests taken from mobile devices and a cellular connection type, e.g. 3G, 4G LTE, 5G NR. "Fixed" refers to tests taken from mobile devices and a non-cellular connection type, e.g. WiFi, ethernet. The data in the figure reflect the median value of the countries' average speeds within each region. CIS = Commonwealth of Independent States.
Source: Authors' calculations based on Ookla Speedtest data. Speedtest by Ookla Global Fixed and Mobile Network Performance Maps was accessed on 20 April 2022 from https://registry.opendata.aws/speedtest-global-performance.

Affordability

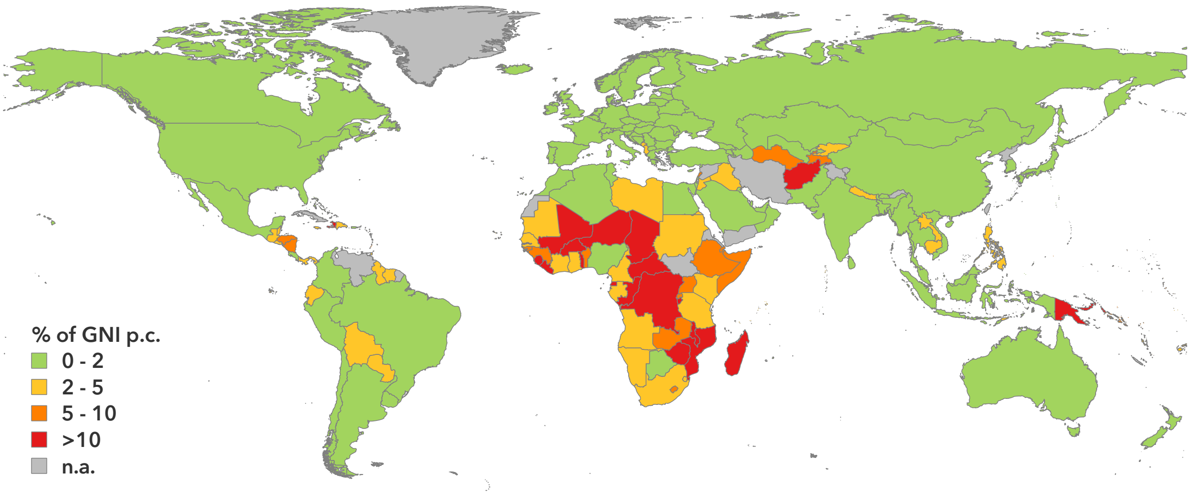
Figure 2.11 highlights the importance of affordability of devices and services. Where income levels are low, price becomes more important, a factor not only relevant in countries in general but one that also applies to individuals within countries. That is why the framework for universal and meaningful connectivity has adopted the Broadband Commission for Sustainable Development target to bring prices for entry-level broadband services below 2 per cent of monthly gross national income per capita (GNI p.c.) and why the framework has an additional target that this target applies to the bottom 40 per cent of earners in a country too.

After years of steady decline, the share of income spent on telecommunication and Internet services increased across the world in 2021, mainly as a result of the global economic downturn triggered by the COVID-19 pandemic (ITU and A4AI 2022). In many economies, the long-standing trend of gradually declining prices for such services was outweighed by a steep drop in average GNI levels in 2020.

In 2021, only 96 economies met the 2 per cent target with regard to the data-only mobile broadband basket in 2021 (seven fewer than in the previous year), and only 64 economies met the target with respect to the fixed broadband basket (two fewer than in the previous year). Figures 2.23 and 2.24 show that the countries where the prices are highest are also the countries where the incomes are lowest and Internet use is low as well.

Figure 2.23: Affordability of mobile broadband

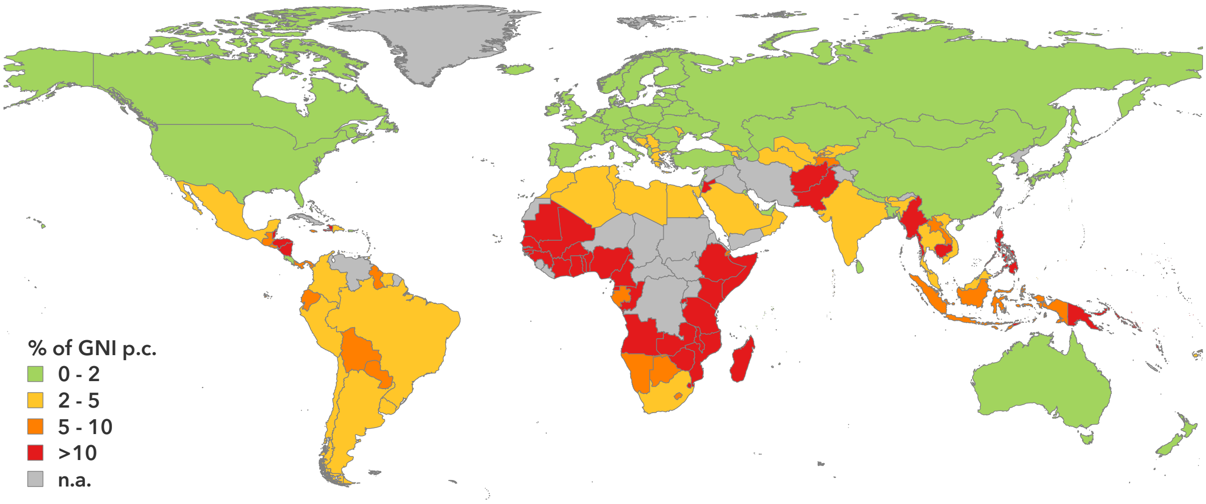
Entry-level data-only mobile-broadband basket prices (% of GNI p.c.), 2021



Notes: Refer to the methodology document, available at: https://www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2021/ITU_ICT_Prices_Methodology.pdf, for a description of the basket.
The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of ITU and of the secretariat of ITU concerning the legal status of the country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. The base map is the UNmap database of the United Nations Cartographic Section.
Sources: ITU and A4AI for price data, World Bank World Development Indicators for GNI per capita data (retrieved November 2021).

Figure 2.24: Affordability of fixed broadband

Fixed-broadband basket prices (% of GNI p.c.), 2021



Notes: Refer to the methodology document, available at https://www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2021/ITU_ICT_Prices_Methodology.pdf, for a description of the basket.
The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of ITU and of the secretariat of ITU concerning the legal status of the country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. The base map is the UNmap database of the United Nations Cartographic Section.
Sources: ITU and A4AI for price data, World Bank World Development Indicators for GNI per capita data (retrieved November 2021).

Furthermore, only 50 out of 110 countries for which these data are available met the 2 per cent target for the bottom 40 per cent in 2021. Due to its high costs, fixed broadband is out of reach for the bottom 40 per cent in most regions, except Europe. Mobile broadband is more affordable, but there are many countries where even if the basket is affordable for the average earner, the bottom 40 per cent would need to pay more than 2 per cent of GNI per capita, and in 22 out of the 110 countries with data available, they would face costs over 10 per cent of GNI per capita.

Chapter 5 on affordability of ICT services offers an in-depth assessment of the price of ICT services and devices, and sets out policy options for improving affordability.

Devices

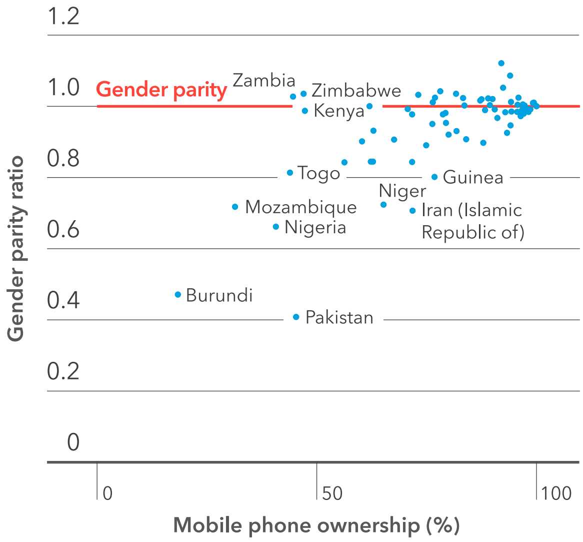
Until the early 2010s, computers were the Internet device of choice. Now however, mobile devices (smartphones and tablets) are a viable alternative, although not a perfect substitute.[18] Indeed, while the share of households with Internet access has been exhibiting a steady growth over the past 15 years, the growth of households with a computer has slowed since the early 2010s as mobile devices became more popular.

The framework for universal and meaningful connectivity recognizes how inexpensive most basic mobile phones are while also taking into account that computers allow for a richer experience. The framework examines the use and ownership of mobile phones, while recognizing that mere access to a device (as opposed to ownership) imposes constraints – including when and for how long the user can be online. The framework sets a target only for mobile phone ownership, which allows someone to go online at any time, rather than first having to ensure a mobile phone is available.

The high cost of mobile telephones in low-income countries is reflected in the low share of individuals owning a mobile telephone. Despite the fact that in many countries mobile phone ownership is very high, there remains a significant number of countries where only some can afford a mobile phone. In eight of 78 countries for which there are data, less than 50 per cent of the population owned a mobile phone, far short of the target of universal ownership. A mobile phone is often the only means of Internet access – so there is a strong correlation between Internet use and mobile phone ownership. According to A4AI data,[19] the average cost of a smartphone in these countries was 41 per cent of monthly GNI per capita. In 22 countries, universal ownership (i.e. over 95 per cent) was achieved, while in an additional 11 countries this percentage stood between 90 and 95 per cent. The average cost of a smartphone in these countries were 8.8 resp. 14.5 per cent of GNI per capita.

Reaching gender parity is also a target for all individual-based indicators. When universal ownership is reached, gender parity is reached. But for many countries, universality remains a distant prospect and the gender divide for ownership persists. Indeed, as Figure 2.25 shows, the further away ownership is from universality, the lower the gender parity score. In 30 countries out of 72 for which data is available, gender parity has been reached. In 13 countries, more women than men own a mobile phone,[20] while in 29 countries the opposite is the case.

Figure 2.25: Mobile phone ownership and the gender gap



Notes: The gender parity ratio is calculated as the proportion of women who own a mobile phone divided by the proportion of men who own a mobile phone. A value smaller than 1 indicates a larger proportion among men than among women. A value greater than 1 indicates the opposite. Values between 0.98 and 1.02 reflect gender parity.
Source: ITU.

Digital skills

Section 2.4 revealed the barriers to using the Internet for individuals (see Figure 2.11) such as the high costs of equipment and services, lack of need of the Internet, and not knowing how to use it. These results confirm the importance of ICT skills as an enabler of meaningful connectivity. In the framework for universal and meaningful connectivity, there are two skills-related targets: by 2030, at least 70 per cent of individuals should have basic ICT skills, and at least 50 per cent should have intermediate ICT skills.

It is difficult to measure the general level of ICT skills in a country. The best way is through assessment tests, such as the International Computer and Information Literacy Study (ICILS).[21] These assessments are expensive to run however and are therefore administered in few countries and only periodically.

Surveys offer an alternative. One approach is to ask people to assess their proficiency for certain skills, although studies show that self-assessment is a poor measure. A study by the ECDL Foundation (2019) for example, "revealed that people tend to overestimate their abilities and that significant digital skills gaps exist in all of the analysed countries. Moreover, young people have digital skills gaps that are just as wide as in the rest of society".

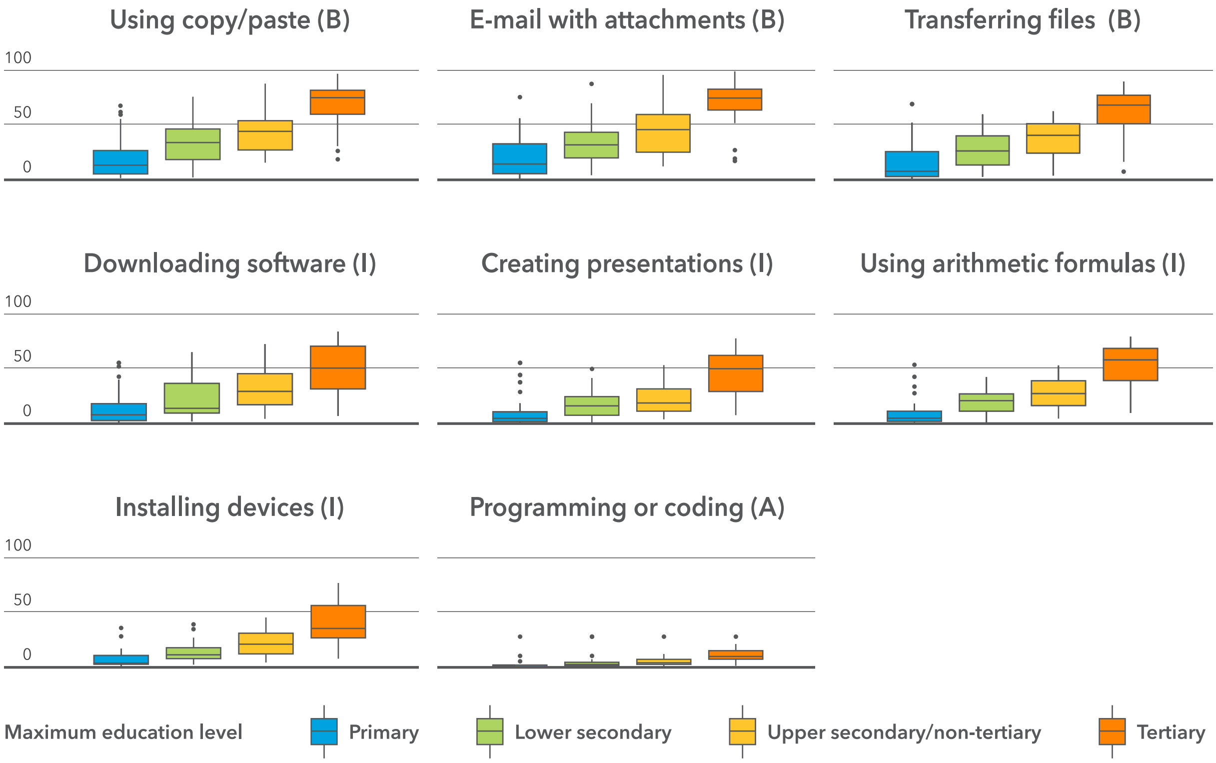
The approach adopted by Eurostat and ITU is to ask survey respondents whether they have undertaken certain tasks or activities using digital devices. The activities are categorized as basic ICT skills, as intermediate ICT skills and as advanced ICT skills.[22] This approach assumes that people who have performed certain tasks have the corresponding skills – and avoids bias.

The data show there is a long way to go to reach the skills-related targets. In only eight of 77 countries for which data is available, 70 per cent or more of the population have basic ICT skills. And in just 11 out of 76 countries, 50 per cent or more of the population have intermediate skills.

For basic skills, in only five out of 70 countries, gender parity has been reached. In 12 countries, a greater share of women have basic skills than men. Similarly, for intermediate skills, gender parity has been reached in five countries and has been exceeded in ten countries (gender parity score above 1.02). For advanced skills (although not a target) two countries could boast gender parity, in one country there was a female majority, but in 59 countries there was a male majority.

Figure 2.26: ICT skills and education level

Share of individuals with various ICT skills compared with maximum education level attained, by skill, latest year available



Notes: B = basic skill, I = intermediate skill, A = advanced skill. Includes countries providing data in 2018 or later. Skills with data from fewer than 20 countries not shown (excludes changing privacy settings, setting security measures and verifying information). Full description of skills (indicator HH15) available in the Manual for Measuring ICT Access and Use by Households and Individuals (ITU 2020a). *Primary* refers to ISCED 0-1, *Lower secondary* to ISCED 2, *Upper secondary/non-tertiary* to ISCED 3-4, *Tertiary* to ISCED 5+. The bars indicate the 25th, median and 75th percentile of all country values. The bottom and top lines indicate the minimum and maximum values (excluding outliers). Outliers are marked with a dot.
Source: ITU.

Education also has a strong bearing on digital ability. Figure 2.26 below reveals stark contrasts in ICT skills by education level for the 44 countries providing data.[23]The higher the level of education, the higher the number of individuals who have performed ICT tasks, regardless of their complexity, from using copy/paste to programming or coding.

Another driver of differences in ICT skills is age. For the 51 countries reporting data, children less than 15 years of age tend to have fewer ICT skills, although this is to be expected since skills are more in demand for tasks undertaken more regularly by adults. Similarly, fewer of those in the 75+ age group have ICT skills than in the general population. This is due in part to the large number of retired individuals in this age group, but also mirrors the gap seen in rates of Internet use.

Individuals in the 15-24 and 25-74 age groups show higher rates of using ICT skills, with those aged between 15 and 24 showing the highest rates for basic, intermediate and advanced skills for all countries providing data. This is consistent with Internet usage rate statistics.

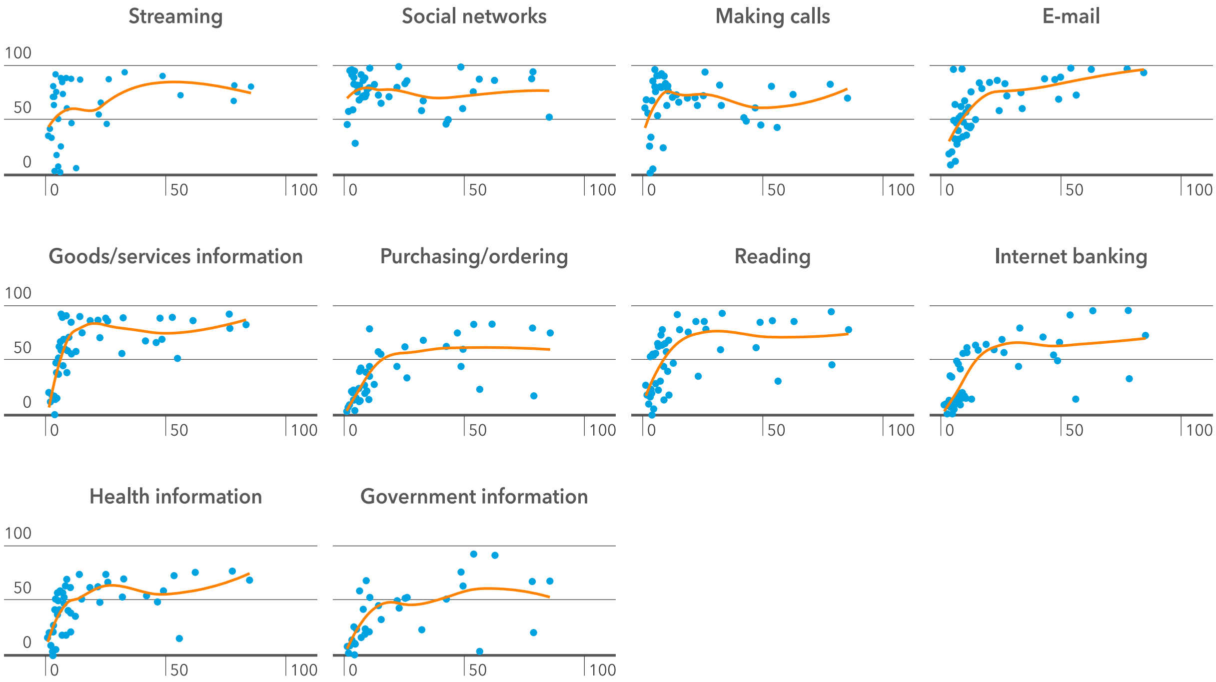
Content

Content does not feature in the framework for universal and meaningful connectivity as it does not directly influence the quality of connectivity.

In recent years, 68 countries have provided some data on how Internet users are spending time on the Internet. Comparing this data to GNI per capita shows a very steep uptake in activities such as Internet banking, acquiring health and government information, reading, and purchasing goods or services as countries' incomes increase (Figure 2.27). This may reflect

Figure 2.27: What people do online

Share of Internet users engaging in various activities versus GNI per capita (USD), by activity, latest year available



Note: Ten most frequently cited activities shown. Full description of activities (indicator HH9) available in the Manual for Measuring ICT Access and Use by Households and Individuals (ITU 2020a). Includes countries providing data in 2018 or later.
Sources: ITU; World Bank World Development Indicators for GNI per capita data (retrieved November 2021).

the increased availability of online services in richer countries. For most activities, there is a flattening off where countries are considered 'high income' by the World Bank,[23] indicating that countries do not need to be wealthy for their residents to have a rich online experience.

A different pattern emerges when looking at the share of those using social networks and making calls. Here similar levels of participation are seen across income levels, illustrating the primacy of communication for Internet users. The analysis suggests that such activities are less dependent on the government and level of development of a country.

Analysis of data from 52 countries suggests that Internet activity connected to information and e-commerce is strongly related to education. This trend stands out for Internet banking, purchasing/ordering goods and services, and researching government information. However, there is a divide in Internet users accessing health information by education level, a factor that may have some bearing on disparities in health outcomes. In contrast, activities related to communication and entertainment are less tied to education level (Figure 2.28).

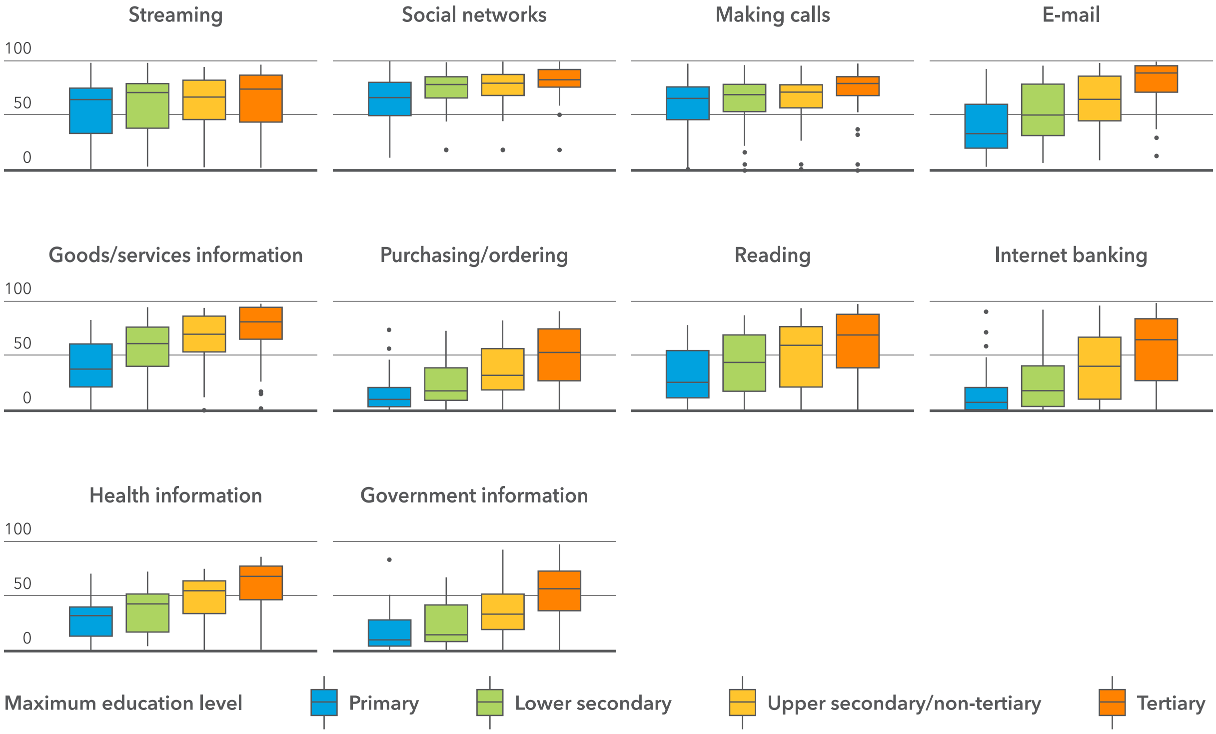
2.6 Conclusions

Achieving universal and meaningful digital connectivity requires a rethinking of what being connected means. The analytical framework introduced in this chapter aims to prompt a major mindset shift, by identifying the key determinants of universal and meaningful connectivity, the relevant indicators to track, and the main targets to chase.

Connectivity is much more than the possibility of connecting. ITU data show that having access does not necessarily translate into usage. While 95 per cent of the world's population is within the footprint of a broadband network, only two-thirds are online. Out of the 151 countries for which data are available, only 13 have met the universality target (at least 95 per cent of the population online). The usage gap is much wider than the coverage gap. This not only means priorities are shifting but that the challenge has grown. It is not only about

Figure 2.28: Online activities and education level of users

Share of Internet users engaging in various activities vs maximum education level attained, by activity, latest year available



Notes: Ten most frequently cited activities shown. Full description of activities (indicator HH9) available in the Manual for Measuring ICT Access and Use by Households and Individuals (ITU 2020a). Includes countries providing data in 2018 or later. *Primary* refers to ISCED 0-1, *Lower secondary* to ISCED 2, *Upper secondary/non-tertiary* to ISCED 3-4, *Tertiary* to ISCED 5+. The bars indicate the 25th, median and 75th percentile of all country values. The bottom and top lines indicate the minimum and maximum values (excluding outliers). Outliers are marked with a dot.
Source: ITU.

building up infrastructure for universal access but also about addressing the many barriers that deter or prevent one third of humanity from going online: lack of money, of skills, of knowledge, of devices.

Lowering these barriers enough so that everyone gets online is an enormous challenge. Moving from *basic* connectivity to *meaningful* connectivity requires *clearing* all the barriers, making the challenge more daunting. For instance, having access to a device may be enough to go online, but owning a device is a necessary condition (but not sufficient) for enjoying meaningful connectivity. Similarly, an Internet subscription may be barely affordable but not offering enough data or bandwidth to allow for a meaningful experience.

The assessments based on disaggregated data reveal that the world's offline population is unevenly distributed across regions, countries, and population groups, creating multiple digital divides such as generation, gender, location, income, education. Measuring and understanding these divides will focus efforts and help to design more effective interventions targeting specific connectivity areas and population groups (see Chapter 3).

Similarly, one must go beyond global or regional figures, which may be misleading. The *global* coverage gap and the digital gender gap have *almost* been bridged, thus wrongly suggesting that these issues have become less pressing. But there are countries where 3G coverage does not exceed 40 per cent of the population (mostly living in urban areas) and 4G has yet to be rolled out. Similarly, while in high- income countries a digital gender gap hardly exists anymore, in countries with low Internet use, men are significantly more likely to use the Internet than women.

Finally, measuring connectivity and how close countries and regions are to achieving universal and meaningful connectivity requires good data, which unfortunately are not universally available, affecting the quality of assessment. This *data divide* mirrors the income digital divide: the less developed a country, the less data available. Low-income countries that stand to benefit the most from digital development are those that know the least about their state of digital development. Improving data coverage and quality must be part of any digital development strategy (see Chapter 10 for an extended discussion about data poverty and options to address it).

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Endnotes

1 See: https://www.un.org/en/content/digital-cooperation-roadmap/

2 Internet use statistics cited in this chapter are for the whole population and differ slightly from what the number for the population aged 15 years and above would be.

3 See: https://www.w3.org/History/1989/proposal.html

4 ITU organizes a World Telecommunication Development Conference (WTDC) every four years. WTDCs set the strategies and objectives for the development of telecommunication/ICT, providing future direction and guidance to the ITU Telecommunication Development Sector (ITU-D).

5 See ITU and UN-OHRLLS 2021.

6 Survey data used in this chapter do not exist for all countries. Conclusions are drawn based on available data, which may only be a subset of countries. For more on household surveys, see Chapter 10 on data poverty.

7 See for example: https://en.unesco.org/themes/building-knowledge-societies/oer

8 Because there may be practical reasons why the ideal state may not be attainable, including measurement errors, the target will be considered met or nearly met when the rate stands at 98 per cent or above.

9 See: https://gigaconnect.org/

10 See: www.projectconnect.world

11 Or, a fancy way to see if there is still coffee in the pot (see https://en.wikipedia.org/wiki/Trojan_Room_coffee_pot).

12 For income groups, the World Bank classification is followed, see: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. For this Figure, dynamic groups are used, which means that each income group is composed of the countries that were included in that group in the year for which data are shown.

13 Latest year available in this chapter means the latest year in the last four years.

14 A fibre-optic ring is a network topology in which each node connects to two other nodes, forming a single continuous pathway – or ring – for signals through each node.

15 See https://www.itu.int/itu-d/tnd-map-public/ for an interactive transmission network map taking stock of national backbone connectivity: optical fibre, microwave links, satellite earth stations, and Internet exchange points (IXPs) as well as of other key metrics of the ICT sector.

16 Considering the difficulties for operators from a technical and financial standpoint to maintain multiple generations of cellular networks simultaneously, the target of 100 per cent applies only to the latest generation that covers at least 40 per cent of a country's population. For example, if 30 per cent of a country's population is covered by 4G, the target of 100 per cent coverage will apply to 3G until 4G coverage reaches 40 per cent of the population, at which point the target will apply to 4G and no longer to 3G.

17 Note that even if these individuals could connect they would not necessarily do so.

18 See: https://en.wikipedia.org/wiki/Mobile_web

19 See: https://a4ai.org/research/device-pricing-2021/

20 Which means a gender parity ratio of more than 1.02.

21 See https://icils.acer.org/

22 The value for basic skills is the average among the following four activities: copying or moving a file or folder; using copy and paste tools to duplicate or move information within a document; sending e-mails with attached files; and transferring files between a computer and other devices. The value for intermediate skills is the average among the following four activities: using basic arithmetic formula in a spreadsheet; connecting and installing new devices; creating electronic presentations with presentation software; and finding, downloading, installing and configuring software. The value for advanced skills is the value for writing a computer programme using a specialized programming language. See the ITU Manual for Measuring ICT Access and Use by Households and Individuals (ITU 2020a) for more information.

23 GNI per capita > USD 12 695 in 2021.

Chapter 3

Accelerating progress towards universal and meaningful connectivity

Chapter 3. Accelerating progress towards universal and meaningful connectivity

This chapter looks at potential solutions to accelerate progress towards universal and meaningful connectivity and mitigate the dangers of online threats to user security and safety. Consistent with the universal and meaningful connectivity framework introduced in Chapter 2, solutions are organized around these enablers: infrastructure, affordability, device, skills, and security and safety. The chapter also examines specific policy options to address the needs of disadvantaged groups and aspects of environmental risk.

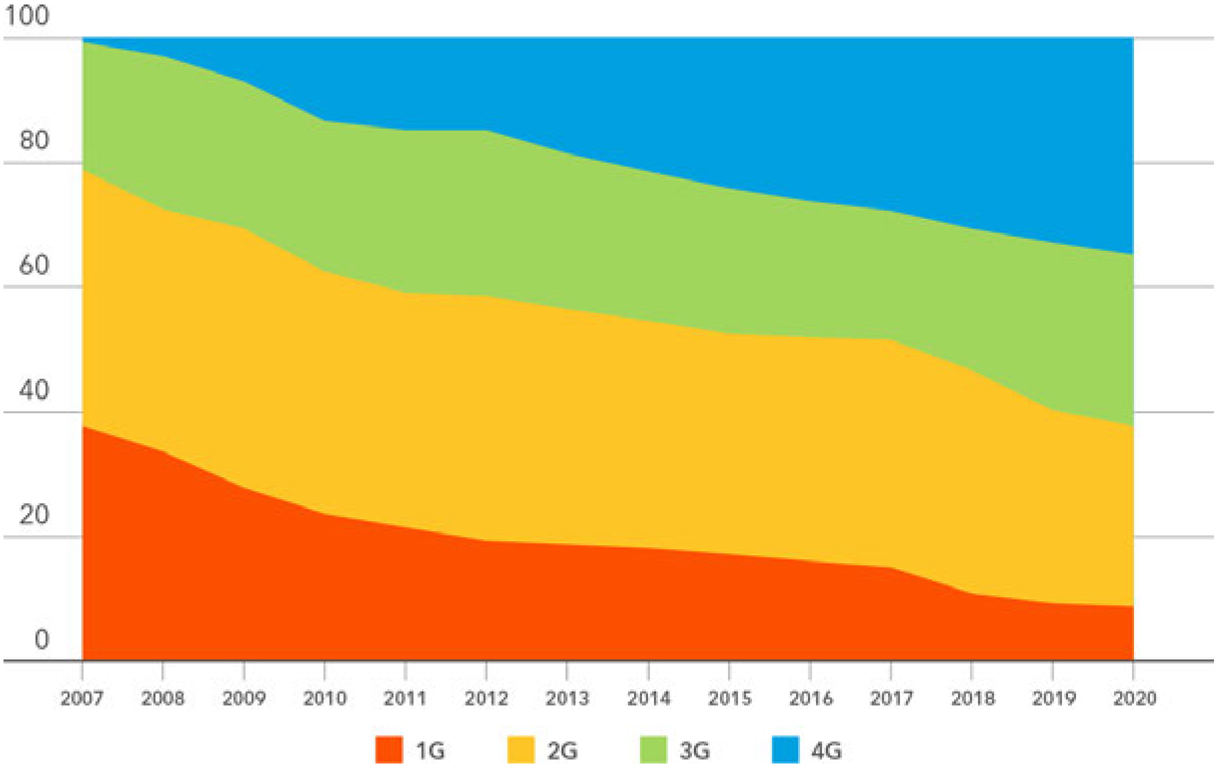
3.1 Infrastructure

This section outlines areas where government measures can expand high-speed telecommunication network coverage to achieve meaningful connectivity.

- Reducing constraints on foreign direct investment (FDI) can be effective in attracting capital to upgrade and expand digital infrastructure. Of the 43 low- and middle-income economies included in the OECD FDI restrictiveness indicator, only six were fully open to foreign investment in their telecommunication sector (OECD 2022). Such restrictiveness limits investment by large international telecommunication groups and the expertise and technology transfer they represent. Some countries profess to have a liberalized sector but often impose restrictions, particularly when governments retain a stake in telecommunication operators.
- Ensuring sound ICT sector regulation will help build competitive markets and enhance predictability, attracting investment. The ITU ICT Regulatory Tracker measures regulatory performance among countries with a framework that identifies how far countries have travelled on their regulatory journey and which 'generation of regulation' they fit into: G1 indicates regulated public monopolies with a command and control approach; G2 indicates basic reform with partial liberalization and privatization; G3 enables investment for innovation and access, has dual focus on stimulating competition in service and content delivery, and provides for consumer protection; and G4 indicates integrated regulation, led by economic and social policy goals.[1] A fifth stage of regulation (G5) is a collaborative generation of regulation where digital transformation is promoted across all sectors of the economy. Almost 40 per cent of countries are at the G1 or G2 generation of regulation, hampering their ability to expand connectivity (Figure 3.1).
- Regulation can improve investment but can also introduce additional rules and costs. A light regulatory touch can result in competitive markets with higher adoption and cheaper prices, particularly in low-income countries. Seventy per cent of the population use mobile money services in Somalia for example, ahead of most countries in Africa (World Bank 2018). In Cambodia, light touch regulation has stimulated competition and foreign investment (UN-OHRLLS 2018). Cambodia also leads LDCs in data usage and mobile-phone ownership, is second for mobile-broadband affordability, and is one of few countries where ownership is higher among women than men (ITU 2021a). Chapter 7 expands on the topic of smart regulation for connectivity.
- Promoting the sharing of infrastructure can reduce costs. Operators could, for example, share mobile towers and underground ducts. Network deployment investment is reduced by laying fibre-optic cable along railway lines, power transmission grids and pipelines. Estimates suggest that sharing antenna sites can save operators up to 40 per cent on both capital expenditure and 5G deployment (Strusani and Houngbonon 2020).[2]
- Ensuring the supply of adequate, inexpensive spectrum can help reduce coverage gaps, ensure sufficient capacity and support the shift to new generations of mobile broadband. Low frequency spectrum is needed for rural areas, as it provides wide coverage, requires fewer

Figure 3.1: Performance in the ITU ICT Regulatory Tracker

Evolution of the generations of ICT regulation worldwide, 2007-2020"



Source: ITU.

sites and reduces investment costs (GSMA 2018). Challenges are delaying progress in this area. In some countries migration from analogue to digital television has been delayed, reducing availability of low frequency spectrum for mobile broadband use. Some countries also auction frequencies with high reserve prices, thereby raising investment costs, which results in higher prices for users. Some governments charge recurring fees for spectrum, raising the cost of deploying infrastructure in rural areas. And spectrum can be allocated quickly and many governments rapidly increased spectrum available to operators in response to COVID-19 and higher Internet use (GSMA 2020a). Box 3.1 proposes technologies for expanding infrastructure in rural and remote regions.

- Ensuring that energy provision is adequate to power ICT infrastructure is essential. This is a challenge in some low- and middle-income countries especially in remote rural locations. Diesel is often used but this is expensive and unkind to the environment (GSMA 2020b). Renewable solutions are not always feasible or price competitive, for instance because of a lack of sunlight, infrequent wind, or the need for expensive battery storage. Solutions to these challenges include reduced duty, tax incentives on green power equipment, and allowing independent power producers (GSMA 2020b).
- Recalibrating universal service funds (USFs) can help deployment of infrastructure in unserved areas. Many funds have been unsuccessful, suffering from challenges such as poor design, mismatches in funds collected and disbursed, political interference, lack of training and education, and maintenance and energy supply (GSMA 2013). Universal service funds might be better utilized if focused on high-risk populations and to reduce gaps among vulnerable groups including women and girls,[2] persons with disabilities[3] and older persons, regardless of where they live. This is particularly relevant given that the coverage gap is much smaller than the usage gap.

Box 3.1: Niche technologies for expanding telecommunication infrastructure

Although a universal solution has yet to be found, a variety of technological solutions to cheap access for people living in rural and remote regions have been available for many years. Examples of such technological solutions include:

- TV white space (TVWS) utilizes buffer frequencies between TV channels to provide broadband Internet access. In remote parts of Colombia cellular coverage has not been feasible due to frequency bands being congested, high licensing costs and limited communication range. TVWS is being used as an alternative to connect rural schools and coffee plantations in geographically challenging locations such as mountainous rainforests.[4]
- High altitude platform service (HAPS) such as Loon (operated by Alphabet, the parent company of Google) uses a network of hot air balloons to provide connectivity to unserved locations (Loon 2020). Loon was used during floods in Peru in 2017 as well as in Kenya to provide Internet access to a region covering 50 000 sq km.[5] Loon stopped operating in January 2021 as it could not be made commercially viable.[6]
- Networked tethered flying platforms (NTFP) are tethered gas balloons.[7] Due to their altitude, an NTFP can replace numerous regular cell towers, lowering costs (Staedter 2018). NTFPs are being proposed for use in Australia where 70 per cent of the land mass has no cellular coverage.[8]
- Satellites provide backbone transmission services as well as direct to consumer television and broadband access. Low earth orbiting (LEO) satellites blanketing the Earth delivering affordable service to handheld devices have been promoted as a solution for remote areas but remain unaffordable for many low- and middle-income countries. LEOs are providing important backhaul transmission services to the Internet in landlocked or remote islands. They can be a useful backup when terrestrial systems are damaged, for example if an undersea volcano were to damage a submarine cable, as was the case in Tonga, or other disasters disrupt the Internet network (Schneider 2022).

In addition to the niche technologies above, improvements in wireless cellular technologies are lowering the cost of deploying last-mile access. The OpenRAN project is promoting the use of inter-operable open source software and hardware to reduce the cost of proprietary products.[9] Moving to a cloud-based, software-driven environment can lower the cost of cellular networks. In Japan, Rakuten launched the world's first cloud-based mobile network, claiming 40 per cent lower costs than those of traditional cellular networks (Kapko 2020).

3.2 Digital skills

Overcoming digital illiteracy is critical to shrinking the usage gap. Effective and large-scale programmes are needed to address the challenge. Providing digital literacy as part of the school curriculum is a solution for those at school. Recent data on how many countries include digital skills training in the curriculum is not available. Data compiled a decade ago indicate that 55 per cent of countries included basic computer skills training for primary schools and 74 per cent for upper secondary schools.[10]

Worldwide only 40 per cent of primary, 51 per cent of lower secondary and 66 per cent of upper secondary schools had Internet access in 2020.[11] Giga, a partnership between UNICEF, ITU and the private sector, seeks to connect *every school* to the Internet. The programme has shown that schools can be "anchor tenants" in a community, extending access and digital skills to those living close by.[12] Funding school connectivity remains a challenge however, with many low- and middle-income countries struggling to build schools with electricity let alone Internet access.[13] Increasingly, the private sector is helping to support digital literacy in schools (see Box 3.2)

Box 3.2: Ensuring school connectivity and digital skills

The private sector plays a key role connecting schools in certain countries (World Benchmarking Alliance 2020). Safaricom's 47-in-1 Initiative is installing a computer lab in one primary school in every county in Kenya.[14] Mobile operator Millicom has committed to the Organization of American States (OAS) goal of connecting every public school in Latin America and the Caribbean to the Internet by 2030, providing Internet access to 2 000 schools throughout the region.[15] Vodafone's Instant Network Schools provides Internet to schools with refugee students.[16] Launched in 2013 in partnership with UNHCR, it has provided school connectivity to 36 schools in five African countries reaching over 86 500 refugees.

Those not in school and without digital skills also need to be reached. The Rwanda Government launched the Digital Ambassador Program (DAP) with the target of training 5 000 youth and sending them all over the country to provide digital skills training to 5 million people. By December 2019, DAP had reached nearly 50 000 people.[17] An evaluation of DAP made specific, practical recommendations to further enhance its impact: i) greater community outreach to increase participation; ii) minimizing technical aspects; and iii) linkages to programmes such as mobile money, device and service charge affordability and national content.[18]

The private sector is providing digital literacy training to adults. The Mobile Internet Skills Training Toolkit (MISTT) was developed by GSMA for mobile operators.[19] Available in Bengali, English, French, Hindi, and Kinyarwanda, MISTT uses a 'train the trainers' approach, whereby staff from the mobile operator train sales agents who then teach customers. MISTT has been used in countries throughout South Asia and Africa. South Africa mobile group MTN offers MISTT in eight African countries and, as of April 2021, has trained over 18 million people, finding that incentives (commissions for trainers and free data for trainees) had a real impact.[20]

Many people are learning digital skills without formal training, resulting in shortcomings in acquiring further skills. They use social media acquiring basic skills from family and friends People with limited literacy in Africa have used a simple customized version of the Internet with audio and icon-based interfaces.[21] These applications often mean people are 'unconscious Internet users', not knowing what the Internet is or that they are actually using it, and therefore unaware of the variety of uses, benefits and risks it can bring (Silver and Smith 2019). Informal training often omits important security skills such as protecting privacy, for example, minimizing the digital trail left on social media and elsewhere. Nor does it teach how to distinguish between fact and misinformation. The result is an urgent need to train millions of people formally in using the Internet to ensure they have safe and meaningful connectivity.

COVID-19 has seriously hampered the provision of face-to-face digital literacy training. Although programmes have moved online, they are not practical for those who have never used the Internet. If there is no other option, courses should be provided in a webinar format with instructors able to interact with students.

3.3 Affordability

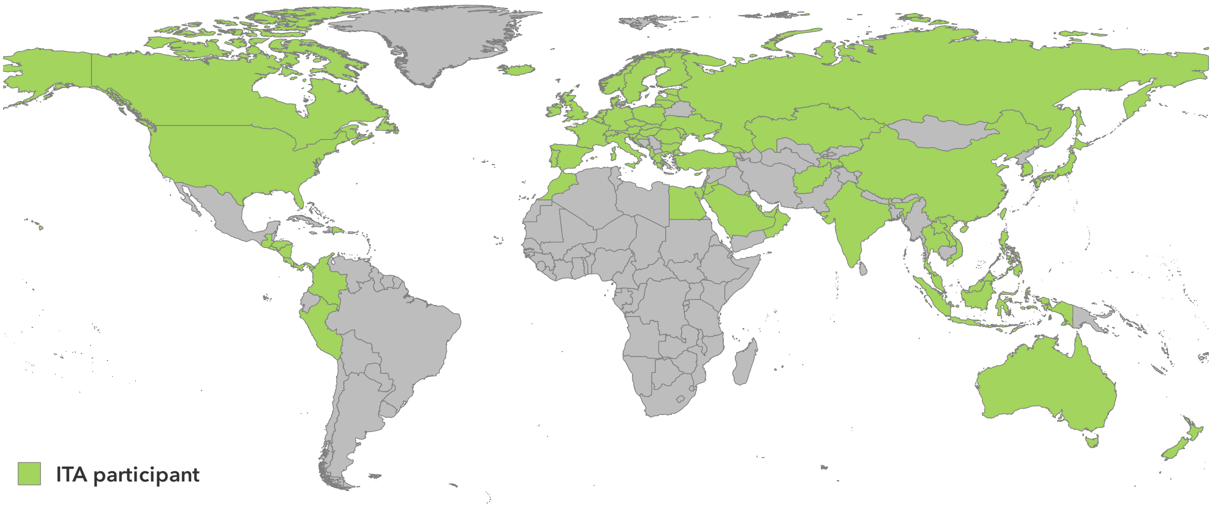
The cost of devices and Internet use represents a major barrier to connectivity. This section sets out recommendations on what can be done to overcome this challenge both in regard to devices and services. Chapter 5 on affordability offers more detail on this subject.

Device affordability

The price of a device is a significant barrier that stops many people developing digital skills (see Chapters 2 and 5). Price reduction has its challenges, however. Very few countries manufacture and therefore control pricing of these products, and importing countries have no say in how the pricing is arrived at. Three approaches set out below offer promise.

Figure 3.2: Trade in information technology products

Participants in the WTO Information Technology Agreement



Note: The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of ITU and of the secretariat of ITU concerning the legal status of the country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. The base map is the UNmap database of the United Nations Cartographic Section.
Source: adapted from https://www.wto.org/english/tratop_e/inftec_e/ita_map_e.htm.

Governments do, however, affect device price (and therefore affordability) through imposing import duties and sales taxes. The World Trade Organization (WTO) Information Technology Agreement (ITA) calls for countries to eliminate duties on information technology products. Despite the initiative having 82 signatories, many of the world's poorest countries, particularly in Africa where the impact could be greatest, have not signed (Figure 3.2). Although sales taxes serve a purpose, taxes on devices should be kept relatively low and certainly not higher than for other products.

A4AI has carried out research on smartphone pricing. They found that the average world price in 2021 was around one-quarter of monthly income,[22] that in South Asia the figure rises to 40 per cent, and in the LDCs it is 53 per cent. Among its recommendations for lowering device prices, A4AI calls for using USF funding to subsidize the cost, highlighting the examples of Malaysia and Costa Rica (A4AI 2020).

Some operators are playing their part to lower the costs of handsets. Mobile group MTN which operates in 21 countries throughout sub-Saharan Africa and the Middle East has launched several initiatives (MTN 2021). Working with Chinese manufacturers, MTN introduced a handset that costs less than USD 40 across its markets. In Zambia it is subsiding handsets and in Uganda it offers customers an installment plan amounting to USD 0.17 per day.

There is a market opportunity for low-cost manufacturers. TECNO, the brand of the Chinese mobile phone manufacturer Transsion, has the highest mobile phone sales in Africa[23] because it sells affordable handsets.[24]

Service affordability

In over half of countries worldwide, ITU analysis suggests broadband services remain unaffordable (see Chapter 5). Governments can however take action to remedy this in these three areas:

1. Reduce taxes on services to make them more affordable. In 2017, of total payments made by mobile operators to governments, almost a third was specific to the mobile sector (mobile consumption taxes, spectrum and licence fees, etc.). This was in addition to other, economy-wide, general taxes paid by telecommunication operators and consumers (GSMA 2019). Reductions in sector-specific taxes enhances affordability and increases demand, with spillover effects on other industries. GSMA studies find that increased demand from lowering taxes and indirect impacts across the economy raise the tax base, off-setting

the loss of sector-specific taxes. Uganda for example has a range of taxes that negatively impact affordability (Stork and Esselaar 2018).[25]In addition to value-added tax, the government levies a mobile services excise tax and an Internet data tax that has replaced a social media tax.[25] Almost half of what is spent on mobile airtime in Uganda consists of taxes.

2 Governments should encourage operators to offer plans that reflect different income levels and circumstances and that offer a minimum of 2 GB data a month for the cheapest plans. In almost all low- and middle-income countries, prepaid and data-limited mobile offers dominate Internet access packages. In Zambia, for example, mobile operators offered 17 plans ranging from a one-hour plan featuring 5 MB of usage, to weekly bundles offering unlimited access to popular social media services such as Facebook and WhatsApp. An ITU report found such bundles successfully enabled access to mobile Internet for lower-income users at low cost. This illustrates that while affordability need not be a barrier to Internet use, it limits how much is consumed and when it is consumed (ITU 2018), a less than perfect solution when measured against the aspiration of universal and meaningful connectivity.

3 Make mobile data more affordable in a world where 6 GB a month is reasonable. COVID-19 has made users look at data consumption, one hour of Zoom for example consumes between 0.5 GB and 2.5 GB.[26] Data consumption patterns vary widely across the world and generally relate to income levels. ITU data for 2020 show that an individual in Finland and Kuwait, for example, consumed 30 GB of mobile data a month in contrast to less than 1 GB for those living in 21 low- and middle-income countries. The volume of monthly data that a person would need to access key online activities was recently estimated at 660 MB per user per month and included access to public services, health information, shopping, learning, and news (Chen and Minges 2021). When recreational activities were included, the estimated volume of data rose to 6 GB per month (an extra 5.2 GB). Such a monthly data package in the six low- and middle-income countries included in the study costs more than 2 per cent of income for the bottom 40 per cent of the population.

However, there are concrete measures that can make data more affordable in low- and middle-income countries. Governments can:

- Ensure provision of unlimited broadband access to community centres and schools, with access to those in the surrounding community who cannot afford it at home.
- Ensure that the temporary COVID-19 concessions that were put in place by operators in many countries (higher data allowances or providing free Wi-Fi) are maintained for the poorest segment of the population , those needing medical support and for students.
- Subsidize data use for the poorest segment of the population through social tariffs similar to those for food allowances.
- Apply zero ratings for critical services such as e-government, education and health services.
- Create charitable data donation schemes. In Australia for example, users can donate their unused monthly data to those in need (Optus 2020).

3.4 Security and safety

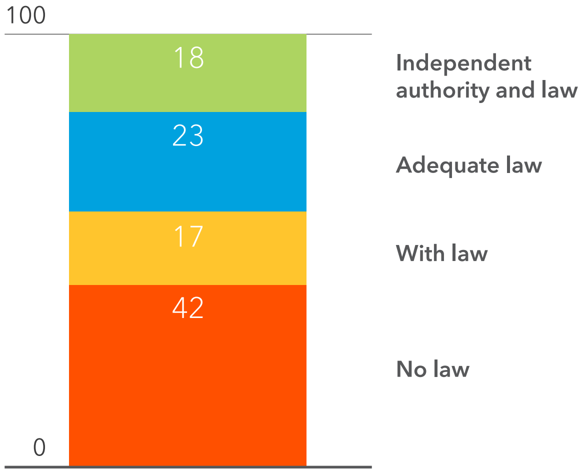
To be sustainable, meaningful connectivity must equate to having limited or no risks associated with connecting to the Internet. This section explores the nature of online threats to user security and safety, and considers personal data, misinformation, overuse of digital technology, and vulnerability of children. Importantly too, it looks at how to counter such risks, vital in preserving trust in our ever-growing use of the Internet brought into focus by the increased exposure to risks during the COVID-19 pandemic.

According to a global survey carried out in 2019, eight out of ten Internet users are concerned about their online privacy and one in four do not trust the Internet.[27] Over a third of Internet users in the European Union experienced a security incident of some description in 2019.[28] Personal data breaches, online harassment, children accessing inappropriate websites, hacking, viruses, pharming and phishing, and the spread of misinformation are just some of the negative consequences of going online.

Protecting personal data is a critical issue but only 23 per cent of countries around the world have adequate data protection laws on a par with the EU General Data Protection Regulation (GDPR) (Figure 3.3). One source reports that 69 per cent of countries have data protection laws,[29] however, many are not implemented; do not adequately reflect present day user needs; often require no user consent for use of personal information; offer limited control mechanisms for transferring personal data abroad; and lack provisions for a data protection authority.

Figure 3.3: State of data privacy legislation

Percentage of countries by data privacy legislation, 2020



Note: Adequate law means that the country provides an equivalent level of protection to the EU GDPR.[30]
Source: *Commission nationale de l'informatique et des libertés* (CNIL) (French regulator of personal data), https://www.data.gouv.fr/fr/datasets/protection-des-donnees-personnelles-dans-le-monde/.

Countries that are falling short need to create adequate data protection laws or update their existing laws in line with best practice, and many telecommunication operators and platform companies should exceed minimum duty of care requirements and put in place a single policy that meets international best practice to ensure the security and safety of their customers.

The spread of misinformation is rising steeply, driven by social media platforms. Analysis of social media use in the United States found that 17 per cent of information from among the top 100 news platforms came from unreliable sources, up from 8 per cent in 2019.[31] The World Health Organization noted that the spread of misinformation about COVID-19 is "proving to be as much a threat to global public health as the virus itself" (WHO 2021). Top social media platforms have begun to label or take down false information, but ex post facto action is often too late. Hate speech is now a major concern and has led to documented violence against ethnic minorities.[32]

Social media companies should take more action, too, for example by increasing moderators on the ground in all countries to detect false and inciteful content. In situations of political conflicts they need to come to a balanced judgement on the type of content they restrict.[33] They need to demonstrate greater transparency of how platforms use algorithms to disseminate content,[34] [35]or add features that discourage the sharing of harmful content[36] or that limit the spread of viral content.[37]

Misinformation is a problem with no quick fix although training and guidelines such as those developed by UNESCO, including policy guidelines, assessment frameworks, and self-taught online modules[38] designed to develop media and information literacy and distinguish between real and fake information should be made available in schools and to the public.

The overuse of digital technology is a now a recognized health risk with a range of dangers. Gaming addiction is estimated to affect around 5 per cent of the population (World Benchmarking Alliance 2020). Internet addiction is also recognized in many countries, for example, in Germany the rate has been estimated at 2 per cent (Müller *et al*. 2013), while in Bangladesh over a quarter of young adults are Internet addicted (Hassan *et al*. 2020). Efforts to limit online gaming addiction include parental controls, limited access set by some online gaming companies and, in China for example, restricted access for those under 18.[39]

Children are also at high risk when using the Internet. In the United States alone, there were almost 22 million reports in 2020 regarding the online exploitation of children, including child sexual abuse material, child sex trafficking and online enticement.[40] ICT companies are trying to mitigate this through initiatives such as parental controls, tiplines and hotlines, and awareness education for parents and children. Chapter 9 expands on how youth can leverage the opportunities offered by connectivity, and at the same time avoid its perils.

3.5 Accelerating connectivity among disadvantaged groups

To attain universal connectivity, special attention must be paid to the needs of disadvantaged groups including persons with disabilities, older persons, women and girls in some countries, those with low-incomes, and people living in remote areas. People with one or more disadvantages are at greater risk of digital exclusion (for instance women with low-incomes and older persons with disabilities.) Other groups at risk are country specific, such as migrants, refugees or ethnic minorities.

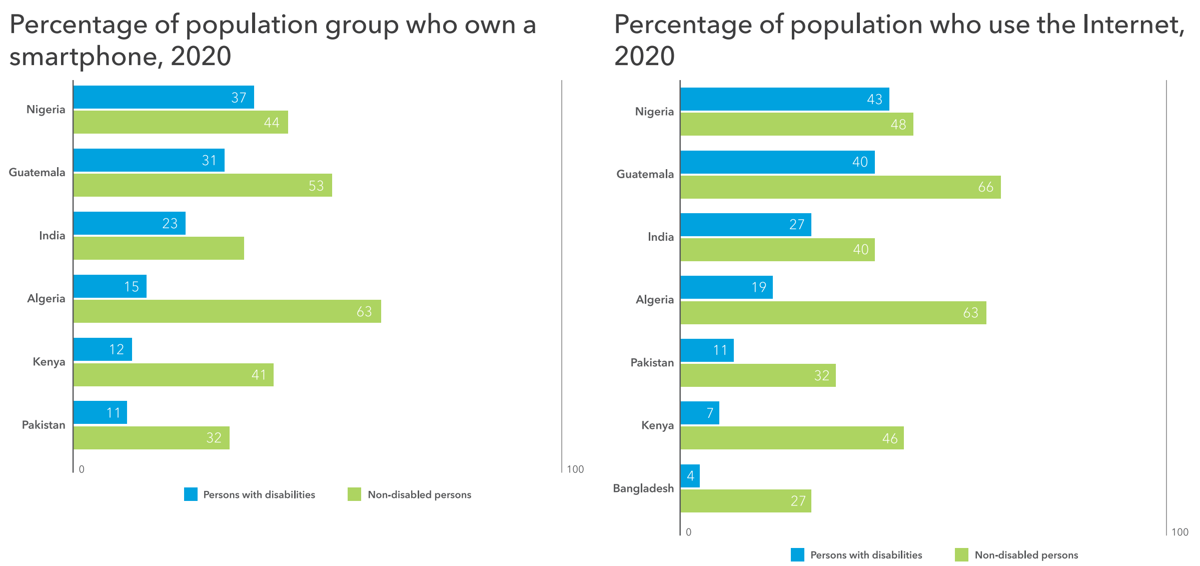
Persons with disabilities

It is estimated that 1 billion people have a disability[41] or about 15 per cent of the global population.[42] Global statistics about the connectivity status of persons with disabilities do not exist. GSMA has collected data for some middle-income countries that indicates significant gaps separating persons with disabilities and the rest of the population in smartphone ownership and Internet use. Figure 3.4 shows that in Algeria, for instance, the smartphone ownership gap extends to almost 50 percentage points and the gap for Internet use is more than 40 percentage points.

Persons with disabilities face accessibility challenges when using computers, smartphones, apps and websites. Some governments legislate to ensure accessibility of digital products for persons with disabilities. In 2019, the Directive (EU) 2019/882 of the European Parliament and of the Council brought in European Union-wide standards that ensure products and services are easier to use for persons with disabilities.[43] Legislation in the United States requires federal agencies to develop, procure, maintain and use information and communication technology that is accessible to persons with disabilities, including Federal Government websites.[44] The Accessible Canada Act requires telecommunication operators to implement accessibility features for their services.[45] According to the United Nations e-Government Survey 2020,[46] 71 Member States had national e-government portals that followed the World Wide Web Consortium (W3C) international accessibility guidelines.[47]

Many leading hardware manufacturers have adapted products to be more disability friendly through features such as enabling large fonts and screen readers,[48] and many adhere to the W3C global standard for web accessibility.[49] Designed with disability experts, the GSMA Principles for Driving the Digital Inclusion of Persons with Disabilities offers guidelines for the mobile industry to reduce the gaps in access and use.[50]

Figure 3.4: Disability gap for smartphone ownership and mobile Internet use



Note: Based on survey results for adults aged 18 and over. n=49–260 for persons with disabilities and n=900–1 866 for persons without disability.
Source: GSMA Consumer Survey 2020.

Innovation is an important means of empowering persons with disabilities,[51] for example, persons with visual impairment are using smartphone technology to scan and read documents, to get accessibility ratings for public places and audio and vibration alerts for approaching obstacles.

To reduce the digital disability gap, there is a need to collect disaggregated statistics to help understand the issues, such as the disability and connectivity gaps, and identify those in need. To this end, the ITU Expert Group on Household Indicators (EGH) recommends countries to collect data for the disaggregations defined by the Washington Group.[52] Governments and NGOs can also raise awareness about the connectivity benefits among persons with disabilities and provide equipment and customized training, drawing on universal service funds where relevant as well as bringing in regulation that require online public services to be accessible to those with disabilities. In addition, the private sector can develop contextually relevant digital assistive technologies and ensure products adhere to accessible design guidelines.

Older persons

Available survey data indicate gaps between rates of Internet usage by age group. Young people use it most and older persons use it least. Many older persons were born decades before the Internet and do not have the technical ease of digital natives. Figure 3.5 shows that those aged 75 and above use the Internet less than the general population (age group 15-74), although the gaps vary. In Norway, for instance, the Internet use gap is much less pronounced at 92 per cent for the 75+ age group compared with 99 per cent for the 15-74 age group. However, for most economies the age gap is wide, at more than 50 percentage points in over half of economies providing data and 80 percentage points in Kazakhstan.

Digital connectivity can reduce social isolation, not least for older persons, and along with other connected digital devices, health-based apps and other interfaces, connectivity contributes to their well-being and safety (Berenguer *et al*. 2017) as well as greatly enhancing productivity, particularly relevant as populations age and they need to remain in the workforce.[53]

Digital skills training for older persons is an imperative for governments if older persons are to access online public services. The New Zealand Government has allocated funding to train up to 4 700 older persons in digital skills over three years.[54] Some digital companies are providing training, for example in Singapore, Singtel is upgrading community centres with Internet access and tablets, its staff volunteer for one-on-one digital skills training, and it opens its shops early to provide training workshops.[55]

However, more collaboration is needed across agencies governments, advocacy organizations and digital companies to accelerate the acquisition of digital skills and ensure that digital technologies have appropriate accessibility features. As with persons with disabilities, more data on how older persons use digital technologies is needed and the scope of ICT surveys needs to address that age group.[56]

Training should be designed for and delivered exclusively to older persons. Design should take comfort levels, learning relevance and application focus into account. Course numbers should be small and include modules on security to build trust in using online services.[57] Training should be ongoing to reinforce learning and have a lasting effect.[58]

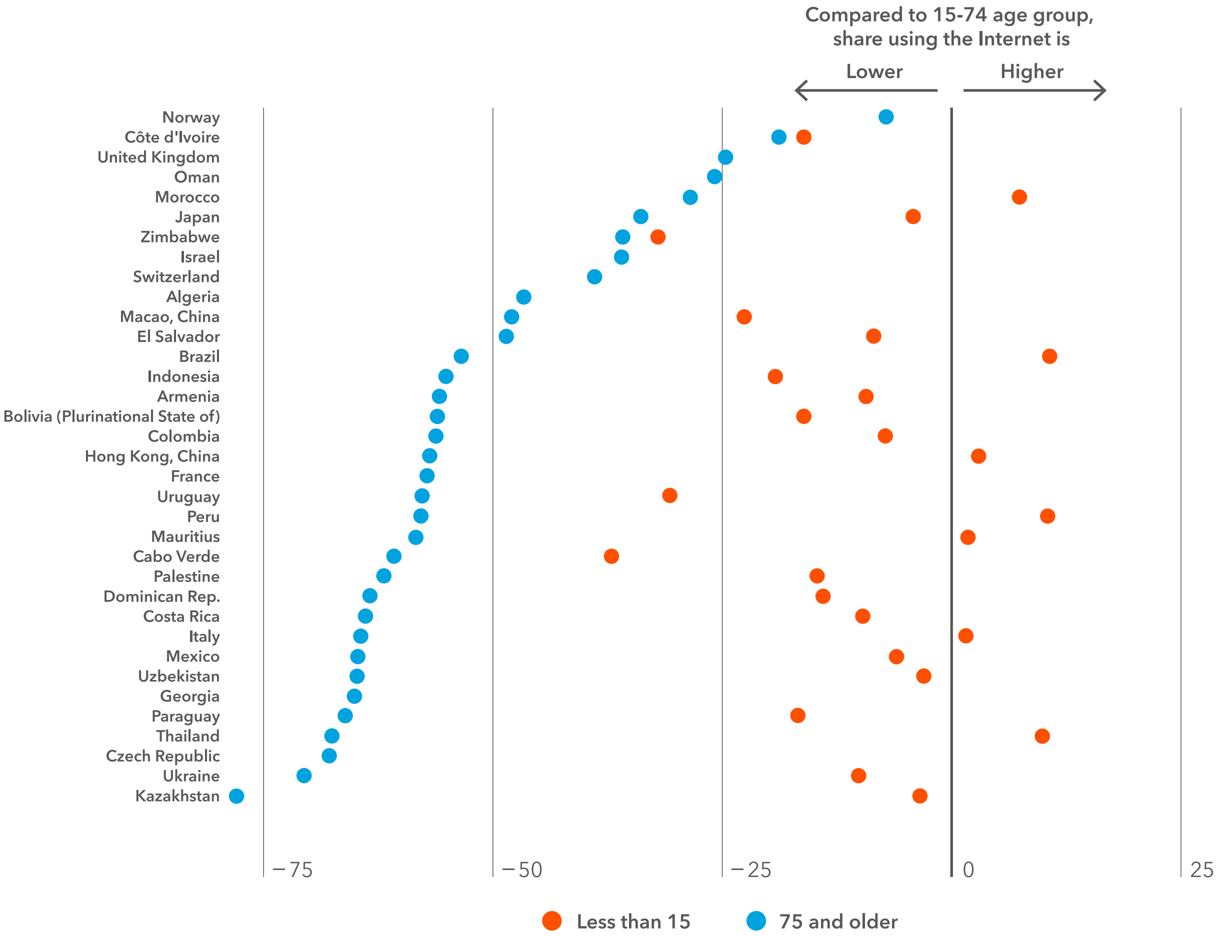
Women and girls

According to ITU data, in 2020 there was an overall 5-percentage point gap in Internet use between women (57 per cent) and men (62 per cent). Although the gap has been shrinking, large divides remain depending on income, geography, and culture. Figure 3.6 shows that although parity exists in the Americas and is almost achieved in Europe, considerable gaps remain in LDCs, where only 19 per cent of women use the Internet compared with 31 per cent of men; with low numbers using the Internet in Africa (24 per cent versus 35 per cent) and to a lesser extent in the Arab States (56 per cent versus 68 per cent).

The gender gap is narrowing in digital technology use but a significant employment gap remains between men and women in technology occupations. On average in 2019, women held only 23 per cent of those occupations such as coding and research and development in leading technology companies. At current rates, it will take a

Figure 3.5: The inter-generational gap in Internet use

Percentage point difference to share of 15–74-year-olds using the Internet, by age group (2018 or later)



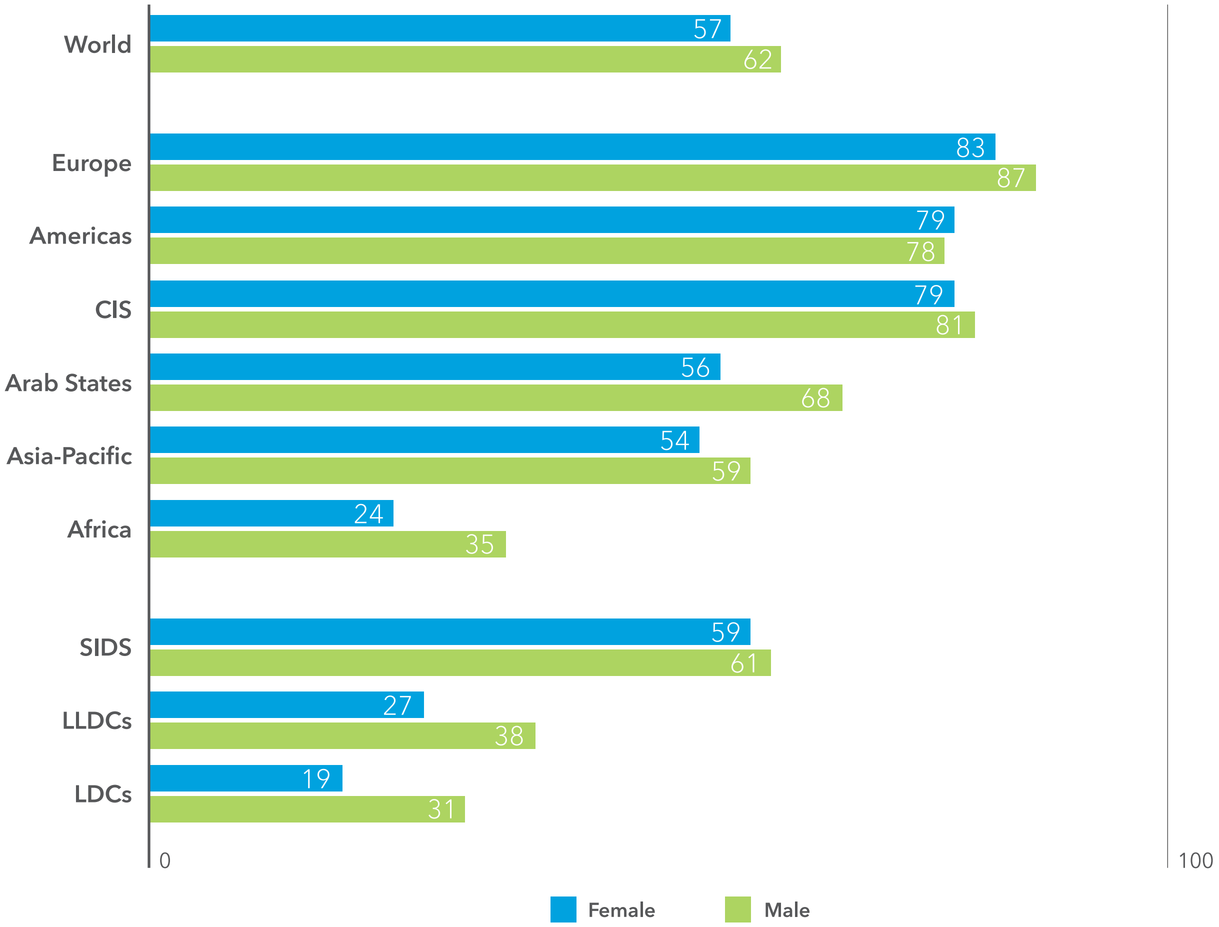
Source: ITU.

quarter of a century to achieve parity (World Benchmarking Alliance 2020). The absence of women in such roles affects the design of digital goods and services, for example, the average smartphone is too big for most women's hands, and speech-recognition software is modelled on male voices.[59]

Cultural norms affecting girls at an early age constitute a challenge to creating digital opportunities and discourage them from pursuing studies in science, technology, engineering and mathematics (STEM). Some NGOs are combating gender stereotypes through mentoring and training. 'Girls Who Code' has trained over half a million girls around the world since 2012 of whom half come from vulnerable groups. Girls in the programme study in STEM subjects at 15 times the national average.[60] EQUALS, a partnership between ITU and UN Women, is working for equal access and use of digital technologies for women and girls by 2030.[61] Activities include mentoring women and girls to acquire STEM skills and the encouragement of entrepreneurship. EQUALS also provides funding for local initiatives offering skills training.

A better understanding of contextual barriers that stop women in different countries from using digital technologies is needed to remedy the situation. In addition, NGOs should be supported in providing mentoring and digital skills training, and technology companies can play a role, not only by supporting skills initiatives but also by setting their own gender equity targets in terms of rights, benefits, obligations, and opportunities for women and girls. Digital products and services should better meet female requirements for design, safety and security.

Figure 3.6: Percentage of female and male population using the Internet, 2020



Note: CIS = Commonwealth of Independent States.
Source: ITU.

3.6 Minimizing environmental damage

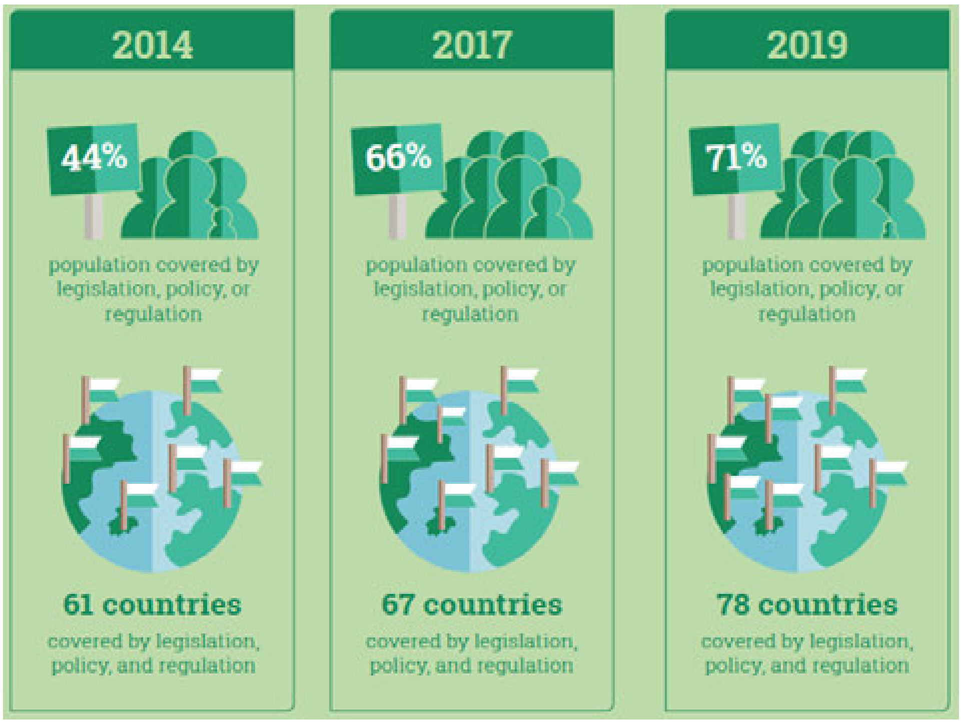
Tackling connectivity-related environmental challenges is essential to minimize the environmental impact of ICTs, from discarded equipment that contains dangerous materials (such as mercury, cadmium, and lead), to telecommunication network carbon emissions and the significant power needed to run data centres.

E-waste volumes continue to grow, reaching 53.6 million metric tonnes (Mt) in 2019 or about 7.3 kg per person,[62] four-fifths of which is disposed of without trace. As of 2019, 78 countries covering 71 per cent of the world's population have e-waste regulations (Figure 3.7). The ITU Connect 2030 Agenda has set global targets: 30 per cent e-waste recycling rate, increasing the number of countries with e-waste legislation to half, and to reduce the volume of redundant e-waste by 50 per cent by 2023.

Leading smartphone and computer manufacturers are supporting device return and recycling collection programmes. Apple uses robots to recover materials from its used products.[63] Samsung works with local partners to provide recycling in 55 countries and extracts materials such as copper, aluminum and plastic for reuse.[64] Lenovo is working to reduce harmful materials in its products, has a big data set of all parts and their composition, and works with suppliers to minimize their e-waste.[65] Nevertheless there is still scope to make the recycling process easier for consumers.

Data centres and transmission networks used around 2 per cent of global electricity in 2020 (IEA 2021). Today, the sector processes more data, where data centres are larger, more efficient, and uses less electricity. Telecommunication network upgrades are also improving efficiency. Fibre-optic cable is more energy efficient than copper wires and each generation of wireless technology uses less energy than previous generations, for example,

Figure 3.7: Countries with an e-waste policy, legislation or regulation 2019



Source: https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf.

4G networks can be more than 50 times more energy efficient than 2G networks.

Despite the rise in electricity consumption used by the ICT sector, greenhouse gas (GHG) emissions remain flat (World Bank 2021). Almost all major ICT companies have committed to future zero-carbon targets. In addition, an ITU standard (ITU L.1470) calls for the ICT industry to reduce emissions by 45 per cent between 2020 and 2030.

In the near future, connectivity has the potential to reduce carbon emissions in many sectors of the economy. The Global e-Sustainability Initiative found that an increased use of ICT solutions could deliver a 20 per cent reduction of global CO_2 emissions by 2030 (GeSI 2015), a reduction of almost ten times that of the ICT sector footprint during the same period. In the post-COVID-19 world, reduced carbon emissions could be further supported as both the work and education sectors use video conferencing tools that reduce both travel and fuel consumption and the growing use of ICT-enabled sensors generate energy efficiencies across many other sectors.

For many low- and middle-income countries it is a challenge to balance the provision of sufficient energy for connectivity infrastructure with the shift to renewable fuel sources. Foreign investors are increasingly concerned about climate change in their risk assessments and may be reluctant to invest in projects that are not environmentally responsible. There is, however, considerable untapped renewable potential from solar, wind, hydroelectric and geothermal power sources in many low- and middle-income countries. As major energy users, ICT companies can provide the scale of investment to make renewable energy economically feasible. Governments can help enormously by creating climate friendly energy strategies and liberalizing markets, particularly by working with independent renewable power producers.

3.7 Conclusions

There is no single pathway to universal and meaningful connectivity. The scope and nature of intervention depends on where a country stands on the path from basic connectivity for the few to meaningful connectivity for all. Multiple factors are at play, including a country's institutional framework, income level, demographics, geography, and culture that require a range of options, rather than a single solution, and which can differ significantly across countries within a region. Box 3.3 proposes more tailored recommendations for Africa.

Achieving universal and meaningful connectivity requires a concrete and coordinated effort by many actors. Box 3.4 presents examples of ongoing and successful multistakeholder initiatives. Success will depend on a high-quality needs assessment, pinpointing issues, identifying gaps, and setting priorities. Success will also depend on the availability and quality of connectivity data, as explained in Chapter 10.

Box 3.3: Achieving universal and meaningful connectivity in Africa

African countries have made great strides in the maturity of ICT regulation in recent years (ITU 2021). However, the weakness of institutions in many countries (Alhassan, A. and Kilishi, A.A. 2019) remains an impediment to the development of a robust and well-balanced market to connect the unconnected. Notably, more effective regulation is needed to combat market dominance of incumbents in both fixed and mobile markets (Robb and Paelo 2020). Currently new players cannot easily enter the market. Barriers to entry include tariff-mediated network effects, anti-competitive measures taken by incumbents and the high cost of building a network. Effective regulation would allow countries to apply necessary competitive levers such as interconnection, wholesale access regulation, infrastructure sharing, and pricing transparency.

Universal service funds have largely been unsuccessful on the continent, often sitting unused or misused, instead of connecting the unconnected (Lewis 2017). The effect has often been counterproductive. Extractive rents in mobile company taxation in some instances and secondary taxes through universal service funds have often increased prices of services and devices, constraining the take-up and use of broadband services.

There are then several ways governments could take on these challenges by:

- creating an enabling environment for the entry of service providers with low-cost access business models;
- removing customs or excise tax on entry-level devices;
- scrapping regressive end-user taxes on social networking platforms, which are often the most cost-effective communication means for those in the subsistence economy;
- providing free public Wi-Fi at all public buildings;
- exploring new forms of demand aggregation that will allow people to connect through public Wi-Fi and mesh networks from their homes;
- exploring long-term public sector anchor tenancies to get adequate infrastructure to underserved areas.

Box 3.4: Example of multistakeholder initiatives for improving connectivity

ITU has initiated several multistakeholder partnerships and is contributing to a number of initiatives.

Mobile- and fixed-network infrastructure. Fixed connectivity was initially provided by state-owned operators. Sector reform then liberalized telecommunication markets and allowed for competition.[66] Private operators have since increased availability of mobile services and competition in broadband services, built on spectrum allocated by ITU, as highlighted in Chapter 7.

Gaps remain however that stakeholders are working to fill and that governments are targeting through broadband plans, universal access and service funds. These plans are promoted by the Broadband Commission for Sustainable Development.[67]

The World Bank Group is supporting the Eastern Africa Submarine Cable system (EASSy), a regional first, with a novel open access model. The Internet Society is helping develop community networks.[68] Meta (formerly Facebook) are now investing in submarine cables and Wi-Fi platforms.[69]

Affordability of connection and device. The Alliance for Affordable Internet works to reduce connectivity and device costs,[70] setting an affordability target where 1GB of mobile broadband data costs a maximum 2 per cent of average monthly income, also supported by the Broadband Commission. GSMA has a focus on meaningful connectivity,[71] highlighting tax impact on consumers and operators.

Access to mobile and fixed devices. Some companies seek increased availability of smart devices, lowering manufacturing costs and addressing taxation. Safaricom and Google are helping make devices more affordable by spreading the cost (Gilbert 2020). KaiOS offers an operating system that makes less expensive phones 'smart' for as little as USD 10.

Digital skills. The International Labour Organization (2017) has a focus on digital skills for decent jobs, including the Digital Ambassador Program developed by the Digital Opportunity Trust, a Canadian non-profit organization that provides digital skills to people across Rwanda (ITU 2019).

Connection security and navigation safety. ITU has a number of initiatives to help build cybersecurity confidence including its Global Cybersecurity Index to help foster the capabilities of nations.[72] The World Economic Forum helps improve digital trust, while the Internet Society has initiatives strengthening the Internet.[73] Microsoft helped to set up the CyberPeace Institute and brokered the Cybersecurity Tech Accord (Burt 2019).

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Chapter 4

The critical role of middle-mile connectivity

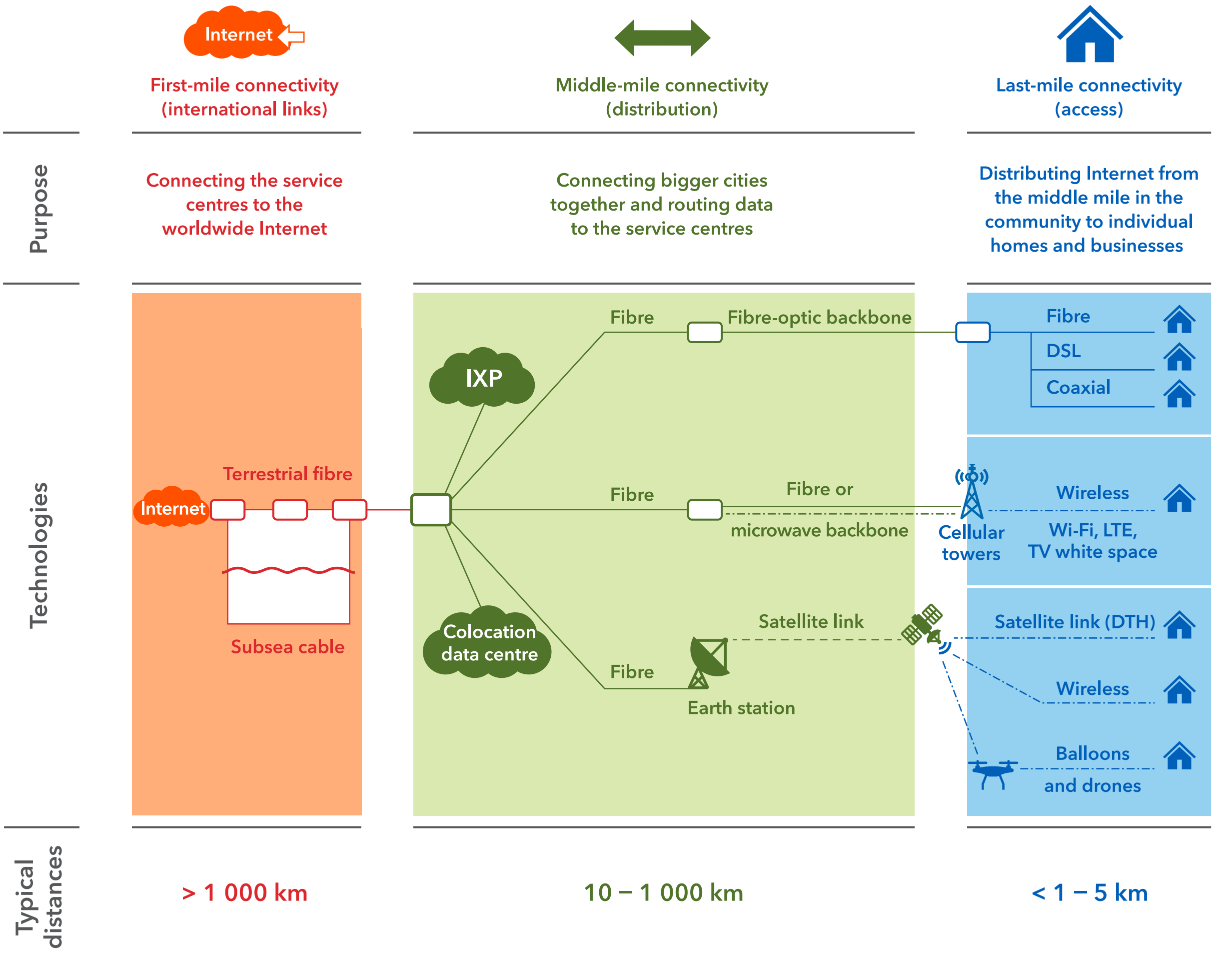
Chapter 4. The critical role of middle-mile connectivity

This chapter explores the importance of middle-mile connectivity as countries develop digital economies – achieving better quality, lower costs and greater redundancy. The "middle mile" consists of infrastructure responsible for storing and exchanging data.[1] It is an overlooked yet critical link in the connectivity chain, between international connectivity – or "first-mile" connectivity – and "last-mile" connectivity, made of the infrastructure that connects the users, which is hence more visible and tangible (Figure 4.1).[2] The three key components of a domestic data infrastructure ecosystem are Internet exchange points (IXPs), data centres and cloud computing.

4.1 Internet exchange points

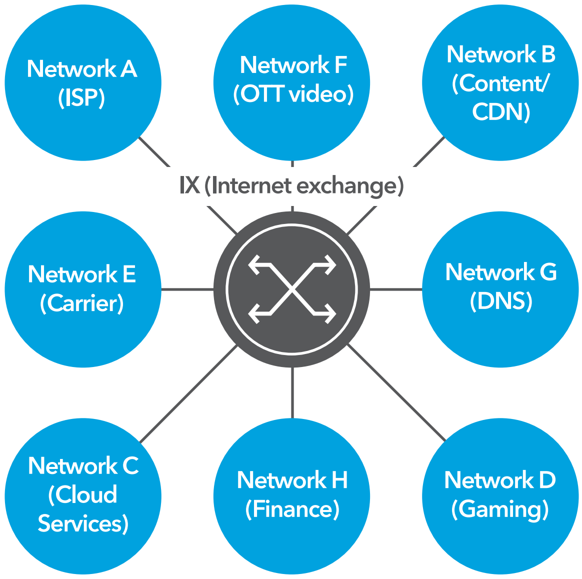
As IXPs grow to handle an increasing amount of data, they are relocated to a professionally managed data centre, allowing companies that need to exchange data to be closer to the IXPs and with their servers located in the same data centres. Similarly, as demand increases for cloud computing, service providers also situate data centres to be closer to customers. The IXPs sit at the core of this ecosystem (Figure 4.2). IXPs have been indispensable during COVID-19, keeping the Internet working and handling huge increases in traffic (Box 4.1).

Figure 4.1: The connectivity chain and the "miles" of connectivity



Note: IXP = Internet exchange point; DSL = digital subscriber line; DTH = direct-to-home; LTE = Long-term Evolution.
Source: Adapted from World Bank (2021).

Figure 4.2: The IXP ecosystem



Source: Adapted from Deutscher Commercial Internet Exchange (DE-CIX) (2021).

Box 4.1: COVID-19 and IXPs

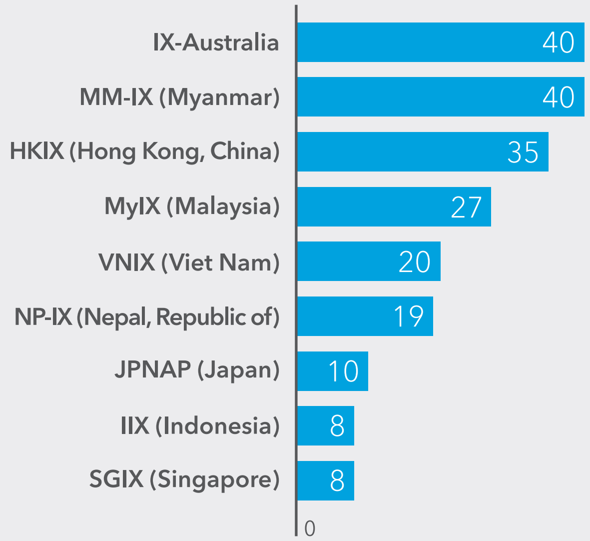
IXPs have been indispensable during COVID-19, keeping the Internet working and handling huge increases in traffic. Quarantine measures, remote working and schooling, and the streaming of video content all generated major increases in data traffic.

According to the Organisation for Economic Co-operation and Development (OECD), IXPs saw record net increases of up to 60 per cent in total bandwidth between December and March 2020 (OECD, 2020). Several IXPs reported breaking traffic records during lockdown periods. Peak traffic grew by more than 10 per cent at the world's third largest IXP, DE-CIX in Frankfurt, with applications such as Skype and Zoom doubling in traffic, and gaming increasing by 50 per cent (Dietzel, 2020). One study of IXPs in North America and Europe found a 15–20 per cent traffic increase within a week of restrictions, driven by applications used at home, such as videoconferencing and gaming (Feldmann *et al.*, 2020). The Norwegian Internet Exchange saw a shift in traffic patterns – peak traffic occurred in the day rather than in the evening. Traffic also moved from being mainly inbound to mainly outbound as a result of uploaded videoconferencing traffic on the back of home working. Though unclear whether related to COVID-19, there was an increase in traffic in late 2020 as more members joined (Olsen, 2021).

The Asia Pacific Internet Exchange Association (APIX) surveyed its members in June 2020 on the traffic impact of COVID-19 – all experienced growth, which ranged from 8 to 40 per cent (Figure 4.3).

Figure 4.3: COVID-19-induced traffic increase on Asian IXPs

Percentage peak traffic increase, April-June 2020



Source: Katsuyasu (2020).

IXPs are a core component of data infrastructure, enabling Internet service providers (ISPs) and content providers to exchange their data traffic – known as "peering". The IXP method of data exchange offers substantial advantages, some of which are listed below:

- It is less costly than using international bandwidth, since traffic is not sent back and forth over costly overseas links. Latin America could slash by one-third the USD 2 billion a year it spent on international bandwidth through greater use of IXPs, according to one study (Agudelo *et al.*, 2014). Studies for Kenya and Nigeria also find that IXPs reduce overseas payments and improve latency (Kende, 2020).
- ISPs do not need to make peering agreements with each potential partner.
- Redundancy is enhanced, since countries do not rely on international bandwidth if there is a disruption.
- IXPs also improve quality, since they are situated closer to the user and hence have less latency.
- IXPs reduce the time it takes to retrieve data, enhancing user engagement. In Rwanda, it is 40 times faster to access a local website (<5 milliseconds) compared with those hosted in the United States or Europe (>200 milliseconds) (Kende and Quast, 2017).

IXPs grow organically – and attract big content providers

IXPs begin as locations for ISPs to exchange traffic. Initially, this may not amount to much traffic, since in many developing countries locally relevant content is limited or is hosted abroad. IXP participation has grown more diverse over time, now frequently including companies, governments, content providers and cloud operators as members. Diverse and growing participation also stimulates demand for data centres, boosting the economy. Companies also want to be closer to end users to reduce latency and enhance the Internet experience.[3]

IXPs also reduce the need for international bandwidth due to a reversal of network routing. Instead of countries having to pay international transit fees to access content overseas, large content and cloud providers are increasingly moving to IXPs (Table 4.1). These companies handle the backhaul to their data centres, on occasion through their own submarine cables.[4] Content providers have now overtaken telecommunication carriers as the largest users of international capacity.[5] Three content

Table 4.1: Top 10 companies by presence on an IXP, December 2021

Company	ASN*	Type	Number of IXPs present on
Hurricane Electric	6 939	Network service provider (NSP)	275
Cloudflare	13 335	Content delivery network (CDN)	263
Packet Clearing House	3 856	Educational/Research	212
Google	15 169	Content	207
Microsoft	8 075	Content	194
Akamai	20 940	CDN	182
Facebook	32 934	Content	168
Amazon	16 509	Enterprise	129
Subspace	32 261	CDN	116
Netflix	2 906	Content	107

*ASN = Autonomous System Number uniquely identifying organizations routing traffic over the Internet.
Note: There were almost 24 000 organizations with an ASN in December 2021. CDNs deliver other companies' data to the IXP, whereas "Content" refers to companies that deliver their own content to the IXP.
Source: PeeringDB (www.peeringdb.com).

providers – Google, Facebook and Netflix – account for two-thirds of all mobile application traffic (Sandvine, 2020), highlighting the importance of attracting content providers to IXPs.

According to Packet Clearing House, there were 726 active IXPs around the world in December 2021. Despite the benefits of an IXP, 65 countries and territories do not have one.[6] These are mainly countries where there is only one ISP or are small island States where the volume of domestic traffic may be insufficient to warrant an IXP. In contrast, a number of countries have multiple IXPs – much needed to reduce latency in large countries with dispersed populations. Multiple IXPs also deliver redundancy and, through competition, are likely to reduce costs of use. However, introducing multiple IXPs in a country in the early stage of middle-mile connectivity risks reducing the scale of the IXP and its attractiveness to content providers.

The top 10 IXPs by the volume of traffic exchanged speak to well-developed ecosystems with high levels of participants (Table 4.2). While most are based in high-income nations, two entries are based in Brazil and one in Ukraine. This top 10 group boasts an average age of 17 years, reflecting the importance of experience in developing an efficient IXP. Most have hundreds of participants and are available in multiple data centres to better reach their customers. Some are expanding operations into other countries. For instance, Deutscher Commercial Internet Exchange (DE-CIX) is available in 16 other countries.[7] Of these, nearly all are high- and upper-middle-income nations – but this model could be more widely applied through partnerships in developing nations. Amsterdam Internet Exchange (AMS-IX) has opened IXPs in Hong Kong, China; the United States; Curacao; and India.

The existence of an IXP does not guarantee its potential benefits. Although the number of IXPs has grown in developing nations, many in low-income nations are stuck in first gear, with few participants and very little traffic. Average membership per IXP in low-income nations is 9, compared with a world average of 57 (Figure 4.4, left). Interestingly, upper-middle-income economies – not high-income economies – have higher membership levels and traffic per IXP. This is because large countries such as Brazil, Russian Federation and South Africa have well-developed IXP ecosystems and boast some of the largest IXPs in the world.

Regionally, there are also notable gaps (Figure 4.4, right). Europe generates 260 gigabits per second (Gbit/s) of traffic per IXP, the highest of any region. Most long-established IXPs are European, with many years of experience. On the other hand, Africa (excluding South Africa) has on average 14 participants per IXP, compared with a world average of 57, and generates just 9 Gbit/s per IXP, compared with a world average of 173. While South Africa accounts for just over 10 per cent of the continent's IXPs, it boasts two-thirds of all African IXP participants and 86 per cent of African IXP traffic.

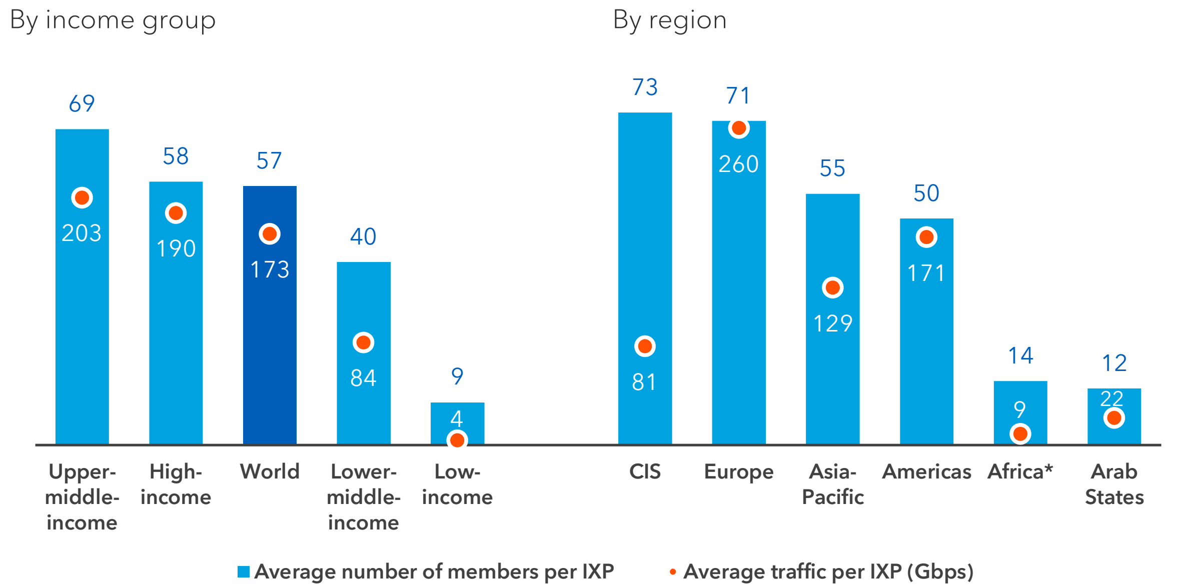
Table 4.2: Top 10 IXPs by traffic exchanged, December 2021

IXP	Country	Age* (years)	Number of data centres located on	Number of participants	Peak traffic (terabits)
IX.br São Paulo	Brazil	17	17	2 413	12.5
AMS-IX	Netherlands	24	15	881	10.8
DE-CIX	Germany	26	22	1 066	10.2
London Internet Exchange (LINX)	United Kingdom	27	18	885	6.6
PIT Chile – Santiago	Chile	5	3	109	6.1
Neutral Internet Exchange (NL-IX) – Amsterdam	Netherlands	19	22	448	3.4
Japan Network Access Point (JPNAP) Tokyo	Japan	20	8	130	2.7
EPIX. Warszawa-KIX	Poland	8	3	702	2.7
Giganet Internet Exchange Kiev	Ukraine	9	7	119	2.5
IX.br Rio de Janeiro	Brazil	11	12	470	2.1

Age* = From the year it was established.
Sources: PeeringDB (www.peeringdb.com) and IXP websites.

Figure 4.4: IXP membership and traffic

Average members and traffic per IXP, December 2021



Notes: * Excluding South Africa. Chart shows the average of peak traffic based on available data. CIS = Commonwealth of Independent States.
Source: Packet Clearing House (www.pch.net/ixp/dir).

Problems facing IXPs in developing countries

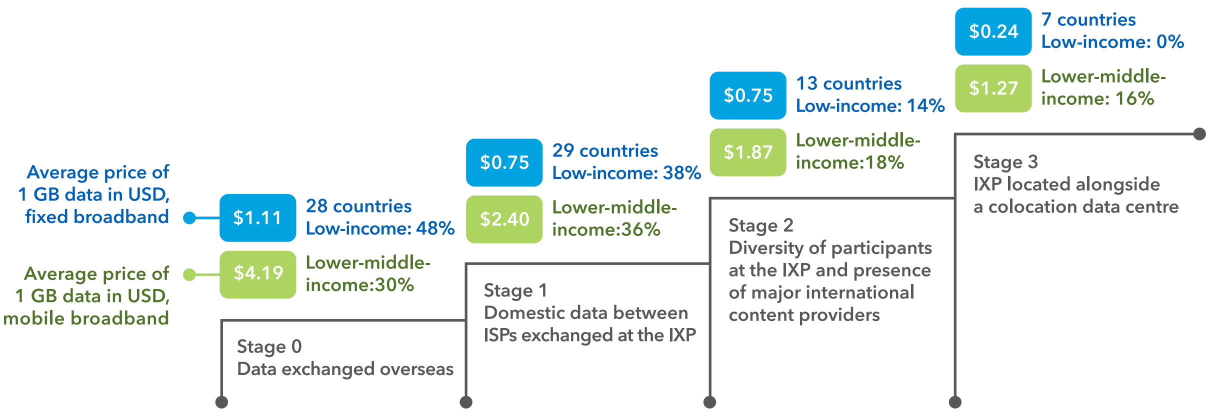
Many IXPs in developing countries are dysfunctional, with few participants and little traffic. In some cases, IXPs are located on government premises, typically in a small server room and using equipment provided through development assistance. For instance, the European Union (EU)-financed African Internet Exchange System project established IXPs in 14 African countries (EU-AITF, 2018). They generate limited amounts of traffic, sometimes with low participation of ISPs, and suffer from a lack of resources to upgrade equipment and train and retain staff. There may also be regulatory restrictions forbidding players other than ISPs from participating in the exchange – and onerous ISP licensing procedures limiting ISPs. Some incumbent ISPs are reluctant to participate because of fears that their dominant market position will be impacted. Government-operated IXPs or those located in State-owned facilities can discourage international content and cloud providers from participating. Another factor is that some IXPs in developing regions are recently established. In other markets, IXPs have flourished, as larger ISPs realize the economic benefits of peering at the IXP to create better and faster connections at lower costs. This success in turn attracts big content companies and cloud providers.

Stages of IXP growth

IXPs progress in stages, and each higher stage of development increases its impact. The first IXPs are typically established by universities or as non-profit associations of ISPs. They are located in small server rooms, with technical tasks carried out by volunteers. As traffic increases, and new participants join, a more sustainable technical and operational environment becomes necessary – more formal governance, staff hiring and equipment upgrades. The final stage sees many participants wishing to join without having to deploy a physical connection to the exchange. Multiple IXPs in different locations are created and the IXP is relocated to a colocation data centre (discussed below).

Developing countries are at different stages of maturity in regard to IXPs. At one end of the scale are countries with no IXPs, while at the other are countries that boast a dense fabric of multiple IXPs located in connected data centres, usually operated by the private sector and with many different participants. As countries progress through the stages, prices drop, performance improves and traffic increases (Srinivasan *et al*., 2021) (Figure 4.5). (See Box 4.2 for IXP profiles from Kenya and Viet Nam.)

Figure 4.5: IXPs and stages of growth



Notes: Data provide close to global coverage for the year 2020, and are compiled from a variety of industry sources, including Packet Clearing House, CAIDA, PeeringDB, EURO-IX and AF-IX. Amounts are in United States dollars. Average price figures updated using the ITU 2021 price statistics and refer to the entry level data-only mobile broadband (2 GB) and the fixed-broadband (5 GB) baskets. GB = Gigabyte; ISP = Internet service provider; IXP = Internet exchange point.
Sources: ITU; Srinivasan *et al.* (2021).

Box 4.2: Kenya and Viet Nam: IXPs in action

The Kenya Internet Exchange Point (KIXP) is an established, efficient IXP in a middle-income economy. Launched in 2000, KIXP is operated by a non-profit organization representing technology companies. Its board follows IXP best practices, such as those adopted by Euro-IX.[8] KIXP has no restrictions on the types of organization than can connect to the exchange, and is located in colocation data centres in Nairobi and Mombasa. Participants include national, regional and international ISPs; government agencies; financial companies; and international content and cloud providers such as Amazon, Facebook, Google, Microsoft and Netflix.

The Viet Nam National Internet eXchange (VNIX) is managed by the Viet Nam Internet Network Information Center (VNNIC) under the Ministry of Information and Communications. VNNIC is responsible for the country's Internet resources, including the country code top level domain (.vn), as well as IP addresses and ASNs. VNIX, established in 2003 according to government regulation, is run as a non-profit organization. There are three locations throughout the country (Hanoi, Ho Chi Minh City and Da Nang), with 18 participants, all Vietnamese. VNIX has played an important role in the development of the country's key Internet infrastructure, connecting ISPs and organizations, reducing costs, improving network quality, maximizing security and fostering cooperation. VNNIC has leveraged its responsibility for the country's core Internet infrastructure to maximize VNIX's impact. While the exchange has historically only hosted domestic participants (local ISPs), VNIX is moving to the next stage of data infrastructure maturity – planning to locate within a data centre and inviting international content providers to participate.

Source: Srinivasan *et al.* (2021).

4.2 Data centres

Data centres provide space, power and cooling for servers hosting data and network cabling. They play a fundamental role in the digital economy by the storing of data, and the local hosting of domestic content. In addition, data centres offer a significant advantage when processing large volumes of data – and in the development of big data services. Their presence is also a measure of the digitalization of the economy, reflecting demand from the information and communication technology (ICT) sector and beyond – finance and insurance, transportation, legal and accounting activities, research and development, advertising and the public sector (Calvino *et al.*, 2018). IXPs also benefit from data centre hosting, attracting more diverse participants and enjoying more professional facilities.

Data centres can be classified into four broad categories:

- *Enterprise data centres* are single-tenant facilities owned by a company to store data. They are either located on a company's site or in a dedicated facility off-site.
- *Carrier data centres* are provided by telecommunication operators to host their clients' data. This has historically locked clients into exclusive use of the operator's data centre services. However, growing numbers of telecommunication operators are now providing "carrier-neutral" connectivity.
- *Multi-tenant data centres* (MTDCs) are operated by companies that rent out space for data storage. Leading operators usually have certifications for security and reliability.[9]
- *Hyperscale data centres* belong to major content and cloud providers such as Facebook, Google, Amazon and Microsoft (who together account for over half). There were close to 600 hyperscale data centres at the end of 2020, more than doubling in five years (Synergy Research Group, 2021).

In the past, data centre connectivity was often via a direct telecommunication link between a company's office and the data centre. Today, however, more flexible communication links from the data centre to the outside world are essential – many companies may be using the centre and employees can also be at disparate sites throughout a country or the world and, as the case during COVID-19, working from home.

Three ways to organize data centre connectivity

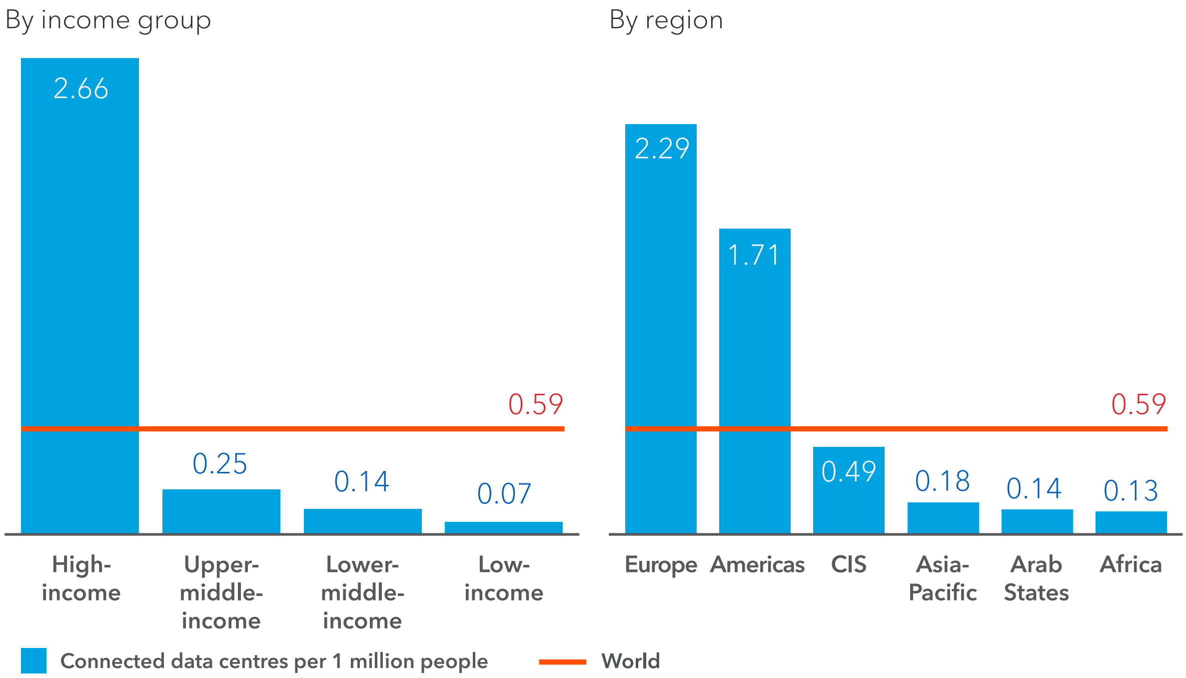
Data centre connectivity can be accomplished in different ways. In some instances, telecommunication companies may operate MTDCs *but require the tenant* to use their services – this can result in higher prices and a lack of flexibility. A further option is for an IXP located in the data centre to handle data exchange – an attractive option, since this is often done through free peering arrangements. The benefit is magnified when content and cloud providers are also in the data centre. A third option is carrier-*neutral* MTDCs operated by companies that do not provide telecommunication services – tenants are free to use any telecommunication provider to handle their data transport needs. Notably, some telecommunication operators now offer open peering MTDCs and own IXPs.

Global overview of data centres shows large disparities

PeeringDB provides a global listing of companies that exchange traffic over the Internet and the data centres they are located in.[10] Globally, there were 4 300 data centres connected to the Internet in November 2021. Large disparities exist in connected data centre penetration: 57 economies do not have a connected data centre. While connected data centre penetration is 2.7 per million inhabitants in high-income nations, it is considerably less in low- and middle-income nations (Figure 4.6, left). Similarly, sharp regional disparities exist – with a penetration of more than 1.5 connected data centres per 1 million inhabitants in Europe and North America, compared with less than 0.5 in other regions (Figure 4.6, right). While such disparities are related to income and demand for large-scale data storage, they are also caused by a lack of complementary infrastructure (particularly energy) and by policies that have inhibited private investment.

Figure 4.6: Data centres penetration

Connected data centres per 1 million people, 2021



Notes: *Connected data centre* refers to any kind of data centre connected to the Internet. CIS = Commonwealth of Independent States.
Source: PeeringDB.

Another view of data centre dispersion is to examine where the leading carrier-neutral MTDC operators are headquartered (Table 4.3). The MTDC big picture is dominated by United States-headquartered operators, including the two largest, Digital Realty Trust (DRT) and Equinix, with some hundreds of data centres between them. Of the 2 113 organizations with a connected data centre, 1 565 (74 per cent) report operating just one. The top 20 MTDCs account for less than 1 per cent of organizations offering connected data centres – but do account for over a quarter (27 per cent) of the total data centres and 74 per cent of the total of those operating more than five data centres.

Mapping data centre locations of the 20 largest MTDCs reveals stark geographical gaps (Figure 4.7). Dense concentrations occur in developed regions such as North America and Western Europe, the powerhouses of the digital economy, while in much of the rest of the world there are none.

Data centres are costly to build, and in many low- and middle-income countries, the private sector lacks the capital and necessary expertise. Major MTDC operators such as Equinix, DRT and NTT rarely have data centres in low- and middle-income countries. However, some MTDC companies partner with local investors to build data centres. In India, EdgeConneX (2021), a large MTDC operator, is partnering with local company the Adani Group to help build six data centres. Private companies with a regional focus are also operating MTDCs in developing countries – several companies are building data centres in Africa (The Economist, 2021).

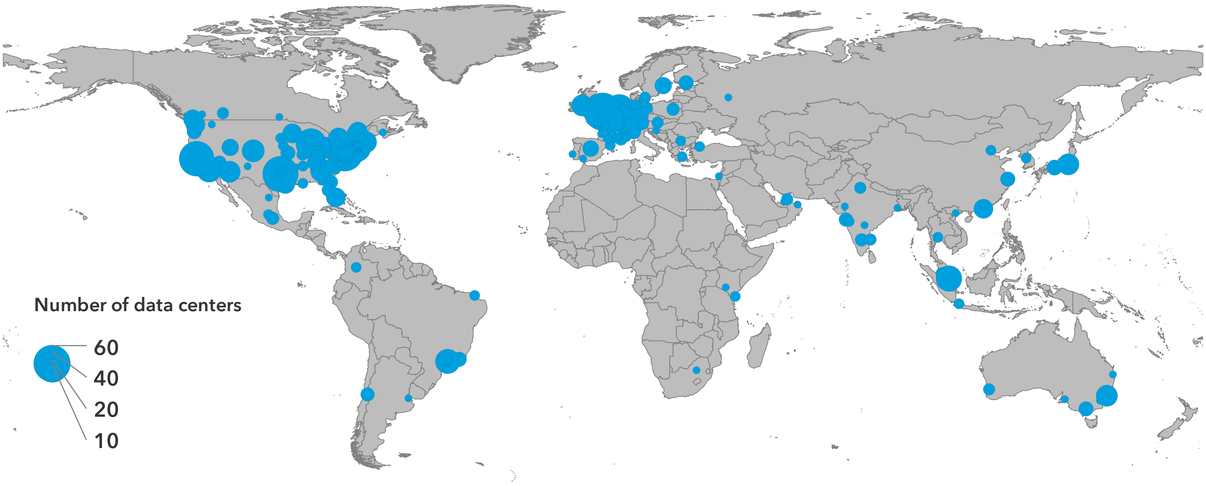
Development partners are providing investment funding in government data centres, but companies often do not want to locate in State-owned facilities. In 2021, China loaned Senegal USD 18 million for a government data centre, with Chinese company Huawei providing equipment and technical support (Swinhoe, 2021a). In Togo, also in 2021, the World Bank provided USD 24 million to the Government for the country's first world class data centre, providing space for non-government tenants (Swinhoe, 2021b). The centre is built by French company APL,[11] and managed by Africa DataCenters,

Table 4.3: Top 20 MTDC operators, December 2021

Operator	Headquarters	Number of data centres	Number of locations	Number of countries
DRT	United States	291	57	24
Equinix	United States	240	65	27
DataBank	United States	63	32	3
CyrusOne	United States	53	24	8
Cogent	United States	52	50	7
NTT	Japan	47	28	15
Cyxtera	United States	42	23	7
EdgeConneX	United States	42	34	10
Flexential	United States	39	19	1
Cologix	United States	38	11	2
TierPoint	United States	38	26	1
STT GDC	Singapore	33	12	4
Ascenty	Brazil	27	11	3
Keppel	Singapore	26	15	11
Evoque	United States	25	20	8
QTS	United States	23	19	2
Telehouse	Japan	23	14	11
Colocation America	United States	22	9	1
Coresite	United States	22	9	1
Iron Mountain	United States	18	16	6
Total		**1 164**		

Source: MTDC operator websites (excluding non-neutral colocation data centres).

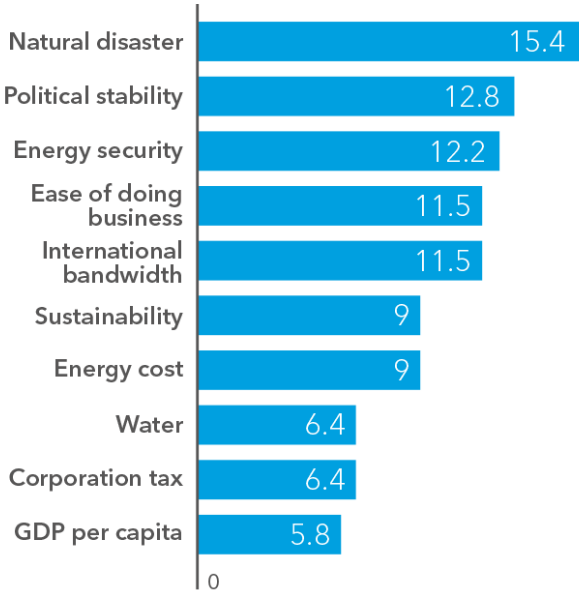
Figure 4.7: Data centre locations of top 20 MTDC operators



Note: The size and colour of the dots refer to how many data centres there are in that location. For example, there are 63 in London.
Source: Compiled from locations reported by top 20 MTDC operators.

which operates nine facilities throughout the continent.

Figure 4.8: Factors affecting successful operation of data centres (weight of importance, %)



Note: Percentages refer to the weight of each factor affecting successful data centre operation.
Source: Cushman and Wakefield (2016).

Low- and middle-income economies remain largely underinvested in data centres. An estimated 700 new data centres are needed in Africa to reach the same penetration rate as South Africa, which has the continent's highest ratio of data centres to population (Oxford Business Group, 2021). While lack of demand and low incomes are often cited as reasons for this gap, other factors are at play – natural disasters, unpredictable political environments, energy supply and ease of doing business all remain significant challenges. Energy costs and taxes are less important factors, while gross domestic product (GDP) per capita ranks the lowest (Cushman and Wakefield, 2016) (Figure 4.8).

4.3 Cloud computing

Cloud computing has transformed data storage and analysis by allowing users to access scalable data storage and computing resources as needed. As broadband connectivity has boomed, delays associated with remote storage, processing and analysis of data have dropped significantly – and cloud use by businesses and governments has taken off. Cloud computing is especially attractive, since it helps avoid costs associated with maintaining on-site hardware, software and storage.

Cloud computing continues to go from strength to strength – offering big data analysis; computing power; on-demand infrastructure; and competitive cost, maintenance and advanced big data technologies. Big data analysis is increasingly taking place over distributed cloud networks. High-performance computers powerful enough to run artificial intelligence programs are frequently only available on the cloud – the same is true for the

Internet of Things generating vast amounts of data.

Microsoft Azure, Amazon Web Services and Google Cloud – large firms from the United States –dominate the cloud. They have hyperscale cloud data centres, most located in developed countries with stringent data protection and sovereignty regulations.

However, the lack of a cloud data centre in a country is overcome through "on-ramps" to cloud computing services (DP Facilities, n.d.). Customers can meet cloud providers at IXPs located in colocation data centres, avoiding costly international transit to access cloud services – and enjoying greater security and reliability, improved performance and reduced costs. (The cloud provider manages and routes the traffic back to its cloud data centre.)

Cloud and content providers have emerged as some of the largest investors in backbone infrastructure, including submarine cables to route traffic from MTDCs to their own hyperscale data centres (Winrow, 2021). Countries no longer need to spend money on international bandwidth to access popular content and the cloud, since the providers will come to a country's MTDC if conditions are favourable.

Big data analysis and sharing applications are often available only on the cloud, and while it may seem attractive to store data on the cloud, there are three factors to consider. First, it can be costly to store data on the cloud. Organizations often use a "hybrid cloud approach",[12] storing on the cloud only the data needed for cloud analytics. Second, latency is a key issue for applications such as finance and gaming, if stored on the cloud. Third, national security grounds may dictate that sensitive data be stored in the country – the cloud data centre needs to be located in the country and the cloud provider needs to adhere to national data laws.

4.4 Conclusions and recommendations

There is a huge divide in core data infrastructure between high-income and other countries. Many low- and middle-income economies have inadequate data infrastructure that cannot support transformation to sustainable digital economies – and which function at higher cost and with poorer quality. While investment has in the past been flat because of a perceived lack of demand, many such countries have seen accelerated use of the Internet, spurred by COVID-19. Investment limitations in core data infrastructure persist, however.

Scale is critical. Private investment in data centres has *not* been forthcoming in countries with small populations – though possibilities are emerging. Smaller, energy-efficient facilities are increasingly viable, as are schemes involving countries working together on regional data infrastructures featuring Internet exchange points. Most low- and middle-income countries in fact increasingly have the scale to attract investment, especially in view of data infrastructure operators' need to be close to customers, to reduce latency. Often what holds back investment is the absence of an enabling environment and an immature data infrastructure ecosystem – it does take time for IXPs to achieve large scale. In short, countries need to build data ecosystem environments that attract investment.

There are five building blocks to create a more conducive environment for middle-mile connectivity.

- **Liberalization:** Liberalization of the telecommunication market fosters growth in core data infrastructure. Deregulation increases investment opportunities and provides businesses more options in their choice of providers. Introducing unhindered competition in the international transit market would benefit IXPs, making large ISPs less dominant and more likely to join an IXP. For example, South Africa attributes its leading data centre position in Africa to the early liberalization of the telecommunication market (Oxford Business Group, 2021). Similarly, Equinix, one of the world's largest multi-tenant data centre (MTDC) operators, entered the Mexican market following the country's 2013 telecommunication reform.[13]
- **Data protection:** Data protection laws are especially important for attracting investment into MTDCs and cloud computing. Such laws stimulate investment if they require certain data to be stored in the country – and offer protection to investors who are looking to limit reputational risk arising from

data breaches.[14] Europe has the highest share of countries (96 per cent) with a data protection law, due to the 2018 introduction of the EU General Data Protection Regulation. Since then, a growing number of economies – including China, Japan, Singapore, Thailand, India, Brazil and the United States state of California – have adopted data protection regulations. Globally, two-thirds of countries have data protection laws, but a number of developing countries have yet to adopt one (UNCTAD, 2020).

- **Energy:** Data centres consume a lot of energy in powering servers and keeping them cool – a challenge that has become more pointed in the context of the climate crisis. Investors have been more focused on a strategic path towards carbon neutrality than on price. Governments could facilitate investment in this regard by liberalizing energy markets, thereby allowing independent renewable power producers and suppliers to enter the market. With set targets for carbon neutrality, most major MTDCs prefer renewable sources to be available in countries where they invest. The largest hyperscale data centre owners are the world's leading buyers of renewable power purchase agreements (IEA, 2021).
- **Collaboration:** This is essential across the many parties involved in a country's data infrastructure – governments, IXPs, ISPs, data centre operators and investors (such as development partners, content developers and cloud providers). Governments need to grasp the vital role that IXPs play in developing a country's data ecosystem – and put in place enabling policies, strategies, laws and regulations. Developing countries should pursue partnerships with large IXPs, providing capacity-building as well as helping to establish facilities. Those developing countries with enabling data infrastructure policies need to market more robustly their advantages, thereby encouraging private sector investment. While some development agencies have supported IXPs and data centres, more work can be done.
- **Key metrics:** There are no official international sources of key metrics for IXPs and data centres at a country level – in spite of the great importance of data infrastructure. Improving the availability of key statistics on the digital economy at country level is essential. Timely, comparable and reliable statistics on data infrastructure are essential for countries to measure their performance and better understand the relationship between international and domestic traffic exchange. Several organizations collect relevant administrative statistics related to IXPs and data centres, and many IXPs and MTDC operators also report on their activities. Groups such as the Expert Group on Telecommunication/ICT Indicators (EGTI)[15] could partner with those already collecting relevant statistics – to identify and define key indicators, to review and harmonize existing data sets.

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3 Cloudfare, "What is edge computing?" Available at www.cloudflare.com/learning/serverless/glossary/what-is-edge-computing.

4 In this case, the "backhaul" is the portion of the network that links the international network and the data centre.

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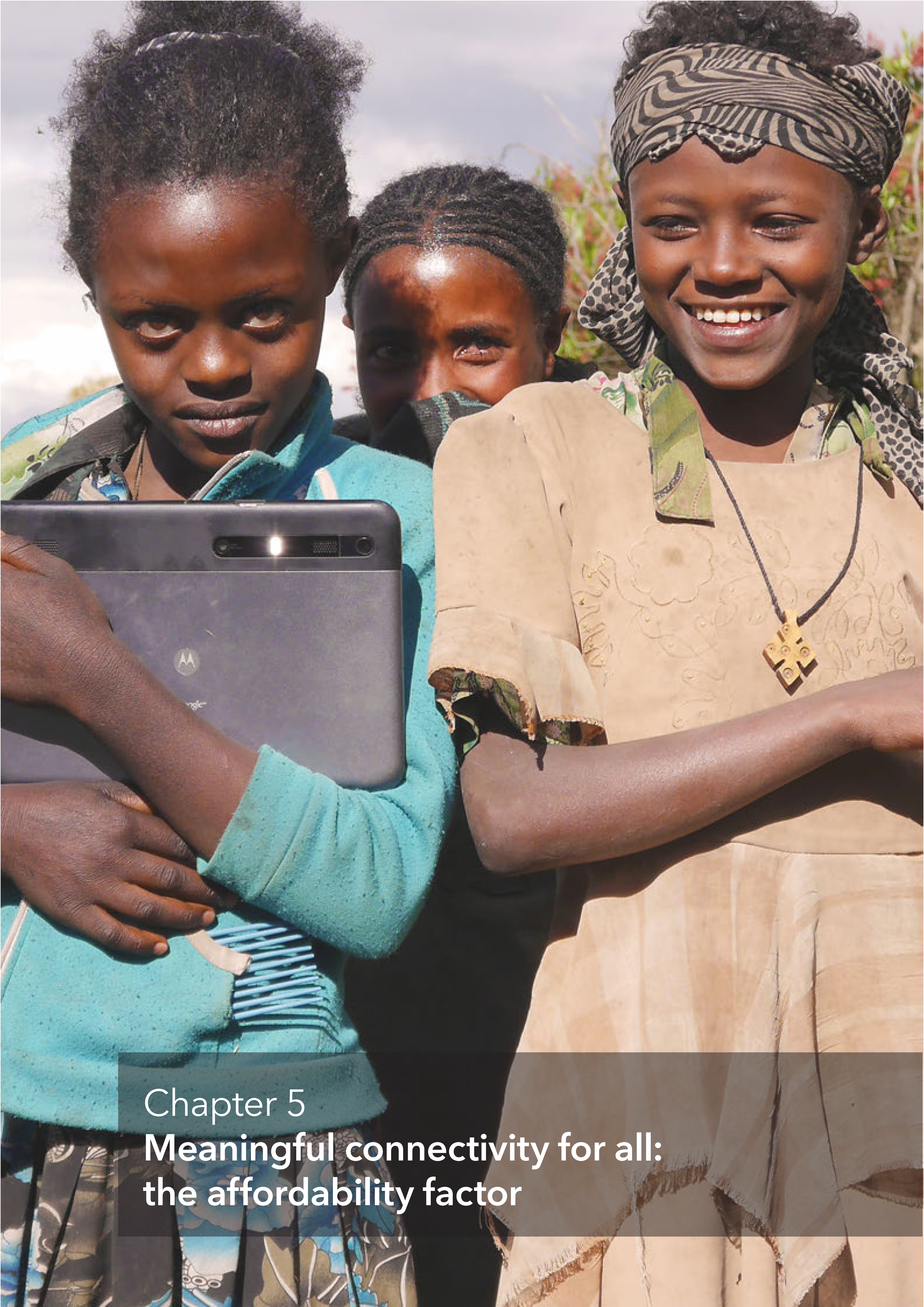


Chapter 5

Meaningful connectivity for all: the affordability factor

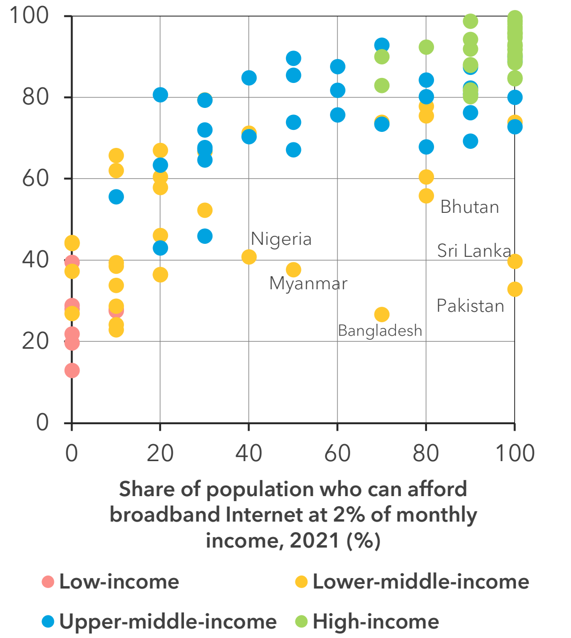
Chapter 5. Meaningful connectivity for all: the affordability factor

5.1 Introduction

Excessive connectivity pricing is an important barrier preventing millions from using the Internet, or using it to its full potential. What one considers "excessive" depends on user preferences, the price of the connection device and the service, as well as one's personal economic situation. Evidence shows that the share of those who can afford a broadband connection and the share of Internet users are closely linked (Figure 5.1). In low-income economies, where at most only 10 per cent can access a benchmark broadband basket[1] by paying no more than 2 per cent of their monthly incomes, the share of those who used the Internet barely reached 40 per cent in 2021. Users in many low- and middle-income economies often paid significantly more than 2 per cent of their incomes on mobile broadband access – or had to accept more limited services than those in high-income economies, where almost everyone can afford entry-level broadband services (and where the share of Internet users was highest). Figure 5.1 clearly illustrates the affordability gaps across and within countries, which this chapter will address. At the same time, the outliers in the lower-right corner (e.g. Sri Lanka, Pakistan and Bangladesh, where Internet penetration is below 50 per cent) show that the lack of affordability is not the only obstacle to connectivity.

Figure 5.1: Affordability – a barrier to connectivity

Share of Internet users vs. share of population who can afford the entry-level mobile or fixed broadband basket, 2021



Note: The share of population who could afford the benchmark broadband Internet (horizontal axis) is measured by adding up the population deciles ordered by income, for which the benchmark fixed or mobile broadband basket (whichever was cheaper) did not cost more than 2 per cent of monthly income.
Sources: ITU (2021 Internet user estimates); ITU and Alliance for Affordable Internet (A4AI) (2021 price data); World Bank PovcalNet (income distribution, latest available year).

5.1.1 Defining service affordability

Affordability of ICT services is defined as the relative cost of an established minimum combination of telecommunication services (the usage of Internet data, voice calls, sending SMSs) compared with a given income. ITU applies the definition of entry-level services as set by its Expert Group on Telecommunication/ICT Indicators (EGTI) when measuring ICT prices and affordability (Box 5.1).

Box 5.1: ITU's approach to measuring ICT prices and affordability

ITU supports the international benchmarking of affordability by collecting and publishing annual statistics on ICT services.[2] To ensure international comparability, ITU's data collection relies on the basket approach. Baskets are globally comparable units of ICT services (commercially available plan(s) and, if necessary, add-ons) with set allowance thresholds (i.e. how much data or voice should be included as a minimum) and characteristics adhering to strict rules. The **five baskets** for which ITU currently collects data are shown in Figure 5.2. These include a fixed-broadband basket (with a minimum of 5 GB monthly data allowance) and four mobile baskets. Three of these include broadband data usage: one is the data-only mobile broadband basket with a minimum of 2 GB monthly allowance, while the other two are low- and high-consumption mobile data and voice baskets, with 70 minutes, 20 SMSs and 500 MB, and with 140 minutes, 70 SMSs and 2 GB data allowance, respectively. Finally, data are collected for a mobile cellular low-consumption basket, which offers the cheapest means for mobile communication, especially for the lowest-income communities, given the lower network and device needs.[3]

Figure 5.2: The ICT price baskets currently monitored by ITU

	ICT price baskets	Minimum monthly allowance: Voice (min)	SMS (#)	Data	Affordability measure: % of GNI per capita
1	Data-only mobile-broadband basket	-	-	2 GB	*
2	Mobile data and voice low-consumption basket	70	20	500 MB	
3	Mobile data and voice high-consumption basket	140	70	2 GB	
4	Mobile-cellular low-usage basket	70	20	-	
5	Fixed-broadband basket	-	-	5 GB	*

Note: * refers to baskets considered for the Broadband Commission for Sustainable Development's affordability target (see Box 5.2).
Source: ITU.

The baskets were defined by EGTI to reflect entry-level or basic usage, rather than the needs for meaningful connectivity, which implies being able to do whatever one wants to do. Actual user demand for monthly allowance often exceeds 2 GB. Nevertheless, for developing countries, the World Bank estimated that basic online activities – such as visiting websites for public services, health information, shopping, learning and news – require around *660 MB data usage per month, per user*; if common recreational online activities – including social media use – is considered as well, this increases to around *6 GB* (World Bank, 2021).[4] The COVID-19 pandemic showed that Internet access is a necessity for which users are willing to pay, and data have been gradually taking over other forms of communication, *thus the entry level data usage is an evolving threshold*.

Comparing prices obtained in local currency requires a conversion to common units. To measure affordability of a basket in a country, the monthly basket price (in local currency) is divided by the monthly average per capita gross national income (GNI), in local currency, which expresses what share of the income users have to pay to afford the basket. Alternatively, basket prices can also be expressed in United States dollars for a simple comparison, or in international dollars (purchasing power parities (PPPs)) to reflect differences in purchasing power.[5] A basket is considered affordable if the rate as a percentage of GNI per capita is below a normative target rate – e.g. 5 per cent or 2 per cent (see below).

There are alternative measures of affordability that take into consideration income distribution within a country – i.e. the GNI per capita price of a basket relative to the income of the bottom 40 per cent of the population, or the share of the population that does not pay more than a set amount of its national income on a basket.

This chapter builds on the 2021 data (collected by ITU and A4AI), as well as on historical ICT price statistics. It aims to expose affordability gaps and emerging trends, and to explore what may drive affordability. Affordability strategies today focus on both fixed and mobile broadband data connections. The chapter focuses on the two data-only broadband baskets (fixed and data-only mobile-broadband). Where relevant, statistics are shown for other baskets.

How much should entry-level ICT services cost so that they are affordable? The question recurs and evolves with changes in the ICT domain. This chapter (especially Figure 5.9) suggests that countries achieved high levels of mobile broadband penetration when the population was able to access entry-level broadband services for not more than 2 (or at most, 5) per cent of average income. This is in line with the 2 per cent of GNI per capita policy target set by the Broadband Commission for Sustainable Development (see Box 5.2).

Box 5.2: Setting the affordability target

The Broadband Commission for Sustainable Development was established in 2010 by ITU and the United Nations Educational, Scientific and Cultural Organization (UNESCO) to bring broadband to the top of the international policy agenda. In 2018, it reaffirmed its commitment to connect the "other half" of the world's population, and defined seven measurable targets. On affordability, the target aims to reduce the price of entry-level fixed or mobile broadband services in developing countries to less than 2 per cent of monthly GNI per capita by 2025. Prior to 2018, the target was 5 per cent of GNI per capita.

Source: Broadband Commission for Sustainable Development.[6]

5.2 Affordability gaps and trends around the world

How does the affordability of broadband services differ across the world? Where are the most important divides?

To access the Internet, users face one-off costs of device and recurring costs for service. Initial service activation can be burdensome, too. ITU data collected for the entry-level fixed broadband price baskets indicate that the global median initial connection fee is equivalent to a 60 per cent surcharge to the first month's subscription fee. How this fee is charged varies across service providers (e.g. some waive the fee when users sign up for a longer commitment period), and data show only a slightly declining trend over the past decade.

5.2.1 Affordability of devices

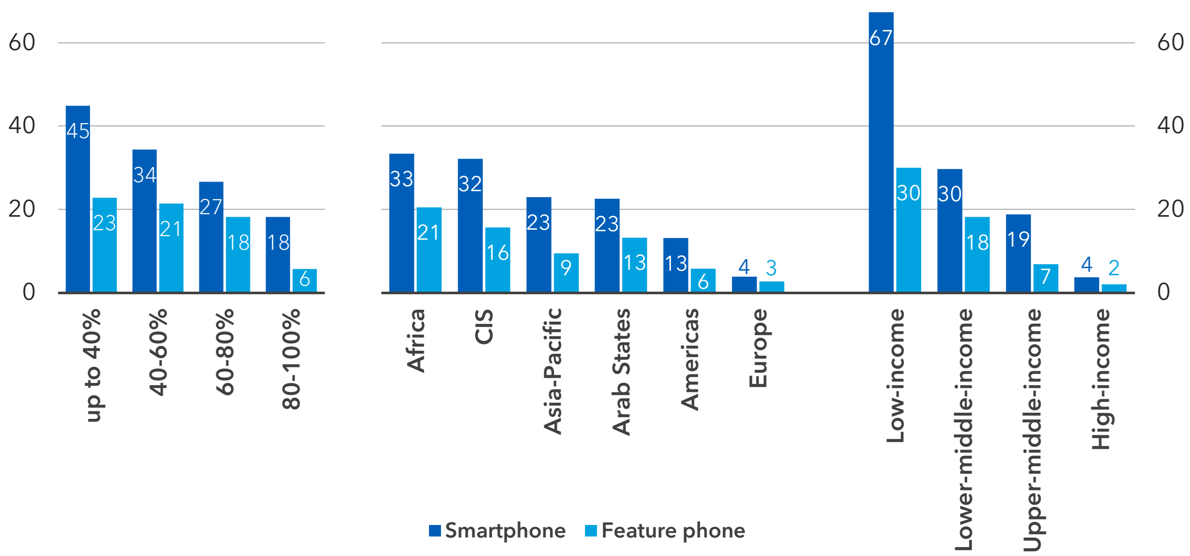
Purchasing a device (e.g. a smartphone) is a fixed cost and, for those on low incomes, can pose a barrier for Internet access. Data show that the lower the share of Internet users in a country, the less affordable the devices are. Users are expected to pay nearly 60 per cent of their monthly incomes to buy new smartphones from their operators in economies where the share of Internet users is less than 40 per cent – four times the price paid by consumers living in countries with 80 per cent or higher connectivity rates (Figure 5.3, left side). To a large extent, the gap is explained by income levels. The average monthly income in a high-income economy is sufficient to buy 27 of the cheapest smartphones (Figure 5.3, right side). By contrast, in a low-income economy, the average monthly income is less than 1.5 times the price of a basic smartphone. These figures are based on the median price for a country group, hiding a much wider range of prices across low-income economies than across high-income ones.

The affordability of devices differs across countries and goes beyond income levels. Device prices are shaped by development, production, marketing and transportation costs, as well as tax and trade policies, market competition and consumer preferences.

In many low- and lower-middle-income economies, only the richest strata of the population can afford new smartphones. However, the rest of the population does have alternatives. Free or cheaper devices are often available for consumers if they sign up for longer commitment periods, while smartphones can be bought from other retail channels,[7] often second-hand. "Feature phones" are less capable than smartphones, but provide a level of Internet connectivity, and are typically less than half the cost of smartphones.[8] The differences, where data

Figure 5.3: Affordability of smartphones and feature phones

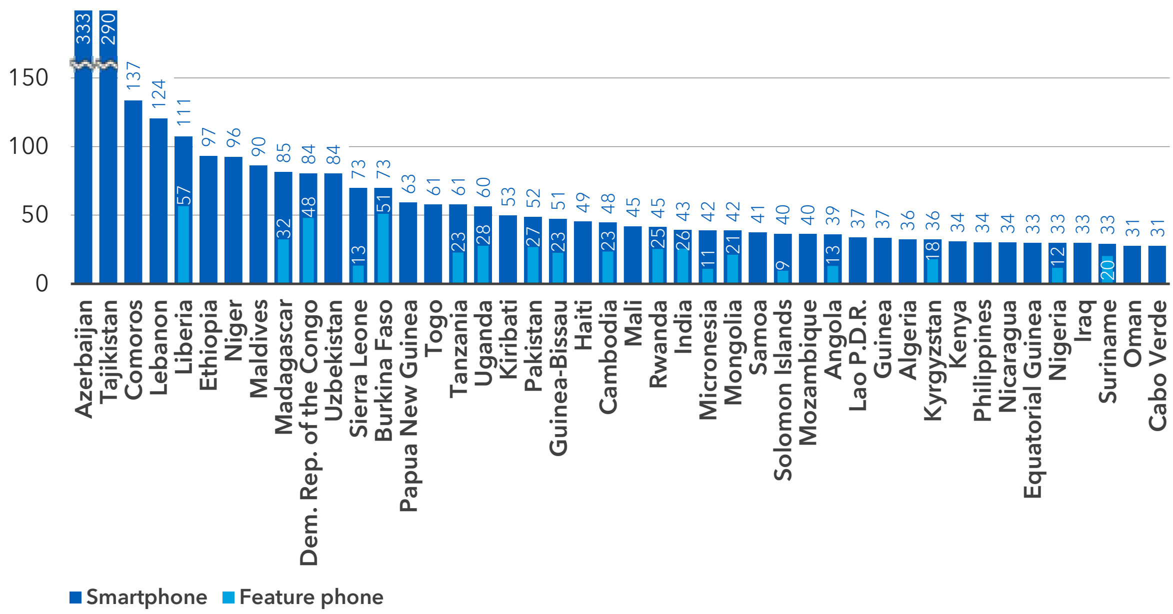
Median price (percentage of monthly GNI per capita), 2021



Note: CIS = Commonwealth of Independent States.
Source: ITU based on A4AI.

Figure 5.4: Affordability of devices

Price of smartphones and feature phones (percentage of monthly GNI per capita), 2021



Note: Showing data for economies where a smartphone costs more than 25 per cent of monthly GNI per capita.
Source: A4AI.

are available, are shown in Figure 5.4 for economies where a smartphone costs more than 25 per cent of monthly GNI per capita.

5.2.2 Affordability of service – mobile broadband is central to universal connectivity

The infrastructure for household fixed broadband Internet access is still lacking in many parts of the world – but is widely available for mobile broadband access – which is why its affordability is particularly important in achieving universal connectivity. At 2 per cent of GNI per capita, the global median price of a data-only basket with 2 GB monthly mobile data traffic is on the cusp of the affordability target. However, there are variations in the cost of such a basket across countries. In 40 of the 89 economies that did *not* meet the target, it cost *more than 5 per cent* of GNI per capita, as shown in Chapter 2 Figures 2.23 and 2.24. Affordability varies hugely across regions and income groups, as well as by type of connection (Figure 5.5). Most noticeably, African consumers (many living in low-income economies where the annual per capita income rarely exceeds USD 1 000[9]) would need to pay *more than three times* the world price in relative terms, while those in the Americas would pay *more than twice* the world price. In sharp contrast, the typical price in Europe was a quarter of the world price in 2021.

Substantial differences persist between the price of the entry-level *fixed* broadband and data-only mobile broadband baskets. In general, fixed broadband costs 50 per cent more than the *mobile* broadband basket, but often includes more monthly data usage and a higher-quality user experience, albeit without the advantages of mobility. The price gaps are also more pronounced between all four income groups for fixed broadband – costing a hefty 12.1 per cent of monthly income for the average earner in a typical lower-middle-income economy in 2021, and a massive 37.3 per cent of the monthly income in the typical low-income economy.

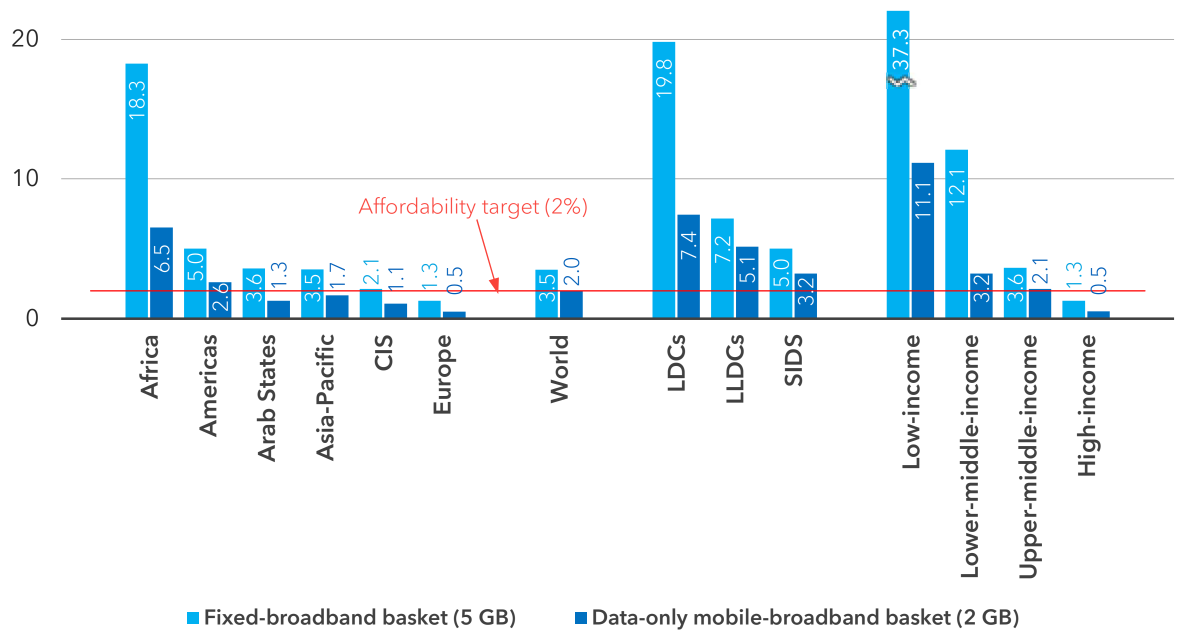
5.2.3 Affordability gaps within countries

There can be significant inequality in income and consumption within a given country – so even if the average earner can afford a basket, it does not follow that the poorer segment in that country can afford it.

ITU uses a second measure of affordability: the cost of service as a percentage of the

Figure 5.5: Fixed and mobile broadband affordability gaps

Median price of the entry level fixed- and data-only mobile-broadband broadband basket (percentage of monthly GNI per capita), 2021



Notes: Median prices for the fixed broadband basket (5 GB) are computed based on 177 economies with data available for 2021; the basket is defined as the cheapest fixed Internet subscription available domestically, with a minimum of 5 GB monthly data allowance and an advertised download speed of at least 256 kbit/s. Median prices for the data-only mobile broadband basket (2 GB) are based on 190 economies with available data; the basket is defined as the cheapest data-only mobile broadband subscription available domestically, with a 3G or more advanced technology, and a minimum monthly data allowance of 2 GB. CIS = Commonwealth of Independent States.
Sources: ITU and A4AI.

average income of the bottom 40 per cent of the population. In the universal and meaningful connectivity framework, the affordability target of 2 per cent of monthly income, set for 2030, also applies to this part of the population (Chapter 2).

In economies with large income disparities, the bottom 40 per cent would spend a far higher share of their incomes – two to five times more – than the average earner, to use the same broadband services (Figure 5.6). For example, in Honduras, the mobile broadband basket with 2 GB allowance costs around 8.7 per cent of the average per capita income, but the bottom 40 per cent will not be using this basket, since it would represent over 30 per cent of their incomes.

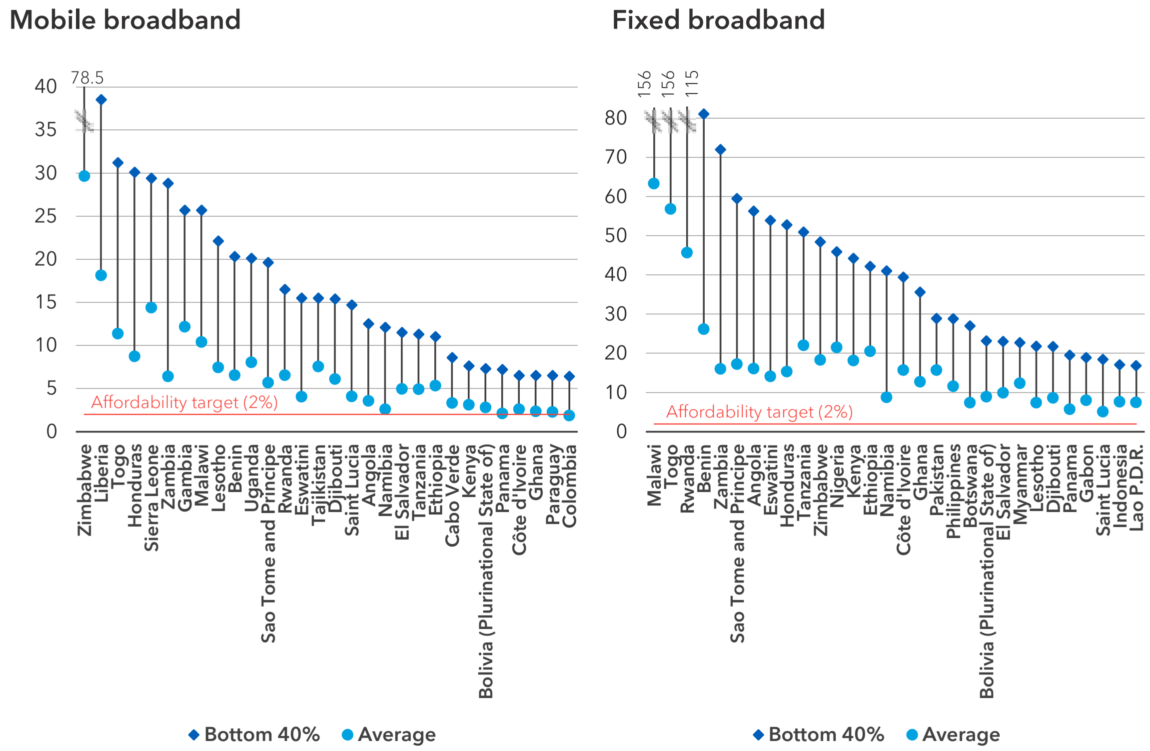
Fixed broadband services are even less affordable for the bottom 40 per cent. In low- and lower-middle-income economies, the basket is only accessible for the wealthiest few. Even in higher-income Europe, prices for the bottom 40 per cent are above the 2 per cent threshold. Mobile broadband is a fairly affordable alternative for the lowest-earning 40 per cent across the world, at a median price of 2.5 per cent of income per capita – not the case, however, in Africa (5.5 per cent) and in the Americas (14 per cent).

If we apply the 2 per cent affordability threshold to the lowest-earning 40 per cent of the population, only 16 of the 66 middle-income economies with available data and none of the low-income economies would meet the affordability target for the data-only mobile broadband basket.

If a large part of the population with low income cannot afford the benchmark broadband basket, they do not necessarily remain offline. What are their alternatives? Mobile operators in many low-income economies provide prepaid broadband plans with shorter validity periods (e.g. daily or weekly plans) or lower data caps than the monthly 2 GB benchmark for a fraction of the price. In many markets, discounted prices are available during off-peak or night

Figure 5.6: Broadband prices are often beyond reach for the lowest-earning 40 per cent

Prices, percentage of monthly income



Notes: Prices shown are for the 30 economies where the baskets are the least affordable for the bottom 40 per cent. Prices refer to the data-only mobile broadband (2 GB) and the fixed broadband (5 GB) baskets (see Box 5.1).
Sources: ITU, based on World Bank PovcalNet (income distribution, latest available year) and ITU and A4AI (2021 ICT price baskets) data.

hours, or during weekends. While such options provide some of the benefits of broadband access for users at the "base of the pyramid", these are suboptimal solutions, falling short of the requirement of having a continuous monthly subscription implied in entry-level or basic connectivity, as well as being against the concept of meaningful connectivity.

5.2.4 Affordability trends

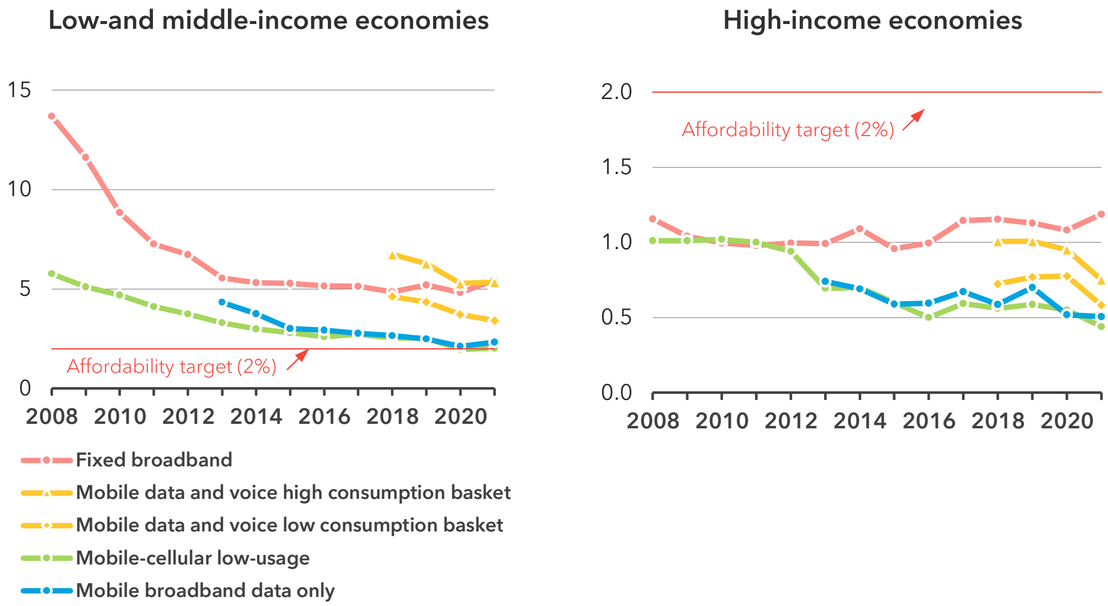
Many elements can impact affordability – the set of services may change, their price levels may change, and the average GNI levels may change. While trends have been uneven across countries and across baskets, three have shaped global affordability over the past decade – a decline in nominal and real price of telecommunication, a gradual increase in the basket content (especially data allowance),[10] and rising income levels – at least until the economic crisis triggered by the pandemic.

The median price of mobile baskets in low- and middle-income economies dropped significantly over the 2010s (the data allow a longer comparison – see Figure 5.7, left side). For example, the relative price of the data-only mobile broadband basket dropped by half between 2013 and 2021, as more advanced generations of broadband network technology were deployed (4G and, most recently, 5G). More recently, the provision of bundled services resulted in a drop in mobile data and voice basket prices in this group. While low- and middle-income countries saw a steep increase in affordability for the fixed broadband basket between 2008 and 2013, relative prices have stagnated at around 5 per cent of GNI per capita since then – and, sparked by the economic crisis ensuing from the COVID-19 pandemic, even increased in 2021.[11] The price of the basket also stagnated in high-income economies, but around a very different level of 1 per cent of GNI per capita (Figure 5.7, right side), well below the affordability threshold.

A further crucial trend regarding the fixed broadband basket sees high-income countries pulling further ahead. Whereas the data

Figure 5.7: Affordability trends of ICT services

Median prices of selected baskets, percentage of GNI per capita



Note: Median values for each of the baskets are based on the set of countries for which data were available for the respective time series. For changes in basket composition, please refer to the Methodology note. Income groups are as defined by the World Bank (2021).
Sources: Price data are from ITU (2008–2019), and ITU and A4AI (2020–2021); GNI per capita data are from the World Bank's World Development Indicators (accessed November 2021).

allowance threshold increased globally from 1 to 5 GB from 2018, the quality of the actual plans meeting the requirements of this entry-level basket *increased most noticeably in high-income economies*. In 2012, the median advertised speed in high-income economies was 2 Mbit/s, but by 2021, this had increased to 50 Mbit/s. In the rest of the world, the median advertised speed increased only marginally – from 0.5 to 6 Mbit/s over the same period. Thus, there is not only an affordability gap between high-income economies and the rest of the world, but also a widening quality gap.

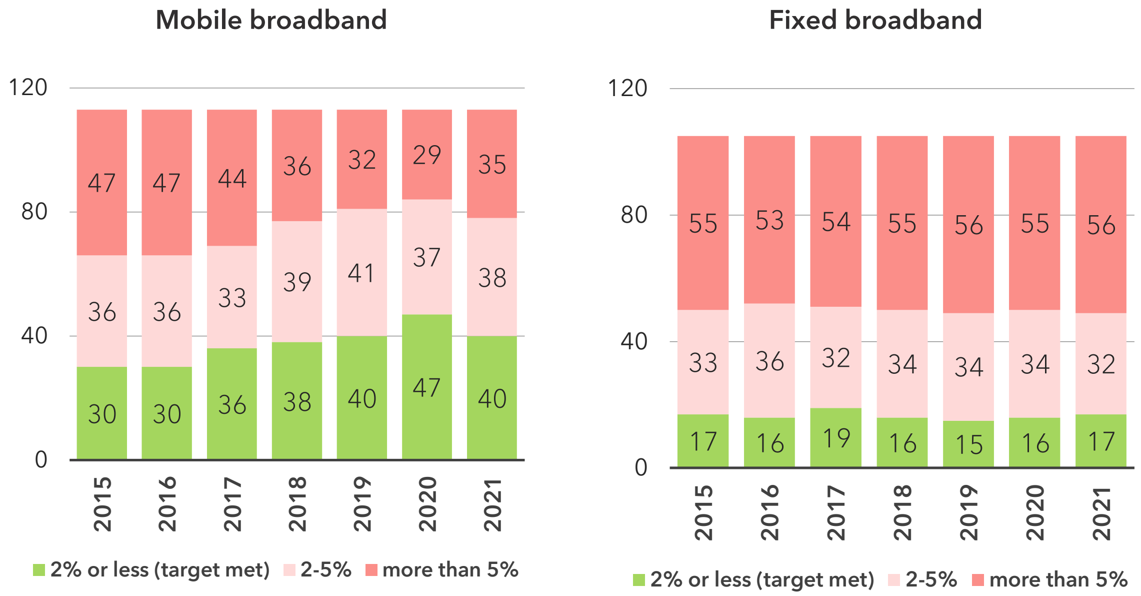
The number of economies that met the 2 per cent affordability target of the Broadband Commission for Sustainable Development (Figure 5.8, left side) increased between 2015 and 2020 – driven by the increasing affordability of the data-only mobile broadband basket across low- and middle-income economies. In 2015, only 30 of the low- and middle-income economies (where data were available) met the target, and 47 had prices exceeding 5 per cent of GNI per capita. Five years later, as many as 47 met the target and only 29 exceeded 5 per cent. The pandemic, however, set back this progress by at least a year. This may be temporary if income levels return to pre-pandemic levels. However, there is little room for optimism, given the high share of economies with barely affordable prices. The trend of stagnation in the case of the fixed broadband basket is also sobering: the number of low- and middle-income economies where the basket was affordable has not changed substantially since 2015 (Figure 5.8, right side).

5.2.5 More affordable broadband services, more subscriptions?

When targeting higher broadband adoption rates, we must endeavour to make broadband services more affordable. There is a clear-cut negative relationship between mobile broadband prices and penetration rates (Figure 5.9). Where mobile broadband costs more than 5 per cent of monthly GNI per capita, the penetration rate is never observed to be higher than 70 per cent – this is where affordability is clearly a barrier. Conversely, in economies where mobile broadband penetration was at least 70 per cent, mobile broadband has never cost more than 5 per cent of GNI per capita in past years.

Figure 5.8: Progress towards achieving the affordability target

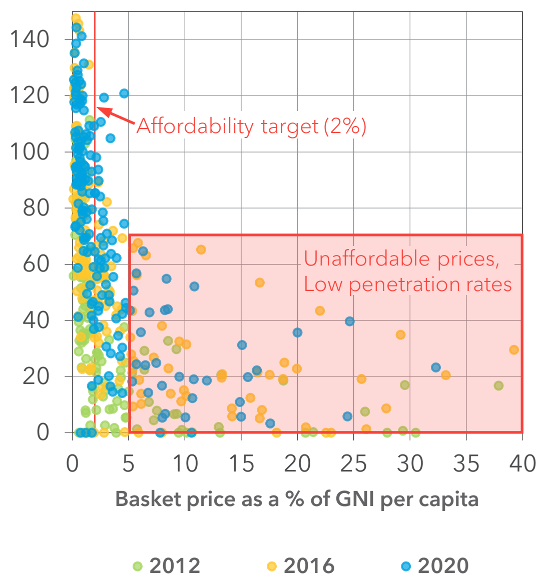
Progress of low- and middle-income economies with respect to the 2% affordability target



Note: These figures are based on a constant sample of low- and middle-income economies with data available for all years from 2015 to 2021 for the benchmark data-only mobile broadband basket and fixed broadband basket.
Sources: ITU and A4AI.

Figure 5.9: Mobile broadband prices and subscriptions across time

Mobile broadband subscriptions per 100 inhabitants



Sources: ITU and A4AI.

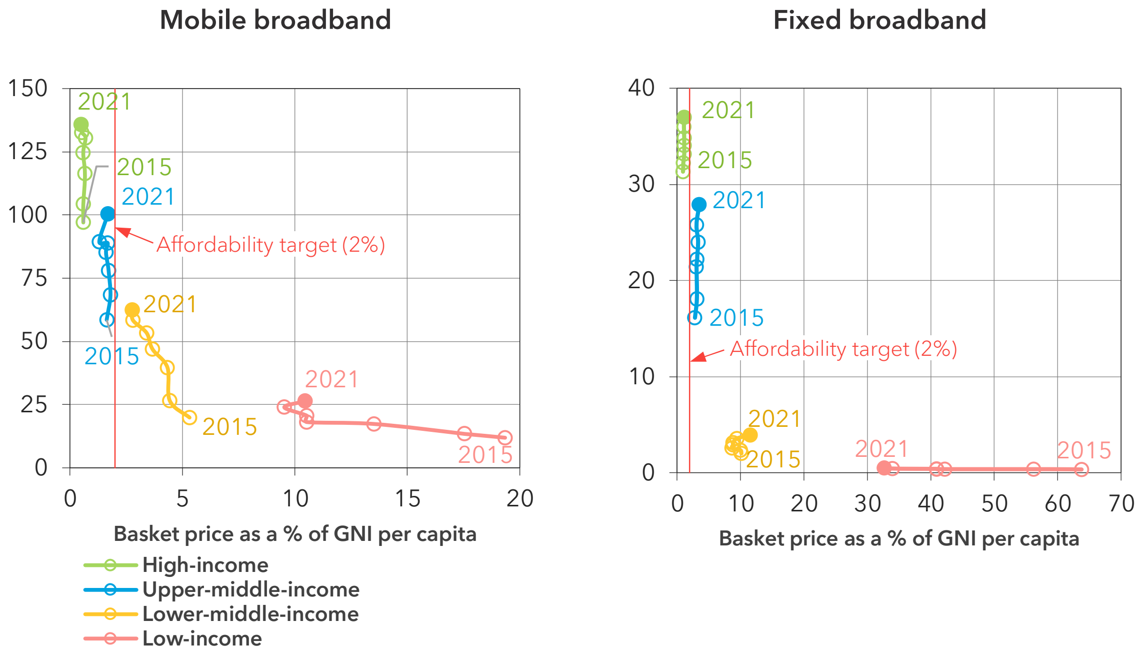
Over time, prices tend to decline and subscription rates tend to increase. Operators can increase supply and reduce service prices by deploying newer, more cost-efficient technologies, or realizing economies of scale in areas with higher population density – while network effects and improving living standards increase user demand. However, these changes do not follow a linear trend, as Figure 5.10 shows, by tracking the joint progression of median prices and subscriptions for the four income groups. The evolution of mobile broadband prices in low- and lower-middle-income economies reveals a threshold (around 5 per cent of monthly GNI per capita), above which subscription rates remained low, even if prices dropped significantly. The presence of a threshold is in line with earlier evidence from country-level studies.[12]

5.3 What are the drivers of affordability?

Of the factors that influence the affordability of fixed and mobile broadband services in a country, many are structural – such as the distribution of population, physical geographic features, or the size of the economy and disposable income levels – factors unlikely to change in the short or medium term. Other factors are not structural – the pace of technological change, the competitive environment and the regulatory framework, all of which are subject to policy interventions and can have an effect in the short or medium

Figure 5.10: A non-linear relationship between broadband prices and adoption (2015–2021)

Subscriptions per 100 inhabitants vs. basket prices, percentage of GNI per capita



Note: The connected lines show the evolution of country group median values from 2015 to 2021.
Sources: ITU and A4AI.

term. The list is not exhaustive, and evidence provided below reveals only high-level correlation patterns based on country-level data. Many of these factors are interlinked, so to understand the underlying causal mechanisms, further research is needed.

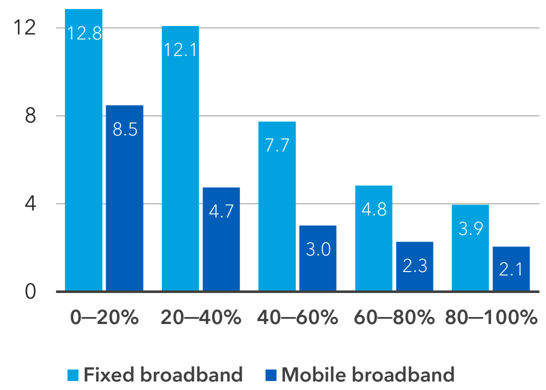
5.3.1 Geography and its impact on affordability

Country size and physical geography play a central role in the development of all kinds of infrastructure, not just telecommunications. Large distances, mountainous terrains, deserts and jungles, and remote island locations all increase the cost of network deployment – and the presence of roads and electricity are especially important for last-mile connectivity.

Deploying broadband networks in urban areas is cheaper and more scalable for suppliers – a prospect sweetened by the likelihood of higher disposable incomes of clients. In fact, the benchmark mobile broadband basket in low- and middle-income economies was *four times more affordable* in countries with urban population shares of at least 80 per cent, compared with countries where the rural population share was at least 80 per cent. Similarly, fixed broadband services were almost *three times more affordable* where the urban population share was over 60 per cent, as opposed to where it did not exceed 40 per cent (Figure 5.11). Country location can, however, complicate this association: prices were generally less affordable in landlocked developing countries and small island developing States, despite their having higher shares of urban population.

Figure 5.11: Urbanization and broadband prices

Median price of entry-level fixed and data-only mobile broadband baskets as a percentage of monthly GNI per capita by share of urban population in low- and middle-income economies, 2021



Sources: World Bank World Development Indicators and ITU.

5.3.2 Size of the economy

The size of the economy influences the affordability of broadband services in multiple ways. Higher levels of disposable income by definition improve affordability – this was clearly visible in the charts showing the affordability gaps – as they incentivize operators to invest. This is starkly reflected in figures for average revenue per mobile subscription. While this figure was as low as USD 1.4 in low-income economies and just below USD 6 in upper-middle-income economies, the average revenue per mobile subscription in high-income countries was over USD 30 in 2020 (Figure 5.12, left panel). If we add to this the reality of overall declining mobile market revenues (see also ITU, 2018a), short-term prospects alone are an insufficient incentive for deploying new infrastructure to increase the subscriber base and decrease prices.

Indeed, investments in telecommunication services in low-income economies were on average very low in the 2018 to 2020 period, compared with both revenues (14 per cent) and also per fixed and mobile broadband subscription (USD 8) (Figure 5.12, right panel). Operators in low-income markets face equipment and network deployment costs that are similar to those in high-income markets, as the cost of capital is similar (if not higher due to distance), and cannot fully benefit from cheaper labour costs, as network deployment and maintenance require specialized skills.

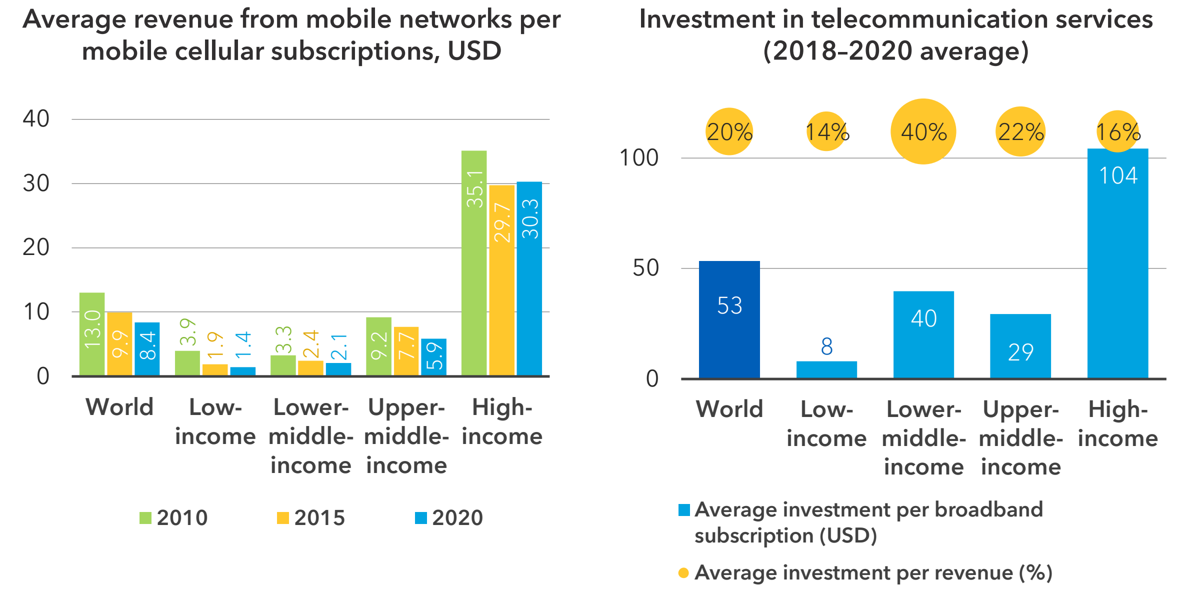
At the same time, the data show some promising trends. Investment levels in lower-middle-income economies were relatively high, reaching a rate of 40 per cent of revenue, and boosted by foreign direct investment. Moreover, operators benefit from directing investments in densely populated urban areas, and can take advantage of demand generated by local economic activities and the associated agglomeration and network effects.

5.3.3 Absent infrastructure – barrier to affordability

The absence of international and country-level data infrastructure are key barriers to affordable broadband prices. International bandwidth usage is a good proxy for measuring the international data linkages (e.g. through submarine or overland cables or satellite connection) – and data show that the median price of 1 GB of data mobile broadband data is radically higher in economies with limited bandwidth usage (Figure 5.13). This underlines the importance of national data infrastructure and the "middle mile" for the cost of broadband data (see Chapter 4).

The infrastructure for last-mile connectivity also plays a key role in affordability, especially that of fixed broadband. Users in high- and upper-middle-income economies, where the most widespread technology is fibre, generally enjoy lower prices than users in countries where other technologies dominate (such as cable or DSL – or even fixed wireless). Interestingly, in low- and lower-middle-income economies, where fixed broadband infrastructure is lacking, the fixed wireless connections offer a competitive alternative – for example, in Côte d'Ivoire, Guinea and Namibia, the price of the fixed broadband basket was relatively competitive, and at significantly lower levels than in other countries in the group where the most common technology was fibre – although at 13.4 per cent of GNI per capita, this was still only available for the wealthiest.

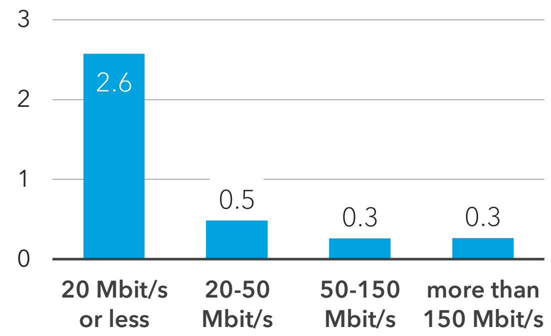
Figure 5.12: Operator economics: mobile market revenues and investment



Notes: Investments include total annual investment in telecommunication services. Broadband subscriptions include fixed and mobile broadband. Period average 2018–2020 serves to correct for annual fluctuations.
Source: ITU.

Figure 5.13: The advantages of international connectivity

Median price of 1 GB of mobile broadband data by average international bandwidth usage per Internet user, in USD



Notes: Bandwidth usage data are for 2020, price data are for 2021. Based on actual data allowance included in the plans used for the data-only mobile broadband (2 GB) basket.
Sources: ITU and A4AI.

5.3.4 Competition and affordability

The general trend indicates that the higher the degree of competition in the mobile cellular market, the more affordable mobile broadband becomes. However, the association is more complex in regard to income groups.

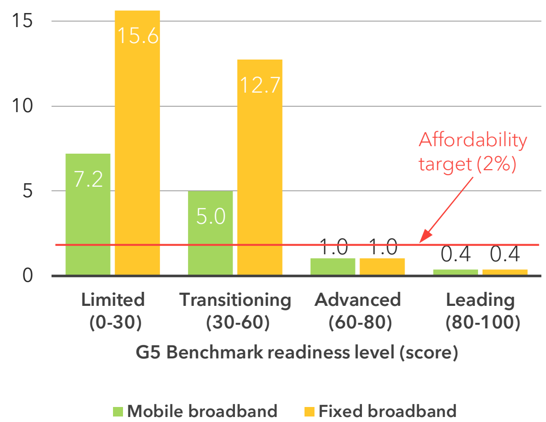
Across high- and middle-income economies, competitive markets enjoy the lowest mobile broadband prices (as a share of GNI per capita). In lower-middle-income economies, contrary to expectations, countries with very high market concentration (typically with a dominant operator) may have lower prices than countries with a higher degree of competitiveness brought about by regulatory intervention. Prices in such markets are still far above the affordability threshold, but with consumers worse off than those in a competitive market.

5.3.5 Regulatory frameworks as a driver of affordability

The right regulatory framework is important in engendering a telecommunication market that serves its people. Regulatory interventions are especially important where supply and demand forces alone cannot increase broadband network deployment and improve affordability beyond a certain level. An active ICT policy agenda expands well beyond the provision of ICT services, and seeks collaboration with agencies and ministries in other sectors, such as education, industrialization and rural development.

ITU's benchmark of fifth-generation collaborative digital regulation (G5 Benchmark) is a tool that helps quantify how far countries have progressed towards a collaborative regulatory environment – one that fosters digital development. (For more details on what is included, see Chapter 7 and ITU, 2021b.) Having in place a set of regulatory measures signals policy intentions, and are not an end in themselves. Their success depends on the country context. Their impact on the telecommunication market may be lagged, so their evaluation requires careful study design, which is beyond the aim of this chapter. Nevertheless, Figure 5.14 indicates a general trend that broadband services are more affordable in countries that are further ahead in their pathways towards collaborative regulation, measured by G5 Benchmark readiness levels. We can discern within this trend, however, a non-negligible variation of prices within lower readiness levels, confirming there is no single approach to digital regulation. There is a considerable number of countries with a *limited* G5 readiness level, but which offer affordable broadband prices. For countries with *advanced* and *leading* readiness levels, the prices are always affordable.

Figure 5.14: Average broadband price by G5 Benchmark readiness level



Note: Detailed information about the G5 Benchmark scores are available in ITU (2021b).
Source: ITU.

5.3.6 What can governments do to improve affordability?

Governments can resort to direct and indirect policy interventions to reduce the price of telecommunication services. Policies stimulating competition in the retail market are important indirect measures. There is a range of options for more direct measures. Governments may choose to condition regulatory approval on the availability of low-priced plans or services targeting specific regions or segments of society. A State-owned service provider, in countries where it exists, can directly assume the responsibility for delivering affordable access. The availability of free or low-priced service at public-access locations can help drive down telecommunication prices. This may be achieved by governments negotiating with operators the provision of such services in exchange for licenses or directly funding free public access (e.g. Wi-Fi hotspots in libraries, schools, hospitals, other public administration facilities). Businesses can also assume the cost of providing such services, capitalizing on opportunities to advertise services and gain market share. Subsidizing service usage or access to devices (through, for instance, tax refunds or cash transfers) can further help lower the relative costs for a target population.

Many of these policy interventions may build on the shared interest of governments and telecommunication operators in having affordable prices that enable the expansion of the subscriber base. The challenge is curbing retail prices in selected or all market segments without restraining investments. Successful interventions[13] depend on, among others, local market conditions and dynamics, and are typically part of more comprehensive broadband strategies.

5.4 Conclusions

The past decade has seen significant improvements in affordability of broadband access, especially mobile broadband. There remain, however, persistent affordability gaps in regard to both device and service – gaps between and within countries.

COVID-19 and the ensuing economic crisis increased affordability gaps between low- and high-income economies. They also left in place less visible gaps within countries – between the bottom 40 per cent and the average earner.

Affordability and connectivity go hand in hand. Countries where broadband is affordable have high numbers of Internet users. Conversely, countries where prices are not generally affordable have the highest share of the population remaining offline. Such countries are those where digital development is hampered – for example, due to geographic features, uneven population distribution or low levels of disposable income – which deters investment. Such factors combine to create a vicious cycle, where market size cannot drive down prices, while affordable connections do not attract new subscribers. The consequence is that many people remain offline. The least mature ICT regulatory environment goes hand in hand with the least affordable prices in countries. There is hope that policy intervention has the potential to set in motion a virtuous cycle – one where the promise of digital development attracts investment in network infrastructure, which in turn expands the market and drives down prices below affordability thresholds.

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Endnotes

1 This is mostly a data-only mobile broadband basket (2 GB) or a fixed-broadband basket (5 GB). See more details on the methodology in Box 5.1.

2 See the latest results in ITU and A4AI (2022) or recent analyses in ITU (2021a).

3 These baskets were defined by the ITU Expert Group on Telecommunication/ICT Indicators (EGTI) to benchmark the cheapest price plans for five categories of services across economies. The baskets are revised from time to time to adjust for changes in the global market for ICT services.

4 For comparison, ITU statistics for 2020 show that the average monthly mobile broadband data traffic in low-income economies was 1.4 GB and did not exceed 2 GB in 25 economies with available data, while in low- and middle-income economies, the total average monthly use was 4.5 GB.

5 The detailed Methodology document for data collection, price conversion as well as on definition changes in times series is available online at www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2021/ITU_ICT_Prices_Methodology.pdf.

6 Broadband Commission for Sustainable Development, "Make Broadband Affordable". Available at www.broadbandcommission.org/advocacy-targets/2-affordability/.

7 Smartphone affordability statistics are based on advertised prices for the cheapest new smartphones available from mobile network operators. See detailed data collection methodology at https://docs.google.com/document/d/1Vnc_jwumXZEOE-zNzDecSk8hJgtrkaCR0j1tYNUi8GE/edit.

8 In the data collection, a feature phone is defined as an Internet-capable mobile device (which typically has a physical number pad); a smartphone is distinguished by having an operating system, the ability to download third-party applications, and a touchscreen of at least three inches.

9 See World Bank, "World Bank Country and Lending Groups", available at https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

10 From time to time, EGTI has revisited the definition of baskets to align with the evolution of the global telecommunication market. For instance, the data-only mobile broadband basket that consists of 2 GB monthly data allowance has been introduced as of the 2021 data collection. Between 2018 and 2020, the reference basket included only a 1.5 GB monthly allowance, which in turn replaced the mobile broadband postpaid USB/dongle-based basket with 1 GB monthly allowance in use between 2013 and 2017.

11 See ITU and A4AI (2022).

12 See ITU (2018b).

13 See country case studies in the World Bank Broadband strategies toolkit (Kelly *et al*, 2014).

Chapter 6
Financing universal connectivity

Chapter 6. Financing universal connectivity

How to finance meaningful connectivity for all? This is the question that lies at the heart of this chapter. The cost of deploying fast, reliable and affordable broadband infrastructure – only one feature of meaningful connectivity (see Chapter 2) – is considerable. A recent study estimates that financing universal broadband access in developing countries over the next decade will cost between USD 0.62 trillion using 4G and USD 1.1 trillion using 5G Non-Standalone (NSA).[1]

Operators have generally provided last-mile Internet connectivity as part of their commercial deployments of infrastructure. Historically, mobile operators upgraded their voice networks to provide Internet, and then would use at least 3G for new deployments. Similarly, fixed telephone operators upgraded legacy copper networks to offer broadband service (e.g. DSL), while some upgraded parts of the network by rolling out fibre optic to increase bandwidth and broadband speeds, often all the way to homes – otherwise known as fibre-to-the-home (FTTH).[2]

However, in many areas around the world, first and foremost rural areas of developing countries, there is limited to no coverage, because commercial deployment of Internet access is not currently viable or seen as viable, due to high deployment cost and/or low user demand. In Africa, 4G coverage in urban areas is four times the coverage in rural areas (see Chapter 2). In some countries, 3G coverage does not exceed 40 per cent of the population and 4G has yet to be rolled out.[3] These areas are the focus of the innovative financing strategies examined in this chapter.

Networks benefit from economies of scale as more potential users are covered by the network. Investment is more profitable where population is denser – a mobile tower covers more people. Deployment is also more profitable where the geography is more conducive, and the demand and willingness to pay for services are bigger.

Rural areas feature deserts, mountains, large bodies of water, and/or great distances between population centres. Populations in rural areas are usually poorer than in cities, and spread over greater distances. All these features result in few economies of scale, effectively raising the cost of deployment.

6.1 Creating a conducive regulatory environment

Removing artificial constraints on deployment and demand can go a long way in improving commercial viability and encouraging investment.

On the cost side, regulatory obstacles may raise the cost of connectivity. Mobile services need radio spectrum to provide services, and mobile operators require exclusive licences to use the spectrum. These licences can be costly and can greatly reduce resources that could fund rural deployment (GSMA, 2019a). Moreover, operators need access to rights of way to deploy fibre networks and mobile towers – these may absorb both time and funds before being granted, again creating roadblocks. Import duties and delays may further raise the cost of equipment, again lowering the viability of deployments. While regulations are necessary, we should ensure that these do not result in unduly high costs, which block commercial network deployment in unconnected areas.

On the demand side, populations living in rural areas often have lower incomes, making Internet access less affordable. Compounding this problem, increased regulatory costs of deployment may mean higher retail prices. In addition, operators may have market power in retail markets or upstream connectivity markets, such as the gateway to access international connectivity, which may result in higher retail prices. Other government measures can also increase the cost of access – these include import duties and taxes on access devices or retail Internet services (GSMA 2019b). These costs fuel the usage gap – those for whom connectivity is available, but not taken up (see Chapter 1).

Addressing these regulatory obstacles will make services more affordable and increase demand. Policy and regulation can promote deployment and adoption of connectivity.

For example, governments can ease access to rights of way, and promote infrastructure sharing – facilitating mobile operators in the sharing of towers.[4] Governments can subsidize adoption, provide increased digital skills training, waive taxes on devices and services, and help to promote locally relevant content.

Taken together, these actions can enable companies to deploy in marginalized areas and with increased demand, and reduce, but likely not eliminate, the gaps towards achieving universal meaningful connectivity. More financing is therefore needed. However, current financing models have not yet been able to close the gap, and are not meeting the urgency of ensuring universal connectivity. These models can be supplemented with new sources of contributions, while innovative models can also be explored. Together, these models should provide not only the resources for financing new connectivity, but also the means for deploying those resources.

6.2 Current financing models

Current models for financing connectivity include public and private sources, at national and international levels. These are set out below.

6.2.1 Commercial deployment

Fixed and mobile operators continue to deploy networks at the national level commercially to fill gaps. As suggested above, however, and even with supportive policies, commercial deployment on its own will fail to meet the pressing need for universal connectivity.

A new source of commercial investment has emerged in the past decade from Meta (formerly Facebook), Google, Amazon and Microsoft, which is helping close connectivity gaps. They now use 66 per cent of the submarine cable capacity that connects coastal countries and continents, and are investing in new cables, often in partnership with traditional telephone carriers.[5] This increases bandwidth and lowers the cost of international connectivity for Internet service providers in connected regions. These companies are investing in national infrastructure, with local operators:

- Meta is providing technology to local Wi-Fi and mobile operators for connectivity and backhaul, helping reduce costs and service deployment – and deploying national backbone with operators in Uganda and elsewhere.[6] In addition, Meta is a co-founder of the Telecom Infra Project, which works to develop open, disaggregated equipment solutions to advance global connectivity.[7]
- Google is deploying urban metro fibre links in Ghana and Uganda, available to Internet service providers via a partnership (International Finance Corporation of the World Bank Group, Convergence Partners, and Mitsui and Co.) deploying infrastructure in Africa.[8] Google has recently committed USD 1 billion to Africa for connectivity, start-ups and digital skills training.[9]
- Since 2013, Microsoft's 4Afrika initiative has been developing affordable Internet access and digital skills, and promoting innovation in Africa, via investment in local start-ups, small and medium-sized enterprises (SMEs), and educational societies.[10] The initiative involves local partners and has brought cloud services to 1.7 million SMEs in Africa, and has provided training for 1.6 million people.[11] Internet access initiatives are now part of the Microsoft Airband Initiative, which partners with organizations to utilize television white space (TVWS) devices to provide Internet access.[12]

6.2.2 Universal service funds

Several countries have universal service funds (USFs).[13] USFs are funds collected by governments to reach universal service. They are raised through contributions from licensed telecom operators, as a percentage of revenues or as fixed fees. Studies suggest that USFs are underused – for instance, a study of 64 USFs noted that USD 11 billion was not being utilized (GSMA, 2013). Another study examined 43 such funds and found that 20 had used 50 per cent or less of the funds, 8 of these used less than 25 per cent, and 3 had used no funds at all (ITU, 2021). Reasons included poor governance (mismanagement, corruption, and lack of accountability and transparency), unclear or unmeasurable objectives, poor coordination and unfair process to allocation of resource, all contributing to underutilization, misallocation and inefficient use of resources.

6.2.3 Governments

Governments are increasingly adopting *national broadband plans* to promote broadband. The Broadband Commission for Sustainable Development has as its first advocacy target: "By 2025, all countries should have a funded National Broadband Plan (NBP) or strategy or include broadband in their Universal Access and Service (UAS) definition."[14] The Commission's latest report states that 165 countries had a broadband plan in place as of the end of 2020, which are evolving to address demand-side issues, as well as increasing the supply of broadband (Broadband Commission for Sustainable Development, 2021a). However, other than having a link to universal service funds, these plans do not necessarily incorporate concrete financing mechanisms.

6.2.4 International organizations

Several organizations contribute to increasing broadband availability. These include the World Bank and Inter-American Development Bank, and national aid agencies such as the United States Agency for International Development (USAID) and the Swedish International Development Cooperation Agency (SIDA). Support includes providing policy and regulatory advice to governments, and grants and loans for developing telecom networks. Development finance institutions – for example, the International Finance Corporation – invest in private sector companies supporting broadband deployment. In addition, foundations, non-profits and individuals provide funds.

6.2.5 Community networks

Bottom-up community networks are emerging at local level to serve their own needs.[15] These often use unlicensed spectrum for Wi-Fi services or offer mobile broadband using licensed spectrum. While often focusing on unserved rural communities in developing countries, some serve underserved urban communities even in developed countries.[16] These networks use grants from universal service funds or from non-governmental organizations such as the Internet Society, and can charge fees to ensure that they are sustainable. Such networks are low-cost, developed and operated by community members, and are responsive to the demands of their users.

Box 6.1: Giga initiative

Giga is a community initiative, developed by ITU and the United Nations Children's Fund (UNICEF), seeking to connect every school to the Internet. While aiming to ensure that every child has online access, Giga also creates a platform for the infrastructure to connect the local community and its residents to the Internet. Giga has created a real-time map of school connectivity to identify demand and measure progress. It recommends the best technical means to reach those schools, and partners with industry and governments in developing models for financing connectivity. Giga is proposing a USD 5 billion Connectivity Bond for infrastructure investment, backed by donor grants from governments and private foundations.

Sources: See https://giga.global and https://giga.global/bond/.

6.3 Innovative funding models

The efforts set out above will narrow, but not close, the digital divide. In 2021, the Broadband Commission for Sustainable Development set up the Working Group on Twenty-First Century Financing Models for Sustainable Broadband Development to develop new approaches for investment, funding and financing models. The Working Group addressed both the coverage and usage gaps, making three important strategic recommendations:[17]

- Broadening the base of contributors: New contributors could include digital companies, such as those with an e-commerce or other online focus, along with other companies deriving benefits from broadband. These contributors should cover many sectors of the economy that are undergoing digital transformation. In addition to the private sector, multilateral development banks, corporate social responsibility funds and philanthropic donors can all contribute to broadband-supporting projects. Contributions can come in a variety of forms, including investments and in-kind contributions such as digital skills training.

- Earmarking existing contributions from ICT sector participants: Telecom operators by law pay operator licensing fees, spectrum licensing fees, digital taxes, fees to access rights of way for infrastructure, and equipment import duties. These sector-specific contributions could be earmarked to support broadband initiatives. For example, the United States Federal Communications Commission earmarked funds from a spectrum auction to aid conversion to digital television, which in turn released spectrum for 4G roll-out. In Burkina Faso, among other African countries, a part of the licensing fees is invested in the USF.
- Reforming USFs: As noted above, USFs often fall short of their objective – failing to distribute as appropriate funds raised in support of infrastructure deployment where this is not commercially viable. Reforms proposed include the setting of clear, measurable objectives, establishing a fair process to allocate resources, and providing sound governance – including an independent administrator and stakeholder consultations.[18] A more fundamental reform would involve a "pay or play" option, which sees operators directly implementing approved projects instead of making financial contributions to the USF.[19] It may be more efficient to include coverage obligations directly into spectrum licences, so that mobile operators invest directly in coverage rather than indirectly through USFs.[20]

In addition to broadening the source of contributions, we need to broaden the target of investments. While capital expenditure (capex) is of course needed to deploy broadband, investment focus should broaden to support deployment and adoption:

- Capital expenditures (CAPEX): This is traditionally central to the development of any broadband connectivity project. New approaches, as noted above, can provide capital expenditure. In addition, in-kind assets can be made available – for example, access to rights of way can be exchanged for network assets such as power lines or discounted/free spectrum licences for use in unserved areas.
- Operating expenditures (OPEX2030): OPEX contributions make a business plan more sustainable. These can include direct subsidies or incentives, such as tax reductions, and can include in-kind contributions – for example, human resources needed to operate a community network in a village, or train delivery for new users.
- Risk protection: Governments or international institutions can offer guarantees that limit risks beyond the investor's control – for example, political or currency risks. Governments, for instance, could offer loss-guarantee schemes protecting investments; or international institutions could offer insurance products.
- Demand-side support: The government can ensure demand by becoming an "anchor tenant" with a future contract for connectivity in an underserved region. Indirect support for demand can be provided by subsidizing the cost of a device or data plans, increasing digital literacy and developing locally relevant content.

However the contribution is sourced, it must be done sustainably and predictably if the funding of broadband connectivity investment projects is to succeed.

6.4 Conclusions

Universal connectivity holds significant development opportunity – especially in rural areas and for vulnerable groups, allowing them to enjoy services to which they would not otherwise have access. However, many areas remain unserved or underserved. Current investment models for broadband connectivity are less and less commercially viable for uncovered areas, due to the high cost of deployment and low demand. Policy and regulation can shrink the connectivity gap to some extent by removing obstacles to deployment and raising demand for broadband – but these are both inadequate and too slow in responding to the urgent need to close the gap. Three elements are needed, supported by all participants over the long term, to move rapidly towards universal and meaningful connectivity. First, we need to increase the base of contributors. Second, we must ensure existing funds are fully and efficiently used. Third, we must find innovative models for funding, financing and investing in broadband.

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Endnotes

1 See Oughton *et al.* (2022). Estimates are based on meeting minimum capacity requirements for urban (approximately 25 Mbits/s), suburban (approximately 10 Mbits/s) and rural (approximately 2 Mbits/s) users. Developing countries are those in the low-income, lower-middle-income and upper-middle-income groups of the World Bank's classification. NSA 5G is the model of deployment where 5G services are provided without an end-to-end 5G network. This means that the network partly relies on some previous generation infrastructure.

2 Fibre optics are glass or plastic cables that transmit data as pulses of light, and can send more data, faster, over longer distances than other media such as copper networks.

3 See also https://datahub.itu.int/ for country-level statistics.

4 For instance, Oughton *et al.* (2022) estimate that across the two most plausible technological choices, 4G (W) and 5G NSA, the creation of a regulatory environment supportive of infrastructure-sharing can reduce the financial cost of reaching universal broadband in developing countries by approximately 10–70 per cent, with a Shared Rural Network providing the single largest cost reduction.

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15 For background see Internet Society, "Deploying and Growing Community Networks", available at www.internetsociety.org/issues/community-networks/; or Association for Progressive Communications, "Community networks", available at www.apc.org/en/tags/community-networks.

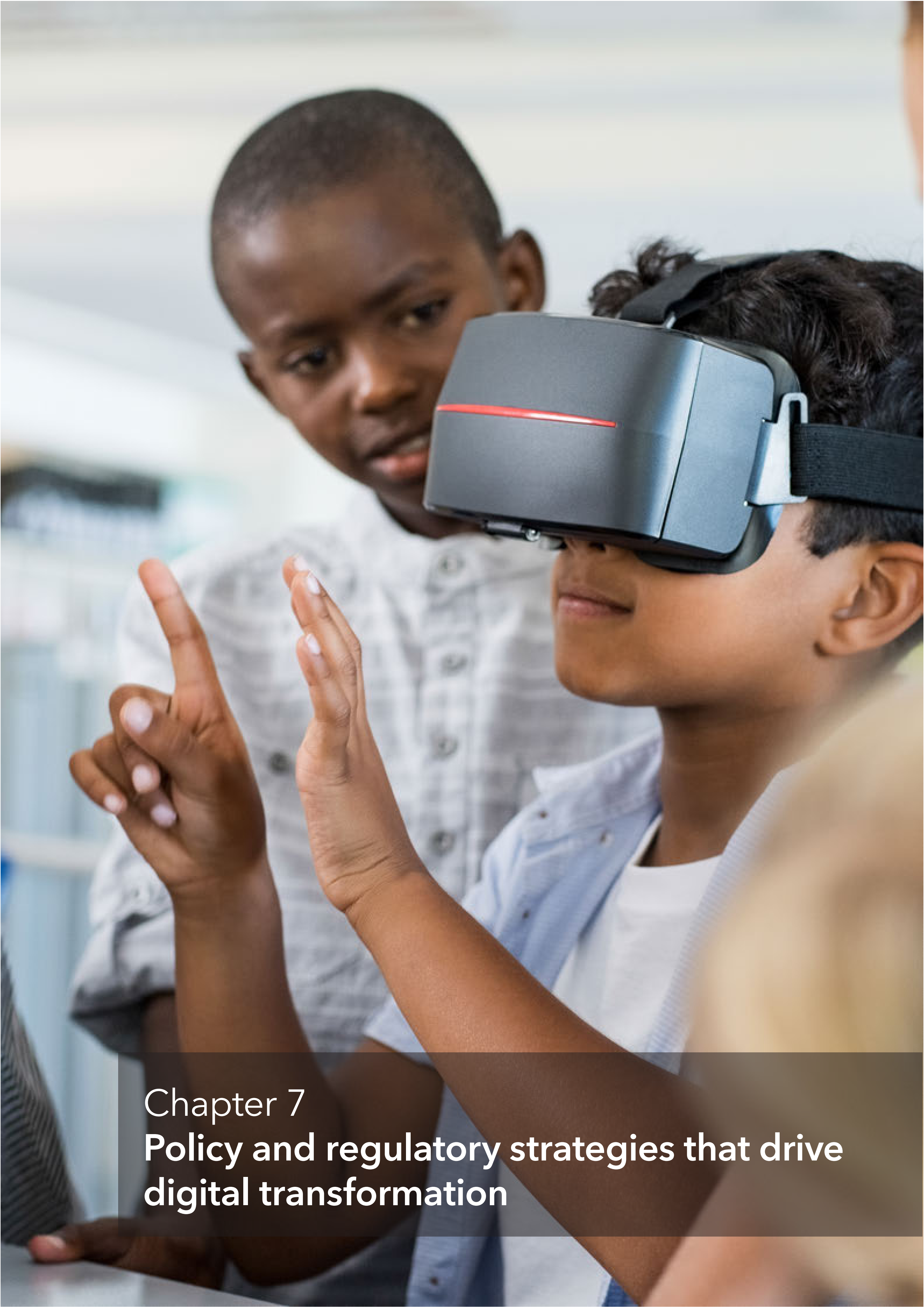
16 For instance, the NYC Mesh network in New York City serves underserved populations in the city. Available at www.nycmesh.net.

17 See Broadband Commission for Sustainable Development (2021b).

18 For additional recommendations on USF reform, see ITU (2021).

19 For example, Moroccan legislators introduced such a "pay or play" regime in 2004, whereby operators can either pay their financial contributions to the fund, or implement projects approved by the fund's management committee. Operators submit their proposals to the committee, which validates them and sets the conditions. The Moroccan regulator, ANRT, recognized that this regime was successful, and many universal service projects were suggested by the operators and approved, including the coverage of more than 1 500 rural villages within four years (ITU, 2021).

20 ITU, "Connectivity in the least developed countries: Status report 2021". Development Sector, 2021, p. 46. Available at www.itu.int/hub/publication/D-LDC-ICTLDC.2021-2021/.



Chapter 7
Policy and regulatory strategies that drive digital transformation

Chapter 7. Policy and regulatory strategies that drive digital transformation

7.1 Introduction

In a world in flux, policy- and decision-makers have the greatest of responsibilities in ensuring universal and meaningful connectivity, sustainable finance for digital development projects, and in supporting the digital transformation of economies, thereby meeting the goals of national digital agendas and ultimately, the Sustainable Development Goals the United Nations 2030 Agenda for Sustainable Development.[1] This undertaking involves a transformation of policy-making processes, governance models and new channels for policy implementation.

The next frontier for digital policy and regulation

As digital technologies have become more widespread, affordable and powerful, policy and regulation have shifted focus from the narrow telecommunication sector to powering the digital transformation across the economy. The baseline for effective regulation has changed. Furthermore, new approaches offer multiple paths through the digital transformation. Such approaches rely on shorter and more inclusive policy cycles, agile regulatory responses and continuous experimentation, to match the pace of innovation and the ambition of the global development agenda. Unlike traditional telecommunication regulation, there is no single blueprint for best practice, but an array of tools that converge towards common goals that match the specificities of national contexts, political and legal systems, cultural backgrounds and economic priorities.

In the vortex of widespread change in the aftermath of COVID-19, the need to redefine policy priorities and the roles of stakeholders, and to identify new tools, has become more pressing. Tensions nevertheless persist between established and emerging approaches (see Box 7.1), so new strategies will need to prove themselves as old certainties may not hold true – and new norms are yet to form.

Below, this chapter will go on to explore five strategies that policy-makers and regulators can adopt to navigate the digital transformation, and deliver on the ambition and needs of both the connected and the unconnected. Each of these strategies broadens the policy options at hand, and avoids anchoring decisions in the past or using a silo perspective. They put decision-makers in the driver's seat through the digital transformation journey, and offer the keys to unlocking digital dividends for all. These strategies are grounded in the findings of the G5 Benchmark,[4] a reference framework of good practices for digital policy and regulation (see Box 7.2).

Box 7.1: Tensions between established and emerging approaches

The transition to new policy and governance models will take time to settle down against the backdrop of emerging and new challenges. Tensions, however, persist between established and emerging approaches. Decision-makers – regulators and policy-makers – need to come to grips with five inherent tensions, and find a point of equilibrium on all of them to advance digital development agendas across geographies, levels of development, legal frameworks and institutional capacity:

- **Fast vs slow regulation – regulation needs to function at different speeds**

  Market players expect both *agility*, when new products or services are on the way to markets, and *predictability*, when investment plans are made. Hence, regulatory processes will continue to evolve at several speeds. Some authorities may take a few years to adopt a new law, while introducing versatile, modular rules when new challenges arise, or when markets run out of steam.
- **"Hard-wired" vs "soft-wired" regulation**

  In areas such as spectrum management and licensing, traditional regulatory approaches will continue to dominate. In other areas – such as online services delivered by digital platforms,[2] where the asymmetry of information is more pronounced – co- and self-regulatory patterns will emerge, allowing for more decentralized governance, and by each player, namely through voluntary or enforceable codes of conduct. Such decentralized regulatory models will be more practical to enforce while being more straightforward to comply with by market players.
- **The watchdog vs ecosystem builder approach**

  The rise of digital markets[3] has triggered the extension of core telecommunication regulatory mandates to cover new areas such as the Internet of Things (IoT), the cloud and Internet content. What's more, holistic policy goals such as digitization of the economy increasingly require a market approach using an ecosystem perspective and enabling synergies across economic sectors. Regulators are thus expected to build a common ground, including industry and consumers, government and citizens, and to engage with stakeholders at every step of the policy and regulatory process – from design, to piloting, to the enforcement of legal instruments – as opposed to the command-and-control approaches of the past.
- **Sustainability vs economic growth as an overarching policy goal**

  Sustainability as a policy imperative has been gaining importance, while the traditional gross domestic product approach is increasingly seen as insufficient, unsustainable in the mid-to-long term, and inadequate when it comes to driving digital transformation. The sustainability trend is clearly seen in the accelerated pace of adoption of environmental, social and corporate governance or environmental performance-based measures by governments and matching private sector initiatives, such as corporate social responsibility schemes.
- **National vs global regulation**

  With digital becoming more prevalent in both government and economic activities, an important objective at international and regional levels is the harmonization of legal frameworks in key areas such as competition policy, data privacy and cross-border data flows. On the other hand, some countries choose to favour national, often protectionist measures regarding issues related to data governance or competition – with the aim of keeping tighter control over markets and market players, in particular global digital platforms. Reconciling national with regional and global rules is a work in progress, and new patterns of cooperation and compliance are yet to emerge.

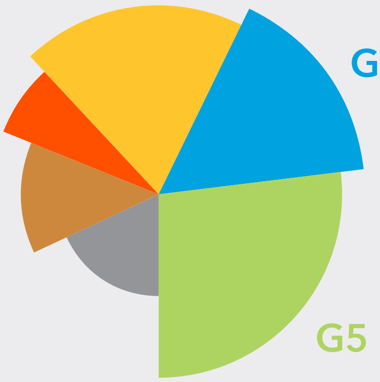
Source: ITU (2022a).

Box 7.2: Generations of regulation and the G5 Benchmark: guiding regulators

Regulators and policy-makers overseeing telecommunication and digital markets need evidence to inform their decisions on a wide range of issues underpinning the development of a competitive digital economy – evidence that helps them compare practices across countries and regions.

ITU has developed the framework of generations of regulation and two complementary benchmarking tools, the ICT Regulatory Tracker[5] and the G5 Benchmark, to help understand global trends and identify policy and regulatory gaps. The ICT Regulatory Tracker captures the evolution of generations of telecommunication sector reform. In parallel, the G5 Benchmark charts the digital transformation journey from its inception to building a thriving digital economy and society.

Figure 7.1: Generations of regulation



Generations one through five have steadily shaped novel approaches to policy and regulation, the gold standard for collaborative digital governance.[6] The gold standard has been co-created with the global community of information and communication technology (ICT) regulators as part of the annual consultation on best practices by the Global Symposium for Regulators (GSR).[7] Based on this work, the G5 Benchmark assesses the evolution of digital policy and regulatory frameworks, and helps countries establish roadmaps to navigate the digital transformation.

The 2021 edition of the G5 Benchmark is structured around four pillars:

- **Pillar I: National collaborative governance** measures the breadth and depth of cross-sector collaboration between the ICT regulator and its peer regulators and policy-makers. The pillar factors in the institutional set-up (agencies and their mandates) as well as practices around regulatory collaboration, formal and informal, across 16 areas, including consumer protection, spectrum management, education and e-waste.
- **Pillar II: Policy design principles** focuses on the design of frameworks and what keeps them together. As all sectors' regulation shifts from rules to principles, new elements have become paramount to ensure sound outcomes from regulatory processes and the success of policy implementation – from applying tools for evidence-based decision-making, to providing space for regulatory experimentation, to strengthening the accountability of multistakeholder policy initiatives, to ethics.

- **Pillar III: Digital development toolbox** focuses on the tools needed by regulators to stimulate development of a sustainable digital economy. It considers new consumer needs, business models and market dynamics. The G5 toolbox spans areas such as cybersecurity, data protection, emergency telecommunications and infrastructure sharing. The toolbox also includes universal instruments geared towards the achievement of middle- to long-term social and economic goals – such as youth employment and sustainable consumption and production – where digital has a central role to play.
- **Pillar IV: Digital economic policy agenda** features policies and interventions deployed by a country to promote the development of the digital economy, entrepreneurship and investment. The areas covered range from an innovation framework to digital transformation to sector taxation and adherence to international and regional integration initiatives with ICT chapters.

Each pillar is composed of sub-components grouping a total of 70 indicators, all of which are focused on policy and regulatory frameworks for the digital transformation. According to their score, 193 countries are associated with a level of national policy and regulatory framework maturity, namely: Leading, Advanced, Transitioning and Limited.

What can we learn from the 2021 edition of the G5 Benchmark?

- Two-thirds of countries are in their early digital days,[8] with only partially adequate legal instruments in place and underdeveloped collaborative governance practices. Climbing up the digital development ladder will require consistent effort by government and the active involvement of all stakeholder groups aligned around key policy priorities.
- One-third of countries have progressive digital policy and regulatory frameworks. They form the Advanced group of countries on their digital transformation journey,[9]and their population is more likely to enjoy digital dividends, rather than suffer digital divides – because their legal and regulatory frameworks are fit-for-purpose and are rich in best practice.
- According to the Benchmark, only nine leading countries – Australia, Canada, Estonia, Finland, Germany, the Republic of Korea, the Netherlands, Singapore and the United Kingdom[10] – are reaping the full benefits of the digital transformation, leveraging strong cross-sectoral policies and delivering on digital development objectives.

National and international best practices and benchmarks are useful in setting out a master frame[11] for understanding the principles of collaborative governance, avoiding a spotlight effect[12] and anchoring.[13] Such frameworks provide context and a broad perspective on cross-sectoral policies, while allowing comparisons across countries and policy areas, and help identify new patterns of collaboration conducive to co-creating an inclusive and innovative digital ecosystem globally.

Source: ITU, G5 Accelerator. Available at gen5.digital/.

7.2 Strategy 1: Build ambidextrous leadership

When the only constant is change, sound policy leadership is imperative.

Through a natural process of tension and disruption, the mainstream policy perspective has shifted towards more inclusive multistakeholder processes. These seek to meet both complementary and competing objectives of governments, businesses and citizens – from affordability and inclusion to sustainability and economic growth, to innovation and investment. National decision-makers need to pursue long-term market development, while remaining agile and retaining short-term flexibility and a 360-degree perspective. New leaders in policy and regulation need to master the blending of traditional and experimental approaches, combining styles of rule-making and enforcement – and adapting their implementation to local context and circumstance. Signature policy leadership through the digital transformation is built squarely around embracing ambiguity and uncertainty, with a growth mindset and out-of-the-box thinking – and when new challenges emerge, policy-makers and regulators can combine the tried-and-tested with a new approach, and with equal ease. Building leadership capacity across all levels of government will equip decision-makers to lead markets in the right direction, to the benefit of digital economies and societies.

Moving the needle

While traditional policy and regulatory approaches remain prevalent, experimental techniques are emerging and are increasingly adopted. In the experimental space, several models have been gaining momentum:

- **Sandboxing:** Regulatory sandboxing promotes innovation and allows open, dynamic participation of stakeholders, while encouraging the adoption of new technologies and business models by industry and society (ITU, 2022b). Today, nearly a quarter of countries worldwide have created safe spaces for regulatory experimentation – regulatory sandboxes.[14] Rwanda stands out with its "test and learn" environment: companies can obtain a one-year permit allowing them to try new ideas, concepts and services within a light-touch regulatory framework. Rwanda's proof-of-concept hubs have enabled the development of transformative services and applications including drone-based and artificial intelligence (AI)-driven health services, such as Zipline. The performance-based approach allows both regulators and operators to respond dynamically to technical challenges, including ensuring public safety (ITU, 2021a). In Colombia, a regulatory sandbox designed by CRC, the communications regulator, has provided an alternative regulatory mechanism to test communication products and services for a limited period under flexible or no regulation. The first regulatory sandbox in 2020 piloted 23 different proposals, ranging from bringing 4G coverage in rural areas with new technologies to a platform for real-time measurement of the mobile Internet user experience, and a simplified contracting process for fixed and mobile services through a unified service agreement.[15]
- **Policy labs:** In the United States, some state and local governments have established policy labs to partner with academia, using administrative data to evaluate and improve programmes and policies, while safeguarding personal privacy. The labs provide the technical infrastructure and governance mechanisms to help governments gain access to analytical talent, while the data labs are helping to convert data into insights, and driving more evidence-based policy-making and service delivery (ITU, 2021b; Governing, 2017).[16]
- **High-level framework for experimentation:** Almost a third of countries have identified emerging technologies as a policy priority adopting a forward-looking spectrum strategy[17] or regulations and plans with regard to IoT.[18] Far fewer have specifically tackled key new areas such as cloud computing or AI – respectively one-fifth[19] and one-sixth[20] of countries – with only 16 countries having integrated all of those complementary areas.[21] In effect, the vast majority of governments have yet to canvas emerging technology issues in their policy and regulatory frameworks.

7.3 Strategy 2: Bridge silos and breakthrough insularity

There is universal agreement that demolishing silos is the way forward in modern governance

– and yet, silos are still common in national institutions and policy implementation. Adopting a whole-of-ecosystem approach to policy inception, design, prototyping and implementation is an issue in many countries. Where these issues persist, they hinder digital market development, innovation and value creation. The gold standard for digital policy and regulation (ITU, 2020) has been established as genuine, outcome-based collaboration and coordination across government. Such collaboration builds bridges over decision-making silos, creates efficiencies, builds a common language between institutions and stakeholders, and provides for learning – and yet, the interface between institutions, stakeholder groups and consumers needs fixing in many places.

In the context of digital transformation, a single-sector perspective can no longer be the mainstay of a policy. Many of the cross-cutting topics increasingly mainstreamed in digital policies are rooted in broader development issues and should be addressed through policy coherence across sectoral silos. The design of governance frameworks – or rather, of governance networks for digital – will be different from the previous generations of institutions, moving away from silo thinking and insular decision-making. New models of stakeholder collaboration and coordination will emerge from those that are more prevalent today, taking the breadth and depth of interaction to the next level. Collaboration will likely evolve towards patterns that are functional, blended into governance processes, and multi-modal. Outcome-based approaches will leverage fluid, needs-based collaboration, both formal and informal, as an essential feature of governance networks.

Moving the needle

Traditional models of formal and informal collaboration at the national level have become mainstream across regions, and across different political and legal systems. In traditional areas such as competition and spectrum management, four in five ICT regulators engage with their counterparts, mainly through formal channels.[22] Collaboration is vital, but remains less established with data protection and financial regulators. The collaborative approach in these areas today reaches around half of countries worldwide – effectively doubling in only three years.[23] Anecdotally, data protection agencies appear to collaborate more among themselves through the global network of national data protection agencies than with stakeholders at the national level.[24] The areas with the *least* collaboration are transport and energy,[25] reflecting the disconnect that persists between digital infrastructure deployment and other civil engineering works in the other half of countries. While coherence in policy implementation has taken off, harmonization across important areas needs to be taken further.

As the ICT regulator mandate has expanded into new areas, 60 per cent of them collaborate beyond their traditional sector with ministries of education, health and government services.[26] In this context, informal channels are used more often than among independent regulatory authorities, accounting for a quarter to a third of interactions between the ICT regulator and ministries. After two years of the global pandemic, the case for a whole-of-government approach is clear. In 70 per cent of countries,[27] coordination and collaboration have increased between the ICT regulator and the national agency in charge of the digital transformation.

Strengthening the focus of existing formal and informal collaboration channels, and moving towards outcome-based approaches, will fast-track policy implementation in the digital transformation (see Box 7.3). Moreover, stronger coordination mechanisms at the national and international levels can go a long way towards coherent implementation and attaining policy goals.

Box 7.3: Collaboration frameworks and outcomes: insights from Mexico and Tanzania

In **Mexico**, inter-agency collaboration is an important part of the Federal Telecommunications and Broadcasting Law. Since 2013, Instituto Federal de Telecomunicaciones

(IFT) – the ICT regulator – has implemented 34 collaboration agreements with universities, civil associations, other government entities and other sector regulators. Thus, IFT and the National Commission for the Protection and Defence of Financial Services Users collaborate in the area of cybersecurity and in ensuring the reliability of digital financial services. IFT and Procuraduría Federal del Consumidor (PROFECO), the consumer protection agency, collaborated on the creation of the *Soy Usuario* platform, which enables consumers to file complaints against telecommunication service providers and receive a rapid response to their problems.

IFT has further strengthened the framework for institutional collaboration in its 2021–2025 roadmap, a strategic framework focused on the development of a digital ecosystem from a holistic and collaborative perspective. The roadmap has a strong focus on collaboration: each of the 54 regulatory action lines specifies the entities with which IFT has to collaborate.

In **Tanzania**, inter-agency collaboration has enabled the development of the local financial technology (fintech) sector. The National Financial Framework (2018–2022) sets the basis for collaboration under the National Council for Financial Inclusion. The Council includes the Central Bank Governor (Chairperson), supported among others by the Tanzania Communications Regulatory Authority (TCRA), the ICT regulator, which is a member of the Council Steering Committee Technical Team, and participates both at the executive and expert level through the TCRA Director General, the Director of Industrial Affairs and a principal financial analyst. TCRA plays different roles in the implementation of the fintech strategy – from ensuring that technology and infrastructure are in place, to ensuring that subscribers are registered and supporting cybersecurity implementation.

The Council applied a test-and-learn approach to the then-new mobile money concept in 2008, when the Central Bank granted "non-objection letters" to the TCRA regulated mobile operators and their banking partners. To implement this approach, the Bank of Tanzania put regulations in place that ensured that non-banks (such as Mobile Network Operators) could continue to receive non-objection letters to act as mobile payment service providers. Slightly over a decade later, Tanzania's mobile money penetration reached 53 per cent, with 29.7 million mobile money subscriptions in 2020, for a transaction value of USD 81 billion.[28]

Source: ITU (2022d, 2022e).

7.4 Strategy 3: Develop a common language

Building a common language across stakeholder groups is essential – this avoids policy implementation getting lost in translation in the context of digital transformation. Leveraging stakeholder dialogue and data to guide decisions will allow co-creating more diverse and resilient regulatory solutions.

Effective stakeholder dialogue is one of the main enablers of regulatory compliance and policy implementation in the digital transformation. It is still not very common to integrate the private sector or other economic sectors' perspectives across the policy and regulation processes – from design to prototyping to implementation – although digital policies have an impact on all stakeholders. Regulatory tools and processes are at hand to remedy the perspective gap:

- **Data and analytical evidence** can serve as a common language to weigh the challenges and opportunities of reforms and power balanced decision-making, maximizing positive outcomes while minimizing risks. Both national metrics and global benchmarks can bring valuable insights to support regulatory thinking and decision-making.
- **Regulatory taxonomies** and defining key terms build the basis for constructive debate and clear expectations. What can be obvious for some may mean something

different to others. Is "Internet" the fibre infrastructure layer of the World Wide Web or online services or content? What do we mean by "data" in trade discussions or data localization policies? Beyond the national level, international discussions also benefit from agreeing on common terms to build clear, consistent and enforceable rules.

- **Building an environment and a culture of consultation**, and convening a platform – a network, committee or agency – all play roles in the blending of perspectives and genuine partnerships on policy or regulatory "projects". Active and continuous stakeholder dialogue enhances the quality and relevance of legal frameworks, while accelerating the pace of innovation and entrepreneurship in digital markets.

Moving the needle

Dialogue and consultation are part of the DNA of effective, pro-market regulation. Public consultation on regulatory decisions is today commonplace in 80 per cent of countries.[29] Taking the process to the next level, however, is much less common. Only a fifth of countries commit to designing public consultations as a tool to guide regulatory decision-making by introducing longer timelines for comments, responses to stakeholder views and public hearings.[30] Further along the path towards evidence-based regulatory approaches, half of agencies in charge of regulation apply a formal requirement for conducting Regulatory Impact Assessments before major regulatory decisions are made.[31] The majority of regulators still need to adopt a fully-fledged evidence-based approach to new and emerging issues, and to far-reaching regulatory decisions.

7.5 Strategy 4: Reframe and operationalize policy agendas

While a recipe for perfect policy does not exist, the expectation is that a policy piece will be "living" for five to seven years after its adoption, serving as a launch pad for solving the greatest and newest problems governments and markets face.

How to plan ahead when we are blindfolded by uncertainty and ambiguity? Setting a vision for the future is like walking on a tightrope – balancing needs and wants, and translating them into goals while weighing the required resources.

7.5.1 Reframing policy narratives from single-sector to whole-of-society

Fundamental principles of the modern State – such as equality (based on gender, origin or income), good governance or participation – have become defining elements of policies, and critical vectors of development. They are geared towards directly addressing barriers and challenges in achieving impact and addressing systemic issues, while reinforcing social and economic progress.

Digital policies now span multiple horizontal and vertical areas. Financial inclusion policies focus on digital tools and currencies, along with a focus on the unbanked, the illiterate and those with no official identification. Education policies build in gender and fundamental rights perspectives along with technology. Digital policies are increasingly underpinned by sustainability and innovation, targeting those at the bottom of the pyramid, women and youth. The 2030 Agenda for Sustainable Development is an example of streamlined development imperatives and the policy goals cutting across the board. The almost overwhelming number of issues identified in targets and goals makes it challenging, though, to coordinate and implement a comprehensive, coherent set of policies. Mainstreaming core themes across digital and sectoral policies can make coordination on the ground smoother and allow faster progress towards higher-level development goals.

In the wake of recovery from COVID-19, governments have an opportunity to reframe their policy agendas and mainstream new priorities along with a broad development perspective. The circular economy, digital innovation and gender empowerment have moved to the forefront of a new systemic approach to addressing policy implementation challenges – an approach where new legal instruments will redefine the focus for global action in the face of economic, technological and climate disruption.

7.5.2 Craft roadmaps

When the final destination is clearly defined in policies, regulators need to chart the fastest, safest road to it, breaking it down into milestones and crafting a time-frame. A sound regulatory roadmap will accompany national stakeholders in unfolding implementation and keeping on track. By providing clarity and predictability, a roadmap provides a single reference frame for implementation mirroring a high-level policy vision and operationalizing its objectives. A regulatory roadmap is a useful instrument for keeping everyone aligned to common objectives and in sync with other stakeholders. From stakeholder coordination to planning investment and deployment decisions to making sure efforts deliver desired outcomes, regulatory roadmaps provide a framework for ecosystem orchestration of policy implementation across the economy and society.

Two years of COVID-19 taught us that iteration, trouble-shooting and incremental improvement are decisive in policy implementation. Without such an agile, "work-in-progress" approach, progress can be jeopardized, and national digital ambition can be left behind.

Moving the needle

Slightly more than half of countries[32] have digital strategies covering multiple economic sectors,[33] leading the way to economic recovery. Examples of native digital agendas are the EU 2030 Policy Programme 'Path to the Digital Decade', the Kenya Digital Economy Blueprint (see Box 7.4) and the Malaysia Digital Economy Blueprint.[34] More than a third of countries also have defined mechanisms for implementation and operational objectives in their strategies.[35] While these figures spell good news for millions of digital users in these markets, the majority of countries still need to define digital policy priorities and commit to sound implementation frameworks.

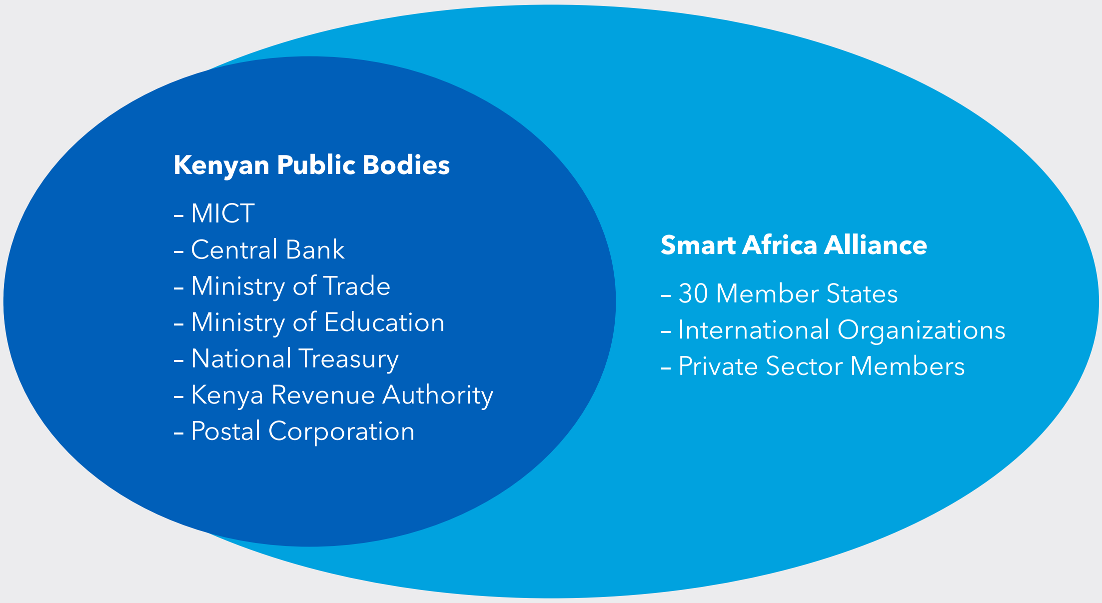
Regional digital agendas provide a much-needed framework for policy and regulatory harmonization – and help in putting digital transformation at the top of national policy agendas. The Digital Agenda for Europe (European Parliament, 2021) and the Digital Transformation Strategy for Africa (2020–2030) (African Union, 2020) are aligned with the Sustainable Development Goals of the 2030 Agenda 2030 goals and elevate national aspirations to the continental level. Leveraging cross-country political and implementation dynamics, and regional harmonization of digital agendas, also offer better chances of achieving the development objectives at hand sooner through economic integration. In 2017, Kenya held a ministerial conference on open data for agriculture and nutrition, where the Nairobi Declaration, a 16-article statement on open data policy in agriculture and nutrition, was signed by 15 African ministers. Francophone African countries have developed a similar network to support public policy development through CAFDO (*Communauté Afrique Francophone des Données*).[37] Such initiatives have the potential to unlock new entrepreneurship and development opportunities and their timely transposition into national law and systemic implementation can

Box 7.4: The Kenya Digital Economy Blueprint

The Ministry of ICT Innovation and Youth Affairs of Kenya (MICT) published the Digital Economy Blueprint in 2019 after collaboration with the Communications Authority, the National Communication Secretariat and the Konza Technopolis Development Authority (all housed within MICT), along with the Central Bank, Ministry of Trade, Ministry of Education, National Treasury, Kenya Revenue Authority and Postal Corporation of Kenya. Private sector stakeholders were also consulted, including the industry group Technology Service Providers of Kenya. The Blueprint defines the digital economy as "the entirety of sectors that operate using digitally-enabled communications and networks leveraging Internet, mobile and other technologies, irrespective of industry" (Government of Kenya, 2019).

Beyond Kenya, the Blueprint contributes to the Smart Africa Alliance initiative, which is working to digitize the economies and trade of 30 countries across the continent to create a single digital market.[36] The 30 member States are expected to adopt the Blueprint and develop their respective country strategies. Figure 7.2 highlights the wide range of national public bodies, as well as international players, responsible for developing and implementing the Blueprint.

Figure 7.2: National and international bodies involved in the Digital Economy Blueprint



The Blueprint establishes a five-pillar framework to realize a successful and sustainable digital economy in Kenya, recognizing that all sectors and industries fall within the definition of the digital economy. The five pillars and underlying objectives include:

- **Digital government:** Improve government services to citizens and increase government revenue, productivity and cost reduction through digitized and streamlined processes.
- **Digital business:** Adopt secure, affordable, open and efficient digital payment systems and financial services that protect consumers and encourage cross-border trade.
- **Infrastructure:** Connect every Kenyan, business and government or public facility with broadband, as well as improve critical broadband infrastructure, such as the national fibre-optic backbone, undersea fibre cables and data centres.
- **Innovation-driven entrepreneurship:** Increase the contribution of digital products and services to the Kenyan economy, and develop a sustainable support system for innovation through industry/academia research collaboration and access to funding.
- **Digital skills and values:** Increase the number of graduates trained in advanced digital skills.

Sources: Government of Kenya (2019) and ITU (2022c).

fast-track digital transformation of economies across the region.

Forward-looking national strategies in specific areas can complement holistic ones and support a more specialized development path – for example, leveraging AI or IoT integration across economic sectors, in smart cities, or robotics. As an example, Colombia's AI strategy aims to develop a dynamic and thriving AI market in Latin America, creating a laboratory for an AI market where designers, suppliers, intermediaries and consumers of this technology interact freely, facilitated by investment incentives to foreign and local entrepreneurs (Government of Colombia, 2019). The National Strategy on Blockchain by the Ministry of Electronics and Information Technology (MeitY) of India has the ambition to create trusted national blockchain infrastructure that can be used to experiment with digital solutions for development and made available across the economy, in sectors such as finance, research and development, and government services and education (Government of India, Ministry of Electronics and Information Technology (MeitY) (2021)).

Moreover, monitoring and evaluation of government policies more generally lags in a vast majority of countries, blurring the blueprint of policy implementation, and failing to address new issues as they come up. In only one-third of countries, ministries or regulatory agencies conduct ex-post policy reviews;[38] and still fewer, one in eight, conduct rolling policy reviews.[39] Without systematic application of basic policy review instruments, keeping implementation on track becomes a challenge, and accountability suffers, to the detriment of users suffering digital divides.

Given the current global technological and economic disruption, countries are trying new approaches to defining digital policy agendas. A small group of countries has come together to craft comprehensive digital foreign policy strategies in order to stay at the forefront of digital transformation and outline a novel national approach to digital issues and digitization in relation to foreign policy. Beyond the national level, Canada, Denmark, Italy, Singapore, Japan, the United Arab Emirates and the United Kingdom have launched an intergovernmental regulatory collaboration network. Called "Agile Nations", whose core mission is to help innovators navigate the complex regulatory landscape, test new ideas in collaboration with regulators, and scale their innovation across digital and other emerging markets – all while upholding protections for citizens and the environment.[40] At the global level, the United Nations Secretary-General has laid out a Digital Cooperation Roadmap, in which all stakeholders play a role in advancing a safer, more equitable digital world – one that will lead to a brighter and more prosperous future for all. The roadmap is co-implemented by United Nations organizations, governments and the international multistakeholder community.[41]

7.6 Strategy 5: Skill up, and up again

In the "new normal", the speed of learning provides a competitive edge in business and technology.[42] This is true for national decision-makers and regulators, too. Problem-solving is impossible without building new skills and competencies, formulating strategic thinking around new issues in digital markets and implementing novel regulatory approaches. A focus on emerging skills is key to building adequate institutional capacity and preparing for current and future challenges.

Continuously upskilling people generates growth in the advisory role of ICT regulators into other sectors going through digitalization, and to citizens – while casting a wider net through initiatives such as innovation labs that help start-ups grow and work together, through digital mentorship schemes and communities of practice and research programmes (ITU, 2019).

Metrics that matter and learning from regional and international best practices help regulators chart the shortest path to achieving policy goals. Benchmarks, econometric models and analytical tools can help improve the outcomes of regulatory decision-making by ensuring they are based on sound evidence and analysis.

Moving the needle

In the private sector, evidence from recent experience has shown that the level of digital skills has a positive impact on firm-level productivity in the service sector and for younger firms (OECD, 2021). What's more, to facilitate the digital transformation and reap its benefits, workers across the board will need a broad set of skills. Recent analysis suggests that both cognitive (numeracy, literacy and digital) and some meta-cognitive skills (critical and creative thinking, learning-to-learn) exhibit a strong and robust positive correlation with labour productivity (European Commission, 2020). Decision-makers – including policy-makers and regulators – are no exception, and regulatory expertise needs to be developed continuously to integrate new technologies, competencies and skills – and to allow for data- and evidence-based decision-making (ITU, 2020).

International benchmarks for key policy and regulatory areas in the digital transformation can support the thinking process and roadmapping of regulatory objectives. Evidence-based frameworks, such as benchmarks and advanced data analysis, can serve as a compass and a track record of practices across countries, regions and time, and can allow for comparison with international best practice.

7.7 Policy and regulation will enable digital transformation

Many of the challenges of the telecommunication sector at the time of the "Missing Link" report in 1984 are still with us – from investment in infrastructure to financing of access initiatives to institutional capacity of government agencies – but in the context of digital transformation, they are much harder (Kelly, 2022) (see Chapter 1).

Connectivity is an important policy goal – it enables economic development and access to education, and fosters entrepreneurship and innovation.

As digital markets grow and move towards everything-as-a-service, an agile and iterative, lean approach to policy and regulation has started to develop. Once a top-down, one-off process, policy and regulation have now become a living interface, enabling the interplay between consumer needs, the delivery of digital services and government priorities. The agency of regulators and policy-makers – their ability to do things that matter and evolve – and their agility, will be the keys to making the implementation of digital policies more impactful.

What's next? Policies will remain at the heart of the transformation aligning national and global development goals. The recovery from the global pandemic provides an opportunity to reframe policy, regulatory and legal perspectives, and redefine priorities of wholesome development in policy narratives.

New fundamentals of digital policies – such as sustainability, innovation, inclusiveness in decision-making and accountability – will gain prominence and change the dynamics of policy design and implementation. The focus shifts from technologies to people – and from economic to the broader social impact on the ground. Long-term considerations guide policy direction, while short-term imperatives define regulatory tactics and implementation strategies.

7.8 Everyone can be a winner

Connectivity has transformed societies, economies and governance systems, shifting priorities for policy-makers and regulators, markets and users. It will underpin every development path from this point forward.

Digital transformation is a once-in-a-generation opportunity to leverage digital technologies and Internet access as an equalizer of global development, providing every country and individual with access to new economic and social opportunities. The current state of digital markets – at the national and, importantly, global level – has not connected everyone everywhere, and new approaches are needed to make the digital economy more inclusive.

New lean patterns of digital policy and regulation will provide a canvas for problem-solving in the context of digital transformation, powering virtuous cycles across ecosystems, and fast-tracking the achievement of social, economic and environmental goals towards the Future We Want for all.

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2 Digital platforms are defined here as two-sided markets for online goods and services, often provided globally by large technology companies and typically having a dominant market position.

3 Digital markets provide access for consumers and business to online goods and services.

4 Available at https://app.gen5.digital/benchmark/metrics.

5 Available at https://app.gen5.digital/tracker/metrics.

6 ITU (2019).

7 ITU (n.d.).

8 A total of 44 countries have Limited preparedness for the digital transformation, and 82 countries are Transitioning, according to analysis based on the G5 Benchmark 2021.

9 A total of 58 countries have Advanced preparedness for the digital transformation, and 9 countries are Leading the global digital transformation, according to analysis based on the G5 Benchmark 2021.

10 These countries have achieved compliance with over 80 per cent of the best-practice framework indicators for policy and regulation for the digital transformation across sectors, according to analysis based on the G5 Benchmark 2021.

11 See: G5 Benchmark and GSR Best Practice Guidelines (ITU, 2019).

12 According to the Nobel Prize-winning psychologist Daniel Kahneman, the "spotlight effect" prompts us to be quick to jump to conclusions because we give too much weight to previous knowledge and experiences and the information in front of us, and we fail to search for new information which might disprove our thoughts. Kahneman called this tendency "What you see is all there is". (See fs.blog, "The Four Villains of Decision Making", available at https://fs.blog/how-to-make-better-choices-in-life-and-work.)

13 Anchoring is a cognitive bias that causes us to rely too heavily on the first piece of information we are given about a topic. When we are setting plans or making estimates about something, we interpret newer information from the reference point of our anchor, instead of seeing it objectively. This can skew our judgment and prevent us from updating our plans or predictions as much as we should. (See The Decision Lab, "Why we tend to rely heavily upon the first piece of information we receive", available at https://thedecisionlab.com/biases/anchoring-bias.)

14 A total of 47, according to analysis based on the G5 Benchmark 2021.

15 Available at www.crcom.gov.co/es/noticias/comunicado-prensa/conozca-proyectos-admitidos-para-experimentacion-en-sandbox-regulatorio.

16 ITU (2021b) and Governing (2017).

17 A total of 62, according to analysis based on the G5 Benchmark 2021.

18 A total of 57, according to analysis based on the G5 Benchmark 2021.

19 A total of 40, according to analysis based on the G5 Benchmark 2021.

20 A total of 30, according to analysis based on the G5 Benchmark 2021.

21 According to analysis based on the G5 Benchmark 2021.

22 A total of 85 per cent of ICT regulators collaborate with the national spectrum agency and 83 per cent with the competition authority, according to analysis based on the G5 Benchmark 2021.

23 Between 2018 and 2021, analysis based on ITU (2018) and the G5 Benchmark 2021.

24 A total of 134 national and subnational data protection agencies from 87 countries and economies (virtually all existing) are part of the Global Privacy Assembly (https://globalprivacyassembly.org/participation-in-the-assembly/list-of-accredited-members) vs 49 per cent of agencies engaging in cross-sectoral collaboration at the national level.

25 A total of 35 per cent of ICT regulators collaborate with the transport regulator/ministry, and 44 per cent with the energy authority, according to analysis based on the G5 Benchmark 2021.

26 Analysis based on the G5 Benchmark 2021.

27 Analysis based on the G5 Benchmark 2021.

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29 A total of 154 countries use public consultations for some or all regulatory decisions, according to analysis based on the ICT Regulatory Tracker.

30 A total of 41 countries gather feedback from national stakeholders in a structured and interactive way, according to analysis based on the G5 Benchmark 2021.

31 A total of 95 countries, according to analysis based on the G5 Benchmark 2021.

32 A total of 103 countries have overarching, cross-sectoral digital policies or strategies, according to analysis based on the G5 Benchmark 2021. (Broadband plans and universal policies are not counted here.)

33 Digital agendas as defined here typically include holistic social and economic goals in multiple economic sectors, and contain operational mechanisms for implementation and a structured monitoring and evaluation framework.

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35 A total of 69 countries, according to analysis based on the G5 Benchmark 2021.

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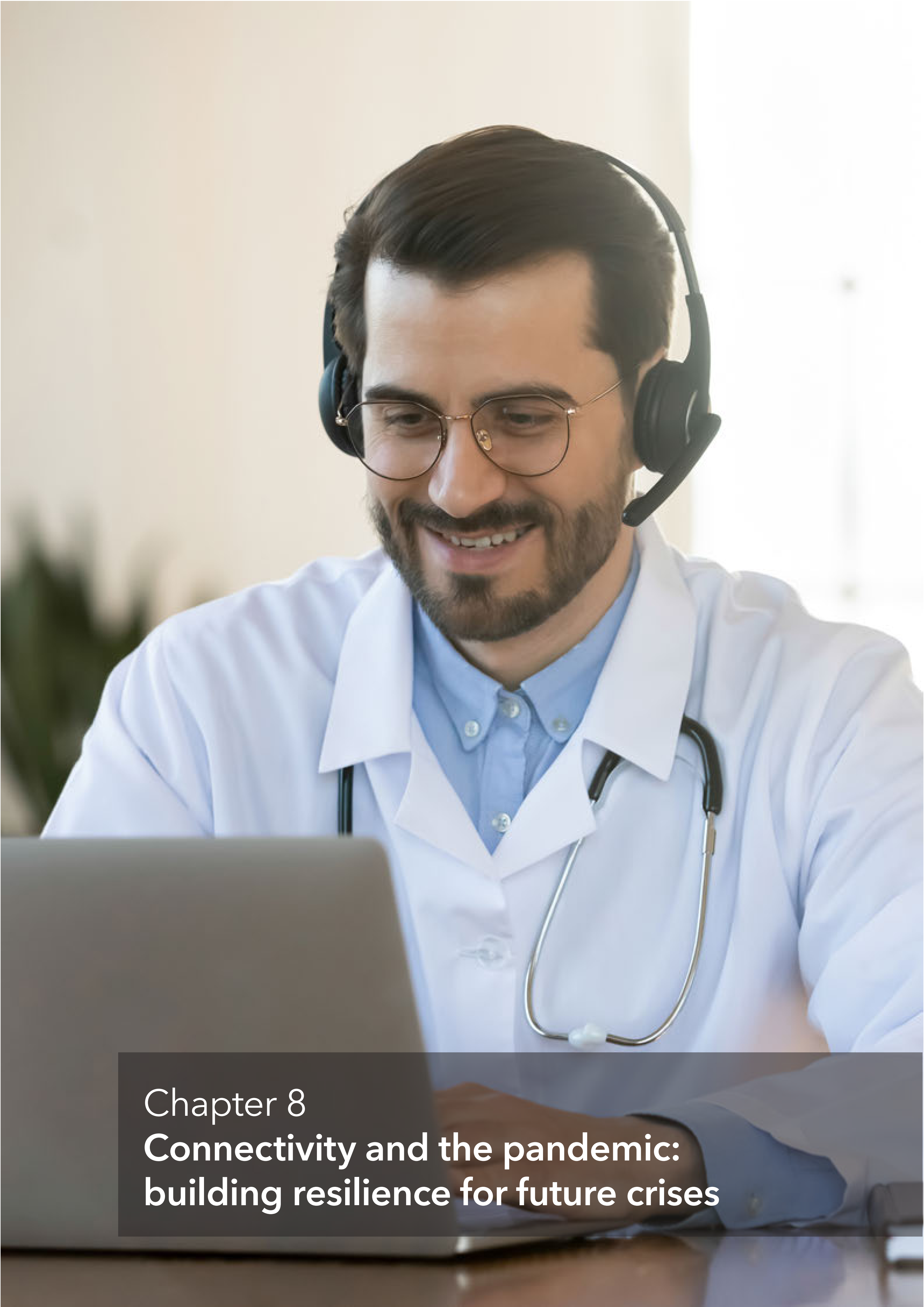


Chapter 8

Connectivity and the pandemic: building resilience for future crises

Chapter 8. Connectivity and the pandemic: building resilience for future crises

8.1 Introduction

Few would dispute that the COVID-19 pandemic ranks among the most disruptive global events of the past 100 years. This chapter considers the impact of the pandemic on the supply of and demand for digital connectivity and the role of connectivity in building resilience to future crises.

It has been estimated that nearly 100 million people have been pushed back into extreme poverty because of the pandemic, setting back progress five years or more in many countries (World Bank, 2021a). In addition to its obvious detriment to public health, the pandemic has been an economic disaster for many people. Those working in the travel, hospitality and entertainment sectors have been especially hard hit, suffering widespread unemployment. All industries based on people being in close proximity to each other have seen revenues fall because of lockdowns and other restrictions during the pandemic. However, industries offering digital alternatives, and those contributing to pandemic responses, such as information technology and pharmaceutical, have thrived.

Communication technologies are both a substitute for physical gatherings and a key resource for pandemic responses. Remote work and learning have emerged as the exemplars of the capacity of modern communication technologies to provide alternatives to activities restricted by the pandemic.

Thus, the rapid increase in demand for communication services and connectivity at the onset of the pandemic was predictable, even if the pandemic itself was unanticipated by most. Beyond this jump in connectivity demand, however, there are many, sometimes oppositional, forces at work on supply and demand. For example, even as people needed communication services more, economic disruption led to lower incomes for many, limiting their ability to pay for such services, especially in developing countries (see Chapter 5). Perhaps the most enduring impact of the pandemic will be the once-in-a-generation leap in the adoption of digital solutions by businesses, governments and individuals, which has been driven by the urgent need to find alternatives to physical gatherings and processes.

8.2 Connectivity supply and demand

In this section, a framework is introduced to help understand COVID-19's impact on connectivity supply and demand. It considers the full range of positive and negative impacts on connectivity supply and demand in the short, medium and long term (see Figures 8.1 and 8.2).

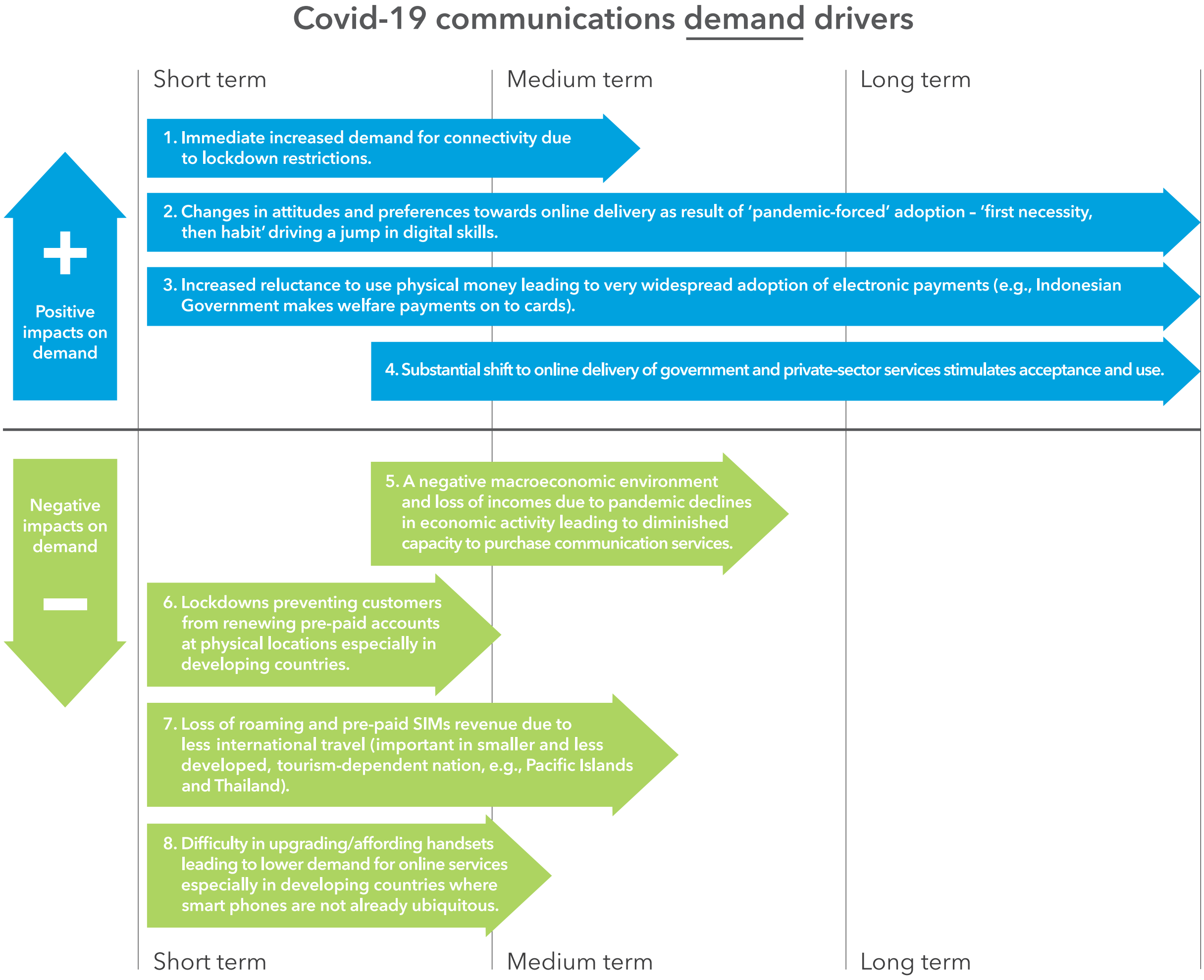
8.2.1 Short-to-medium-term impacts and responses

The demand for connectivity[1] comes from end users, business users and governments, and each of these sectors may respond in different ways to pandemic impacts. The supply of connectivity is obviously primarily driven by telecommunication operators, and is also influenced by upstream supply chain considerations and changes in regulatory and policy settings.

Many supply-and-demand impacts occurred as soon as pandemic lockdowns began, such as the jump in demand for videoconferencing. Others took longer to occur – such as the roll-out of new online government services. Some impacts appear to be long-lived, while others disappeared after the initial emergency phase. An important conclusion from Figure 8.1 is that, while many of the negative impacts on demand are likely to be relatively short-term, the positive impacts on demand are more likely to be long-lived, because they involve changes in attitudes, behaviours and skills. This implies a long-term upward shift to higher levels of connectivity demand.

The early stages of the pandemic and the associated lockdowns that occurred across the world resulted in an immediate spike in Internet usage of around 30 per cent (ITU, 2020a) with

Figure 8.1: Impacts of COVID-19 on demand for communication services



Source: ITU.

demand shifting from enterprise to residential and from central business districts to suburbs.

The short-term pandemic responses of users described in Figure 8.1 were driven by lockdowns and likely by voluntary avoidance of gatherings at a point of high uncertainty about the nature of COVID-19. The changes in the behaviour of end users were apparent from many statistical perspectives. OpenSignal, for example, observed rapid increases of up to 25 per cent in the time that mobile phones were on Wi-Fi networks – indicating a likely increase in time spent at home (Khatri and Fenwick, 2020).

Though this shift to Wi-Fi would predict lower traffic from mobile networks in countries with good fixed-broadband networks, data from Ericsson (2022) show a clear jump in the global mobile network traffic growth rate between the fourth quarter of 2019 and the first quarter of 2020, with the year-on-year traffic growth rate increasing by around 5 percentage points between these quarters. Data from the Organisation for Economic Co-operation and Development show unusually high growth in use of Internet bandwidth from September 2019 to March 2020 (OECD, 2020). In March 2020, the New York Times reported sharp jumps in traffic to websites such as Facebook, Netflix and YouTube (Koeze and Popper, 2020).

This unexpected surge in demand placed infrastructure under significant pressure. Even so, the existing telecommunication infrastructure generally coped well with the increased load – especially in advanced economies. OpenSignal data (Khatri and Fenwick, 2020) show that, in a majority of countries, 4G speed remained unchanged or experienced only moderate decreases in speed (0 to 20 per cent slower than the long-term medium average weekly speed). There were a few significant exceptions of worse performance (for example, Malaysia, Sri Lanka and the United Kingdom).

While connectivity systems generally responded well in developed countries, there were negative pandemic impacts for connectivity, affordability of devices and information and communication technology (ICT) services in developing countries. GSMA reported increases in the average handset replacement cycle, from 2.25 to 3 years, and a pivot to lower cost handsets (GSMA, 2021a). This will tend to retard the shift to smartphones in developing economies, where such phones do not yet dominate. Such a delay is likely to negatively impact digital practices and connectivity demand, and the development of digital economies. In addition, due to falling income levels amid the economic crisis triggered by the pandemic, entry-level fixed- and mobile-broadband baskets became less affordable on a global scale, especially in developing nations (ITU and A4AI, 2022).

Further evidence of reductions in the quality of connectivity in some emerging economies came from the Internet Society, which surveyed telecommunication users in Afghanistan, the Republic of Nepal and Sri Lanka in December 2020. It found that respondents in these countries were experiencing degraded Internet performance, and were spending more on connectivity than before the pandemic (Internet Society, 2020).

Figure 8.2 summarizes the many actions taken to increase the supply of connectivity by operators, regulators and governments around the world in response to surges in demand. Operators in many countries responded with a range of emergency initiatives, including increasing user data allowances, relaxing payment terms, providing some free services and providing "zero rated" access to various health, information and government services.[2] Operators also moved to facilitate online recharging of prepaid phone accounts (ITU, 2020b).[3]

Governments and regulators also moved with unprecedented speed at the start of the pandemic. Many collaborated intensively with operators to encourage increases in broadband capacity and speeds. Some licensee requirements were eased and, in some jurisdictions, the International Mobile Telecommunications spectrum was made available very quickly on an emergency basis. For example, the Independent Communications Authority of South Africa, following an assessment of 35 applications received, announced a range of temporary spectrum licences, which would apply until November 2020 (ITU, 2020b). Many regulators worked with operators to improve network management and performance, while easing some regulatory requirements on licensees. Governments and operators also collaborated on making health information available, and discouraging access to misinformation. The use of mobile phone data to monitor mobility trends and contract tracing was another focus of collaboration.

Some online platforms and content providers also responded quickly: streaming video providers reduced the average resolution of their content, and videoconferencing apps were provided free or on concessional terms. Apple and Google collaborated early on contact tracing apps designed to be effective and to protect privacy (ITU, 2021).

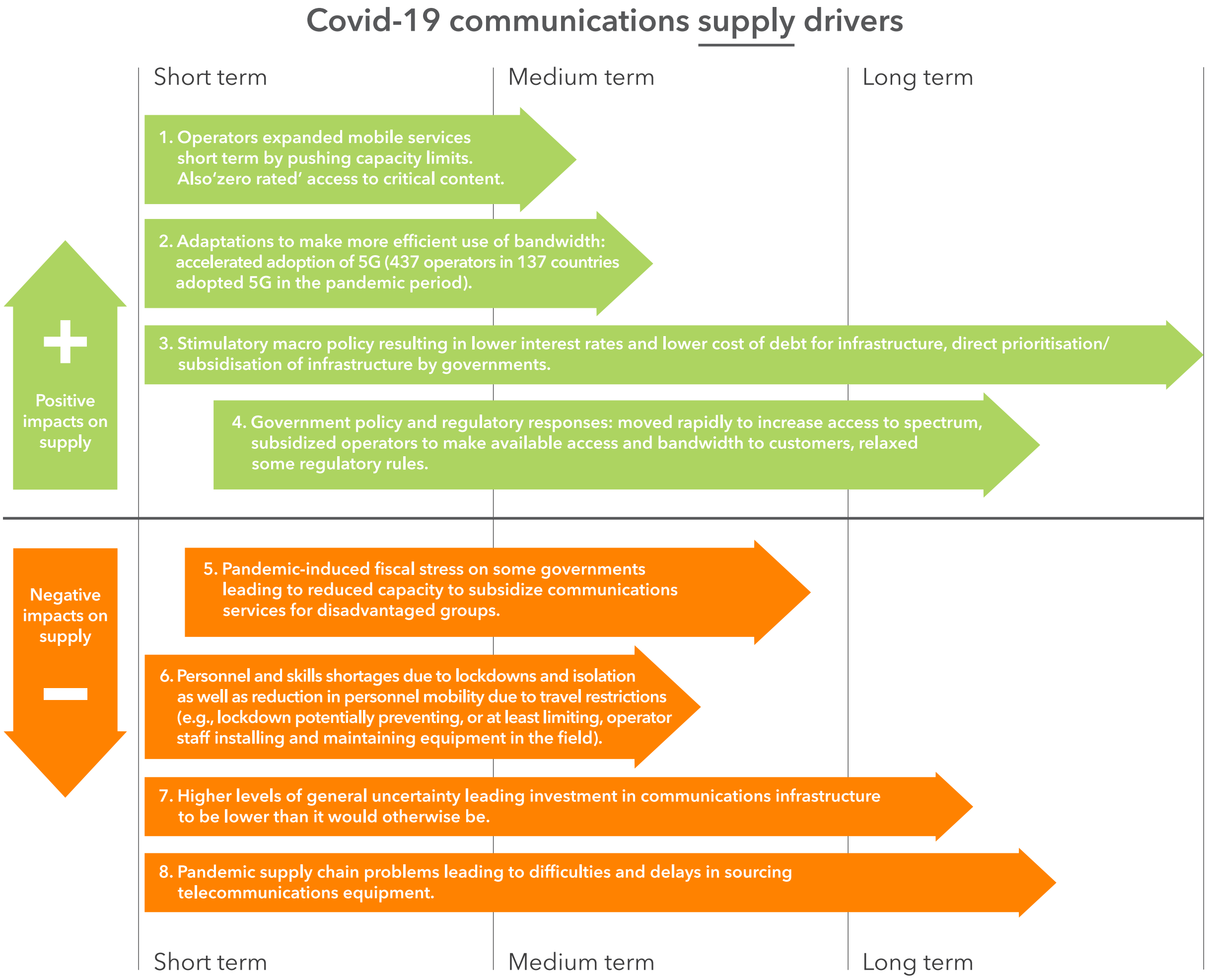
8.2.2 Long-term impacts and responses

As countries around the world struggled with successive waves of COVID variants, it became clear that the pandemic would be "a marathon and not a sprint". This meant that individuals needed to continue and deepen the process of adaption – "first necessity, then habit".

The demand responses illustrated in Figure 8.1 suggest that the pandemic has caused changes in attitudes, skills, behaviours, and regulatory and policy settings. Such changes and the resulting increases in demand are likely to be long-lasting. Changes in behaviours that began in the emergency phase became more ingrained, and interacting with digital processes became more common as businesses and governments moved to bring more processes and services online. As noted in ITU's *Pandemic in the Internet age*, the pandemic crisis "has acted as both catalyst, upending legacy processes and effecting cultural change, and accelerator, driving online trends that may otherwise have taken a decade to emerge" (ITU, 2021).

There is likely to be a "ratchet effect" – once late adopters of technology have overcome the barriers to adoption because of pandemic-driven necessity, it is unlikely that they will

Figure 8.2: Impacts of COVID-19 on the supply of communication services



Source: ITU.

abandon these new practices. It is likely that the pandemic also created a jump in average digital skill levels, as individuals and businesses were put in situations where they could no longer postpone learning new skills.

There is no doubt that some activities that were curtailed by emergency lockdowns and other restrictions will reappear or have already. Schools and tertiary education, for example, have returned or eventually will return to physical classes. The return to business travel and in-person business meetings has also begun. There will be some retreat from work-from-home arrangements. It is evident, however, that many of these activities are unlikely to fully return to their pre-pandemic levels. Hybrid digital–physical models will evolve, and connectivity-enabled activity will remain distinctly higher than pre-pandemic trends would have predicted.

As pandemic conditions persisted throughout 2020, longer-term impacts and responses emerged, including negative financial impacts on digital infrastructure companies (Delta Partners, 2020). Many telecommunication operators accelerated capital expenditure to expand capacity in response to increases in online traffic at the onset of the pandemic. It appears, however, that the direction of capital expenditure was driven by pandemic emergency conditions. As a result, spending related to network modernization was postponed, especially in emerging countries (ITU, 2021). In this way, the pandemic had a distorting impact on capital investment in some cases. To counter these distortions, a renewed focus on long-term infrastructure quality and upgrades will be needed in the future.

Many short-term behavioural adaptations to the pandemic have also seemed to evolve into something more permanent – notably in consumer behaviour. For example, GSMA conducted a 2020 survey (GSMA, 2021a) on mobile money adoption, which showed that, for all types of mobile money transactions, more respondents perceived that their use had increased than decreased. Clearly, these changes happened quickly, and required supporting legislative or regulatory change to enable them. This emphasizes the need for cooperation between political, regulatory and private sector decision-makers.

In the long run, the pandemic will likely drive higher levels of demand for and supply of connectivity. While there may be some retreat from peak levels associated with the pandemic itself, the long-term changes in attitudes, behaviours and skills will become embedded and result in a more rapid and extensive shift to digital practices and growth of the digital economy.

8.3 Policy priorities for resilience in the new normal

In the face of the pandemic's many tragedies, a silver lining has been a resulting acceleration in digital adoption and connectivity. This acceleration has the potential to stimulate economic growth and development – especially in developing economies.

At the same time, this large and discontinuous change in behaviours has been forced by the pandemic rather than carefully planned for. Various not-yet-identified distortions and other issues resulting from such a disruption could arise in the future. For example, high levels of utilization of telecommunication equipment may prove unsustainable and require new investment, which may or may not be forthcoming; it may turn out that regulatory changes result in unexpected adverse outcomes, such as an unacceptable erosion of competition; and rushed deployments of new infrastructure may result in underperforming or unreliable services. Such possible effects need to be considered as policy and regulatory settings emerge from the emergency response and recovery phases of the pandemic, and are fine-tuned for the new normal.

The transition to the new normal of higher levels of connectivity and digital adoption has been rapid, forced and ad hoc – typical of emergency responses. In early 2022, the Omicron wave appeared to be signalling the transition of COVID-19 from a pandemic to its endemic phase. It is now critical to step back and assess how policy and regulatory priorities should be adjusted in response to the changes of the past two years.

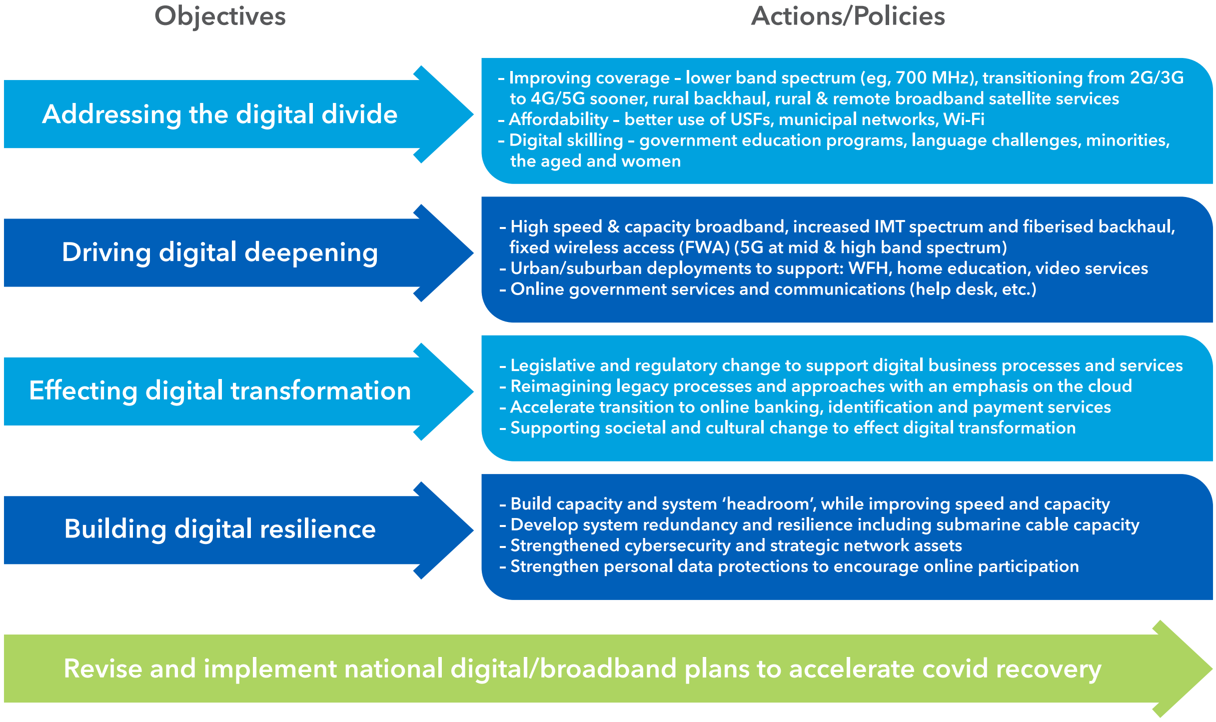
The indispensable role of connectivity is clear, as it has enabled citizens, businesses and governments to overcome many of the restrictions imposed by the pandemic. The scale and ubiquity of modern communication systems, along with rapidly improving "big data" and artificial intelligence (AI) capabilities, have provided governments and public health specialists with another set of tools to facilitate pandemic management. Big data analysis of mobile phone use has enabled monitoring of the effectiveness of lockdowns and their impact on infection rates, as well as the identification of immediate risks facing vulnerable population groups. It has also helped to optimize the allocation of medical facilities and supplies, and guide the planning of the removal of pandemic restrictions and return to normality (GSMA, 2021b).

ITU's REG4COVID initiative is collecting and distributing an enormous number of initiatives and programmes from governments and regulators around the world aimed at achieving the most positive contribution of the telecommunication sector to post-pandemic recovery and subsequent development.[4] Such priorities were categorized in ITU's *Pandemic in the Internet age* (ITU, 2021) under four headings, summarized in Figure 8.3.

8.3.1 Addressing the digital divide

The rapid pandemic-driven increase in online practices has amplified the socio-economic consequences of the digital divide. Socio-economic groups which have no, or limited, connectivity are now at a greater relative disadvantage than they were prior to the pandemic, given the shift online of processes, services and information provision. To give one example, Pew Research Center investigated the extent to which peoples' Internet experience had changed during the pandemic in the United States (Pew Research Center, 2021). This survey showed clearly that barriers to home-schooling are much more prevalent in lower-income households. This is a good example of how existing digital divides have deepened during the pandemic period, and this can also be seen in the broader context of the pandemic deepening existing inequalities.

Figure 8.3: Policy priorities in the new normal



Source: ITU (2021).

Such impacts are likely to be more prevalent in developing nations. The World Bank notes: "Hundreds of millions of children have lost at least a full year of schooling due to COVID-19. This pandemic has brought about the largest loss of human capital in living memory and the worst education crisis in a century" (World Bank, 2021b). The Conversation Africa points out that a large majority of people in many African countries are still unable to afford the cost of mobile devices or data and national exclusive licensing framework predominantly used across the continent. To overcome the divide in digital adoption, governments made efforts to redress digital inequality during lockdowns through spectrum allocations and mandatory price reductions or data lifelines. While these measures assisted those already online, they did not seem to have a substantial impact in bringing those offline online (Gillwald, 2020).

More broadly, as governments and businesses become more aware of the potential cost savings achievable through online service delivery, they may be more likely to withdraw some offline services or let them run down over time. This will cause groups with poor connectivity to experience a more severe digital divide. Governments should now be actively determining the broad savings that can be made through digital delivery, and comparing these with the costs of ensuring that their citizens have ubiquitous access to connectivity. Ubiquitous access and adequate digital literacy are the gateways to all-digital service delivery and associated cost savings and quality improvements.

8.3.2 Driving digital deepening

Higher levels of online service delivery by businesses and governments will drive users to demand better, faster and more affordable and reliable connectivity services. Governments will need to recognize that connectivity is now a more important productivity driver than it was pre-pandemic. It is also more important for socio-economic inclusion than it was previously.

This argues for stronger pro-investment policy and regulatory settings. In emerging economies, this requires rapid deployment of 4G/5G coverage in urban and suburban areas; expanding spectrum availability; more extensive connectivity reach in rural and remote areas; and improved backhaul, cloud infrastructure and international submarine/satellite capacity.

8.3.3 Effecting digital transformation

While digital deepening refers to the changes undertaken by customers and the communication industry, digital transformation refers to the policy and institutional changes necessary to facilitate digital development.

Digital transformation requires renewed commitment by governments and institutions, as well as businesses to move more fully towards "pure digital" processes and services to the extent that this serves the best interests of customers and citizens.

This is a difficult and exacting process that encompasses digital approaches to health care, financial services and delivery of government services, as well as embracing the ubiquitous use of digital transactions. It requires a highly proactive and systematic approach to improving digital literacy and skills of less capable groups. A comprehensive and effective approach to digital security and privacy based on a comprehensive and innovative legislative and regulatory programme is also needed.

8.3.4 Building digital resilience

There are two aspects to digital resilience:

- ensuring that digital infrastructure and systems have sufficient "headroom" to accommodate unexpected peaks in demand due to unforeseen circumstances such as future pandemics;
- ensuring that digital infrastructure and services are able, with little warning, to contribute to responding to unforeseen circumstances and rapid social and economic recovery.

The objective of building additional headroom into communication systems could be addressed within existing regulatory frameworks by requiring licensees to build in additional emergency capacity.

More broadly, COVID-19 has demonstrated the critical contribution of modern communication systems to managing pandemics and other types of emergencies. This capacity intersects with several issues that currently concern governments and regulators. Primary among these are the issues of data security and privacy. There are difficult trade-offs between effectiveness of pandemic management and the privacy of citizens. Throughout the COVID-19 pandemic, countries employed a range of strategies for pandemic management – widely varying levels of population lockdowns and other restraints, as well as very different approaches to tracking and tracing.

Some countries, such as the Republic of Korea, mandated that all citizens use track-and-trace applications. This enabled relatively automated, rapid and effective track-and-trace efforts. In others, track-and-trace applications were voluntary and, in many cases, adoption was disappointingly low. In many countries, the majority of track-and-trace efforts were manual in nature, and such efforts were overwhelmed as infection levels spiked. While track-and-trace applications developed through big data and AI approaches were often technologically capable, efforts were more often hampered by lack of public trust and related social or political concerns.

During the pandemic period, discussion about the uses of detailed personal information was common, and governments adopted a wide range of privacy policies of variable quality. The relatively low participation rates in voluntary schemes suggest that people either believed that these approaches would not be effective and/or that governments could not be trusted with their personal data. Another Pew Research Center survey of United States adults indicated that 66 per cent of respondents thought that risks outweighed benefits for personal data collected by governments (Auxier, 2020). This suggests that governments have a long way to go in developing privacy and data management standards and processes before citizens find the collection of their personal data acceptable – even in a public health emergency. It is likely that there will be significant cultural variations between countries in terms of citizens' willingness to accept these types of interventions.

8.4 Conclusions

As noted in ITU's *Pandemic in the Internet age* with regard to the communication industry: "In overall terms, regulator and industry responses to the twin health and economic crises caused as a result of the spread of the coronavirus and ways to protect public health have been exemplary" (ITU, 2020b). Given the rapid onset and spread of the pandemic, and the dependence of communities and businesses on connectivity in this period, it is difficult to imagine a substantively better set of responses and outcomes in most countries. This is not to say that there were no significant negative consequences in the short-to-medium-term emergency period. As an example, there are a range of digital divide issues that had been exacerbated by the pandemic requiring attention through the recovery period and as an equilibrium emerges.

The new normal policy and regulatory priorities lay out an approach to consolidate and capitalize on the rapid changes towards digitization driven by the pandemic. Building global resilience through digital strategies not only involves building capacity and headroom into digital infrastructure, but also adapting regulatory and policy approaches based on the pandemic experience. Operators, regulators and governments should work together to discuss, agree and formally articulate a set of standby collaborative responses that can be quickly enacted at the onset of national, regional or global crises. Having pre-agreed responses will enable more effective and rapid capabilities.

While COVID-19 extracted a heavy toll on the world, future pandemics may be even more infectious and/or have higher mortality rates. In the face of a pandemic significantly more dangerous than COVID-19, it is possible, even likely, that governments would, under emergency conditions, mandate detailed and highly automated track-and-trace systems. Developing privacy standards and procedures that are transparently operated with well-defined responsibilities, sooner rather than later, could make it more likely that such emergency measures would be supported, and therefore more successful, in protecting citizens. In essence, governments must find an approach to management of their citizens' private information and address underlying trust issues to convince a sufficient proportion of their populations to share their information. This is a challenge most countries and governments have only begun to address.

The pandemic has driven a remarkable discontinuity in digital adoption: a global disaster has generated a leap forward for the digital economy. The pandemic has generated a once-in-a-generation shift in connectivity demand and supply. Regulators and policy-makers now need to focus on consolidating the gain from this "digital discontinuity" into sustainable growth in connectivity supply, while ensuring that, in a world that is suddenly more digital, the reach of the world's communication systems becomes truly ubiquitous and inclusive.

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Endnotes

1 Connectivity in this context is defined as the use of the Internet by individuals.

2 Zero rating refers to the provision of free data for use on specific websites and services by Internet service providers and mobile service providers.

3 For a more comprehensive list of stakeholder responses, see also the ITU REG4COVID database, available at https://reg4covid.itu.int/.

4 Available at https://reg4covid.itu.int/.

Chapter 9

The digital lives of children and youth

Chapter 9. The digital lives of children and youth

9.1 Introduction

Digital connectivity is radically reconfiguring interpersonal, institutional and commercial exchanges. Increasingly, it provides the infrastructure for education, work, business and social relations. During COVID-19, the uptake of connectivity and digital devices expanded rapidly across the globe, allowing individuals to remain connected, despite social distancing regulations. Furthermore, in many countries, online access facilitated academic engagement throughout the pandemic, offering a vital means for children and youth to continue their education when students were out of school due to partial or full closures.

This chapter examines the opportunities – and risks – of being the "most connected" generation. It looks beneath the labels of "digital native", "smartphone generation" and other popular generalizations to explore the diversity of digital contexts and outcomes experienced by today's children and youth. It draws on available statistics and other evidence regarding the nature and impacts of digital technologies. Note, however, that apart from the statistics collated by ITU and the United Nations Children's Fund (UNICEF), most research relates to youth more than children, and is mainly drawn from the world's wealthier countries. The research is also often *not* disaggregated by the economic and cultural factors that differentiate or discriminate within this age group.

While the Internet offers great opportunity – learning, communication, creativity, health, participation and entertainment – it also poses risk. From an inequality standpoint, the greater the degree to which societies become connected, the more a lack of connection presents a problem. In addition, the more that children and youth gain access, the more they may be exposed to potential harm – harmful content, contact, conduct, cyberbullying, sexual harassment, commercial exploitation or hate speech.

In laying out the larger context, the chapter first distinguishes two levels of the digital divide. It then considers the emerging balance between opportunity and risk, noting some of the national and international efforts to improve that balance. Finally, it concludes with evidence-based recommendations for stakeholders on how to mitigate risks and improve opportunity for children and youth in the digital age.

9.2 The digital divide: taking stock of inequality in access and skills

In 2021, 63 per cent of the world's population used the Internet, compared with just 16 per cent in 2005.[1] Initially, information and communication technologies (ICTs) were heralded as an opportunity for freedom of information and communication, and a means of levelling long-standing socio-economic inequality. But while advantages have undoubtedly accrued, boosting development prospects, evidence consistently shows that ICTs have benefitted some groups more than others, making the challenges posed by the "digital divide" starkly apparent. Researchers and policy-makers distinguish three levels of the digital divide as we strive to combat inequalities: (a) digital access and use; (b) digital skills and engagement; and (c) meaningful outcomes (Helsper, 2021). This chapter examines the first two of these divides.

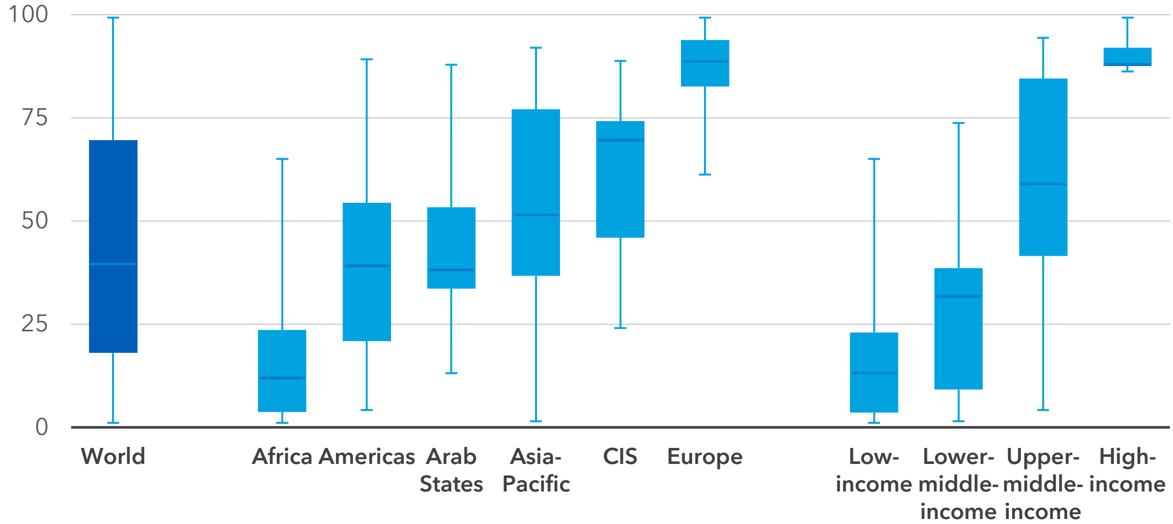
9.2.1 Access and use

As children gain access to ICTs, they are enthusiastic. Data from UNICEF and ITU show that approximately 40 per cent of school-age children have access to the Internet at home. However, there are stark disparities across income groups and regions (Figure 9.1). For example, in high-income countries, 9 of 10 school-aged children have access to Internet at home, compared to fewer than 1 in 5 in most low-income countries.

Data also show geographic and socio-economic inequalities within regions. For example, while more than 80 per cent of school-aged children in Japan and Thailand have access to the Internet at home, fewer

Figure 9.1: Large disparities in children's access to the Internet

Percentage of school-aged children with Internet access at home, by region and income group, latest year available



Notes: Data covering 72 countries are based on data from UNICEF on Internet access at home for children 3–17 years of age, complemented with ITU data on Internet use from home for children younger than 15 years of age. The coloured bars indicate the 25th, median and 75th percentile of all country values. The bottom and top lines indicate the minimum and maximum values. CIS = Commonwealth of Independent States.
Sources: UNICEF (2020a) and ITU.

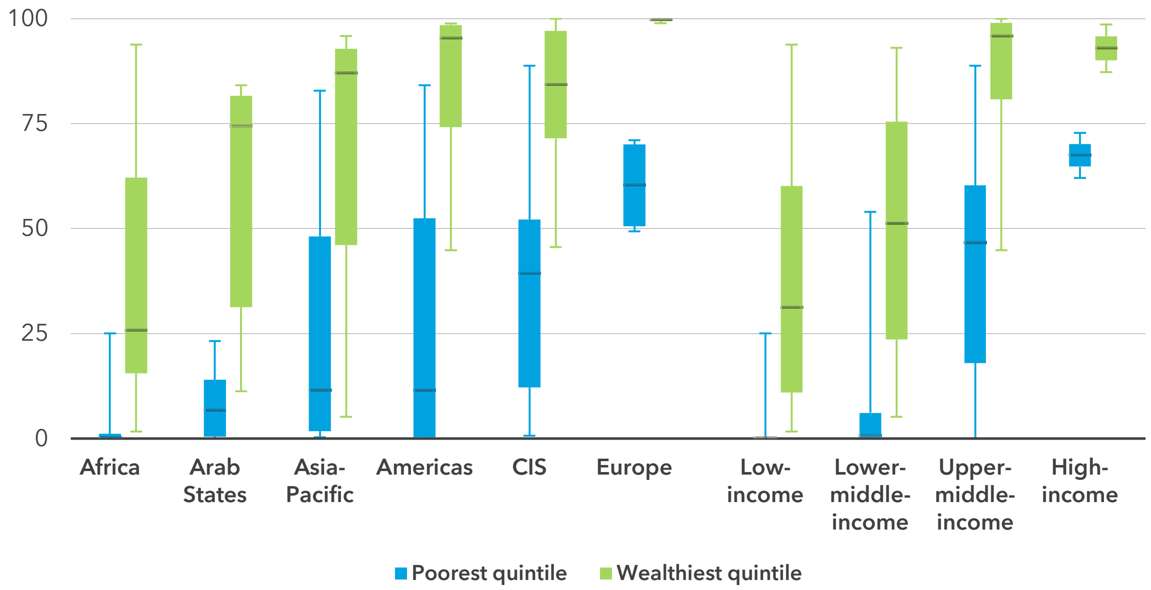
than 40 per cent have access in Indonesia and Bangladesh, and only 9 per cent in Pakistan. The large disparity in access to the Internet within middle-income countries reflects income inequality between the richest and poorest countries. The disparity in access on account of income inequality is further exacerbated by location, with greater access in urban than rural areas.

Furthermore, inequalities within countries are often even larger than across countries. Data indicate that, in nearly all low- and lower-middle-income countries, fewer than 10 per cent of children from the poorest families have Internet access at home. In contrast, in most of the same countries, at least a third of wealthier families have access, and in some – such as Bangladesh, Mongolia and Uzbekistan – more than two-thirds have access.

In Africa, Internet access for children in the poorest families is almost non-existent: in most countries, less than 1 per cent of children living in the poorest quintile of households have Internet access at home, compared with at least 25 per cent of children living in the wealthiest quintile. As illustrated by Figure 9.2, the largest disparities in Internet access as related to household income are in the Americas region. In most countries in this region, fewer than 15 per cent of children from the poorest households have Internet access, compared with over 90 per cent of children from the wealthiest households.

Figure 9.2: Large disparities in Internet access between the rich and poor

Percentage of children 3–17 years of age, from the poorest and wealthiest quintiles with Internet access at home, by region and income group, latest year available



Notes: Data covering 56 countries based on data from UNICEF on Internet access at home for children 3–17 years of age, complemented with ITU data on Internet use from home for children younger than 15 years of age. Blue represents children from the poorest quintile, meaning the poorest 20 per cent of households within the country. Green represents children from the wealthiest quintile, meaning the wealthiest 20 per cent of households within the country. The bars indicate the 25th, median and 75th percentile of all country values. The bottom and top lines indicate the minimum and maximum values. CIS = Commonwealth of Independent States.
Source: UNICEF (2020a).

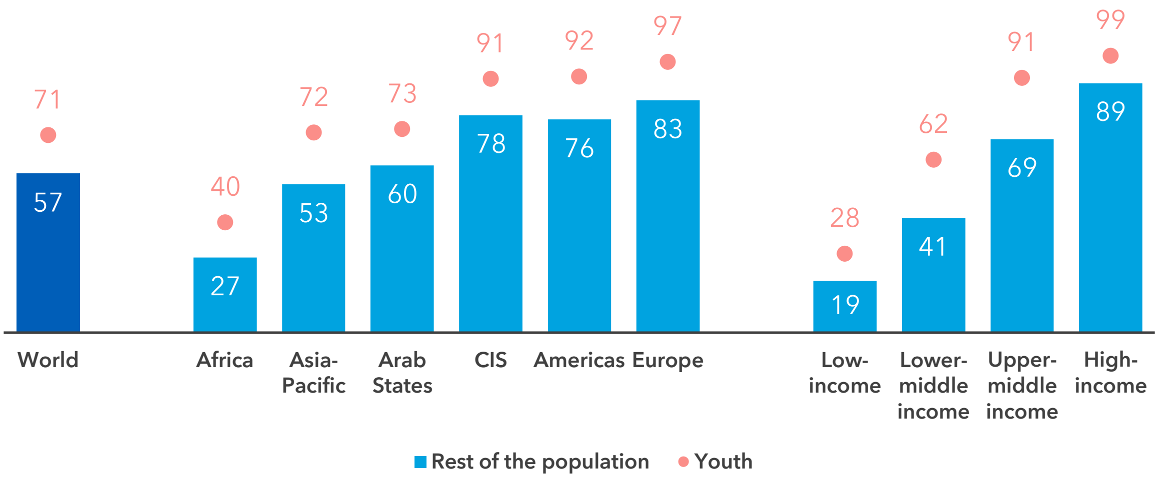
Globally, it is estimated that 71 per cent of youths (15 to 24 years of age) use the Internet. This proportion is far higher than the 57 per cent of other age groups who are Internet users, making them the most connected age group across all regions and income groups (Figure 9.3) (ITU, 2021a). The differences between youth and the rest of the population are especially significant in middle-income countries, where youth is driving digital transformation. Internet use among the youth in upper-middle-income countries is not far from universal. In contrast, although Internet use is higher than in the rest of the population, fewer than one-third of youth in low-income countries are using the Internet, where accessibility and affordability remain key constraints. The largest generation gap within regions is seen in Asia and the Pacific, where nearly three-quarters of the young use the Internet, compared with only half of the rest of the population.

Young individuals are growing up in an increasingly digital world, where digital experience and skills are crucial to future employment prospects. However, significant inequalities in accessing and using the Internet to acquire these skills remain, both within and across countries. Although Figure 9.3 is not broken down by gender, research suggests a complex picture, with girls and young women enjoying less access to the Internet than boys and young men in some countries, while gender parity is evident in others (Banaji *et al.*, 2018).

Initiatives such as One Laptop per Child sought to empower the world's poorest and most marginalized children by providing them with computers. When combined with training and careful adjustment to local circumstances, sustained access to ICTs does offer benefits, especially for girls, though this initiative's global success has been varied, insofar as its Western-centric lens may fail to address digital inequities rooted in the local social and structural problems that sustain inequities (such as cost, inadequate infrastructure and negative side effects) (Rivoir, 2019; Steeves and Kwami, 2017).

Figure 9.3: Youth is the most connected age group

Percentage of individuals using the Internet, 2021



Notes: "Youth" means individuals 15–24 years of age using the Internet as a percentage of the total population aged 15 to 24 years of age. "Rest of the population" means individuals below 15 or over 24 years of age as a percentage of the respective population. CIS = Commonwealth of Independent States.
Source: ITU (2021a).

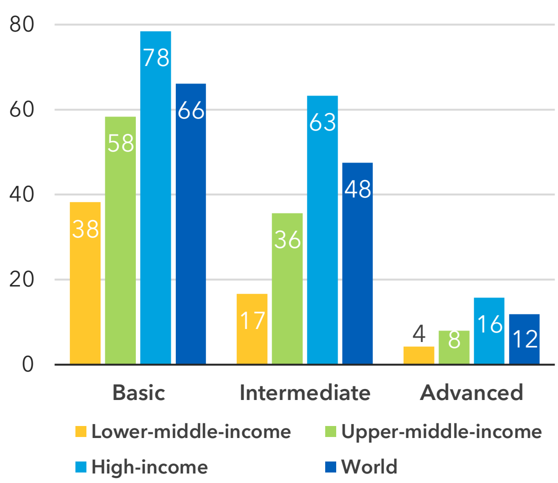
9.2.2 Digital skills

Access in and of itself does not determine the value that children and youth gain from the Internet. Indeed, even if the gap in access were closed, the possibility remains that *how the access is used* may further reproduce existing socio-economic inequalities. This second level of the digital divide – that of digital skills – emphasizes the role of such skills in mediating both the opportunities and risks of ICT use and digital engagement.

The increased uptake of ICTs in recent years has been combined with considerable effort by governments, educators and other actors to foster digital skills, competencies and literacies among children and youth. In designing policies that ensure that all can benefit and be considered digitally included, we must understand the needs and abilities of children and youth – and which characteristics can benefit most from ICT use (Cabello and Claro, 2017). This, in turn, requires a long-term vision, adequate infrastructure, and a structured approach within the education sector, ideally from the earliest years of education and applied across the system, to develop curricula, technical resources and teacher training. Echoing divides of access, stark inequalities remain between youth from countries in different income groups at all levels of ICT skills (Figure 9.4).

Figure 9.4: Youth ICT skills

Percentage of individuals 15–24 years of age, by skill level and income group,[2] latest available year, 2017–2021



Notes: Data covering 62 countries. Low-income countries are not shown because of lack of recent data. The percentages shown are unweighted averages. Data collection for the skills comprising the category Critical literacy only began in 2020. Since only a few middle-income countries have reported on these skills, averages by income group are not yet possible.
Source: ITU.

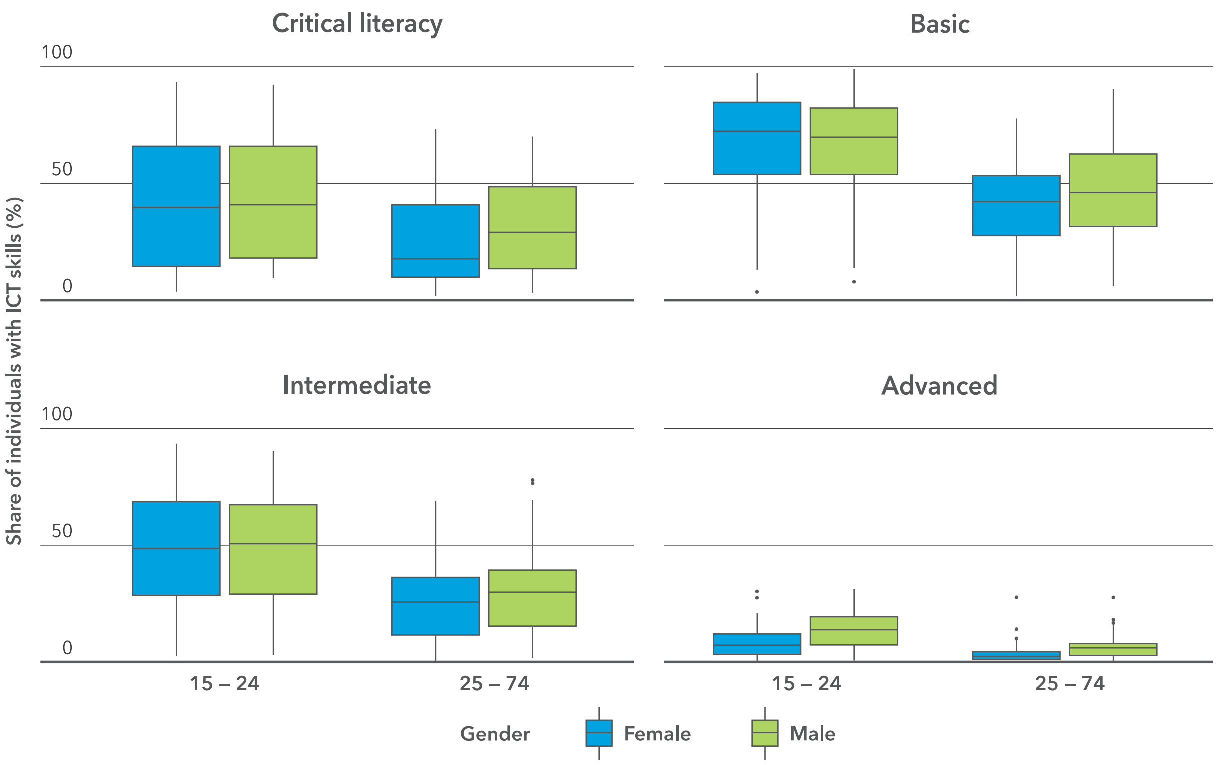
While developing digital skills is important for children under 15 years of age, commonly acknowledged ICT skill categories, with which adults may be familiar, are not designed with children in mind. For example, while sending messages, transferring files and understanding the sensitivity of personal data all can be applied to determine the skills of children, there are few children who are accustomed to making electronic presentations and using arithmetic formulae in a spreadsheet. However, as children grow, more emphasis in schools is put on skills that are important to become competitive in the job market, e.g. making electronic presentations and learning the basics of programming. At the same time, growing up in a digital environment, young people tend to be more tech-savvy, and in many cases choose apps and change settings to ensure greater privacy online. In addition, ICT skills have a strong association with overall literacy skills, which could further reinforce the differences, as young people tend to have better opportunities for education than their parents (Wicht *et al*., 2021). As shown in Figure 9.5, it may therefore not be surprising that ICT skills are generally higher for youth than for adults.

ICTs are often touted as empowering tools for addressing social inequity – without any analysis of who (and crucially *how*) they empower or disempower. While there is apparent gender parity in terms of basic and intermediate skills among youth, gender-based inequalities are more marked for advanced skills (programming) and for adults. Among young individuals, the differences are minor; however, more men tend to have skills in programming and in finding, downloading and installing software, while more women have skills in making electronic presentations and using formulae in a spreadsheet.

The ICT skill categories presented in this chapter are part of the Sustainable Development Goals monitoring framework and are reported on through national household surveys.[4] They are based on whether an individual has recently performed certain activities that require different levels of skill. There are also other skills frameworks which include skills across other domains, such as

Figure 9.5: Youth have more ICT skills than adults[3]

Percentage of individuals 15–24 and 25–74 years of age with different levels of skills, by skill level, latest available year



Notes: Data covering 70 countries or more for basic, intermediate and advanced skills. Critical literacy is based on data from 14 countries. The bars indicate the 25th, median and 75th percentile of all country values. The bottom and top lines indicate the minimum and maximum values (excluding outliers). Outliers are marked with dots.
Source: ITU.

communication and collaboration skills, and content creation and production skills (ITU, 2020d). Irrespective of the framework used, there is clear evidence from a range of studies that digital skills are important for children's and young people's ability not only to learn, but also to participate in both online and offline activities (Haddon *et al*., 2020). As the digital landscape evolves, new skills will become increasingly important, e.g. in areas of artificial intelligence and cybersecurity.

There is also growing evidence that digital skills help reduce unemployment and underemployment, and potentially increase productivity and improve standards of living (UN DESA, 2021). However, the global issues that impact children's and youths' lives are diverse, and capacity-building initiatives should be sensitive to their context. Often, the impact of ICT training is considered primarily from an educational or economic perspective, but a richer, multidimensional approach can consider additional facets, such as psychological, social and civic empowerment (Khan and Ghadially, 2010).

As the digital environment becomes more complex, managing ICT devices becomes just one part of the expanding demands on people's digital skills, as digital transformation reaches increasingly into different aspects of our lives. Children and youth need competence in operating a multitude of devices and accessing and navigating different types of services in the digital age. They must also critically understand the digital world in which they are increasingly immersed and with which they must engage widely and deeply as citizens now and in the future.

9.3 Opportunities and risks of digital connection

Opportunities and risks tend to be correlated: more access and higher digital skill levels are associated with more exposure to online risks, making it challenging to increase the former without increasing the latter (UNICEF, 2021). Many contextual influences have a bearing on whether risk is translated to a harmful outcome – or not – and these are difficult to define and measure. Unsurprisingly, the evidence is patchy, and findings vary considerably by country and by culture (Livingstone *et al*., 2017).

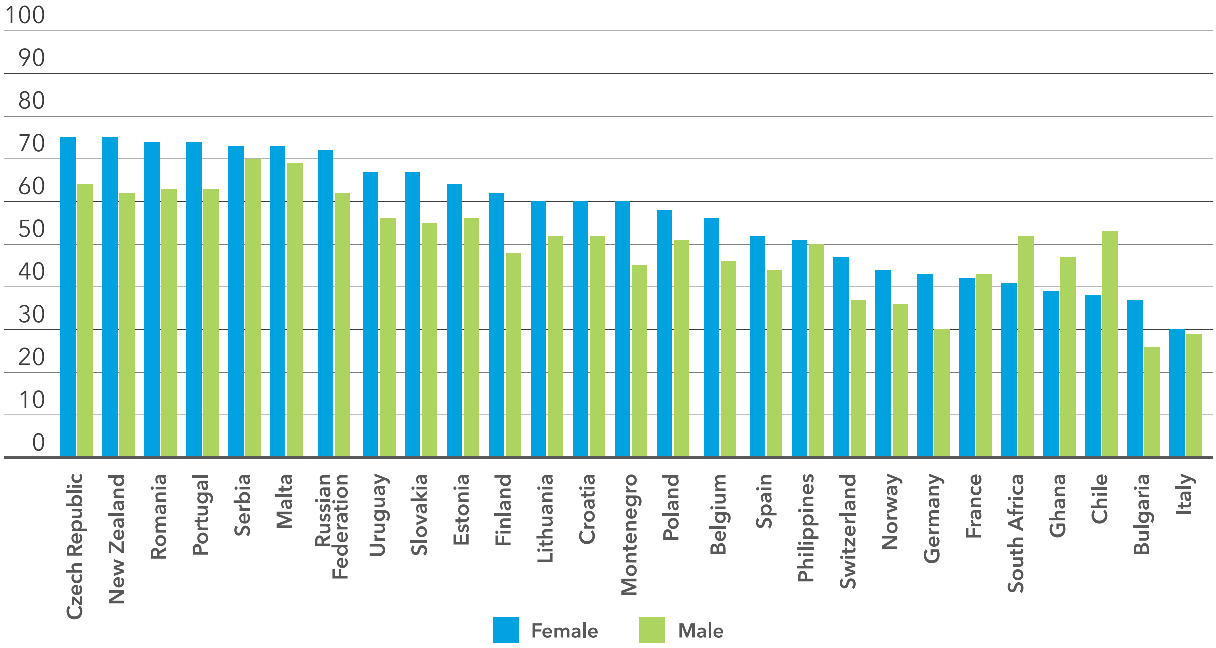
Consider one benefit of Internet access: going online to look for health information. Contributing to research that suggests the use of ICTs can promote healthy psychosocial functioning and well-being (OECD, 2018),[5]survey data from European Union Kids Online and Global Kids Online show that more than half (54 per cent) of 12-to-16-year-olds with access to the Internet look for health information online at least monthly (Figure 9.6) (UNICEF, 2020b). They value its anonymity, the variety of sources available, and the links to professional support. In some contexts, online health information is the only source available to this age group, especially about sexual and reproductive health. This may explain why, in most countries, more girls than boys seek health information. The challenge for the global community is to ensure that children and youth can access reliable health information confidentially, as needed and, ideally, for free (UNICEF, 2019).

There is no doubt that the evolving digital landscape has reinforced and extended some long-standing risk and harm to children and youth, such as cyberbullying and child sexual exploitation (ITU, 2021b). It has also introduced and amplified new risks, such as misinformation and disinformation, influencer marketing and privacy risks. Further, because the digital landscape can change quickly, it presents new risks when children and youth have access *before* they are media literate and have acquired online resilience – or in the absence of legal, regulatory and policy frameworks and protection mechanisms. As a result, the risks for children and vulnerable youth navigating a digital environment are now the focus of growing concern among parents and caregivers, educators, clinicians, civil society, policy-makers and industry (ITU, 2020b).

Following consultation with stakeholders, the European Children Online: Research and Evidence (CO:RE) project classified online risks of harm to children, as shown in Table 9.1 (Livingstone and Stoilova, 2021).

Figure 9.6: Finding information about health

Percentage of 12–16-year-olds who use the Internet to look for health information online at least monthly, by gender



Note: Only children in the Flanders region in Belgium were surveyed.
Sources: European Union Kids Online, Global Kids Online, analysis for this chapter.

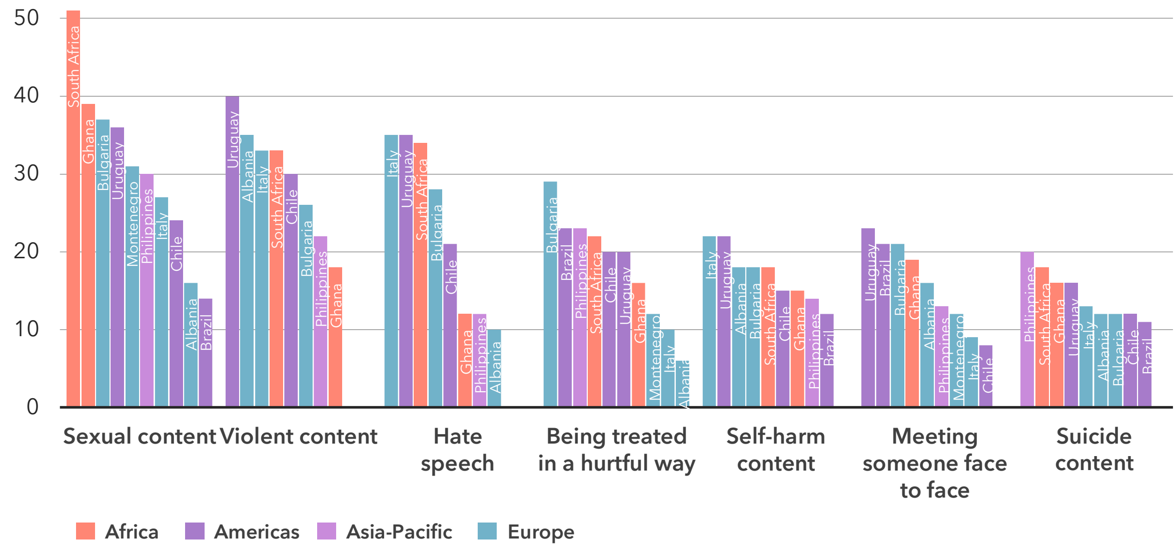
Table 9.1: The 4Cs of online risks to children

CORE	Content Child engages with or is exposed to potentially harmful content	Contact Child experiences or is targeted by potentially harmful *adult* content	Conduct Child witnesses, participates in or is a victim of potentially harmful *peer* conduct	Contract Child is party or exploited by potentially harmful contract
Aggressive	Violent, gory, graphic, racist, hateful or extremist information and communication	Harassment, stalking, hateful behaviour, unwanted or excessive surveillance	Bullying, hateful or hostile communication or peer activity, e.g. trolling, exclusion, shaming	identity theft, fraud, phishing, scams, hacking, blackmail, security risks
Sexual	Pornography (harmful or illegal), sexualization of culture, oppressive body image norms	Sexual harassment, sexual grooming, sextortion, the generation and sharing of child sexual abuse material	Sexual harassment, non-consensual sexual messaging, adverse sexual pressures	Trafficking for purposes of sexual exploitation, streaming (paid-for) child sexual abuse
Values	Mis/disinformation, age-inappropriate marketing or user-generated content	Ideological persuasion or manipulation, radicalisation and extremist recruitment	Potentially harmful user communities, e.g. self-harm, anti-vaccine, adverse peer pressures	Gambling, filter bubbles, micro-targeting, dark patterns shaping persuasion or purchase
Cross-cutting	Privacy violations (interpersonal, institutional, commercial) Physical and mental health risks (e.g. sedentary lifestyle, excessive screen use, isolation, anxiety) Inequalities and discrimination (in/exclusion, exploiting vulnerability, algorithmic bias/predictive analytics)			

Source: Livingstone and Stoilova, 2021.

Figure 9.7: Children and youth's exposure to online risks

Percentage of 9–17-year-olds who use the Internet who reported a range of online risks in the past year, by country



Notes: All children 9–17 years of age who use the Internet. Note that children 9–10 years of age in Chile and 9–12 years of age in Uruguay were not asked if they had seen content relating to self-harm, suicide, hate speech, violence or sexual images; children 9–11 years of age in South Africa were not asked if they had seen content relating to self-harm, suicide, hate speech or violence.
Source: Global Kids Online (2019).

Evidence for these risk categories by country is accumulating, revealing the need for interventions that prevent risk or mitigate harm as well as the contextual factors that account for inter- and intra-country differences. For example, Figure 9.7 shows the percentage of Internet users 9–17 years of age who reported exposure to online risks by country – the most common risks are from sexual or violent content, while there is considerable cross-national variation (Global Kids Online, 2019).

The findings reveal a range of gender differences by country. For example, boys are more likely to see violent content online in Albania, Bulgaria, Ghana and Uruguay, while girls are more likely to see such content in Chile and Italy (Global Kids Online, 2019). As with the other risks, there is a clear age trend in which younger children report less exposure to violent and sexual images than older children. Adolescents 15–17 years of age in South Africa were most likely to report seeing sexual images in the media. While it is not possible to determine from the evidence whether such images are of explicit sexual content, public and policy concerns centre on the fact that children are particularly vulnerable to the persuasive or harmful effects of digital media. This is because their critical thinking skills and impulse inhibition are still developing. In addition, such images are often shared within trusted social networks, encouraged by celebrity influencers, or appear adjacent to personalized content.

Furthermore, children and youth may not comprehend the full complexity of how digital data are collected, analysed and used for commercial purposes (American Academy of Pediatrics, 2021). Such online privacy risks present a paradox: the simultaneous connectedness and voluntary sharing of personal information can be valuable for the development of personal agency – while also constituting a threat to online privacy. Privacy risks were especially concerning given how much personal data were shared during the COVID-19 lockdown. In academic settings, e-learning platforms could undermine privacy due to disclosure of personal data, while in health settings, some governments took extraordinary measures to contain the virus by collecting and sharing large amounts of personal data.

Uncertainty remains about how the use of social media relates to well-being (Ghai *et al*., 2022). The risks and harms of social media have gathered widespread media attention,[5] and academic research in this area has authenticated claims that social media harms children and youth through negative stimuli (Hartanto *et al*., 2021), although there is evidence of benefit, too (Ito *et al*., 2020). The influence of digital media on children and youth who experience socio-emotional vulnerabilities is complex. Globally, approximately 13 per cent of 10–19-year-olds experience mental health difficulties (WHO, 2021).

Research on mental health disorders has identified social media as a risk factor – with analysis suggesting an association between increased use of social media engagement and increased rates of depression (Ivie *et al*., 2020). However, the reliance on correlational data limits the ability to infer directionality, and the link between social media use and depression is debatable. Moreover, there is evidence that the relationship between use of social media and life satisfaction changes across adolescent development (Orben *et al*., 2022), with experiences of online harm varying by age, time online and type of activity (Livingstone and Helsper, 2013). Crucially, vulnerable youth, such as those with lower social self-esteem, encounter more risks online and are more negatively affected as their engagement with ICTs increases (Helsper and Smahel, 2020). The growing consensus is that the relation between media and child and youth development should be conceived not as unidirectional, but as bidirectional (Valkenburg *et al*., 2017) – in other words, we should ask not only how children's media use influences their development, but also how their development influences their media use.

9.4 Conclusions

The digital environment is ever-evolving, and is currently being transformed by the rise of new technologies, such as artificial intelligence, virtual reality and smart environments. To make for positive and long-term change, we need to address the digital divide among children and youth at multiple levels. Given rapid technological development, our children and youth represent the most connected generation – and hopes are high that they will reap the benefits of this. However, the reality is more uneven and unequal. The global pandemic has further exacerbated inequalities by hitting the most vulnerable and disadvantaged the hardest – while accelerating digital innovation in education and health services, and deepening global reliance on digital businesses and networks. This chapter, then, concludes by highlighting some of the many initiatives and policies seeking to close the digital divide. Importantly, it suggests recommendations to improve outcomes for children and youth in the digital age.

9.4.1 Initiatives that address the learning crisis

First, since access to technology is paramount, we highlight initiatives that address the learning crisis post-COVID-19, and which transform education by giving children and youth equal access. For example, the ITU initiative Generation Connect aims to engage youth in the work of ITU, encourages them to contribute to decision-making processes, and promotes ICT youth-related policies within Member States.[6] ITU has also partnered with UNICEF to launch Giga, which aims to connect every school to the Internet.[7]

9.4.2 Removing barriers and closing gaps

Widely endorsed recommendations to governments call for affordable, reliable devices and broadband connectivity for children and youth at home and in schools, public libraries and other community locations. The design of digital products and services places barriers to access by certain groups, and we need ethical and rights-based interventions to prevent discrimination. For example, governments and industry are increasingly adopting the World Wide Web Consortium's Web Content Accessibility Guidelines to make online resources more accessible for those with disabilities.[8] In addition, ITU has developed several programmes to help close the gender gap. These include the International Girls in ICT Day, the EQUALS partnership, the African Girls Can Code Initiative, the American Girls Can Code, and the Women in Cybersecurity Mentorship programme. Through the ITU Digital Transformation Centres Initiative,[9] youth are trained in basic and intermediate digital skills to increase their job opportunities and economic prospects. Also vital are public awareness-raising efforts, including parents and educators (Livingstone and Byrne, 2018; ITU, 2020c), to ensure fair access and use among all children, irrespective of age, gender and other factors.

Children and youth who lack digital skills and literacy may encounter new forms of marginalization, and find it difficult to access the services they need – impacting on opportunities for learning, health and work. Indeed, the more society relies on digital infrastructures, the stronger the exclusion of those already marginalized by factors such as gender, race, income and disability. Such exclusion may extend beyond the mechanics of access to confidence, competence and knowledge, undermining children's and youth's engagement with the services and applications they need.[10]

9.4.3 Online learning initiatives need community support and more

It is time to evaluate the effectiveness of the many initiatives now underway to support and enhance digital learning and engagement – and to promote successful and inclusive interventions (Cortesi *et al*., 2020). Online learning programmes provide a viable solution for bridging the widening achievement gaps between high- and low-income youth, provided they are flexible and address the needs of disadvantaged and vulnerable learners. With over half of the world's population in lockdown due to COVID-19, many have been encouraged to use the time to complete self-directed study and learn new skills. The ITU Academy[11] provides online training opportunities with a dedicated space for online training for children of different ages to be launched by the end of 2022. Research around online learning suggests, however, that without community support, and improvements in literacy and socio-economic equity, online educational opportunities are successfully completed by the already advantaged (OECD, 2020). The challenge then for educators will be to design materials that are accessible, compelling and relevant to the diverse circumstances in which youth live and the many challenges they face.

9.4.4 Working together to protect from harm

The recommendations above are geared towards the development of infrastructure, digital skills and greater opportunity for children and youth. However, stakeholders must work together to protect youth from online harm – especially when the tools needed to mitigate that harm are created in one jurisdiction and not shared in another. The United Nations Committee on the Rights of the Child recently adopted General Comment 25 on the digital environment. This sets out recommendations to States on protecting children from harm of all kinds in relation to digital technologies – and on how to balance their rights to protection with other rights, such as expression, play, privacy and education.[12] In addition, the ITU Guidelines on Child Online Protection are currently being implemented across the globe – these recommendations address the development of a safe, empowering online environment for children and young people.[13] Ultimately, children's best interests and fullest development are at stake.

9.4.5 More research, more data needed on access, use, skills and outcomes

People under 25 years of age constitute 4 in 10 of the global population. It is vital to improve robust evidence on the digital access, use, skills and outcomes of children and youth. This will require international cooperation to ensure comparable definitions and measures – in this way, we can establish benchmarks that enable us to measure progress, examine problems and identify good practice (Livingstone and Stoilova, 2019). Efforts to foster digital inclusion would be improved if there were clearer metrics for monitoring it and a willingness to go beyond simple access measures. For example, while household access to the Internet is most often measured, individual opportunities for children and youth are less well documented, especially when disaggregated by gender, disability, income or migration status.
Even less is known of the quality of digital experiences and outcomes – and this lack of knowledge extends to the benefits that may be realized from online opportunities or the risks of harm, especially for disadvantaged or vulnerable groups. To remedy this, qualitative and contextual research is needed. Equally important is understanding how digital technologies can help support and reinforce digital connection and opportunity. Qualitative and quantitative research should be designed and conducted in collaboration with the affected groups and communities, especially with children and youth themselves.

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Endnotes

1 For the latest figures on connectivity, see Chapter 2.

2 Basic ICT skills: Using copy-and-paste tools to duplicate or move data, information and content in digital environments (e.g. within a document, between devices, on the cloud); sending messages (e.g. e-mail, messaging service, SMS) with attached files (e.g. document, picture, video); and transferring files or applications between devices (including via cloud storage);
Intermediate ICT skills: Connecting and installing new devices (e.g. a modem, camera, printer) through wired or wireless technologies; creating electronic presentations with presentation software (including text, images, sound, video or charts); finding, downloading, installing and configuring software and apps; using basic arithmetic formulae in a spreadsheet;
Advanced ICT skills: Programming or coding in digital environments (e.g. computer software, app development);
Critical literacy: Changing privacy settings on your device, account or app to limit the sharing of personal data and information (e.g. name, contact information, photos); setting up effective security measures (e.g. strong passwords, log-in attempt notification) to protect devices and online accounts; verifying the reliability of information found online.

3 Skills as presented in the footnote for Figure 9.4.

4 Sustainable Development Goal indicator 4.4.1: Proportion of youth and adults with ICT skills, by type of skills. For more information, see ITU (2020a).

5 See documentaries such as The Social Dilemma (2020), and mainstream media coverage of the Facebook Files (2021).

6 www.itu.int/generationconnect/wp-content/uploads/2020/11/ITU_Youth_Strategy.pdf.

7 Available at https://giga.global/.

8 ITU has also developed a series of trainings and resources related to ICT Accessibility. Available at www.itu.int/en/ITU-D/Digital-Inclusion/Pages/ICT-digital-accessibility/default.aspx.

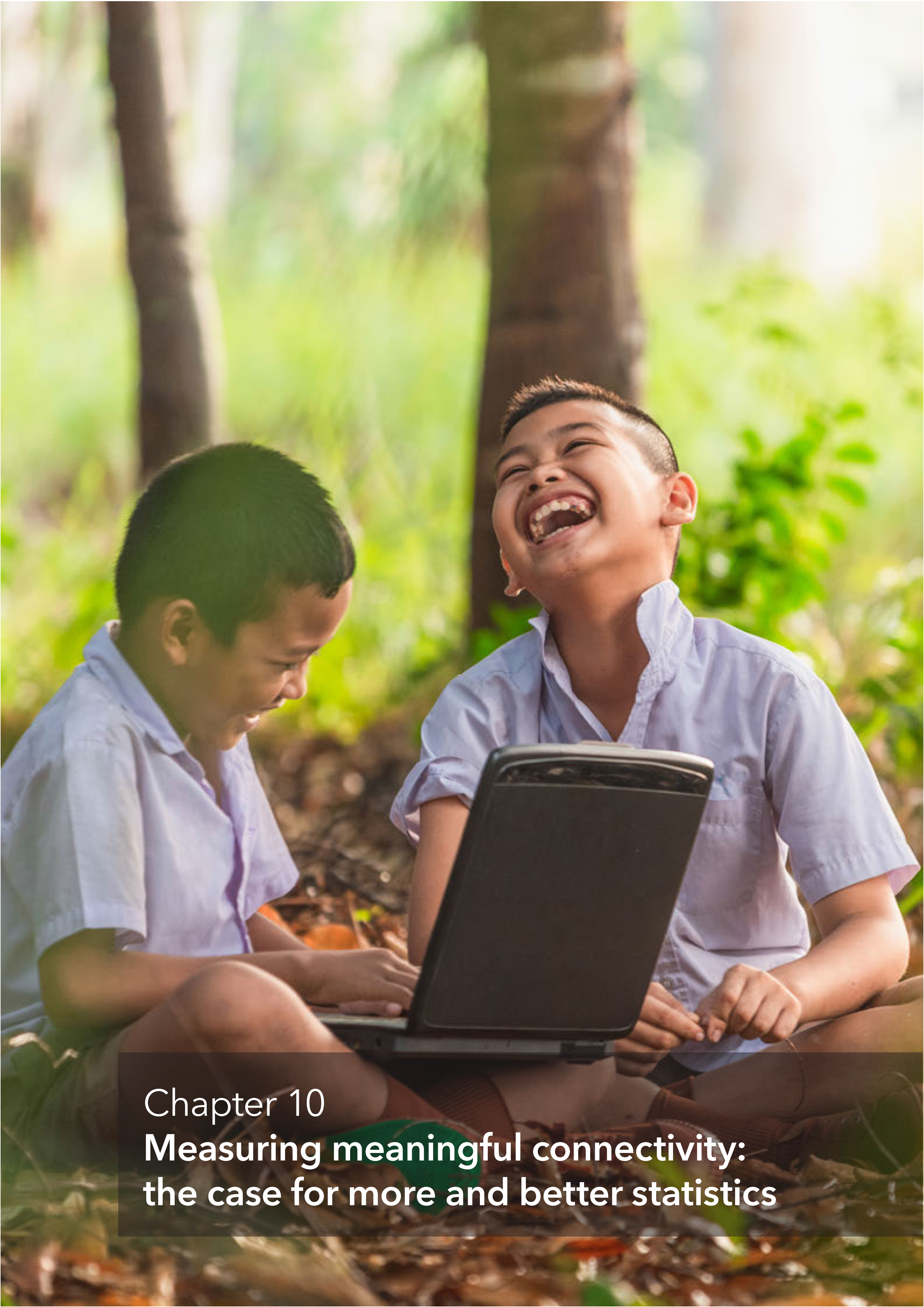
9 Available at https://academy.itu.int/itu-d/projects-activities/digital-transformation-centres-initiative.

10 There are different frameworks to evaluate online safety education. See, for example, Walsh *et al*. (2022).

11 Available at https://academy.itu.int/.

12 See General comment No. 25 (2021) on children's rights in relation to the digital environment. Available at https://www.ohchr.org/en/documents/general-comments-and-recommendations/general-comment-no-25-2021-childrens-rights-relation.

13 For more information, see www.itu-cop-guidelines.com/.



Chapter 10

Measuring meaningful connectivity: the case for more and better statistics

Chapter 10. Measuring meaningful connectivity: the case for more and better statistics

Data are vital for achieving universal and meaningful digital connectivity. Data help us understand our world. They tell us where we were, where we are, what works and what does not. They are a key element in empirical research for identifying trends, patterns and good practices. Data help policy-makers design better, more targeted and more effective policy interventions.

Many societies are witnessing a newfound appreciation for data and what they can do for us. As we go about our lives, we leave data traces everywhere. Data volumes have grown exponentially. The deployment of 5G broadband is already under way, with talk of 6G now begun. The impact of these new technologies will be transformative – and will generate more new data flowing across many additional connected devices. Lower storage and processing costs have in turn led to hugely increased analytical power. Appropriately harnessed, such data will help alleviate data poverty, particularly in the information and communication technology (ICT) context.

However – and somewhat paradoxically – for many countries, reliable statistics in key areas, including digital connectivity, remain surprisingly scant. While raw data are abundant in the ICT domain, a lot of them are privately owned and inaccessible to many countries. Collecting survey data and transforming them into actionable insights require advanced skills and significant resources, which many countries lack.

This chapter makes the case for more and better data. It discusses approaches to data gathering, flags data gaps, highlights the need for more data literacy and governance, and concludes by setting out promising solutions to measuring digital connectivity.

10.1 The case for more and better data

Despite years of warnings that a new, dangerous virus was highly likely, countries worldwide were caught unprepared: the COVID-19 pandemic disrupted lives and societies worldwide. The pandemic brought to the fore the essential role of statistics in decision-making, and they were soon dubbed "the currency of our times" and "the new fuel". Data – and the statistics derived from them – have always been critical in solving problems, indispensable in running businesses, and central to addressing issues such as universal education and disease eradication.

Raw data and analytical insights are indispensable, both for long-term strategic decisions and real-time responses in fast-moving situations where clarity is absent. As the COVID-19 crisis deepened, countries frantically sought the data that could guide them through the pandemic, including data on ICTs. Responses were driven by the constant stream of epidemiological data – the numbers of individuals tested, infected, hospitalized, intubated or dead. The insights from these data then helped manage the roll-out and monitoring of vaccinations. ICT data became essential in governments' responses to curb the pandemic, particularly on matters of digital connectivity at the household level. Do the conditions for telework, telehealth and distance education exist? Where, for how many, and who will be left out? The virus brought to the forefront – in a very tangible way – the importance of ICT statistics as a tool for planning and prioritization.

National ICT statistics are a valuable asset in today's economies. They help us make sense of economic and social transformations under way around us. How we make use of data in decision-making and how we allocate resources to producing them are subject to subtle *data cultures.*

Earlier chapters highlighted how countries access and use ICTs in different ways. The "ICT haves" are generally also countries that are richer in data, and better at harnessing them. Data help the provision of better services by governments and businesses, which encourages further uptake and use – and this in turn deters uptake and use. The poor and disadvantaged are affected disproportionately from actions *not* taken because of this absence of data.

A recent study found that – while a good amount of research on COVID-19 was published in 2020 using data from cellphones, social media and other private sources – lower-income countries, notably in Africa, were underrepresented, due to lack of support, capacity issues and difficulties accessing relevant data.[1] Conclusion – data can help illuminate and address the predicament of less privileged groups.

10.2 Measuring digital connectivity

To assess progress, we need data on the deployment and uptake of digital technologies. ITU, the United Nations specialized agency for ICTs, collects, analyses and disseminates (a) administrative ICT indicators, gathered annually from national telecommunication regulators; and (b) ICT household indicators collected from national statistical offices (NSOs).

National legislation that requires telecommunication operators to report ICT indicators (number of subscriptions and network coverage, etc.) directly to regulators results in good coverage of administrative ICT indicators.

ICT indicators on access and use by households and individuals come from household surveys conducted by NSOs. ICT household surveys are conducted on a needs-only basis. In many countries, NSOs do not have the financial and human resources to conduct ICT household surveys on an annual – or even semi-annual – basis. This results in poorer quality insight into the extent of ICT access, use and skills within the population. While much progress has been made in recent years, large data gaps and blind spots remain – for example, on basics like numbers of connected households and Internet use. Box 10.1 shows how ITU helps expand coverage, improving the quality of ICT data worldwide.

Household surveys help assess how ICTs impact people's lives, providing insights into how people use ICTs. Surveys capture the penetration of connectivity at home according to socio-economic characteristics, and track connection as it evolves from dial-up to broadband, as well as the shift to 5G and beyond. They capture the proliferation of access from the desktop to multiple devices – laptops, tablets and smartphones – and explore frequency, intensity and patterns of use. They also identify barriers and shed light on the level of ICT skills across the population.

Surveys enable the "have-nots" to have a say and their opinions heard. Such surveys have revealed that the poor are prepared to spend a higher proportion of their incomes on ICTs than are well-to-do individuals, indicative of

Box 10.1: The start of the data lifecycle – ITU's work in defining ICT indicators, setting standards and building capacity

For decades, ITU has compiled, disseminated and promoted ICT data. Two sessions of the World Summit on the Information Society (2003 and 2005) led to the creation of the Partnership on Measuring ICT for Development, a multistakeholder coalition of international and regional organizations. Its aim is to improve the quality and quantity of ICT statistics. The Partnership developed a core list of ICT indicators, which has been adopted as United Nations standards.[2]

As a leading partner, ITU continues to add and modernize ICT indicators in line with technology changes. Two ITU-led Expert Groups develop and update methodologies which guide ITU's data collection on administrative and household ICT indicators. The Expert Groups work together online and hold annual in-person meetings.[3]

ITU supports national measurement efforts through two guides, the *ITU Handbook for the Collection of Administrative Data on Telecommunications/ICT* (ITU, 2020a) and the *Manual for Measuring ICT Access and Use by Households and Individuals* (ITU, 2020b). The guides are free, available in six languages, and are the ultimate reference on measuring digital development. These publications are complemented by capacity development activities on the ground and online, via the ITU Academy Platform.[4]

Table 10.1: Percentage of economies with available data, selected indicators (latest year 2018–2021)

	Fixed broadband/ 100 inhabitants	Mobile broadband/ 100 inhabitants	Mobile phone use, %	Internet use, %		Internet access, %	
				All	By gender	All	By urban/ rural
Africa	75.0	72.7	13.6	20.5	22.7	40.9	15.9
Americas	68.6	65.7	31.4	57.1	37.1	60.0	37.1
Arab States	90.5	90.5	38.1	52.4	52.4	52.4	23.8
Asia and the Pacific	70.0	67.5	22.5	42.5	40.0	50.0	17.5
Commonwealth of Independent States	66.7	66.7	44.4	66.7	66.7	88.9	66.7
Europe	95.7	95.7	28.3	87.0	87.0	87.0	58.7
World	79.1	77.6	26.5	53.1	49.5	60.7	33.7

Notes: Data availability weighted by population size is generally higher than as shown in the table. Economies reporting on fixed and mobile broadband represent more than 90 per cent of the world's population. Economies reporting on Internet use and access represent 80 and 66 per cent, respectively.
Source: ITU.

the value they attach to new technologies. Equally, these surveys give voice to concerns about affordability and other issues. Findings from household surveys are integral to inclusive future developments across the board.

Periodic household surveys with quality standards are large-scale and resource-intensive undertakings. They require careful planning, and take time – and are therefore costly. A 2017 World Bank study estimated the average cost at USD 170 per household, with much higher costs in sub-Saharan Africa (Kilic *et al.*, 2017). Many countries simply lack the capacity to collect, process and analyse the data. The availability of such resources is frequently beyond the reach of many developing countries, with resulting data gaps in ICTs. Table 10.1 shows the availability of selected indicators in all economies, by ITU region. Indicators derived from administrative sources, such as fixed and mobile broadband subscriptions, have good coverage across most regions. In contrast, indicators derived from household surveys, such as the share of individuals using the Internet or a mobile phone rarely, are sketchily represented (53 per cent and 27 per cent, respectively, for all economies).

The gap deepens for more granular statistics, such as Internet access among households living in urban or rural locations or Internet use by gender.

These gaps in ICT statistics are symptomatic of wider data gaps elsewhere. Unequal development has disadvantaged lower-income countries, which lack the infrastructure, financial resources and skills necessary to produce data and subsequently extract value from them. They often lack adequate institutional, policy and regulatory frameworks that enable trust in environments conducive to statistics.

If a standalone ICT household survey is not feasible, one alternative is simply to insert key ICT questions into an existing survey. Labour force surveys have been useful, since they exist in most countries and are typically conducted sub-annually, with adequate samples for population coverage. Some countries, such as Mexico and Ghana, have also included questions on Internet access and use in their national censuses.

In parallel, data-gathering efforts by non-governmental organizations (NGOs) contribute to addressing the data gaps. Research ICT Africa has conducted household ICT surveys in several countries for years.[5] The surveys, now entitled "After Access", examine connectivity in households and individuals, and shed light on numerous aspects of digital inequality. Similar surveys were also conducted by LirneAsia in Asia and by the DIRSI (Spanish acronym for Regional Dialogue on the Information Society) in Latin America and the Caribbean.[6]

10.3 Exploring new frontiers in ICT statistics

New solutions have enormous potential in addressing data poverty. ICTs can record astonishing amounts of information. From network infrastructure to service provider gear and end-user access devices, every exchange is recorded and every click is captured – creating an environment teeming with data. Understanding how digital technologies generate data is helping to create new approaches to exploit this potential.

The concept of "big data" has attracted much attention in recent years. Driven by the masses of data harvested by technology companies, it has sparked interest in research on a range of subjects that arise from the timeliness and sheer volume of such data. Other sources are generating big data, too – satellite images, images from still and video cameras, sensors of all kinds, and more. In addition, vast amounts of data are produced from the telecommunication networks themselves.

The latter are more relevant for ICT statistics. ITU is exploring the potential of big data, particularly from mobile-cellular networks. Since 2016, pilot projects with eight countries have developed methodologies and explored how these new data sources might serve to (a) replace or improve disaggregation of current indicators; (b) propose new indicators that would increase the measurement opportunities for ICT; and (c) fill in data gaps. Progress to date is promising, and is set out in a detailed guide that documents methodologies and standards on using mobile phone data for statistical applications (ITU, 2017). The success of these efforts requires the cooperation of mobile-cellular operators and Internet service providers. It also requires careful attention to legal matters concerning confidentiality and privacy. Within the United Nations system, ITU plays an active role in harnessing big data for official statistics, notably for the purpose of measuring progress towards the Sustainable Development Goals (SDGs) (see Box 10.2).

ITU helped define guiding principles to maintain public trust when such data are used for public purposes – aligned with the United Nations' Fundamental Principles of Official Statistics (Jansen *et al.*, 2021). Mobile telephony technology generates large amounts of information that can be tapped. Mobile antennas have unique IDs and geolocation coordinates that allow for granular data by low geographical areas of coverage. Network log records contain domestic subscriptions for inbound and outbound roaming, and call detail records produced by telephone exchanges capture metadata, such as the time and duration of any transaction (Coordinated Universal Time (UTC) timestamp), whether a voice call, text, Short Message Service (SMS) or Internet access.

In addition to ICT indicators, the unique IDs of subscriber identity module (SIM) cards used in mobile-cellular networks have a relevance well beyond ICT statistics – extending, for example, to statistics related to internal mobility and commuting, tourism, infrastructure assets and migration. During the COVID-19 pandemic, many governments worked with mobile phone operators to track the mobility of its citizens to evaluate the effectiveness of lockdown policies or to predict the spread of COVID-19 to inform disease prevention strategies data.[8]

Open-source data can help check the quality and reliability of ICT indicators provided by network operators. Some crowdsourcing tools, for example, can expose access inequality, since they measure signal strength, including dead zones, in what are sometimes reported to be areas with high broadband coverage.

For example, OpenCelliD is the world's largest collaborative community project collecting Global Positioning System (GPS) positions of cell towers. Its database covers millions of cell locations across the globe. WorldPop – an international collaborative project between academia, international organizations, national governments, private foundations and NGOs – is aimed at increasing the resolution of population projections to grid-level data. The project provides gridded population estimates at 1-kilometre and 100-metre grids. Mapping cell tower location with high-resolution population density maps can reveal populated areas that have limited coverage. Figure 10.1 shows an example from central Nigeria, where the green areas represent population density

Box 10.2: UN-CEBD and Big Data Guidelines

In 2014, the United Nations Statistical Commission (UNSC) agreed to create the United Nations Committee of Experts on Big Data and Data Science for Official Statistics (UN-CEBD) to explore the use of big data for official statistics and for monitoring the SDGs. UN-CEBD – composed of experts in international and regional organizations, NSOs, academia and private agencies – serves as a knowledge centre on big data, and addresses issues pertaining to data access, methodology, technology and privacy protection.

The work of the UN-CEBD is divided across eight task teams that explore data from the automatic identification system (AIS), Earth observation, social media, mobile phones and scanner data, and address cross-cutting issues related to capacity-building, privacy-preserving techniques and monitoring of SDGs.

ITU is an active participant in several task teams, and chairs the team on mobile phone data, which will soon release six Guidelines on the use of mobile phone data across various domains, e.g. information society, migration and transportation. The Guidelines on the use of mobile phone big data for measuring the information society, prepared by ITU, summarizes key learning from the ITU pilots, and is specifically focused on the calculation of two key SDG indicators:

- SDG indicator 9.c.1 on the proportion of the population covered by a mobile-cellular network; and
- SDG indicator 17.8.1 on the use of mobile-cellular networks for Internet access.

The Guidelines serve as a guide of how to access, process and calculate the indicators using mobile phone big data. They provide recommendations on partnership models and how to overcome legal challenges. In addition, they present in-depth details on the data sources, including complementary reference data, and how to assess the quality of the data obtained from mobile operators.

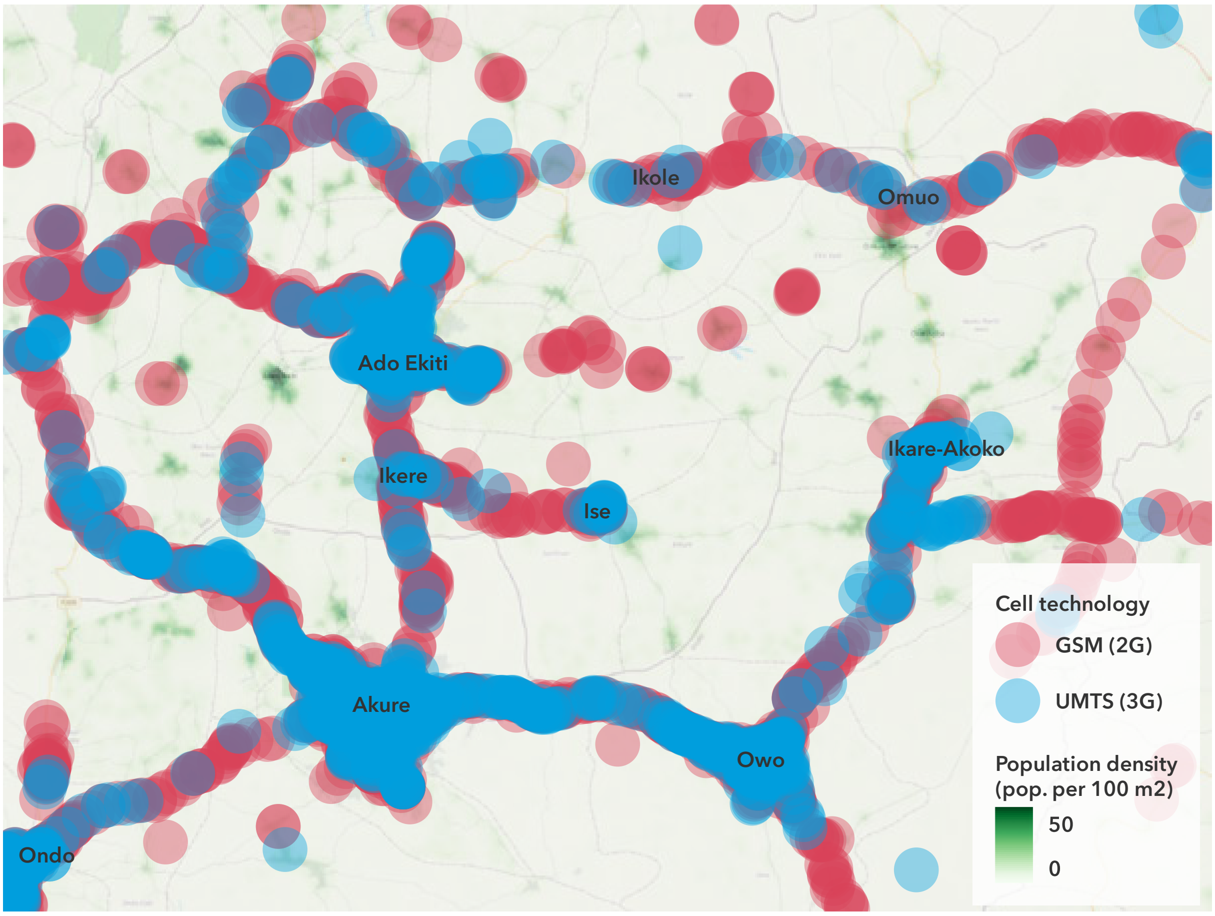
The Guidelines constitute a solid foundation to begin harnessing the power of mobile phone big data. NSOs, regulators, ministries and other data users should take advantage of the methodologies and country experiences included in the Guidelines.[7]

and the circles represent cell towers. In rural areas, cell towers mainly follow the main roads, leaving large areas without coverage.

Speed tests can be used to check in geographical levels down to census blocks, and ascertain if broadband signals meet stated thresholds (Johnson, 2021).[9] Ookla is another example of a private company that repurposes its own data to provide a global index for Internet speeds, ranking countries for their fixed and mobile broadband. The Speedtest Global Index compares Internet speed data from hundreds of millions of tests every month around the world.[10] Data on Internet speed can help in making decisions on broadband investments under consideration by governments or others. They can also support decision-making and first responders in emergencies by getting a better understanding of the type, level and quality of network connectivity after a disaster (see Box 10.3).

Other promising examples come from data made available by social media companies, crowdsourcing platforms and online search engines.

Figure 10.1: Population density map of Central Nigeria overlaid with location of cell towers



Sources: Data on cell locations are extracted from OpenCelliD (https://opencellid.org/) on 28 November 2021. Data on population density are estimates for 2020 extracted from WorldPop (https://www.worldpop.org/) on 11 April 2022.

Box 10.3: Disaster Connectivity Map (DCM): monitoring connectivity in near real-time

Access to telecommunication networks and services is critical for affected communities, governments and first responders if they are to communicate in crisis situations. In reality, connectivity is often disrupted, and telecommunication networks are down, hampering response efforts.

The Disaster Connectivity Map (DCM),[11] a joint initiative of ITU and the Emergency Telecommunications Cluster, with the support of GSMA, is a mapping platform that combines crowdsourced and mobile coverage sources, providing insights on the status of network connectivity.

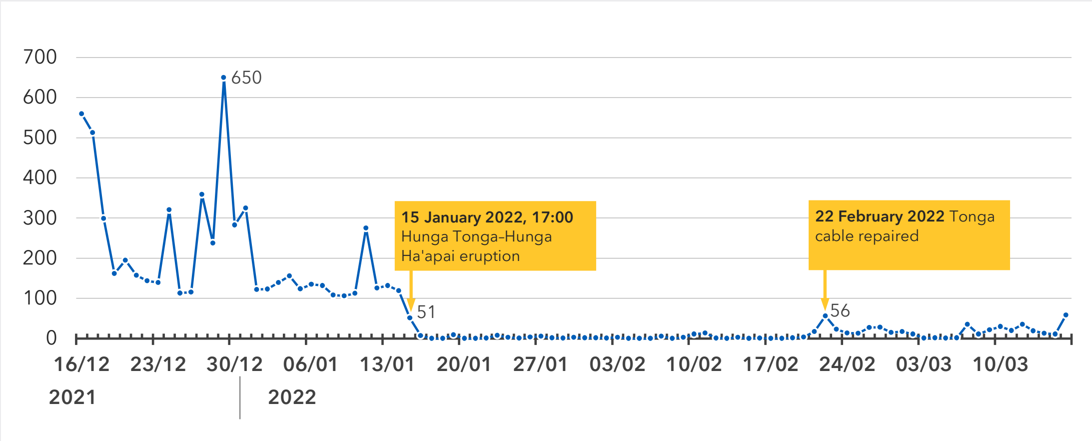
The DCM platform, hosted by ITU, collects near real-time connectivity measurements from end-user devices, and processes the data to show both a historic baseline and a near real-time connectivity map. In the wake of a disaster, the map can be activated for affected zones to highlight differentials in connectivity performance between baseline and real-time maps, identifying where connectivity gaps and outages have arisen.

The DCM has collected data for 28 countries, including Tonga, where a volcanic eruption and ensuing tsunami caused extensive damage in January 2022. The archipelago was cut off from international telecommunication networks (Figure 10.2). The DCM platform can show which cell sites have been transmitting signals by processing connectivity data from the Speedchecker application, installed on user devices, every hour during the activation window. The DCM can indicate those cell sites that may have been damaged or destroyed by the disaster (Figure 10.3), by comparing the coverage to the baseline cellular coverage.

As it develops, the DCM aims to integrate more data sources, including from mobile network operators and other private sector actors to increase scope and reliability.

Figure 10.2 Disruptions in Tonga's telecommunication networks

Data points per day from Speedchecker, Tonga, 16 December 2021–16 March 2022



Source: Speedchecker.

Figure 10.3 DCM map for Tonga before and after the volcanic eruption and tsunami

Before, on 13 January 2022 **After, on 7 February 2022**

Note: White squares show baseline connectivity, all measurement datapoints received since the start of the measurement campaign on 16 December 2021. Red squares show the connectivity datapoints seen during the last 24-hour period.
Source: ITU.

Many accumulated data are held by private companies, generated by mobile phones, retail store scanners, satellites, even sensors connected to the Internet of Things with 5G networks. Initially, these data were essentially used to support companies' business models and operations. Now they are increasingly used for socio-economic research. Growing numbers of companies are making some data assets available as part of "data for good" or "data philanthropy" initiatives.[12] At the same time, there is increasing recognition that access to such data needs to be governed by new codes of conduct – that regulation is needed to guide their use while protecting privacy and confidentiality. Undoubtedly, this area will see continuous evolution.

Partnerships and data-sharing agreements between the private sector and statistical agencies hold great potential in improving the accuracy, timeliness and granularity of official statistics. For example, combining data from telecommunication operators and Internet service providers with a country's population or household registers would generate indicators with an unprecedented level of granularity. Given that mobile penetration is at high levels in most countries, connectivity indicators could be produced for households, individuals and specific groups (older persons, minorities, persons with disabilities). A recent European Union report makes a strong case for the sharing of private business data to reduce information gaps, stating the need "to explore the creation of an enabling environment for privately held data to be shared with (or at least be accessible to) public authorities in complying with their public-interest missions" (European Union, 2020). Data access among different holders might require new legislation – and a new culture favouring collaboration.

Artificial intelligence and machine learning methods also have the potential to help estimate Internet access and use at the subnational level, based on satellite and other available data sources. These projects could contribute to a better understanding of Internet connectivity in countries where no reliable data exist. Artificial intelligence and machine learning models could also complement traditional household surveys by using real-time data to "nowcast" connectivity indicators between surveys.

In the new era of measuring household connectivity, household surveys are no longer the exclusive means of gathering data. Alternative sources offer potential, but trade-offs between what is needed and what is available may not always be palatable. Commercial, privacy and resource limitations may hamper access to the level of granularity and quality needed to derive reliable ICT indicators.

10.4 Improving the data ecosystem

The ability of countries to collect, analyse and extract value from data and realize their potential for public good depends on the presence and quality of a myriad of factors that make up the data ecosystem.

Recent changes in the world of data are challenging traditional statistical ecosystems. "Statistics Acts" may need to be updated in harnessing the potential of big data – for example, by encouraging collaboration between statistical authorities and private stakeholders, or facilitating data exchanges. Additionally, data fit for development purposes require a legal framework for governance that includes both safeguards and enablers.

Lower-income countries in particular face many practical challenges. Low demand for data to inform national decision-making can be demoralizing, while chronic lack of financial and human resources imposes serious capacity constraints. In such a context, data demands from international agencies seem paradoxical. If data are to play a pivotal role in development, investment in data literacy is essential. Data literacy is a long-term and three-pronged effort beginning with attitudes of authorities, the actual production of data and related research capacity, and educating the general public.

Cultivating demand for data begins with decision-makers – and with striking examples that demonstrate the outstanding value of data in policy design, implementation, monitoring and evaluation. Influential advocates in decision-making positions who promote the value of data also further the cause.

The notion of statistical capacity-building is broad in nature and multi-faceted. It includes cooperation among institutions in a national statistical system, adequate infrastructure and evolving organizational capability. For example, human capital investments include retention policies for statisticians, analysts and data scientists; the development of technical skills in data collection, processing, integration and interpretation; and softer skills for the promotion of data use. Targeted subject matter training is also needed, e.g. on ICT statistics. Training and resources also need to extend to researchers who will make further use of data and generate real value from them.

Making progress on data poverty requires data infrastructure and connectivity. More investment is needed in backbone connectivity, Internet exchange points and data centres, to develop the capacity of developing countries to produce and use data. Cloud computing can partly compensate – easing the set-up of statistical infrastructure, providing ready access to modern tools and removing barriers linked to information technology staff shortages.[13]

The high-level challenge before us is to foster data cultures that promote data literacy in our societies. This gradual process is ongoing everywhere, and will contribute to the understanding of the newfound prominence of data among the population at large. The aim is not for citizens to become statistical experts, but to build both an appreciation of – and trust in – quantitative information. At a time when misinformation and disinformation menace stability, strengthening the numeracy and critical capacity of the public is important. Adequate funding, political will and patience will all be necessary.

10.5 Conclusions

Closing the data gaps is crucial for closing the digital divides and achieving universal connectivity. More and better data are needed to understand and remove the barriers to meaningful connectivity, especially for the marginalized and harder-to-reach populations who are still offline.

The value represented in the use of data is garnering greater recognition – the insights and knowledge, which can then be incorporated in decision-making. The totality of work on data – from the conceptualization of a household ICT survey to its deployment, processing, analysis and dissemination – helps drive capacity building and subject matter training.

While international organizations have a role to play, adequate funding, priority setting and national strategies are needed.[14] Broad-based social contracts for data help build trust and support innovation. For now, we must translate the lack of data as a call for action to remedy this lack. In the final analysis, data and data cultures are not elements outside of development. On the contrary, they are integral to it. Funding and improving the collection, processing and use of data are indeed development.

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12 Generally, Facebook, Twitter, Google and other major platforms have various modes of researcher access to parts of their data holdings. Examples of mishaps included the Google Flu debacle and the Cambridge Analytica leak.

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