GLOBAL CONNECTIVTY REPORT 2022

CHAPTER 1. UNIVERSAL AND MEANINGFUL CONNECTIVITY: THE NEW IMPERATIVE

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ABSTRACT

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. This article presents a short version of the report (Part I)

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% 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, xlack 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.

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 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 [27-34].

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 [35-43].

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% increase in fixed broadband penetration increases gross domestic product (GDP) in a country by 0.08 per cent, while a 1% increase in mobile broadband penetration increases GDP by 0.15% (ITU 20181). 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% increase in mobile penetration is estimated to increase GDP by 0.25% (ITU 2019). Mobile broadband penetration in Africa increased from just under 30%in 2018 to just over 40% in 2021 (ITU 2021), and this 10 percentage-point increase corresponds to an increase of 2.5 percentage points in GDP [1].

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 (Fig. 1), although the relationship works both ways, connectivity drives development and more development leads to more connectivity.
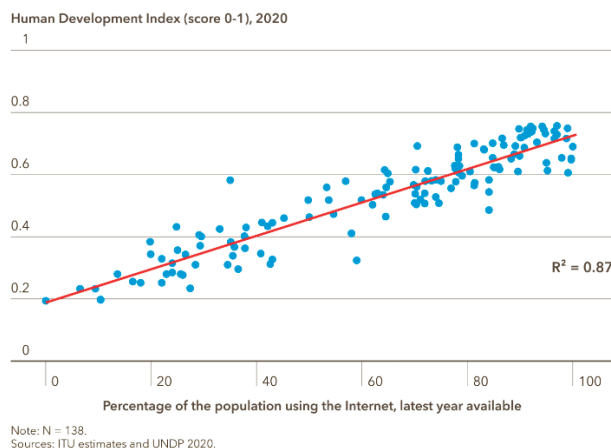

Figure 1. Connectivity and human development

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.

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% of refugees are hosted in developing countries. More than a quarter (27%) 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.

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].

The role of connectivity in sustained, sustainable, and inclusive development and growth is recognized in the SDGs (Table 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 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].

Impact of mobile money: achieving the SDGs

Mobile financial services [21] 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% of all households in Kenya.

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.
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.

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.
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.

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% 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.

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. 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. 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.

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% 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.

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% 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 (Fig. 2).

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.
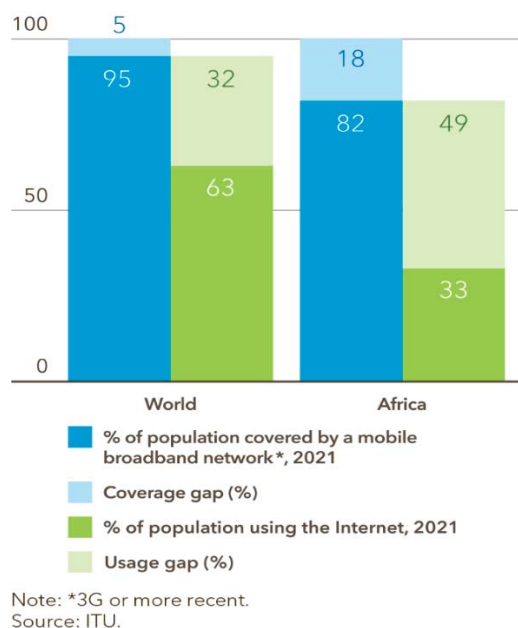
Figure 2. Coverage gap and usage gap

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.

• Affordability. More affordable services will enable many people to come online, while those already online will be able to extend their usage.

• 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.

• D vices. 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.

• Safety and security. We need to strive for an Internet that is safe and secure, one that will engender trust when people go online.

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.

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 [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 (Fig. 3).
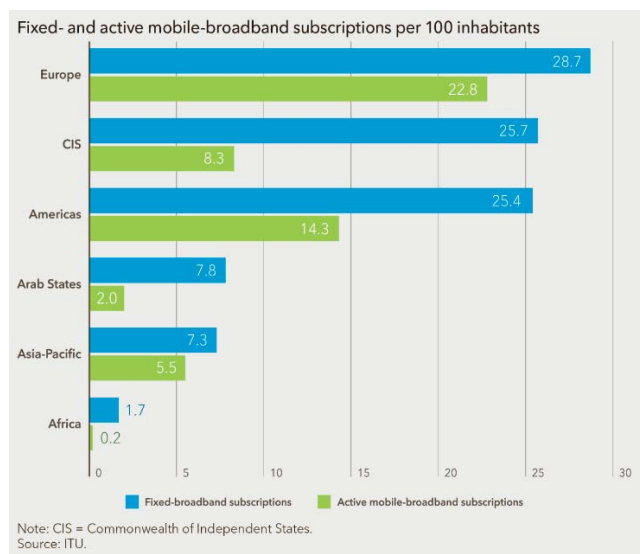

Figure 3. Broadband penetration, 2010

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 4 compares the population coverage of mobile broadband with the uptake of mobile broadband services in 2021. Mobile broadband coverage is nearing 100% 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.
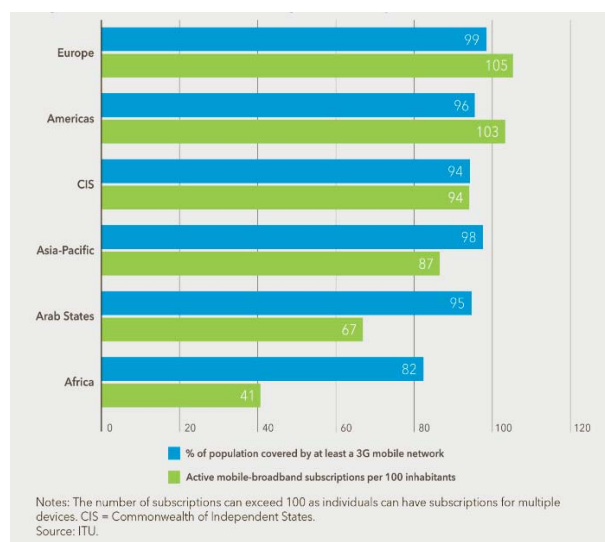

Figure 4. Mobile-broadband coverage and subscriptions, 2021

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