Measuring the Information Society Report

2015

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Foreword

It is my pleasure to present to you the 2015 edition of the Measuring the Information Society (MIS) Report. This annual report presents a global overview of the latest developments in information and communication technologies (ICTs), based on internationally comparable data and agreed methodologies. It aims to stimulate the ICT policy debate in ITU Member States by providing an objective assessment of countries' performance in the field of ICT and by highlighting areas that need further improvement.

One of the key findings of this year's MIS Report is that the least developed countries (LDCs) are making progress with their connectivity initiatives. However, in 2015, only 6.7 per cent of households in LDCs had Internet access compared with 46 per cent of households worldwide and more than 80 per cent of households in developed countries. The report also reveals that, globally, 46 per cent of men and 41 per cent of women are Internet users.

The United Nations 2030 Agenda for Sustainable Development recognizes the great potential of ICTs and calls for significantly increased access to ICTs, which will play a crucial role in supporting the implementation of all the sustainable development goals (SDGs). It is ITU's priority to support our membership in the achievement of the SDGs, in close collaboration with other partners.

One of the core features of the MIS Report is the **ICT Development Index (IDI).** This year's report analyses ICT developments over the past five years. The results show that all of the 167 economies included in the IDI improved their IDI values between 2010 and 2015. This is good news and reflects the continuous evolvement of the global information society.

The progress in a number of developing countries which have displayed significant improvements in their IDI values and rankings since 2010 is particularly encouraging. These more dynamic countries have seen substantial increases in, among others, mobile-broadband penetration, household ICT access and international Internet bandwidth. Their experience confirms the importance of developing enabling environments for ICT investment and innovation, and the policy approaches of these dynamic countries could be relevant to other developing economies.

Over the past five years, there has been a widening of the gap in IDI values between countries ranked in the middle and those towards the bottom of the distribution. In the LDCs, the IDI grew less compared to other developing countries and, in particular, the LDCs are falling behind in the IDI use sub-index, which could impact on their ability to derive development gains from ICTs.

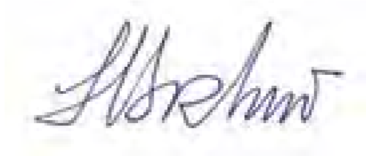
The latest data show that the price of mobile-cellular services continues to fall across the world, as the number of mobile-cellular subscriptions approaches 7.1 billion and mobile network population coverage reaches close to 95 per cent. In LDCs, the mobile-cellular price basket continued to fall, down to 14 per cent of GNI p.c. by end 2014, compared with 29 per cent in 2010.

Mobile broadband tends to be cheaper than fixed broadband. Mobile-broadband prices have fallen significantly and are expected to continue falling over the next years. Prices in this market segment are much more volatile and new innovative pricing schemes are emerging which could provide viable solutions for low-income populations. Over the past year, the decrease in mobile-broadband prices worldwide made the service on average between 20 and 30 per cent more affordable. Prepaid mobile-broadband offers are the most affordable option, and make the service almost as affordable as mobile cellular. These are promising developments which need to be complemented by efforts to extend mobile-broadband services beyond the main cities, into rural and remote areas.

The rapid spread of ICT infrastructure and devices is accelerating the progress of the **Internet of Things (IoT)**. IoT is expected to significantly impact almost every social and economic sector, including education, healthcare, agriculture, transportation and manufacturing. Most of the value derived from IoT comes from the generation, processing and analysis of new data. This report shows how IoT and big data analytics can help address major development challenges such as those related to megacities, climate change, food security and resource management.

The potential of IoT is determined by the available ICT infrastructure and data-processing capacity. While some IoT applications may run with low-speed and low-capacity connectivity, others will require high-capacity broadband connections that rely on fixed-broadband infrastructure, larger international Internet bandwidth and backbone capacity.

I hope you will find this report informative and useful in mapping strategies to grow the ICT sector and drive the socio-economic development of countries.



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1.1 Introduction

Background

Ten years ago, at the World Summit on the Information Society (WSIS), the international community agreed a common vision to build a "people-centred, inclusive and development-oriented information society", and established ten targets, relating for the most part to ICT connectivity and access, that were intended to measure progress towards that vision (ITU, 2005b). The targets were intended to complement the Millennium Development Goals (MDGs), agreed by the United Nations in 2000, by helping to guide the contribution that ICTs could make to achieving those goals by their target date in 2015.[1]

In December 2015, the United Nations General Assembly (UNGA) will complete its ten-year review of the implementation of WSIS outcomes. That review has been informed by a range of inputs from ITU and other UN agencies, including a comprehensive assessment of progress towards the WSIS targets, the *Final WSIS Targets Review*, published by the Partnership on Measuring ICT for Development in 2014 (Partnership on Measuring ICT for Development, 2014a). In September 2015, the UN Sustainable Development Summit adopted the 2030 Agenda for Sustainable Development, composed of 17 new Sustainable Development Goals (SDGs), to succeed the MDGs.[2]

Since 2007, ITU has published a series of reports entitled *Measuring the Information Society*. This year's report includes the latest editions of two indices through which ITU has measured progress on ICT development in general and on the affordability of ICTs for individuals and communities worldwide. The ICT Development Index (IDI), which combines data concerning ICT access, use and skills in an overview assessment of national ICT ecosystems, is reported on in Chapters 2 and 3, while the ICT Price Basket (IPB), concerned with affordability, is the subject of Chapter 4.

ICT monitoring and measurement are complex and challenging tasks that are subject to the varying availability of data from different countries and to the rapid changes taking place in ICT technology and markets. The ITU Plenipotentiary Conference,[3] addressing these challenges at its 2014 session in Busan (Republic of Korea), adopted the Connect 2020 Agenda, which includes four goals, comprising 17 targets, for monitoring and stimulating the development of the ICT sector between 2015 and 2020.

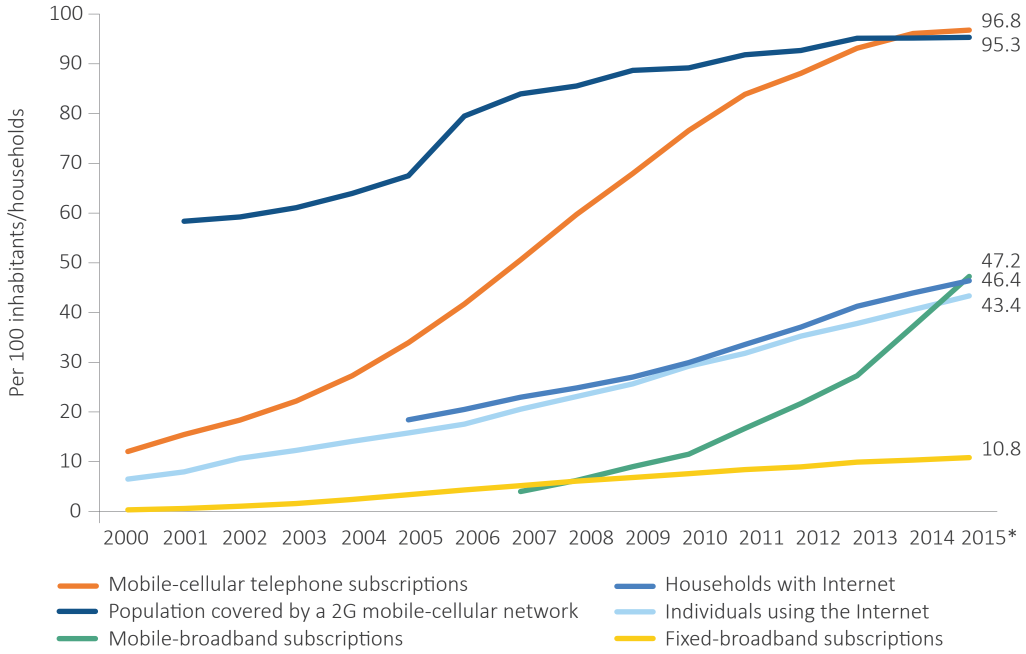
This chapter is primarily concerned with this forward-looking agenda. The remainder of the present section briefly summarizes information society developments since WSIS and during the past year. The second section introduces the Connect 2020 Agenda. Sections 3 to 6 consider, in turn, the measurement of the Connect 2020 Goals concerned with growth, inclusiveness and sustainability of the ICT sector, as well as the monitoring of qualitative targets for innovation and partnership. Section 7 discusses the WSIS+10 review, considers the relationship between ICTs, the SDGs and implementation of the Post-2015 Development Agenda, and addresses the implications of these for the Connect 2020 Agenda.

Recent developments in the information society

The ten years since WSIS have seen substantial growth in access to ICTs and their use, particularly mobile phones and the Internet, while the last five years have seen major growth in the availability and use of broadband networks and services. Global changes in the coverage of mobile networks, the numbers of mobile-cellular, fixed- and mobile-broadband subscriptions, and the individual use of the Internet and household access it, are illustrated in Chart 1.1.[4]

This chart illustrates the strong growth in indicators measuring ICT trends. The growth in mobile-cellular (voice and SMS) and mobile-broadband subscriptions has been particularly rapid, with the deployment of mobile networks in developing countries and adoption by users of mobile devices in preference to those requiring

Chart 1.1: Global changes in major ICTs, 2000-2015*



Note: *ITU estimates.
Source: ITU.

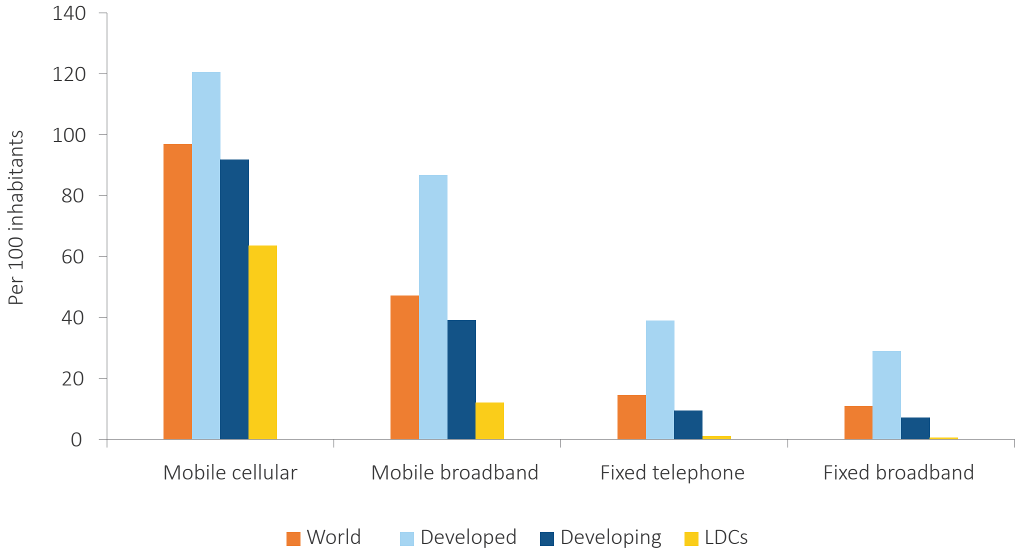
fixed networks. The proportion of the global population covered by mobile-cellular networks is now over 95 per cent (ITU, 2015a), while the number of mobile-cellular subscriptions has quintupled since WSIS (although this is partly attributable to multiple subscriptions). The growth in fixed-broadband subscriptions illustrated in Chart 1.1 has been more sluggish than that of mobile broadband, with the number of fixed-telephone subscriptions worldwide having fallen over the past decade owing partly to fixed-mobile substitution.

The number of Internet users is estimated to have grown almost as rapidly as that of mobile-cellular subscriptions, quadrupling since WSIS, with over 40 per cent of the world's population now estimated to be using the Internet. Data concerning household access to and individual use of the Internet are discussed in below.

Available data suggest that these trends have continued during the period 2014-2015, although with some variations.[5] There has been little additional growth – from 96.1 to an estimated 96.8 subscriptions per 100 persons worldwide – in the ratio between mobile subscriptions and population, as the number of subscriptions approaches 100 per cent (although this does not mean that everyone now has a mobile phone – see below). A continued decline – from 15.2 to 14.5 per 100 persons – is reported in the ratio of fixed-telephone subscriptions to population, while there has been limited reported growth – from 10.3 to 10.8 per 100 inhabitants – in the number of fixed-broadband subscriptions. Growth in the penetration of active mobile-broadband subscriptions has, however, been very sharp, rising from 37.2 to an estimated 47.2 per 100 persons over the last twelve months, reflecting the wider availability of mobile-broadband networks, falling prices and the rapidly growing use of smartphones and tablets. Individual use of Internet and household access to it have continued their steady rates of growth, from 40.6 and 43.4 per cent, respectively, to 43.9 and 46.4 per cent at the global level.

Closer consideration, however, shows that there are still very considerable variations in these data sets, with substantial digital divides between different regions, and particularly between countries in different development categories. Chart 1.2 compares access to fixed and mobile telephone and broadband subscriptions in 2014 between developed countries, developing countries (including LDCs) and LDCs. The data for Internet use and household access to the Internet, which are discussed in section 1.3, show very similar digital divides. It should be

Chart 1.2: ICT access by development status, 2015*



Note: *ITU estimates; numbers refer to subscriptions.
Source: ITU.

noted in this context, however, that fixed and mobile subscriptions are not entirely comparable, since the former tend to make access available to households and businesses (with multiple users), while the latter tend to make it available to individuals.

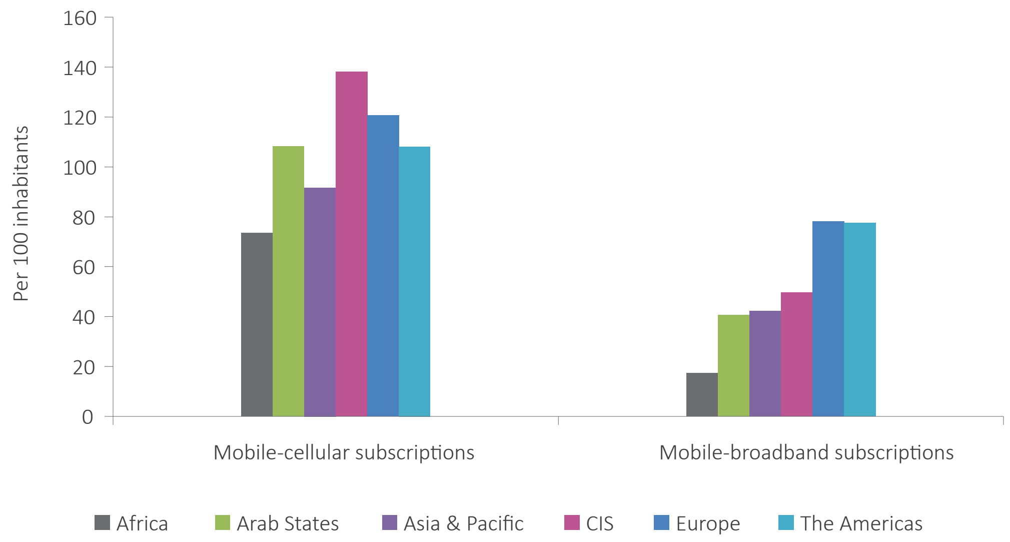
The regional breakdown between these indicators also shows a substantial digital divide, with Africa achieving lower ICT density levels than other regions. This is illustrated by the data for mobile phone and broadband subscriptions in Chart 1.3 and for Internet users in Chart 1.4.

Digital divides are found within as well as between countries, and result from differences in the quality of available networks as well as basic connectivity. In many developing countries, for example, there are substantial differences in telephone and Internet penetration between urban and rural areas, often exacerbated by the lack of broadband capacity in the latter. A significant digital divide persists between men and women in many countries, and there are widespread digital divides between those with more or less income, associated with ICT affordability; with higher or lower educational attainment, particularly associated with the capabilities required for Internet use; and with other factors affecting the inclusion or marginalization of particular social groups, for example persons with disabilities. The Connect 2020 Agenda addresses these diverse aspects of digital inclusion and exclusion by incorporating targets relating to digital divides between countries, and to particular social and economic groups within societies.

The many other important developments that have taken place in the global ICT sector since WSIS form part of the context for forward-looking measurement and monitoring through the Agenda, as well as for implementation of WSIS outcomes and SDGs. The capabilities of networks and devices have continued to grow extremely rapidly, doubling about every two years. The quality of ICT networks and devices, particularly in terms of bandwidth and speed of connectivity, has therefore also grown very rapidly, with broadband and even high-speed broadband networks becoming the norm in developed countries. Smartphones and tablets are displacing basic mobile phones and traditional PCs for many users, making connectivity both more mobile and more capable, in a process that will be strengthened by the spread of LTE networks. Social media services, in their infancy at the time of WSIS, have become crucial drivers of demand for connectivity.

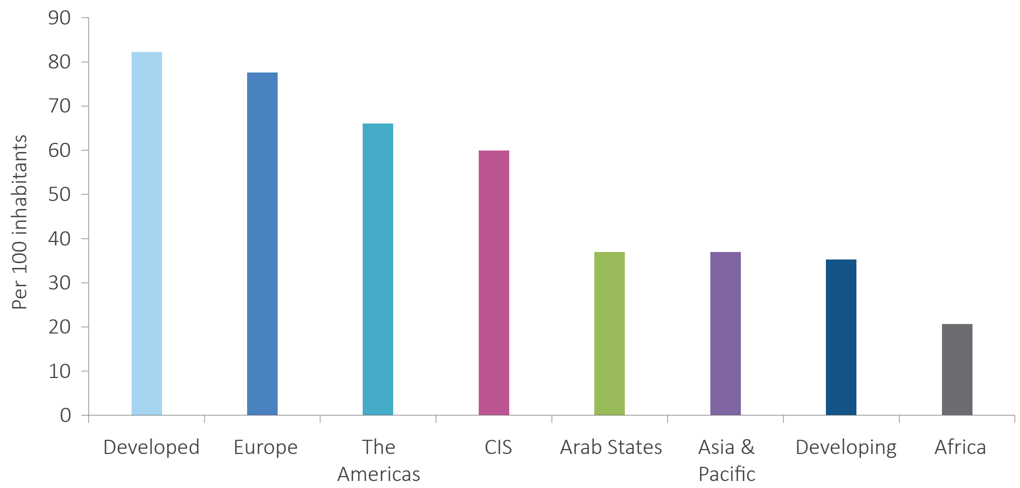
The cloud computing market has likewise grown rapidly, driven by vast data-storage capacities and increasingly by applications in the cloud, allied with flexible user devices. Data-traffic volumes have been driven by higher bandwidth applications, particularly video, while big-data storage and analysis has become very big business, it being estimated that the volume of data generated in

Chart 1.3: ICT access by region, 2015*



Note: *ITU estimates.
Source: ITU.

Chart 1.4: Percentage of individuals using the Internet by development status and region, 2015*



Note: *ITU estimates.
Source: ITU.

digital format is doubling every two years.[6] The Internet of Things is rapidly becoming a reality and machine-to-machine (M2M) communications are also expected to grow significantly.

All of these developments illustrate the continued dynamic growth of ICTs, which have the potential to transform other social and economic sectors. However, it is clear that ICTs are likely to be adopted more rapidly and more extensively in developed countries with higher levels of prosperity than in developing countries, particularly LDCs. This makes it especially crucial to monitor the adoption and use of ICTs in the latter and establish evidence-based approaches to bridging the digital divide.

1.2 The Connect 2020 Agenda

The Connect 2020 Agenda sets out a series of goals and targets for improvements in global ICT access, use and sustainability, and in the contribution of innovation and partnerships. The Agenda was elaborated during the year preceding the ITU Plenipotentiary Conference in 2014, through dialogue involving Member States and other stakeholders including equipment vendors, telecom operators, international, regional and national associations and organizations, civil society and private-sector businesses. It was adopted by the Plenipotentiary Conference as part of ITU's strategic plan for the 2016-2019 quadrennium (ITU, 2014). In adopting the Agenda, ITU Member States committed themselves to the shared vision of "an information society, empowered by the interconnected world, where telecommunications/ICTs enable and accelerate social, economic and environmentally sustainable growth and development for everyone".

At the heart of the Agenda are four Connect 2020 goals, relating to:

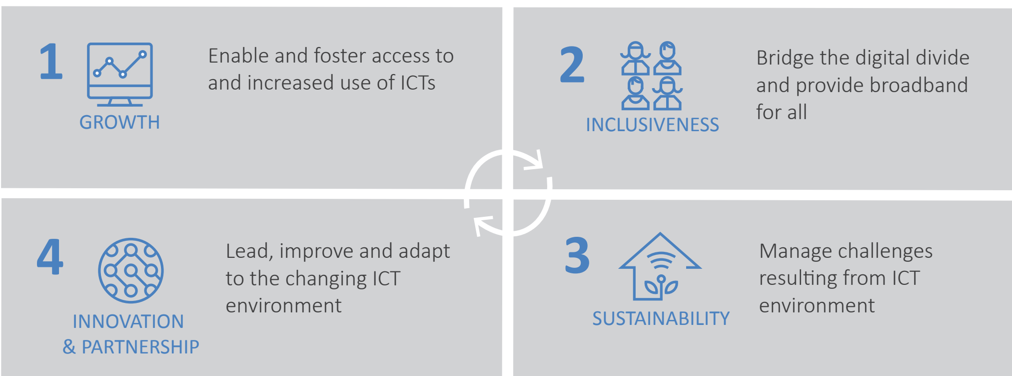
- Growth – enabling and fostering access to and increased use of ICTs.
- Inclusiveness – bridging the digital divide and providing broadband for all.
- Sustainability – managing challenges resulting from ICT development.
- Innovation and partnership – leading, improving and adapting to the changing technology environment.

These goals, which are illustrated in Figure 1.1, are mutually reinforcing. Greater ICT access will foster growth in the use of ICTs, which should in turn have a positive impact on short- and long-term social and economic development. Addressing inclusiveness should extend the potential benefits of ICTs to all, bridging digital divides between the developed and developing worlds and reaching marginal and vulnerable populations – although it is understood that connectivity in this context needs to be accompanied by efforts to ensure affordability, develop relevant and local content, and build the capabilities of individuals and communities to take full advantage of those potential benefits. The ability to sustain the benefits delivered by ICTs and ensure that they contribute to the wider sustainable development agenda is critical, since growth also brings challenges and risks that need to be managed. It is through innovation and partnerships that the evolving ICT ecosystem can adapt effectively to the rapidly changing technological and social environment.

The four goals include 17 targets, designed to provide an indication of whether each of the goals is being achieved up to 2020 and to help ITU and other stakeholders to focus their priorities during that period. These targets have been set in accordance with the requirement that they should be:

- specific – describing tangible impacts that should be achieved during the time available;
- measurable – building on existing statistical indicators, leveraging available knowledge bases within ITU, relatively easy to gather in a majority of countries, and with established baselines;
- action-oriented – and thus able to guide both policy and practice;
- realistic – i.e. ambitious but achievable;
- relevant – linked to the goals of which they form a part; and

Figure 1.1: The Connect 2020 Goals



Source: ITU, see http://www.itu.int/en/plenipotentiary/2014/Documents/connect2020-roundtables.pdf.

- time-bound and traceable – corresponding to the four-year time-frame for the strategic plan, and reflecting the difficulty of anticipating ICT trends over the longer term.

These targets, which also reflect experience with the WSIS targets (see below) are listed in Table 1.1. The targets for the first three goals – concerned with growth, inclusiveness and sustainability – are, with one exception, quantitative, while those concerned with innovation and partnership are qualitative. Four of the five targets concerned with inclusiveness are divided into two subsidiary targets – in two cases setting separate targets for developing countries in general and for LDCs; in one case setting separate affordability targets for ICTs in general and broadband services in particular; and in one case setting separate inclusiveness targets related to gender and to disability.

The remainder of this section considers the overall objectives and challenges of monitoring and measuring these targets, and the wider ICT environment, during the period up to and beyond their target date of 2020. Sections 3 to 5 of the chapter look in more detail at definitions, current evidence and monitoring and measurement challenges for the quantitative targets concerned with growth, inclusiveness and sustainability. Section 6 briefly addresses the challenges involved in monitoring innovation and partnerships.

WSIS and Broadband Commission targets

The monitoring and measurement of trends and establishment of benchmarks and targets against which performance can be assessed are critical to the development of policy and implementation of programmes in all areas of economic and social development, including the ICT sector. Policy-makers and practitioners need accurate information about the availability and use of ICTs if they are to make appropriate decisions about how they can most effectively be used to achieve developmental outcomes. Businesses, too, need accurate information in order to develop investment strategies for infrastructure and services that will meet society's needs and maximize commercial value. Everyone involved in social and economic development needs evidence about the impact that ICTs are having on society in order to target their resources most effectively.

Table 1.1: The Connect 2020 Goals and Targets

Goal 1. Growth – Enable and foster access to and increased use of tlecommunications/ICTs
1.1 Worldwide, 55% of households should have access to the Internet by 2020
1.2 Worldwide, 60% of individuals should be using the Internet by 2020
1.3 Worldwide, telecommunication/ICT should be 40% more affordable by 2020
Goal 2. Inclusiveness – Bridge the digital divide and provide broadband for all
2.1.A In the developing world, 50% of households should have access to the Internet by 2020
2.1.B In LDCs, 15% of households should have access to the Internet by 2020
2.2.A In the developing world, 50% of individuals should be using the Internet by 2020
2.2.B In LDCs, 20% of individuals should be using the Internet by 2020
2.3.A The affordability gap between developed and developing countries should be reduced by 40% by 2020
2.3.B Broadband services should cost no more than 5% of average monthly income in developing countries by 2020
2.4 Worldwide, 90% of the rural population should be covered by broadband services by 2020
2.5.A Gender equality among Internet users should be reached by 2020
2.5.B Enabling environments ensuring accessible telecommunication/ICT for persons with disabilities should be established in all countries by 2020
Goal 3. Sustainability – Manage challenges resulting from telecommunication/ICT development
3.1 Cybersecurity readiness should be improved by 40% by 2020
3.2 Volume of redundant e-waste to be reduced by 50% by 2020
3.3 Greenhouse gas emissions generated by the telecommunication/ICT sector to be decreased per device by 30% by 2020
Goal 4. Innovation and partnership – Lead, improve and adapt to the changing telecommunication/ICTenvironment
4.1 Telecommunication/ICT environment conducive to innovation
4.2 Effective partnerships of stakeholders in telecommunication/ICT environment

Source: ITU.

The growing recognition that ICTs can perform a catalytic enabling role in almost all aspects of development makes it even more important to build a solid evidence base that can underpin decision-making by governments, businesses and other development stakeholders.

ITU has over many years gathered and published extensive data on changing ICT environments and has, since WSIS, stepped up its work and collaboration with other UN agencies, particularly those in the Partnership on Measuring ICT for Development.[7] Its work on definitions and methodologies, together with its established data-gathering procedures, indicators and indices, provide an essential backdrop, including baselines, for effective monitoring and measurement in accordance with the criteria for the targets summarized above.

The Connect 2020 goals and targets were agreed at a crucial point in the development of both the information society and the wider development agenda, coinciding with the ten-year review of WSIS outcomes and discussions concerning the Post-2015 Development Agenda and SDGs.

The Agenda draws on experience in monitoring and measuring the WSIS targets, which are set out in Table 1.2. These targets, which were agreed in 2003, are primarily concerned with connectivity and access.

Progress towards achieving the targets was summarized in the Partnership on Measuring ICT for Development's 2014 *Final WSIS Targets Review* (Partnership on Measuring ICT for Development, 2014a), which identified a number of significant challenges that have informed the development of the Connect 2020 Agenda. In particular, experience has illustrated the need for clear and consistent definitions of terms such as "ICTs" and "connectivity", and for the selection of indicators, with established baselines, that can be readily measured in the majority of ICT environments. In practice, only a small number of countries, and even fewer LDCs, were able to supply data for many of the indicators associated with the WSIS targets. Experience has also highlighted the difficulty of setting targets that will remain appropriate over an extended period of time. The rapid growth of mobile-cellular and broadband networks after WSIS led the Partnership to adjust the WSIS targets in 2010, as set out in Table 1.2, since by that time broadband connectivity had

Table 1.2: The WSIS targets, 2003 and as adapted in 2010

Target	Target set in Geneva Plan of Action	Target as amended in 2010/2011
1	To connect villages with ICTs and establish community access points	To connect all villages with ICTs and establish community access points
2	To connect universities, colleges, secondary schools and primary schools with ICTs	To connect all secondary schools and primary schools with ICTs
3	To connect scientific and research centres with ICTs	To connect all scientific and research centres with ICTs
4	To connect public libraries, cultural centres, museums, post offices, and archives with ICTs	To connect all public libraries, cultural centres, museums, post offices, and archives with ICTs
5	To connect health centres and hospitals with ICTs	To connect all health centres and hospitals with ICTs
6	To connect all local and central government departments and establish websites and e-mail addresses	To connect all central government departments and establish websites
7	To adapt all primary and secondary school curricula to meet the challenges of the information society, taking into account national circumstances	To adapt all primary and secondary school curricula to meet the challenges of the Information Society, taking into account national circumstances (unchanged)
8	To ensure that all of the world's population has access to television and radio services	To ensure that all of the world's population has access to television and radio services (unchanged)
9	To encourage the development of content and to put in place technical conditions in order to facilitate the presence and use of all world languages on the Internet	To encourage the development of content and to put in place technical conditions in order to facilitate the presence and use of all world languages on the Internet (unchanged)
10	To ensure that more than half of the world's inhabitants have access to ICTs within their reach	To ensure that more than half of the world's inhabitants have access to ICTs within their reach and make use of them
11	(proposed)	To connect all businesses with ICTs (proposed target)

Source: Adopted from Partnership on Measuring ICT for Development (2011).

Table 1.3: Broadband Commission targets to 2015

Target 1	Making broadband policy universal	By 2015, all countries should have a national broadband plan or strategy or include broadband in their Universal Access / Service Definitions
Target 2	Making broadband affordable	By 2015, entry-level broadband services should be made affordable in developing countries through adequate regulation and market forces (amounting to less than 5% of average monthly income)
Target 3	Connecting homes to broadband	By 2015, 40% of households in developing countries should have Internet access
Target 4	Getting people online	By 2015, Internet user penetration should reach 60% worldwide, 50% in developing countries and 15% in LDCs

Source: Broadband Commission (2012a).

become a much more crucial factor in assessing the changing digital divide.

The Connect 2020 Agenda targets have also drawn on work undertaken by the Broadband Commission for Digital Development, which brings together expertise from ITU, the United Nations Educational, Scientific and Cultural Organization (UNESCO), other UN and international organizations, the private sector and civil society to encourage broadband deployment in pursuit of developmental goals.[8] In 2012, the Commission adopted four targets concerned with broadband policy, affordability and uptake, with terminal dates in 2015, which are set out in Table 1.3. In 2013, it set a further target to achieve gender equality in broadband access by 2020.[9]

Finally, the Connect 2020 targets were adopted in the context of wider targets concerned with other areas of social and economic development, in particular the eight MDGs, concerned with poverty reduction and basic needs, which were agreed by the United Nations in 2000, achievement of the WSIS targets often being linked with achievement of the MDGs. As previously mentioned, in September 2015 the United Nations agreed the 17 SDGs to succeed the MDGs, covering a much wider range of issues. The relationship between the Connect 2020 Agenda, the WSIS+10 review, the SDGs and the Post-2015 Development Agenda of which they form part is discussed in the final section of this chapter.

1.3 Connect 2020 Agenda Goal 1 – Growth

The first goal in the Connect 2020 Agenda seeks to enable and foster access to and increase the use of telecommunications and ICTs, recognizing the importance of this to both short- and long-term social and economic development as well as its significance for the ICT sector itself. It builds on experience in monitoring and measuring the connectivity and access targets which were adopted at WSIS in 2003 and the more ambitious targets for broadband connectivity adopted by the Broadband Commission for Digital Development in 2011, both of which are described in section 2 above.

The Connect 2020 Agenda includes three global targets for growth in access and usage, as set out in Table 1.4.

Table 1.4: Connect 2020 Agenda – Goal 1 Targets

1.1	Worldwide, 55% of households should have access to the Internet by 2020
1.2	Worldwide, 60% of individuals should be using the Internet by 2020
1.3	Worldwide, telecommunication/ICT should be 40% more affordable by 2020

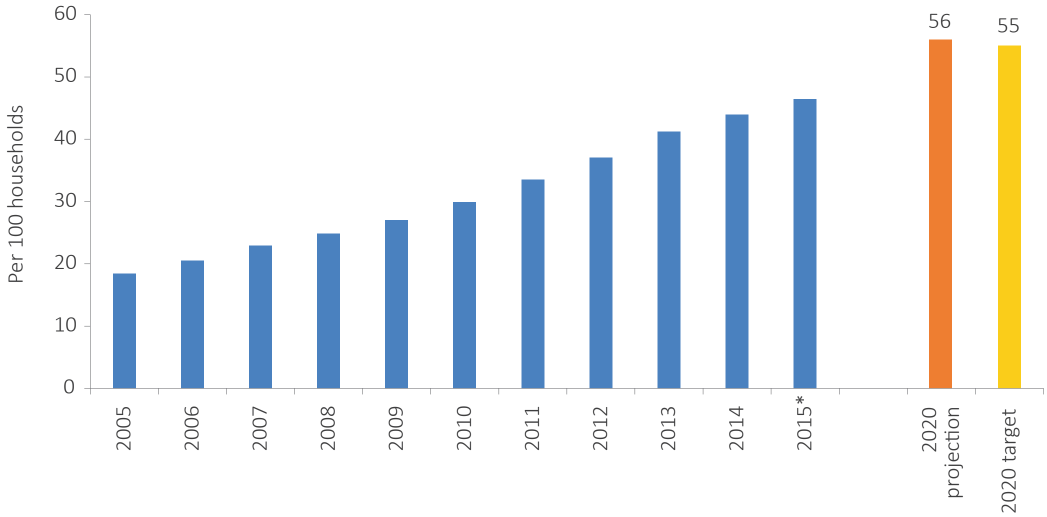
Source: ITU.

Target 1.1: Worldwide, 55 per cent of households should have access to the Internet by 2020

This global target is associated with Targets 2.1.A and 2.1.B, which are comparable targets for the proportion of households in developing countries and LDCs that should have access to the Internet by 2020.

Currently available data illustrating the development of this target over the past decade are set out in Chart 1.5, which shows a figure for household Internet access of 43.9 per cent in 2014, rising to an estimated 46.4 per cent in

Chart 1.5: Households with Internet access worldwide, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU.

2015. The compound annual growth rate in this indicator has been 9.7 per cent over the period 2005-2015. ITU estimates that 56 per cent of households worldwide will have Internet access by 2020, and that the Connect 2020 target will thus be met. The increasing deployment of wireless-broadband networks in rural areas of developing countries and the displacement of feature phones by smartphones are expected to accelerate the pace of growth in this indicator in developing countries during this period and contribute to the achievement of the target. However, this target should also be considered in conjunction with Target 2.1, which shows a less satisfactory rate of progress in developing countries and LDCs.

Target 1.2: Worldwide, 60 per cent of individuals should be using the Internet by 2020

This global target is associated with Targets 2.2.A and 2.2.B, which are comparable targets for the proportion of Internet users in developing countries and LDCs that should have access to the Internet by 2020.

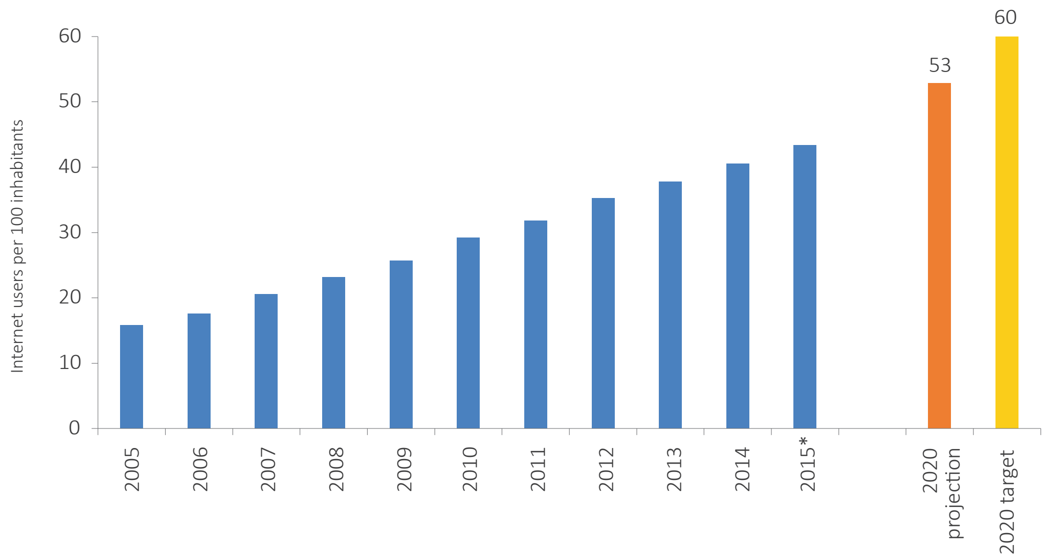
Data illustrating the development of this target over the past decade are presented in Chart 1.6, which shows a figure for Internet usage of 40.6 per cent in 2014, rising to an estimated 43.4 per cent in 2015. This indicator recorded a compound annual growth rate (CAGR) of 10.6 per cent over the period 2005-2015. ITU estimates that 53 per cent of individuals worldwide will be using the Internet by 2020, seven percentage points below the Connect 2020 target. As noted above, the increasing deployment of wireless-broadband networks in rural areas of developing countries and the displacement of feature phones by smartphones are expected to accelerate the pace of growth in this indicator in developing countries during this period.

Target 1.3: Worldwide, telecommunication/ICT should be 40 per cent more affordable by 2020

This global target is associated with Targets 2.3.A and 2.3.B, which are concerned with affordability in developing countries and with the affordability of broadband. ITU has selected the year 2012 as the baseline year against which price changes for this indicator will be measured.

The diversity of ICT services, from voice telephony to broadband Internet, means that affordability cannot be evaluated by focusing on just one such service but must include a variety of services. Since 2008, ITU has published the results for three baskets of telecommunication services – fixed telephone, mobile cellular and fixed broadband – and presented the prices as a percentage of average monthly GNI per capita (GNI p.c.), thereby indicating the affordability of each ICT service. Since 2012, ITU has also been gathering and publishing data for mobile-broadband prices, including four sub-baskets concerned with different mobile-broadband packages. ITU data on

Chart 1.6: Percentage of individuals using the Internet worldwide, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU.

prices covers some 180 countries, and the latest results are reported and analysed in depth in Chapter 4 of this report.

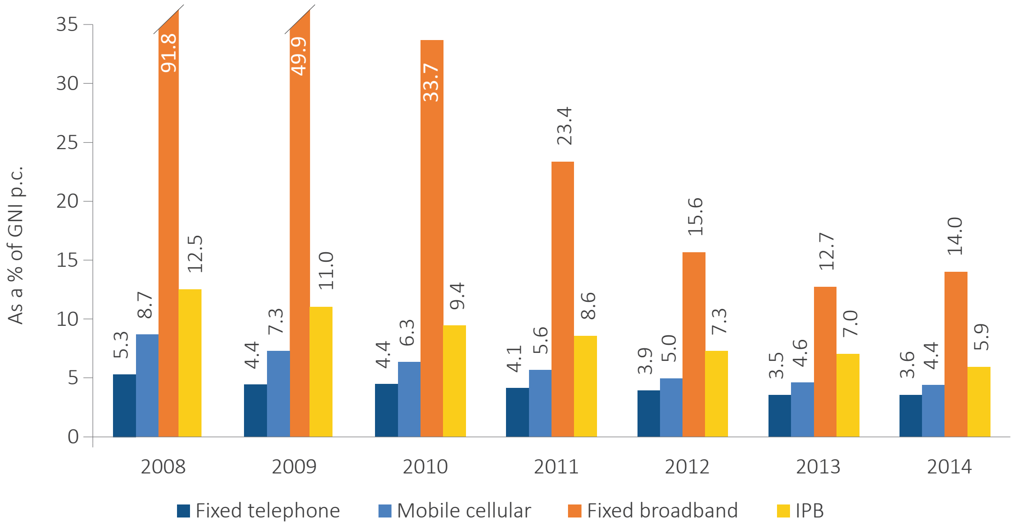
Data illustrating the evolution of the global level for the fixed-telephone, mobile-cellular and fixed-broadband sub-baskets over the period since collection of those data began are set out in Chart 1.7. This shows that there was a marked drop in fixed-broadband prices over the period 2008-2012 (-36 per cent CAGR).[10] Price reductions in fixed-broadband services saw a slowdown between 2012 and 2014 (-5 per cent CAGR for the two years), despite the fact that average fixed-broadband prices are still relatively unaffordable in several developing countries. Fixed-telephone and mobile-cellular service prices also fell during the period 2008-2014, albeit at slower rates (-6 per cent CAGR and-11 per cent CAGR, respectively) than fixed broadband given the initial lower levels of fixed-telephone and mobile-cellular prices. Further analysis of these data can be found in Chapter 4.

Data concerning mobile-broadband prices for 2013 and 2014 are presented in Chart 4.16 in Chapter 4, where they are analysed in depth. Price data show that there was a decrease in all four of the sub-baskets used to assess mobile-broadband prices (computer-based 1GB and handset-based 500MB, in each case for both prepaid and postpaid plans). Prices in all four cases remain substantially lower, in relation to monthly GNI p.c., in developed than in developing countries, but have fallen most markedly in LDCs.

Table 1.5 shows the results of applying Target 1.3 of the Connect 2020 Agenda to each of the telecommunication services for which ITU collects price data, as well as the progress achieved in the period 2012-2014. For instance, the cost of a mobile-cellular service corresponded on average to 5.0 per cent of GNI p.c. in 2012, having fallen to 4.4 per cent of GNI p.c. in 2014. Considering that by 2020 the cost of the service should, according to the Connect 2020 target, correspond to 3.0 per cent of GNI p.c., this means that 29 per cent of the price reduction required to meet the target has already been achieved in the period 2012-2014. The progress made towards achieving the target is somewhat lower for the fixed services: 26 per cent for fixed broadband and 21 per cent for fixed telephony. These findings provide a clear indication that significant progress has already been achieved in terms of improving the affordability of these three services, but that sustained regulatory and policy attention will be required in the coming years to keep prices on track to meet the target.

Concerning mobile broadband, 2013 is taken as the baseline because in 2012 a number of countries did not yet have all the four mobile-broadband plans available. Despite it having taken only one year to assess the progress made towards

Chart 1.7: The IPB and sub-baskets, worldwide, 2008-2014



Note: Simple averages. Based on 140 economies for which price data on the three services were available for 2008-2014.
Source: ITU.

Table 1.5: Affordability of ICT services: baseline, current status and Connect 2020 target for each telecommunication service

Service	Value in 2012 (% GNI p.c.)	Value in 2014 (% GNI p.c.)	Target value for 2020 (% GNI p.c.)	Progress achieved (% of the target reduction for the period 2012-2020 achieved in the period 2012-2014)
Fixed-telephone	3.9	3.6	2.3	21
Mobile-cellular	5.0	4.4	3.0	29
Fixed-broadband	15.6	14.0	8.4	26
Mobile-broadband				
Postpaid handset-based (500MB)	6.5*	5.1	3.9	55
Prepaid handset-based (500MB)	6.7*	4.8	4.0	72
Postpaid computer-based (1GB)	8.9*	7.2	5.3	48
Prepaid computer-based (1GB)	10.4*	7.1	6.2	79

Note: Simple averages. Fixed-telephone, mobile-cellular and fixed-broadband averages based on 140 economies for which price data on the three services were available. Mobile-broadband average based on 119 economies for which 2013 and 2014 data on mobile-broadband prices were available for the four types of data plan. * For mobile broadband, 2013 is taken as the baseline because, in 2012, mobile broadband services (or some of their modalities, such as handset-based plans) were not yet available in several countries.
Source: ITU.

the target, the decrease in prices recorded is remarkable, reflecting both the dynamism of the mobile-broadband market and the relatively high starting prices of the service in 2013. Considering the significant progress achieved in a single year, the target set for 2020 is likely to be met in the case of mobile broadband.

1.4 Connect 2020 Agenda Goal 2 – Inclusiveness

The growth in ICT access and use, measured in Goal 1, is only one dimension of the development of an information society as envisaged by the international community. Inclusiveness – bridging the digital divides between and within countries and enabling broadband access for all – is equally important. Bridging the digital divide requires focus to be given not just to access but also to accessibility, affordability and use of ICTs in all countries and regions and by all people, female and male, and including marginal and vulnerable populations such as children and older people, indigenous peoples, persons with disabilities, and those on lower incomes.

The second Connect 2020 Agenda goal is concerned with issues of inclusiveness, and comprises nine targets. These can be divided into two groups, as set out in Table 1.6.

- The first group, consisting of Targets 2.1, 2.2 and 2.3 is concerned with the inclusion of particular development categories within the international community, namely developing countries in general and LDCs. The six targets in this group are closely associated with, and use the same indicators as, the three targets in Goal 1.
- The second group, consisting of Targets 2.4 and 2.5, is concerned with the inclusion of particular groups within countries – rural dwellers, women and persons with disabilities. Two of the targets in this group – those relating to rural areas and gender – are quantitative, while the third – relating to disability – is qualitative.

It should be noted in this context that the definition of developing countries used in United Nations data includes a number of high-income economies, including some at the very top of the global income distribution which also have high ratings in the IDI (see Chapter 2). These include, for example, economies in East Asia such as Singapore, Hong Kong (China) and the Republic of Korea, and oil-producing economies in Western Asia such as Qatar, Kuwait and the United Arab Emirates. At the other end of the distribution, the developing-country grouping includes all of the LDCs. There is therefore a much wider distribution of GNI p.c. levels in the developing-country than in the developed-country category. The LDC group is also much more economically homogeneous than the developing-country grouping as a whole.

The developing-country group includes some very large countries such as China and India, which between them account for over one-third of the global population, and five further countries (Indonesia, Brazil, Pakistan, Nigeria and Bangladesh) with populations over 150 million. Significant changes in the outcomes for these large-population countries can have significant impacts on the overall outcomes for the developing-country category, even if they are not widely reflected in the other countries belonging to this group.

Target 2.1.A: In the developing world, 50 per cent of households should have access to the Internet by 2020
Target 2.1.B: In LDCs, 15 per cent of households should have access to the Internet by 2020

These targets establish separate goals for developing countries and for LDCs within the overall global target for household Internet access established by Target 1.1.

Worldwide data for households with access to the Internet are presented in Chart 1.5 above. There are, however, very substantial differences between regions and between countries with different development levels within this indicator. As Chart

Table 1.6: Connect 2020 Agenda – Goal 2 targets

2.1.A	In the developing world, 50 per cent of households should have access to the Internet by 2020
2.1.B	In LDCs, 15 per cent of households should have access to the Internet by 2020
2.2.A	In the developing world, 50 per cent of individuals should be using the Internet by 2020
2.2.B	In LDCs, 20 per cent of individuals should be using the Internet by 2020
2.3.A	The affordability gap between developed and developing countries should be reduced by 40 per cent by 2020
2.3.B	Broadband services should cost no more than 5 per cent of average monthly income in developing countries by 2020
2.4	Worldwide, 90 per cent of the rural population should be covered by broadband services by 2020
2.5.A	Gender equality among Internet users should be reached by 2020
2.5.B	Enabling environments ensuring accessible telecommunication/ICT for persons with disabilities should be established in all countries by 2020

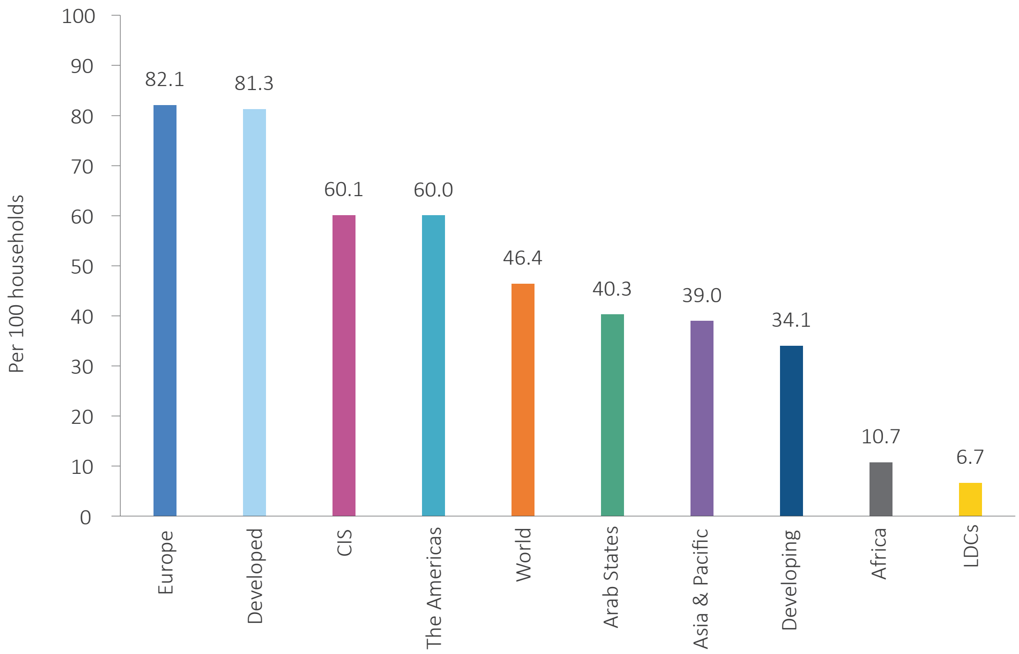
Source: ITU.

1.8 shows, the level of household access is much higher in developed countries than in developing countries, and much higher in developing countries overall than in LDCs or Africa.

Chart 1.9 illustrates the data trend for household Internet access in developing countries, for the period 2005-2015. The CAGR was 15.4 per cent between 2005 and 2015, and 15.7 per cent in the five years from 2010 to 2015. ITU estimates that 45 per cent of households in developing countries will have Internet access by 2020, five points below the Connect 2020 target. This projected performance in developing countries – including LDCs (see below) – is notably less satisfactory than that for worldwide household access, which is projected to meet Target 1.1 (see above).

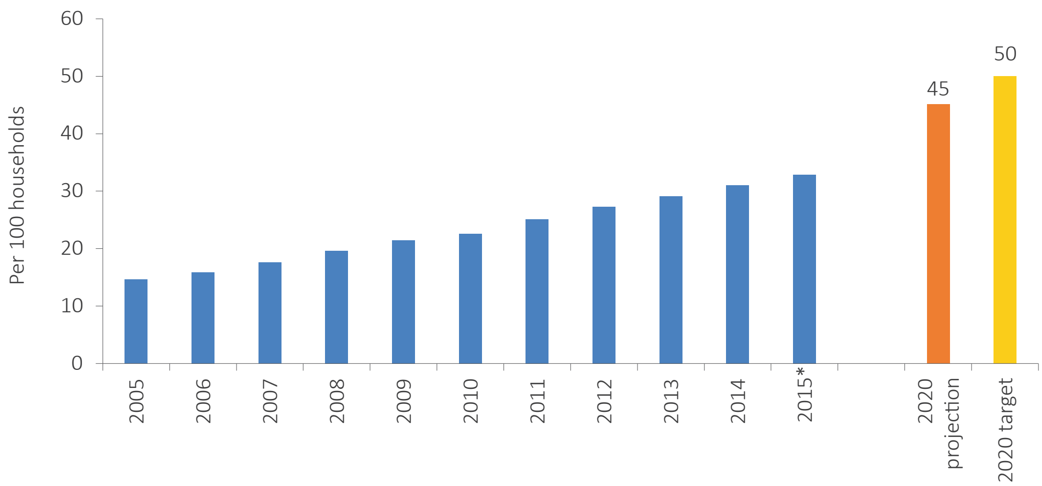
Chart 1.10 illustrates the comparable data trend for household Internet access in LDCs. The CAGR

Chart 1.8: Households with Internet access, by region and development status, 2015*



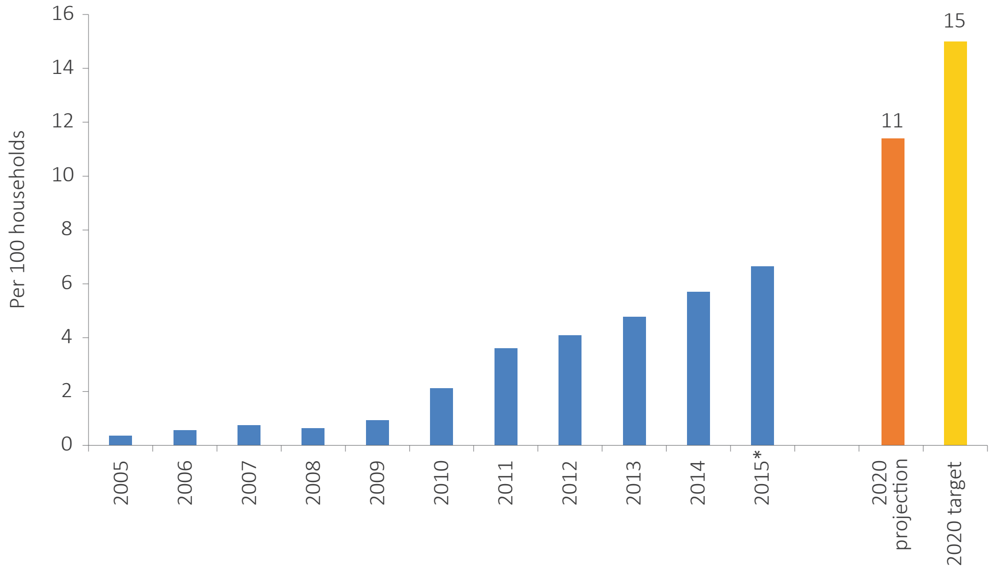
Note: * Estimates.
Source: ITU.

Chart 1.9: Households with access to the Internet, developing countries, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU.

Chart 1.10: Households with access to the Internet, LDCs, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU

in this case was 33.9 per cent between 2005 and 2015, and 25.6 per cent in the five years between 2010 and 2015, much higher than for developing countries in general. Despite the high growth rates, LDCs are starting from a much lower baseline and therefore the progress in absolute terms is smaller. This is also reflected in the projections: ITU estimates that 11 per cent of households in LDCs will have Internet access by 2020, four percentage points below the target of 15 per cent set in the Connect 2020 Agenda.

This is consistent with other evidence suggesting that LDCs may be falling behind other countries in ICT access and usage, and that additional measures may be needed to stimulate faster growth in Internet access where they are concerned. Mobile-broadband networks and smartphones have become the norm in developed countries and are increasingly available in middle-income developing countries, as is evidenced by data in the IDI and reported on in Chapter 2. It is possible that additional efforts from the public and private sectors, such as regulatory changes, investment and new public-private partnerships, but also technological development, may accelerate the trend illustrated in Chart 1.10 during the period to 2020.

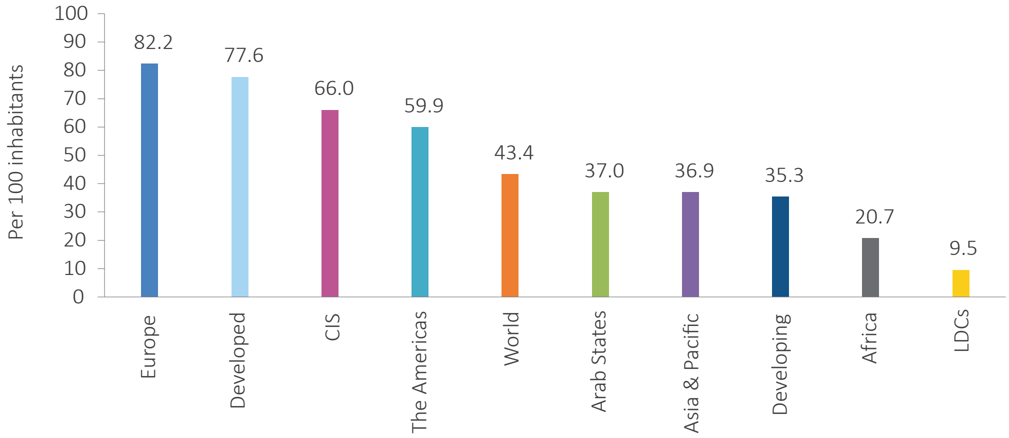
Target 2.2.A: In the developing world, 50 per cent of individuals should be using the Internet by 2020
Target 2.2.B: In LDCs, 20 per cent of individuals should be using the Internet by 2020

These targets establish separate goals for developing countries and for LDCs within the overall global target for individual Internet use established by Chart 1.10.

Worldwide data for Internet use in 2015 are presented in Chart 1.6 above. As with household access, there are very substantial differences between the results for different regions and development categories for this indicator. Chart 1.11 shows that, as with household access, the level of Internet usage is much higher in developed than in developing countries, and much higher in developing countries overall than in LDCs.

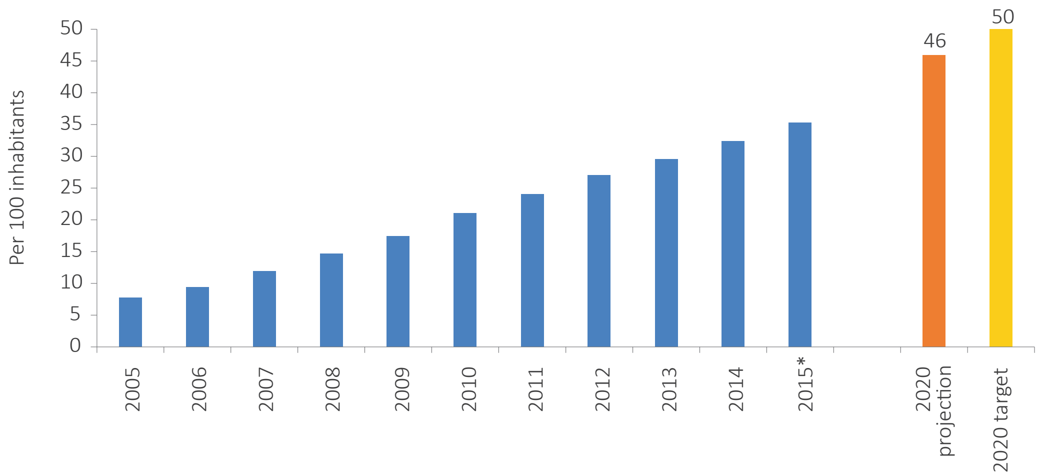
Chart 1.12 illustrates the trend in Internet usage in developing countries for the period 2005-2015. This indicator recorded a CAGR of 16.4 per cent for developing countries over the period, the same as that for all countries, although from a lower baseline. ITU estimates that 46 per cent of individuals in developing countries (including LDCs) will be using the Internet by 2020, this being four percentage points below the target set in the Connect 2020 Agenda. As with household access, however, it is possible that other factors, such as regulatory changes, investment including

Chart 1.11: Percentage of individuals using the Internet, by region and development status, 2015*



Note: *Estimates.
Source: ITU (2015a).

Chart 1.12: Percentage of individuals using the Internet in developing countries, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU.

new public-private partnerships, and further technological development, may have a positive impact that will help to achieve the target more quickly.

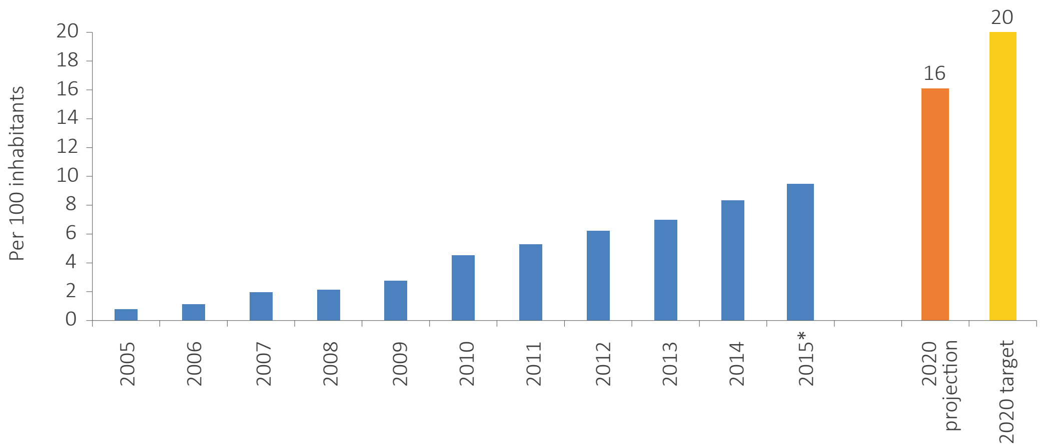
Chart 1.13 illustrates the comparable data trend for Internet use in LDCs. The CAGR in this case was 28.4 per cent between 2005 and 2015, also on a very steady trend. ITU estimates that 16 per cent of individuals in LDCs will be using the Internet by 2020, this being four percentage points below the target set in the Connect 2020 Agenda.

Target 2.3.A: The affordability gap between developed and developing countries should be reduced by 40 per cent by 2020

Target 2.3.A is concerned with the relative affordability of services between developed and developing countries, and is related to Target 1.3 which is concerned with affordability at the global level. Target 1.3 seeks to improve the affordability of ICTs globally by 40 per cent, and is assessed above in relation to fixed telephony, mobile cellular and fixed broadband, as well as mobile broadband.

Target 2.3.A seeks to reduce the ICT price differential between developed and developing countries by 40 per cent by 2020. As with Target

Chart 1.13: Percentage of individuals using the Internet in LDCs, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU.

1.3, the baseline date selected for this target is 2012.

Data illustrating the evolution of fixed-telephone, mobile-cellular and fixed-broadband prices over the period since 2008 are presented in Chart 1.14, while Chart 1.15 presents data for the four mobile-broadband packages for which data were collected in 2013 and 2014. These show that the difference in the affordability of fixed and mobile-cellular services between developed and developing countries fell steadily and significantly during the period 2008-2012, followed by a slowdown in the period 2012-2014, and even an increase in the case of fixed broadband in 2014. On the other hand, the difference in the affordability of mobile broadband between developed and developing countries narrowed from 2013 to 2014.

Fixed broadband remained the service with the largest affordability difference between developed and developing countries (prices 14 times less affordable in developing than in developed countries), followed by postpaid computer-based mobile broadband (ten times less affordable in developing countries). Differences in affordability were smaller for the other services, yet still significant, with fixed-telephone and mobile-cellular services around five times less affordable in developing countries, and prepaid mobile broadband eight times less affordable.

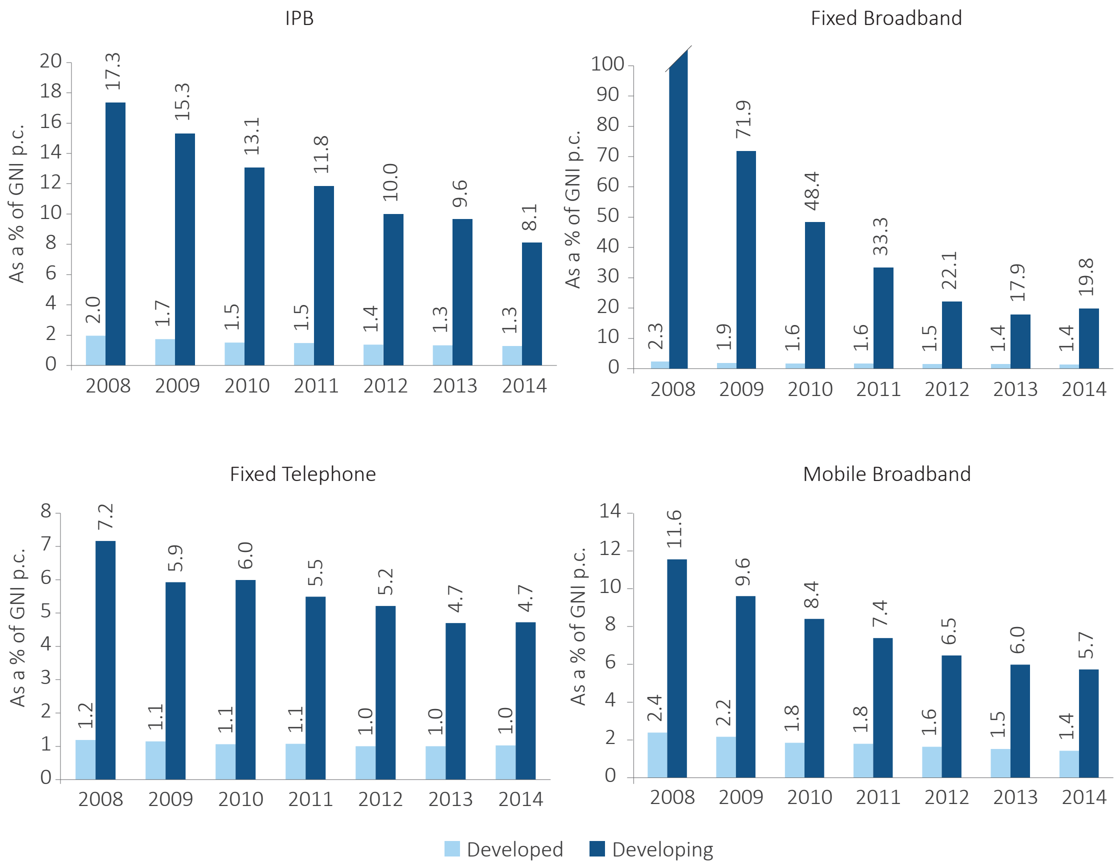
Target 2.3.B: Broadband services should cost no more than 5 per cent of average monthly income in developing countries by 2020

The IPB includes data for fixed-broadband and mobile-broadband services, both of which can be assessed in measuring this target, while average monthly income refers to GNI p.c.

In recent years, in broadband as in telephony, the growth in mobile/wireless connections/subscriptions has greatly exceeded the growth in fixed connections. This is particularly so in developing countries, and most particularly in LDCs. As illustrated in Chart 1.16, the estimated fixed-broadband penetration in 2015 is 7.1 per 100 persons in developing countries and just 0.5 per 100 persons in LDCs, compared with 29.0 per cent in developed countries. The estimated mobile-broadband penetration is 39.1 per cent and 12.1 per cent, respectively, compared with 86.7 per cent in developed countries. As noted earlier in this chapter, however, the two indicators are not directly comparable since they are principally associated, respectively, with household/businesses and individual access.

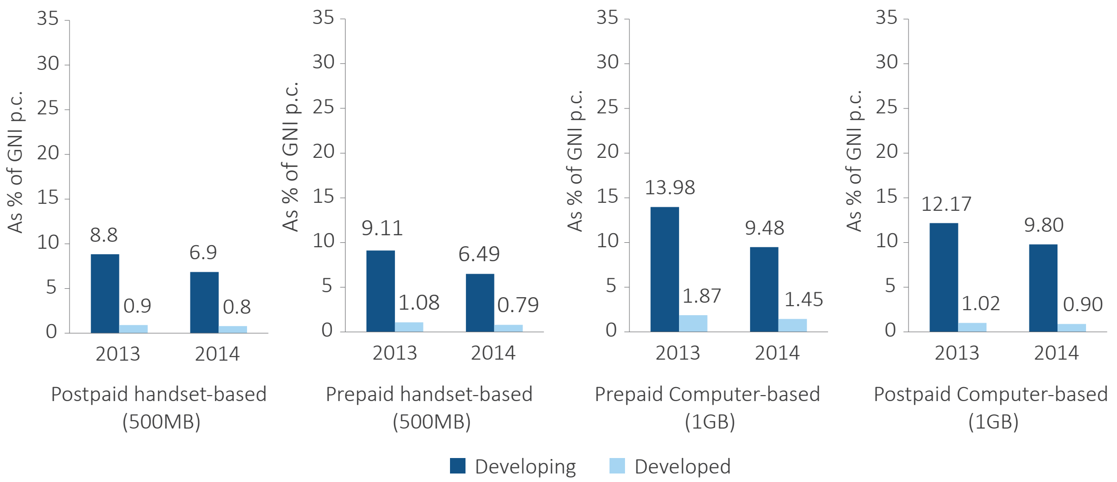
Target 2.3.B is derived from the second of the four targets agreed in 2012 by the Broadband Commission for Digital Development, which sought to achieve affordability at the 5 per cent level of monthly average income (as measured by GNI p.c.) for entry-level broadband services by 2015. By early 2015, a total of 111 economies had achieved that target, out of 160 for which

Chart 1.14: The IPB and sub-baskets, by development level, 2008-2014



Note: Simple averages. Based on 140 economies for which price data on the three services were available for 2008-2014.
Source: ITU.

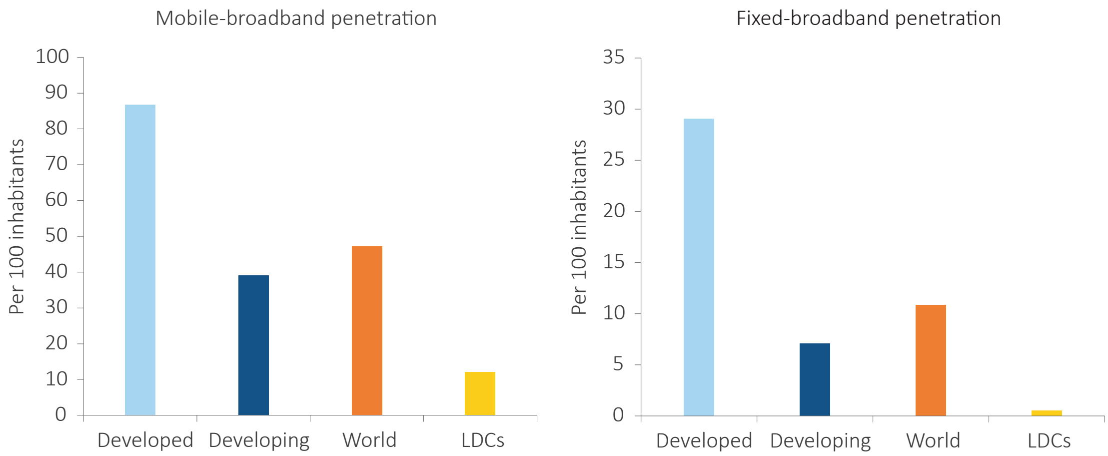
Chart 1.15: Mobile-broadband prices, by level of development, 2013-2014



Note: Simple averages. Based on 119 economies for which price data on the four services were available for 2008-2014.
Source: ITU.

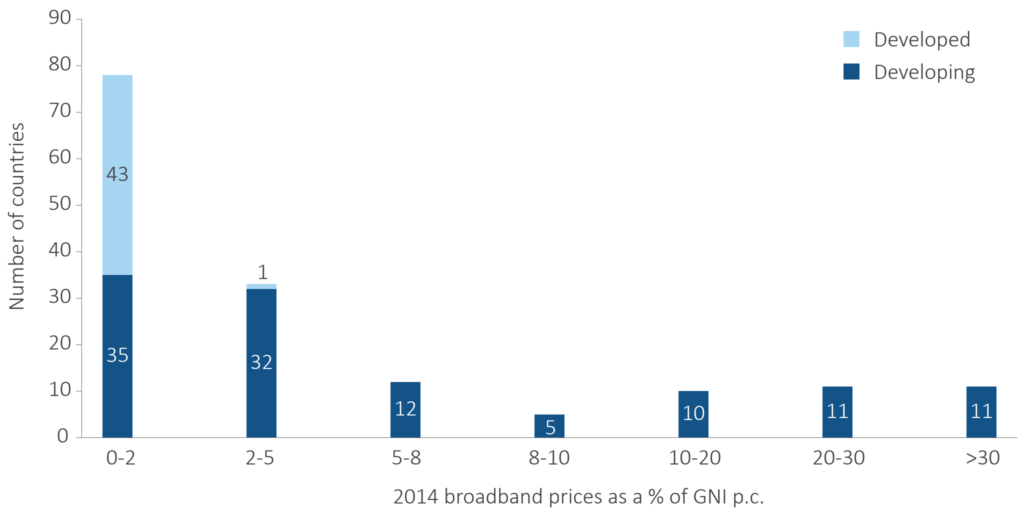
data were available, including all of the developed countries and 67 developing countries in the data set (ITU, 2015a). Of these, 102 had achieved the target for fixed-broadband prices and 105 for mobile-broadband prices. As can be seen from Chart 1.17, however, a small number of countries had very much higher broadband prices, including 22 countries with broadband prices equivalent to more than 20 per cent of monthly GNI p.c. Altogether, 49 developing countries for which data

Chart 1.16: Mobile-broadband and fixed-broadband penetration, 2015*



Note: *Estimates.
Source: ITU.

Chart 1.17: Country performance against the affordability target, 2014



Source: ITU.

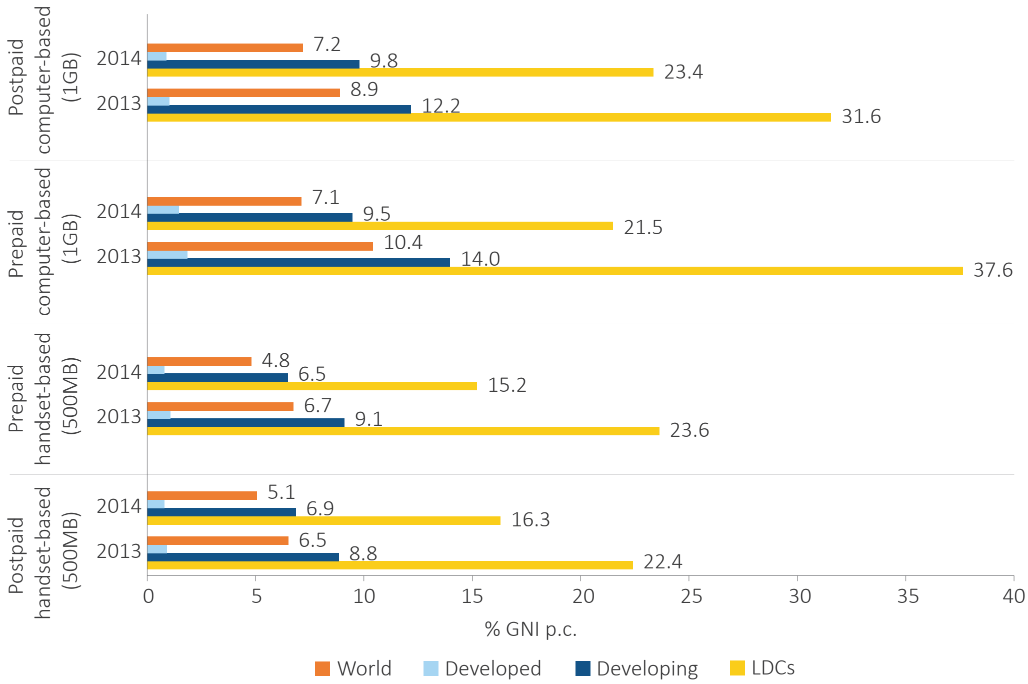
were available need to achieve further reductions in broadband prices in order to achieve the target, together, it should be assumed, with a number of other countries for which no data were available.

The global average price of an entry-level fixed broadband package is also 1.7 times higher than that of a comparable mobile broadband package (PPP$ 52 compared with PPP$ 30) (ITU, 2015a).

As noted above, however, it is mobile-broadband prices that are currently more significant in developing countries, especially LDCs. The IPB includes data concerning four separate packages of mobile broadband services, each of which it measures against monthly GNI p.c. These are concerned with prepaid and postpaid access using either a computer or a handheld device such as a phone or tablet. Chart 1.18 illustrates the average values for developed and developing countries for each of these mobile-broadband packages in 2013 and 2014 for the 119 economies that offered all of these services in the market. It should be noted that these average values relate to the experience of different countries, and are not weighted according to those countries' populations.

As Chart 1.18 shows, LDCs in particular have a considerable way to go in order to achieve the target for these particular mobile-broadband packages. The affordability challenge is particularly acute in LDCs because their average GNI p.c. levels are so low, making it more difficult to secure a positive return on network investment. It will be

Chart 1.18: Mobile-broadband prices, developed and developing countries and LDCs, 2013-2014



Source: ITU.

important in this context for broadband providers to offer services and applications geared towards low-income groups, such as prepaid packages that allow users to buy data in small volumes, for small cash sums, as and when required. Applications and services can also be adapted to use lower data volumes for those who need them. Such broadband-sector innovations focusing on the needs of low-income consumers can, alongside policy and regulatory initiatives by governments, contribute significantly to improving affordability.

Target 2.4: Worldwide, 90 per cent of the rural population should be covered by broadband services by 2020

In most countries, connectivity has tended to favour urban areas – which have higher levels of aggregate demand and are thus likely to achieve earlier returns on investment – over rural areas, leading to concern about an urban/rural digital divide. The first of the ten targets agreed at WSIS in 2003 sought to address this concern by calling for all villages to be connected with ICT and for the establishment of community Internet access points.

Substantial changes have occurred since WSIS in the connectivity options available for rural areas, as wireless networks can be, and have been, more widely deployed in ways that enable quicker returns on investment to be achieved from the larger numbers of users adopting mobile phones.

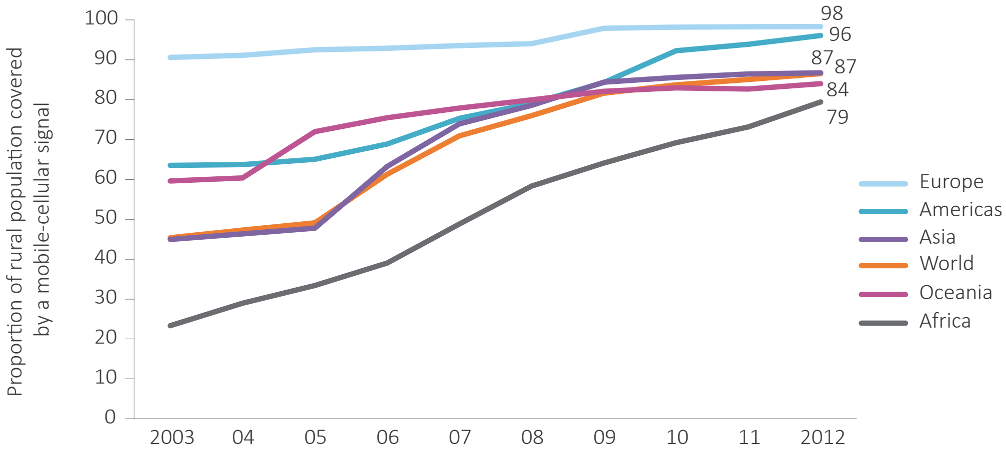
The *Final WSIS Targets Review* included ITU estimates, illustrated in Chart 1.19, for growth in the percentage of the rural population in different world regions covered by a mobile-cellular signal between 2003 and 2012 (Partnership on Measuring ICT for Development, 2014a).

In 2015, ITU estimates that over 95 per cent of the world's total (i.e. both urban and rural) population is covered by a mobile signal.

Since WSIS, the focus of concern regarding rural connectivity has shifted to broadband, as indicated by Connect 2020's Target 2.4.

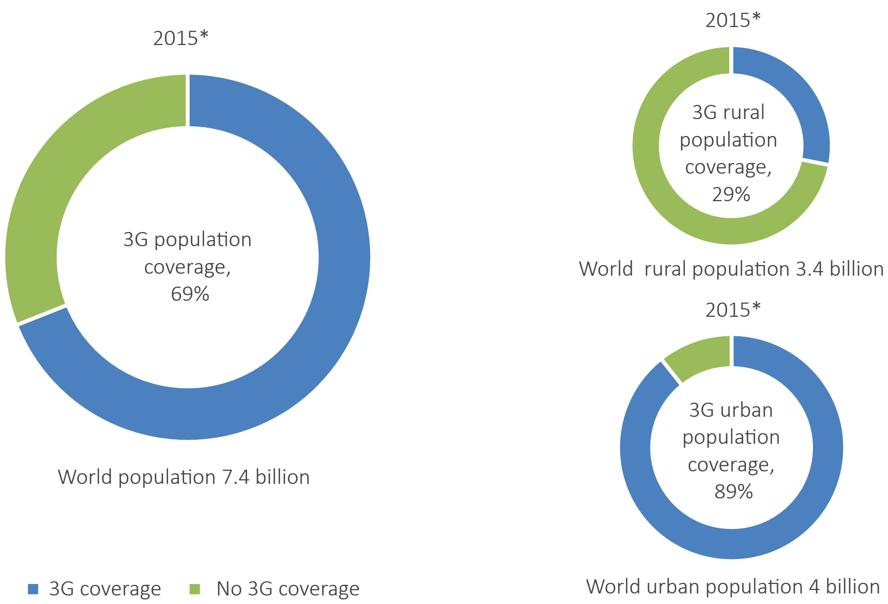
ITU estimates suggest that 3G network coverage grew from 45 per cent of world population in 2011 to 69 per cent in 2015, by which time, as illustrated in Chart 1.20, 3G networks covered 89 per cent of people living in urban areas and 29 per cent of those in rural areas. This is in line with the observed fact that 3G networks remain absent from many rural areas in low income countries, particularly Africa.

Chart 1.19: Rural population covered by a mobile-cellular signal, by region, 2003-2012



Source: ITU.

Chart 1.20: Population coverage by 3G networks, urban and rural areas, 2015*



Note: * Estimate.
Source: ITU.

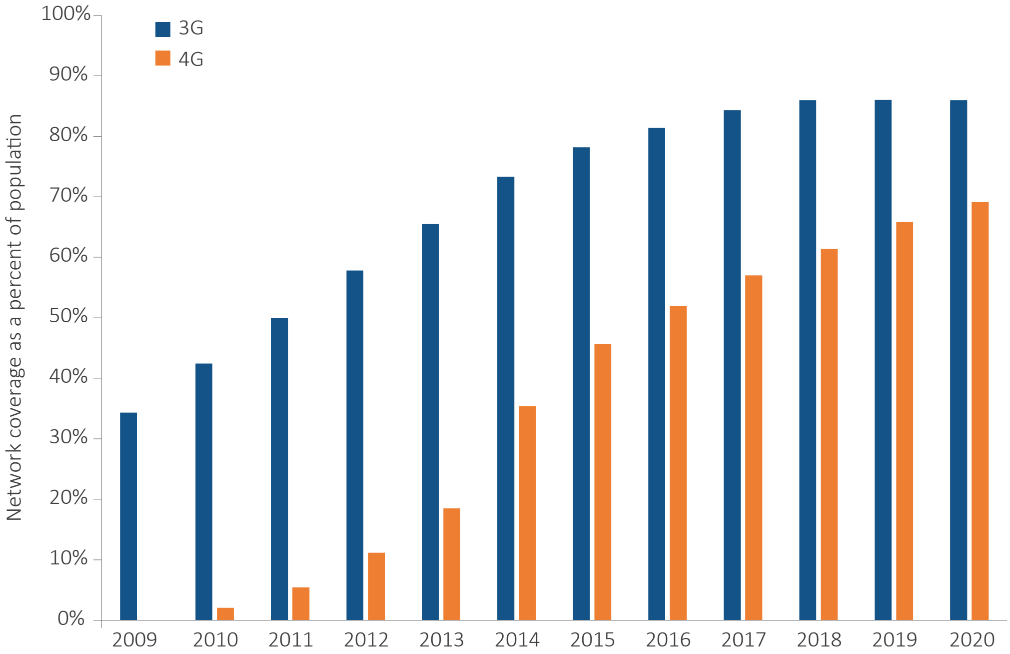
In 2015, the GSM Association estimates that 73 per cent of the world's population is now covered by 3G networks, as against 90 per cent covered by 2G networks, and predicts that this figure will rise to 80 per cent by 2020, with 60 per cent then enjoying 4G coverage.[11] These data and projections, which still fall short of Target 2.4, are illustrated in Chart 1.21.

In its proposed ICT indicators for the SDGs, ITU has suggested that future data relating to network coverage should be gathered for both 2G and 3G networks, with scope for later generations of mobile networks to be added, and that data for household broadband access should be disaggregated between urban and rural areas.

Target 2.5.A: Gender equality among Internet users should be reached by 2020

Digital divides occur within countries, not just between different geographical areas but also between different sections of society. One of the most prominent such divides, which has been widely discussed and is increasingly being researched, is the gender digital divide, i.e.

Chart 1.21: GSMA data and projections for global 3G and 4G coverage, 2009-2020



Source: GSMA.

differences in levels of access to, and use of, ICTs between men and women.

ICT access is considered important for gender equality because it can enable women to achieve greater independence and autonomy, providing them with new economic and social opportunities, including employment and access to money, thereby increasing their level of empowerment. The measurement of ICT and gender is a critical factor in understanding developments in the information society and in informing policy-makers, analysts and other stakeholders involved with issues of gender equality and ICT for development. The importance of equal access for women to economic resources, and the value of ICTs for women's empowerment, have been recognized in proposals for the SDGs.[12]

It is generally agreed that the gender digital divide stems primarily from the structural inequalities that exist between men and women in many societies, although there may also be some ICT-specific factors. The Partnership on Measuring ICT for Development, for example, noted in 2014 that "Socio-cultural factors that cause a higher concentration of women in the uneducated, unemployed and poor segments of society also marginalize them in terms of access and use of ICTs" (Partnership on Measuring ICT for Development, 2014a). Household surveys by Research ICT Africa, conducted in twelve African countries in 2011, demonstrated a close relationship between Internet access differences by gender and other variables, such as level of income and level of education (Dean-Swarray et al, 2013). The Connect 2020 Agenda target of achieving gender equality among Internet users by 2020 will therefore depend as much on efforts to address these structural inequalities within society as on ICT-specific interventions.

Since its launch in 2004, the Partnership on Measuring ICT for Development has been formulating core indicators in the areas of infrastructure and access, household ICT access, individual use of ICT, the use of ICT in education, business and government, and the ICT sector. While many of these indicators can be broken down by gender, the fact that not all of them are collected internationally and/or nationally means that data availability is patchy at best, particularly where developing countries are concerned.

The Partnership launched a Task Group on Gender in 2013, co-led by ITU and the United Nations Conference on Trade and Development (UNCTAD), with the aim of improving the availability of internationally comparable indicators on gender and ICT, especially in developing countries. Its 2014 report on *Measuring ICT and Gender* recognized the need for much more comprehensive and systematic gathering of gender-disaggregated data in order to enable effective responses to the gender digital divide, covering not just access and use but also issues related to wider socio-economic factors, including affordability, capabilities and women's safety or vulnerability online (Partnership on Measuring ICT for Development, 2014b). It made a number of recommendations concerning future data gathering, from ICT-sector and other data sets and from household surveys, while recognizing that the most critical factor in improving data from developing countries was likely to be the need for resourcing and capacity-building in national statistical offices and other relevant statistical institutions.

ITU has been collecting sex-disaggregated ICT data annually since 2009. Using available data, ITU estimated the gender digital divide in developed and developing countries in 2013 and 2015. These data, which are illustrated in Chart 1.22 and in Tables 1.7 and 1.8, suggest that the Internet user penetration rate has been around 11 per cent lower for females than for males in both years. The gap between the two rates is lowest in developed countries (at 5.4 per cent in 2015), significantly higher in developing countries (15.4 per cent in both years), and highest in LDCs (28.9 per cent in 2015). The data suggest that the gap has narrowed in developed countries between 2013 and 2015, while remaining stable in developing countries and LDCs. Only one region, the Americas, displays an Internet user penetration rate that is higher for females than for males. This is partly attributable

Chart 1.22: Percentage of individuals using the Internet, by gender, development status and region, 2015*

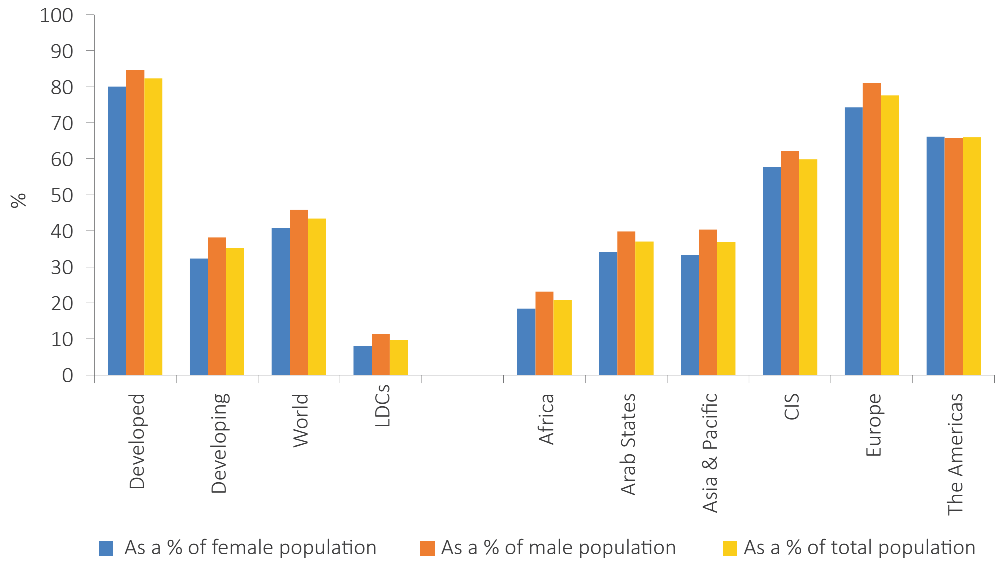


Table 1.7: Percentage of individuals using the Internet, by gender, development status and region, 2015*

Region	Female population	Male population	Total population
Developed	80.1	84.6	82.3
Developing	32.3	38.2	35.3
World	40.8	45.9	43.4
LDC	8.1	11.3	9.7
Africa	18.4	23.1	20.8
Arab States	34.1	39.8	37
Asia & Pacific	33.3	40.4	36.9
CIS	57.8	62.2	59.9
Europe	74.3	81	77.6
The Americas	66.2	65.8	66

Note: *Estimates.
Source: ITU.

Table 1.8: Gap in Internet user penetration rate between males and females, 2013 and 2015*

Region	Gap 2013 (%)	Gap 2015 (%)
Developed	6.3	5.4
Developing	15.6	15.4
World	11.0	11.1
LDC	29.9	28.9
Africa	20.7	20.5
Arab States	15.5	14.4
Asia & Pacific	17.7	17.6
CIS	7.5	7.0
Europe	9.4	8.2
The Americas	-0.4	-0.7

Note: *The gap represents the difference between the Internet user penetration rates for males and females relative to the Internet user penetration rate for males, expressed as a percentage.
Source: ITU.

to the data from its two largest countries, the United States and Brazil, where female Internet usage exceeds that of male usage.

In 2015 ITU began, through its annual statistical questionnaire to Member States, to request data for the indicator "Proportion of individuals owning a mobile phone, by sex." It is now encouraging all countries to collect such data – thus far available for only a few countries – through national household surveys. This indicator has been proposed as a potential indicator to support the measurement of Sustainable Development Goal 5.b "Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women".

Target 2.5.B: Enabling environments ensuring accessible telecommunication/ICT for persons with disabilities should be established in all countries by 2020

The final target in Goal 2, relating to persons with disabilities, differs from previous targets inasmuch as it is not concerned with direct measurement of access or use but with the enabling environment to support access and use. It is therefore a measure of policy and regulatory frameworks rather than of ICT access and use *per se*.

The World Health Organization estimates that 15 per cent of the world's population lives with a disability, representing about one billion people worldwide, of whom 80 per cent live in developing countries.[13] Persons with disabilities often experience additional disadvantages stemming, for example, from old age or from difficulties in accessing economic opportunities and social services. ICTs such as mobile phones and the Internet can facilitate their inclusion in economic and social development by enhancing their access to opportunities and services. However, ensuring that persons with disabilities can derive benefit from the potential of ICTs requires networks, devices and services to be accessible to them on terms and in ways that are equivalent to those enjoyed by other people.

Accessibility to services, including ICTs, is mandated in article 9 of the United Nations Convention on the Rights of Persons with Disabilities, as follows:

To enable persons with disabilities to live independently and participate fully in all aspects of life, States Parties shall take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation, to information and communications, including information and communications technologies and systems, and to other facilities and services open or provided to the public, both in urban and in rural areas.

Article 9 of the Convention also explicitly includes electronic services, emergency services and the Internet in this definition.

For the past seven years, ITU has been working with the Global Initiative for Inclusive ICTs (G3ict) to gather and disseminate information and promote ICT accessibility in line with the UN Convention. In 2014, ITU and G3ict jointly published a *Model ICT Accessibility Policy Report*, designed to inform public policy on ICTs and disability and including a model institutional framework which builds on the ITU/G3ict online *e-Accessibility Policy Toolkit for Persons with Disabilities* (ITU/G3ict, 2014). The model framework includes guidelines and recommendations in six areas of policy and practice, which will form the basis for assessment of this target. These six areas are:

1. The existence of a legal, policy and regulatory framework explicitly concerned with ICT accessibility, including arrangements for

consultation with persons with disabilities; technical and quality-of-service standards; appropriate universal access/service provisions and provisions for emergency communications; dissemination of information to persons with disabilities; and targets for monitoring progress.

2. Accessibility of public access facilities, including payphones, telecentres and cybercafés.

3. Accessibility of mobile communications, including the availability of facilities such as screen readers to assist the blind and partially-sighted, relay services and hearing-aid compatibility to assist those with hearing disabilities, and voice recognition and automated text to assist those with physical disabilities.

4. Accessibility of television and radio programming, including features such as audio description, closed captioning and signing, as well as visual and audio subtitles.

5. Web accessibility, similarly enabling access to the World Wide Web for those with various types of disability, ensuring that government websites are accessible to persons with disabilities and encouraging private-sector websites to meet accessibility standards, as well as supporting greater awareness and responsiveness to accessibility issues among ICT students and professionals.

6. The inclusion of mandatory accessibility requirements in public procurement of ICTs.

ITU has been gathering data on telecommunication policy and regulatory environments for more than 20 years, through an annual regulatory survey completed by Member States. The data gathered through the survey enable ITU to measure the progress made, at national, regional and global levels, in creating an enabling policy and regulatory environment conductive to ICT development and adoption, and to analyse ICT policy and regulatory trends, with the findings being published in the annual *Trends in Telecommunication Reform* and other publications.

In 2015, the survey questionnaire for the first time included the following specific question derived from the above-mentioned *Model ICT Accessibility Policy Report*:

Have you established a regulatory framework to ensure ICT accessibility for persons with disabilities? If so, please indicate which areas are addressed by your ICT accessibility regulatory framework (Check as many as are established):

- Mobile communications accessibility
- Television/video programming accessibility
- Web accessibility
- Public ICT accessibility (e.g. payphones and telecentres)
- Public procurement of accessible ICTs
- Other, please specify

This question seeks to establish which areas are addressed in different Member States' ICT accessibility frameworks, including accessibility of mobile communications, broadcasting (television and radio), the World Wide Web, public access facilities (such as payphones and telecentres), and how these frameworks address issues such as public procurement.

The information gathered in 2015 will establish a baseline to enable progress made against the target to be measured through annual responses by Member States during the period to 2020. Data from the first survey will be included in the 2016 edition of the *Measuring the Information Society* report.

1.5 Connect 2020 Agenda Goal 3 - Sustainability

Goal 3 of the Connect 2020 Agenda is concerned with sustainability. This goal recognizes the need to manage challenges that emerge from the rapid growth of telecommunications and ICTs. It includes three targets, the first of which is concerned with threats to the integrity and security of ICTs and the Internet, seeking to minimize the negative impact of cybersecurity risks, including potential harm to vulnerable groups, while the second and third are concerned with negative impacts on the environment, specifically e-waste and greenhouse-gas emissions.

Table 1.9: Connect 2020 Agenda Goal 3 – Sustainability

3.1	Cybersecurity readiness should be improved by 40 per cent by 2020
3.2	Volume of redundant e-waste to be reduced by 50 per cent by 2020
3.3	Greenhouse gas emissions generated by the telecommunication/ICT sector to be decreased per device by 30 per cent by 2020

Source: ITU.

Target 3.1: Cybersecurity readiness should be improved by 40 per cent by 2020

Cybersecurity has, over the past decade, become an increasingly important issue in the evolving information society. ICTs have become an important factor in almost every aspect of social and economic life, and now provide the principal channels for financial transactions and other critical interfaces between citizens, businesses and governments. Personal and organizational data are increasingly held in international data centres and leveraged for a wide variety of administrative and commercial purposes by global businesses and other actors. People, businesses and governments have come to rely on ICTs and the Internet to such an extent that any breakdowns in connectivity or failures in communications and data security can have serious and lasting negative consequences. All stakeholders, including individual citizens but also businesses and public administrations, are concerned about risks arising from their data becoming available to those who may use the information to do them harm. If people are to derive maximum benefit from information and communications, they need to be sure that their use of them, and the data they make available to others through them, are secure.

Cybersecurity is defined by ITU as "the collection of tools, policies, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance and technologies that can be used to protect the cyber environment and organization and user's assets."[14] This includes connected computing devices, personnel, infrastructure, applications, services, telecommunication systems, and the totality of transmitted and/or stored information in the digital environment.

There are many different threats to these resources. For governments, these include risks associated with national security, cyberterrorism and fraudulent access to and misuse of official data. Businesses are particularly concerned about the security of commercial data. Individual users of the Internet fear that their personal data may be compromised and fraudulently used, and are also concerned about issues such as online harassment and child protection. Cybersecurity strives to ensure that the assets and data of organizations and individual users remain secure in the face of these and other risks arising in the online environment.

It would be very difficult to measure cybersecurity itself because security breaches are for the most part not publicized for reasons of administrative or commercial confidentiality. It is more feasible to measure the cybersecurity commitment of governments and others within national ICT environments, basing assessments around relevant legal and regulatory frameworks. Target 3.1 therefore focuses on measuring cybersecurity readiness.

ITU has worked with ABI Research to establish a Global Cybersecurity Index (GCI), a country-level index which aims to capture each country's commitment and preparedness in respect of cybersecurity, rather than its detailed capabilities or possible vulnerabilities. It considers this level of commitment in the five areas set out in Table 1.10, with the following performance indicators, definitions of which can be found in the GCI's Conceptual Framework:[15]

The first edition of the GCI, with findings from 2014, was published in the report *Global Cybersecurity Index and Cyberwellness Profiles* (ITU and ABI Research, 2014). As well as regional and country-by-country comparisons, the GCI report also includes "cyberwellness profiles" summarizing findings for 196 individual economies.

Information for the GCI in this report was compiled from responses received from Member States to a questionnaire, and from secondary sources, which have been assessed against seventeen performance indicators. These indicators have limited granularity, with only three scores in each

Table 1.10: Global Cybersecurity Index (GCI) performance indicators[16]

Legal measures	Criminal legislation Regulation and compliance
Technical measures	Establishment of a national computer incident response team (CIRT) or equivalent A government-approved framework for cybersecurity standards A government-approved framework for certification
Organizational measures	A policy to promote cybersecurity A roadmap for governance A responsible agency for managing a national strategy or policy National benchmarking
Capacity-building	Standardization development Professional skills development Professional certification Agency certification
Cooperation	Intra-State cooperation Intra –agency cooperation Public private partnerships International cooperation

Source: ITU, see: http://www.itu.int/en/ITU-D/Cybersecurity/Pages/GCI.aspx.

case (0 for no activities, 1 for partial activities and 2 for comprehensive activities). The outcomes of aggregate scores for the GCI will provide the basis for assessing progress towards the target of improving cybersecurity readiness by 40 per cent by 2020. Further development of the Index, including more detailed data-gathering, will enhance these indicators for the future.

Chart 1.23 and Figure 1.2 present findings from the first (and only) edition of the GCI, which show a high degree of variation between countries and regions in the results. The average rating in the GCI in 2014 was 0.28. The 40 per cent improvement in the GCI required by the target would therefore require this rating to be improved by 2020 to 0.39. The highest level of ranking between the different indicator groups was that relating to legal measures, which averaged 0.50, while the other groups all averaged between 0.24 and 0.28, indicating that particular attention is needed in these areas.

Chart 1.23 gives a regional breakdown of the average ratings for each region, while Figure 1.2 shows the distribution of ratings between countries. Countries in North America showed the highest level of cybersecurity preparedness, and there were relatively high levels in most other developed countries, but very low levels in many developing countries, particularly those in Africa. The United States had the highest GCI rating, at 0.824, followed by Canada with 0.794 and Australia, Malaysia and Oman with 0.765. Nine other countries had ratings above 0.7 – New Zealand, Norway, Brazil, Estonia, Germany, India, Japan, the Republic of Korea and the United Kingdom. At the other end of the scale, nine of the countries included in the Index had zero ratings, while a further 42 also had ratings below 0.1.

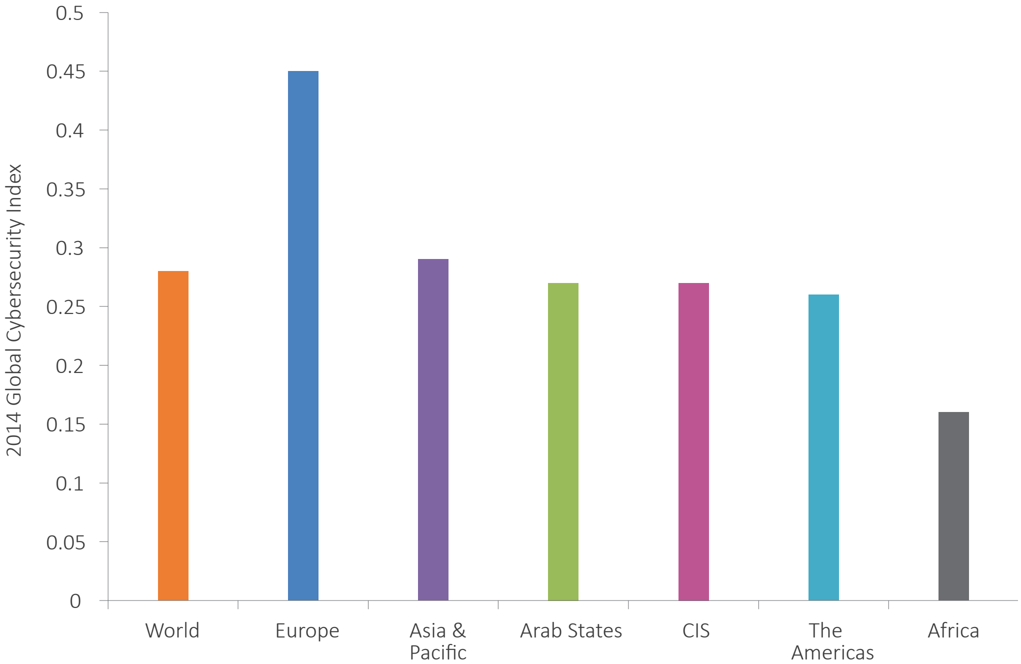
Many of the countries with the highest rankings are countries with equally high rankings in the ICT IDI, which measures the national ICT environment (see Chapter 2). Nineteen of the 27 countries with the eight highest values in the GCI are also in the highest quartile of the IDI. However, some countries such as Malaysia, Oman and Brazil have achieved a higher GCI than IDI ranking.

Target 3.2: Volume of redundant e-waste to be reduced by 50 per cent by 2020

The use of ICTs can significantly mitigate environmental challenges to sustainable development, by enabling the more efficient use of energy and natural resources, and helping countries, cities and individuals to adapt to environmental threats. However, the ICT sector also adds to global environmental challenges, in particular to the generation of waste and greenhouse gas (GHG) emissions. These challenges are addressed in Targets 3.2 and 3.3.

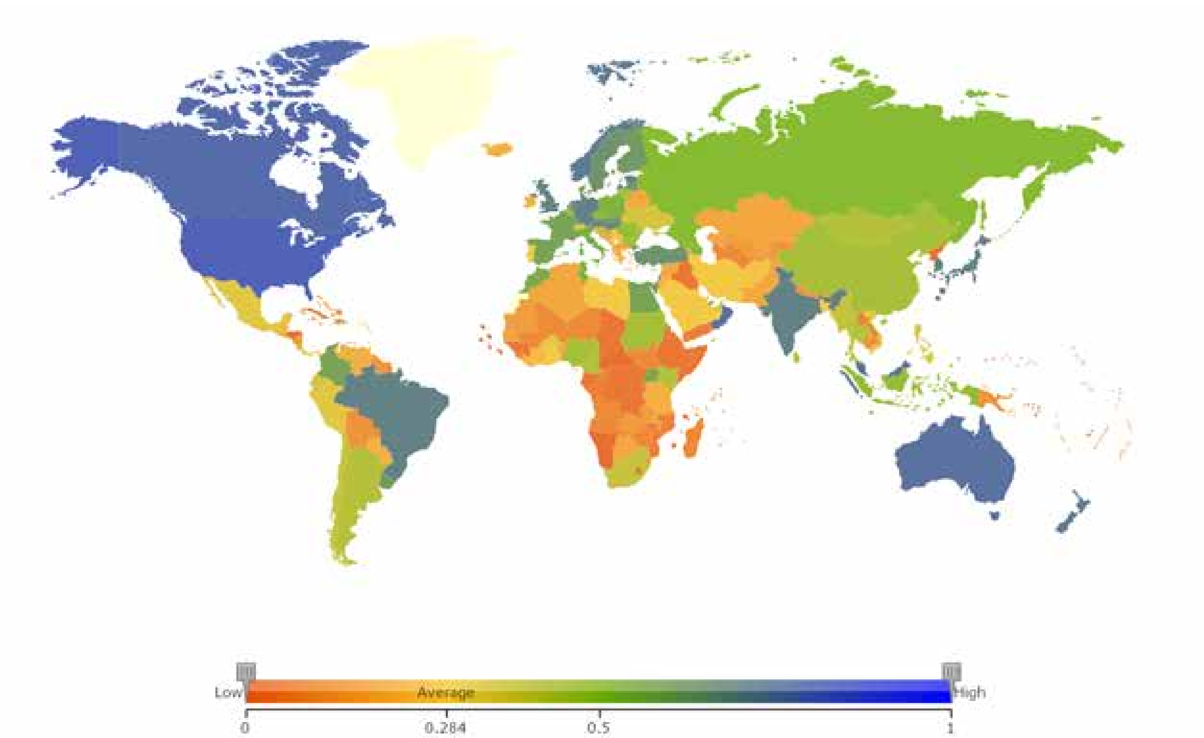
There is no agreed international system for measuring e-waste flows at country level, but it is generally agreed that e-waste constitutes one of the fastest growing streams of physical waste in today's global environment. Guidelines

Chart 1.23: Levels of cybersecurity by region, 2014 Global Cybersecurity Index



Source: ITU and ABI Research (2015).

Figure 1.2: Levels of cybersecurity, 2014 Global Cybersecurity Index



Source: ITU and ABI Research (2015).

for classification and reporting on e-waste have recently been developed by several stakeholders including the Partnership on Measuring ICT for Development (Partnership on Measuring ICT for Development, 2015). The United Nations University (UNU), for example, has calculated that about 42 million tonnes of e-waste were generated globally in 2014, of which six million tonnes were ICT-related.[17] The rate of growth of ICT-related e-waste is particularly high because of the rapid pace of change in technology, as a result of which devices like computers and mobile phones tend to be replaced every two to four years. Additionally, as the growth of markets for ICT goods is rapid, each year more people worldwide own more devices which will in due course become redundant. The United Nations Environment Programme (UNEP) has pointed out that a high proportion of e-waste is traded and treated informally or illegally, most often in developing countries.[18]

Target 3.2 seeks to reduce the volume of "redundant e-waste" – i.e. waste resulting from products and devices which are outdated, have been phased out or have reached the end of their productive life – by 50 per cent by 2020. This target can be achieved only through a combination of activities addressing different stages of the ICT product life cycle, including the manufacturing process, standards and licensing, trade and tax, recycling and disposal. Responsibility for progress will involve a range of stakeholders, including international agencies concerned with trade in waste, governments which establish regulatory environments for waste management, private sector businesses involved in the design, development, production and marketing of ICT products, waste management enterprises, and ICT consumers – both organizations and individuals – who make decisions concerning the procurement and longevity of the devices that they use. Therefore, ITU, together with the UNEP Basel Convention, United Nations Industrial Development Organization (UNIDO), UNU and ITU membership, has been developing a roadmap for implementing Target 3.2, which aims to establish a policy and regulatory and technical framework to steer production, handling, growth and innovation in the ICT sector in a sustainable direction.

For this target to be operationalized, it will be necessary to clarify definitions and establish a baseline year against which progress can be measured. From a definitional point of view, the target should relate specifically to ICT-related redundant e-waste, rather than the wider range of electronic goods to which the term "e-waste" is generally applied. Establishing a baseline will be challenging given current weaknesses in the e-waste measurement and management system. ITU together with other partners will undertake awareness initiatives to develop outreach material, and will interact with stakeholders directly involved in ICT production and handling, to reduce e-waste generation on a global level. ITU Member States will be invited to prepare national reports on e-waste, and a report on national e-waste monitoring will be compiled in the following year. This will provide a basis for assessing progress on this target by 2020 and effectively reduce e-waste generation worldwide. In addition, the roadmap aims to turn the e-waste challenge into an opportunity by creating jobs and facilitating technology transfer from developed to developing countries.

Target 3.3: Greenhouse gas emissions generated by the telecommunication/ICT sector to be decreased per device by 30 per cent by 2020

The second major environmental challenge to be addressed in the Connect 2020 Agenda concerns GHG emissions. ICTs can both contribute to GHG emissions, through the energy consumption involved in the production, use and disposal of ICT products and services, and offer opportunities for reducing GHGs in other economic sectors where they can improve efficiency in production and energy consumption. These two aspects of the relationship between ICTs and GHGs are, however, distinct. Target 3.3 is concerned specifically with reducing GHG emissions per ICT device, and not with possible impacts on emissions resulting from the use of ICTs in other sectors.

The increase in GHG emissions arising from ICT production, use and disposal results primarily from growing connectivity, access and usage. Energy consumption by ICTs increases as they become ever more pervasive in government and business activities, and as people make ever greater use of ICTs in terms of spending more time and doing more things online, making use of more devices and greater bandwidth, and interacting more extensively with one another.

As with e-waste, ITU, together with its Sector Members and industry associations is in the process of developing a roadmap to address the challenges arising from these developments and the GHG emissions associated with them.

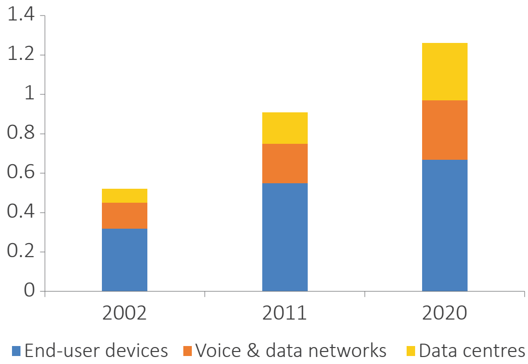
A number of attempts have been made to quantify the GHG emissions generated by the ICT sector.

ITU has been working on the development of Recommendations to assess the environmental impact of ICTs in terms of GHG emissions within the ICT sector, and to estimate the reductions in emissions resulting from the use of ICTs in other sectors of the economy, such as transport or construction. The most substantial recent analysis of GHG emissions can be found in the 2011 *SMARTer 2020* report by the Global e-Sustainability Initiative (GeSI), which works with major ICT companies and organizations including ITU.[19] GeSI estimates that GHG emissions from the sector as a whole rose 6.1 per cent per year between 2002 and 2011 and will rise 3.8 per cent per year between 2011 and 2020. This is more than twice the 1.5 per cent rate of growth projected for emissions from all sectors worldwide, and GeSI thus predicts that the ICT sector's contribution to total emissions will rise from 1.3 per cent in 2002 to 2.3 per cent in 2020 (GeSI, 2011) (Chart 1.24).

The Connect 2020 target for GHG emissions covers the ICT sector's own emissions. In this regard, ITU-T Study Group 5 is proposing Recommendation ITU-T L.1420, which provides a methodology for assessing the impact of ICTs on energy consumption and GHG emissions in companies across the ICT sector value chain, as one alternative to assess attainment of the proposed target. ITU proposes to use this Recommendation as the basis for monitoring and measuring elements relating to Target 3.3, including both direct and energy-related indirect emissions across the life cycle of devices (defined in the Recommendation as Scope 1 and Scope 2 emissions). Initially, however, this indicator will not include non-energy-related indirect emissions (Scope 3 in the Recommendation), which arise for example from the production processes for purchased components, outsourced activities, retail or waste disposal.

The GHG emissions roadmap of the Connect 2020 Agenda aims to position the ICT sector as the key enabler of a low carbon and climate resilient economy, within the international climate arena, led by the United Nations Framework Convention on Climate Change (UNFCCC). It also includes a proposal to reduce the ICT sector's own emissions and to highlight the enabling effect of ICTs to reduce the emissions of other sectors. The ICT industry must work to promote the development of energy-efficient projects in their operations and carry out life cycle assessments for their processes,

Chart 1.24: Global ICT emissions (gigatonnes of CO_2 equivalent – GeSI estimates and projections)



Source: UNCTAD (2015), derived from GeSI (2011).

in order to reduce the carbon footprint of their ICT goods, networks and services.

As noted earlier, ICTs are expected to enable improvements in the efficiency of production processes and energy use in all economic sectors, which will help, over time, to reduce global GHG emissions. GeSI has estimated that the aggregated impact of such efficiency improvements could substantially exceed the negative direct impact of ICT production, use and disposal in GHG emissions, if they are implemented across the board. The potential for mitigating GHG emissions in other sectors should therefore also be considered by the ICT sector, and by businesses in other sectors, in the context of the Sustainable Development Goals.

1.6 Connect 2020 Agenda Goal 4 – Innovation and partnership

The fourth goal in the Connect 2020 Agenda is concerned with fostering innovation and adaptation to the changing ICT environment. In the rapidly changing context of ICTs, innovation in technology and services has become a critical driver of social and economic change, and a potential driver for achievement of the Post-2015 Development Agenda. To maximize the value of innovation, it is necessary to adapt systems and practices on an ongoing basis, for which partnership between different stakeholders has been shown to be of substantial value. Goal 4 therefore includes two targets related to innovation and partnership. These are both qualitative targets, and are discussed more briefly here than the quantitative targets that are associated with the other goals. Further work is required in order to establish precise objectives and identify appropriate indicators for this goal.

Target 4.1: Telecommunication/ICT environment conducive to innovation
Target 4.2: Effective partnerships between stakeholders in the telecommunication/ICT environment

Innovation is widely recognized as a powerful driver for development. The ICT sector has proved to be one of the most dynamically innovative economic sectors in human history. For five decades, the rate of growth in the capabilities of ICT networks and devices has been extremely rapid, and this seems set to continue. Such dynamic growth has fostered an innovation-oriented enterprise culture within the sector, and has also enabled ICTs to act as drivers of innovation in other areas of economic and social development.

In some respects, however, ICT innovation has differed from innovation in other sectors, particularly in regard to the open characteristics of ICT innovation, including open standards, which have enabled wider participation in developing new products and services. These differences mean that ICT innovation cannot be measured effectively using the traditional means of assessing innovation, which have focused on indicators such as investment in/expenditure on R&D, registrations of intellectual property, or measures of educational performance. Within the ICT sector, it is also important to assess the enabling environment for innovation within a country – for example, how easy it is to set up new businesses, obtain investment capital, or partner with other enterprises. Partnerships, including public-private and other multistakeholder partnerships, have proved to be particularly effective drivers of the dynamism apparent within ICT innovation since the emergence of the Internet.

ITU is working with partners to develop indicators to measure achievement of Targets 4.1 and 4.2. In the case of Target 4.1, which is concerned with innovation capacity, it may be possible to establish proxy indicators that draw on ICT-focused data within data series which are used for wider innovation measurements such as the World Intellectual Property Organization's Global Innovation Index[20] and the Global Entrepreneurship Monitor published annually by a group of international universities.[21] In the case of Target 4.2, which is concerned with partnership, it will be necessary to develop new indicators for innovation which can be assessed alongside established indicators. Work will continue on the development of indicators for these targets.

1.7 Future monitoring and measurement of the Connect 2020 Agenda, WSIS outcomes and sustainable development goals

The final section of this chapter is concerned with the future monitoring and measurement of the Connect 2020 Agenda goals and their relationship with two important United Nations processes taking place during the latter half of 2015 – the ten-year review of implementation of the outcomes of WSIS, and the agreement of a new post-2015 development agenda including SDGs.

The WSIS+10 Review

WSIS was held in two phases, in Geneva in 2003 and Tunis in 2005. It established a vision for the development of a "people-centred, inclusive and development-oriented information society", which has guided the relevant work of United Nations agencies and other stakeholders during the past decade. The *Geneva Plan of Action* agreed at WSIS established ten targets, mostly for connectivity and access. These targets, which are listed in Table 1.2, provided the initial framework for assessing progress in achieving WSIS goals. Indicators for them were agreed through the Partnership on Measuring ICT for Development in 2010.

The *Tunis Agenda for the Information Society*, agreed by WSIS in 2005, requested the United Nations General Assembly to review the implementation of WSIS outcomes after ten years. A number of important preparatory initiatives have been undertaken to support this review, including:

- the outcome document from the conference "Towards Knowledge Societies for Peace and Sustainable Development", organized by UNESCO in 2013 in conjunction with ITU, UNCTAD and the United Nations Development Programme (UNDP);

- the two outcome documents from the WSIS+10 High Level Event and its preceding Multistakeholder Preparatory Process, organized by ITU in 2014 in conjunction with UNESCO, UNCTAD and UNDP – the *WSIS+10 Statement on the Implementation of WSIS Outcomes* and the *WSIS+10 Vision for WSIS Beyond 2015*;

- the *Final WSIS Targets Review*, including a comprehensive assessment of progress towards each of the ten WSIS targets, published by the Partnership on Measuring ICT for Development in 2014; and

- the report *Implementing WSIS Outcomes: a ten-year review*, prepared by the secretariat of the United Nations Commission on Science and Technology for Development (CSTD) and published by UNCTAD in 2015, which includes a comprehensive assessment of progress across the whole range of WSIS outcomes.

The outcomes of WSIS have also been regularly reviewed in annual reports by the United Nations Secretary-General, at meetings of CSTD and at the United Nations Economic and Social Council (ECOSOC).[22] In particular, the ECOSOC resolutions have highlighted and appreciated the work of the Partnership on Measuring ICT for Development and encouraged Member States to collect relevant ICT data to monitor the WSIS targets. The United Nations General Assembly will hold a two-day high level meeting in December 2015 to conclude the review.[23]

A number of common themes have emerged during these review activities. It is generally accepted that considerable progress has been made towards achieving WSIS goals, particularly in connectivity and access to basic (and in particular mobile-cellular) communication services, and that there has been a reduction in digital divides for these basic services both within and between countries. At the same time, rapid developments have taken place in ICT technology, particularly in the deployment of mobile and broadband networks enabling much higher quality Internet access. These have led to equally rapid changes in ICT markets that have opened up new digital divides for higher-quality and particularly broadband services, both between and within countries. Evidence suggests that there is a particular risk that LDCs, which are often also least connected countries (LCCs, see Chapter 2) are experiencing a growing digital divide, and risk becoming detached from the ICT-enabled achievements of other countries. Growing concern has been expressed about this risk, and also about the gender digital divide, in international discussions concerned with the WSIS+10 review.

The role of targets and indicators will be crucial to policymakers and practitioners concerned with both the ICT sector and its role in development during the period after 2015. The Connect 2020 Agenda responds to the need to identify targets and raise the visibility of effective data-measurement and analysis to meet the needs of policy-makers and practitioners.

The *Final WSIS Targets Review*, which was published by the Partnership on Measuring ICT for Development in 2014, examined experience with targets in some detail. It stressed the importance of targets, including their ability to attract global attention to development challenges and opportunities, but also problems that had arisen with the WSIS targets for which it had been difficult to establish viable indicators or secure sufficient accurate or reliable data. It recommended that the Partnership on Measuring ICT for Development should "continue its work on identifying and disseminating statistical standards, concepts and classifications on ICT measurement, in order to produce data needed to assess information society progress and measure the impact of ICTs on development" (Partnership on Measuring ICT for Development, 2014a).

The Post-2015 Development Agenda and the Sustainable Development Goals (SDGs)

In September 2015, the 2030 Agenda for Sustainable Development was agreed at the United Nations Sustainable Development Summit held in New York. This new Agenda, which succeeds that agreed in the Millennium Declaration of 2000, establishes the framework for international cooperation to promote sustainable development between 2015 and 2030. The Agenda recognizes that "The spread of information and communication technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies" (United Nations General Assembly, 2015).[24]

Alongside it, the Summit agreed seventeen SDGs, covering a wide range of areas within the overall framework of sustainable development, which seeks to achieve mutually reinforcing progress in economic growth, social justice and environmental sustainability in line with agreements reached at the United Nations Conferences on Environment and Development, the first and third of which were held in Rio de Janeiro, Brazil, in 1992 and 2012. These SDGs, which are listed in Table 1.11, succeed the eight MDGs, which were agreed in 2000 with a timescale up to 2015. They are backed by 169 targets – some quantitative, some qualitative – with target dates between 2020 and 2030.

While none of the SDGs are solely concerned with ICTs, one specific target for ICTs was set within Goal 9. Target 9.c seeks to "significantly increase access to information and communication technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020." While this SDG target is not specifically quantified, it is closely related to those in Connect 2020 Goals 1 (Growth) and 2 (Inclusiveness) which are discussed above. These Connect 2020 targets will provide an effective means of monitoring progress towards SDG Target 9.c, at least up to its initial target date of 2020. The rapid pace of change in ICT technology and markets suggests that, in any event, it will be appropriate to review the Connect 2020 targets and related indicators at that point and revise them to take account of developments both in technology and markets and in modalities for monitoring and measurement.

Three other targets within the agreed SDGs, also listed in Table 1.12, refer explicitly to ICTs. Target 5.b, which is concerned with women's empowerment, has specific relevance to Connect 2020 Target 2.5.A, which is concerned with women's access to the Internet.

In addition, a number of other targets refer to the importance of technology, innovation and information in enabling achievement of other SDGs.

ICTs are, however, expected to play a much more substantial, catalytic role, as enabling, cross-cutting resources, in both monitoring and implementing the SDGs across the board, not just in these four areas. The scope and scale of their role is expected to grow year-on-year during the implementation period for the goals as ICTs become more pervasive and more powerful, playing an increasingly important part in all government and business activity and in the ways

Table 1.11: The Sustainable Development Goals

GOAL 1	End poverty in all its forms everywhere
GOAL 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
GOAL 3	Ensure healthy lives and promote well-being for all at all ages
GOAL 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
GOAL 5	Achieve gender equality and empower all women and girls
GOAL 6	Ensure availability and sustainable management of water and sanitation for all
GOAL 7	Ensure access to affordable, reliable, sustainable and modern energy for all
GOAL 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
GOAL 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
GOAL 10	Reduce inequality within and among countries
GOAL 11	Make cities an human settlements inclusive, safe, resilient and sustainable
GOAL 12	Ensure sustainable consumption and production patterns
GOAL 13	Take urgent action to combat climate change and its impacts*
GOAL 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
GOAL 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
GOAL 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
GOAL 17	Strengthen the means of implementation and revitalize the global partnership for sustainable development

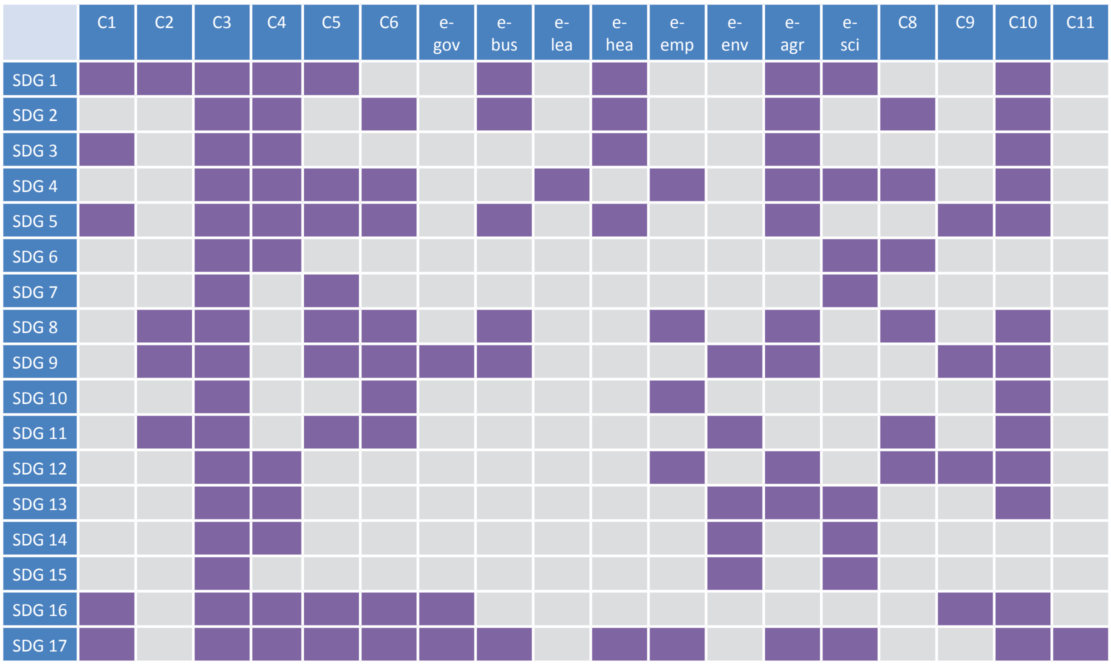
Source: United Nations (2015).

Table 1.12: Sustainable Development Goals with direct reference to ICTs

Goal	Theme	Target
4.b	Education and lifelong learning	By 2020, substantially expand by globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries
5.b	Women's empowerment	Enhance the use of enabling technology, in particular information and communication technology, to promote the empowerment of women
9.c	Infrastructure, industrialization and innovation	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
17.8	Implementation and global partnership	Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology.

Source: United Nations (2015).

Figure 1.3: The relationship between WSIS action lines and SDGs



Source: ITU/WSIS.

in which individuals access social and economic opportunities and interact with one another.

The relationship between ICTs and the SDGs has been an important focus for discussion during the WSIS+10 review. ITU and other agencies concerned with the implementation of WSIS action lines have drawn up a matrix juxtaposing action lines against the SDGs, which is presented in Figure 1.3 and Table 1.13. This matrix identifies both areas in which there are important relationships between the development of the information society and sustainable development as a whole (for example, regarding infrastructure, capacity-building, cybersecurity and the enabling environment for investment and innovation – Action Lines C2, C4, C5 and C6 respectively), and areas in which ICTs can make a powerful specific contribution to specific development sectors (for example, e-government, e-business, health, education and agriculture – all of which have subsidiary action lines in Action Line C7).

Table 1.13: The relationship between WSIS action lines and SDGs

Sustainable Development Goal	Relevant WSIS Action Line
Goal 1. End poverty in all its forms everywhere (1.4, 1.5, 1.b)	C1, C2, C3, C4, C5, C7 e-business, C7 e-health, C7 e-agriculture, C7 e-science, C10
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture (2.3, 2.4, 2.5, 2.a)	C3, C4, C6, C7 e-business, C7 e-health, C7 e-agriculture, C8, C10
Goal 3. Ensure healthy lives and promote well-being for all at all ages (3.3, 3.7, 3.8, 3.b, 3.d)	C1, C3, C4, C7 e-health, C7 e-agriculture, C10
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (4.1, 4.3, 4.4, 4.5, 4.7)	C3, C4, C5, C6, C7 e-learning, C7 e-employment, C7 e-agriculture, C7 e-science, C8, C10
Goal 5. Achieve gender equality and empower all women and girls (5.5, 5.6, 5.b)	C1, C3, C4, C5, C6, C7 e-business, C7 e-health, C7 e-agriculture, C9, C10
Goal 6. Ensure availability and sustainable management of water and sanitation for all (6.a, 6.b)	C3, C4, C7 e-science, C8
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all (7.1, 7.a, 7.b)	C3, C5, C7 e-science
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (8.1, 8.2, 8.3, 8.5, 8.9, 8.10)	C2, C3, C5, C6, C7 e-business, C7 e-employment, C7 e-agriculture, C8, C10
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (9.1, 9.3, 9.4, 9.a, 9.c)	C2, C3, C5, C6, C7 e-government, C7 e-business, C7 e-environment, C7 e-agriculture, C9, C10
Goal 10. Reduce inequality within and among countries (10.2, 10.3, 10.c)	C1, C3, C6, C7 e-employment, C10
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable (11.3, 11.4, 11.5, 11.6, 11.b)	C2, C3, C5, C6, C7 e-environment, C8, C10
Goal 12. Ensure sustainable consumption and production patterns (12.6, 12.7, 12.8, 12.a, 12.b)	C3, C4, C7 e-employment, C7 e-agriculture, C8, C9, C10
Goal 13. Take urgent action to combat climate change and its impacts (13.1, 13.2, 13.3, 13.b)	C3, C4, C7 e-environment, C7 e-agriculture, C7 e-science, C10
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development (14.a)	C3, C4, C7 e-environment, C7 e-science
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	C3, C7 e-environment, C7 e-science
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels (16.2, 16.3, 16.5, 16.6, 16.7, 16.10, 16.a, 16.b)	C1, C3, C4, C5, C6, C7 e-government, C9, C10
Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development (17.6, 17.8, 17.9, 17.11, 17.14, 17.16, 17.17, 17.18, 17.19)	C1, C3, C4, C5, C6, C7 e-government, C7 e-business, C7 e-health, C7 e-employment, C7 e-agriculture, C7 e-science, C10, C11

Source: ITU/WSIS.

The future direction of these action lines was addressed in the multistakeholder *WSIS+10 Vision for WSIS Beyond 2015*, which was agreed at the WSIS+10 High Level Event organized by ITU, in conjunction with UNESCO, UNCTAD and UNDP, in 2014.

Work towards developing indicators for the SDGs is taking place under the auspices of the United Nations Statistical Commission, and is scheduled for completion in the first half of 2016. As well as facilitating implementation of the SDGs, ICTs are expected to play an increasingly important part in the monitoring and measurement of these indicators across the range of SDGs. ITU, including through its work within the Partnership on Measuring ICT for Development, is assisting this work by identifying areas in which ICT-specific indicators can contribute to the monitoring of particular SDGs[25]. Suggestions for indicators concerned with targets that explicitly mention or most directly concern ICTs were presented by ITU to the Inter-Agency and Expert Group Meeting on SDG Indicators (IAEG-SDGs), held by the United Nations in June 2015, as set out in Table 1.14.[26]

Table 1.14: ITU-proposed ICT indicators for the SDG monitoring framework

SDGs and targets			Proposed ICT indicators	Connect 2020 targets
Goal 1	End poverty in all its forms everywhere	Target 1.4 concerning equal rights to economic resources	Proportion of households with broadband Internet access, by urban/rural	Goal 1 target 1.1; Goal 2 targets 2.1.A and 2.1.B
Goal 4	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	Target 4.4 concerning relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	Proportion of individuals with ICT skills, by type of skills	
Goal 5	Achieve gender equality and empower all women and girls	Target 5.b concerning enabling technologies including ICT	Proportion of individuals owning a mobile phone, by sex	Goal 2 target 2.5.A
			Proportion of individuals with ICT skills, by type of skills	
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Target 9.1 concerning quality, reliable, sustainable and resilient infrastructure to support economic development and human wellbeing	Proportion of households with broadband Internet access, by urban/rural	Goal 1 target 1.1; Goal 2 targets 2.1.A and 2.1.B
		Target 9.c concerning access to ICTs and the Internet)	Broadband Internet prices	Goal 1 target 1.3; Goal 2 targets 2.3.A and 2.3.B
			Percentage of the population covered by a mobile network, by technology	Goal 2 target 2.4

Source: ITU.

These proposed ICT indicators build on data sets which are already gathered by ITU and other agencies, and on the Connect 2020 targets, but with additional granularity. For example, proposed Indicator 1 above focuses attention on rural connectivity, proposed Indicator 2 on the gender breakdown of ICT ownership, and proposed Indicators 5 and 7 on the different capacity levels of ICT subscriptions. Proposed Indicator 3 addresses the important additional dimension of human capacities, which are not directly covered in the Connect 2020 Agenda Goals, while proposed Indicator 8 is included in the ICT Development Index but not the Connect 2020 goals.

Work is continuing to address the role of ICT-specific goals in monitoring and measuring other SDGs, which will form an important part of the indicator framework to be agreed in 2016. Much emphasis has been placed in the context of SDG measurement on the potential of big data, i.e. the gathering and analysis of multiple large-scale data sets in ways that can generate evidence for development policy and practice. In recognition of the role of big data as an important source of information for the post-2015 development agenda, in 2014 the United Nations Statistical Commission created the Global Working Group on Big Data for Official Statistics. ITU is an active member of the Global Working Group and its associated task teams. The Task Team on Big Data for SDGs is particularly concerned with providing concrete examples of the potential use of big data sources for monitoring the indicators associated with the SDGs. The topic of big data was also discussed in Chapter 5 of the 2014 edition of the *Measuring the Information Society Report* and is addressed in Chapter 5 of this report.

Future monitoring and measurement of the Connect 2020 Agenda

The Connect 2020 Agenda goals and targets provide a strong foundation for the basic assessment of progress in the development of an information society between 2015 and 2020, building on the experience of the WSIS targets while addressing their weaknesses and responding to the evolution of ICT networks and services since WSIS. The Agenda goals and targets also draw on the work of the Partnership on Measuring ICT for Development to establish core indicators which can be used by national statistical offices, notably in household surveys, and the work of the Broadband Commission for Digital Development which set initial targets for broadband to be achieved by 2015.

The majority of those Connect 2020 targets which are concerned with growth/access and inclusiveness make use of established ITU data sets and can be effectively measured against historic trends within those data sets. Others, particularly those concerned with gender, cybersecurity and environmental impacts, require new data sets, which are currently in the process of development. Three of the targets – those concerned with disability, innovation and partnerships – require qualitative assessments of policy environments, and indicators for these are also under development.

The data challenges associated with measuring the information society, including the Connect 2020 targets, should not be underestimated. The greatest difficulty lies with those targets in Goals 3 and 4 which require further conceptual definition and agreement on indicators on which reliable and internationally comparable data can be gathered in a wide range of countries. Even where appropriate indicators have been agreed, the data sets available to national administrations and thereby to ITU vary in a number of respects. Regular household surveys are not yet undertaken in many countries, especially LDCs, and do not always follow the same guidelines for data gathering on ICTs. The rapid pace of change in technology and markets also affects the comparability of data, so that targets and indicators need to be kept under review and updated from time to time to meet changing data availability and policy requirements. More attention also needs to be addressed to building the capacity of national statistical offices and others concerned with data gathering and analysis.

Projections for the Connect 2020 targets using data which are currently available suggest that, if current trends continue, global access targets and targets for the inclusiveness of developing countries overall are likely to be met or close to being met by the target date of 2020. It is possible, too, that increased deployment of broadband networks and more widespread availability of smartphones will accelerate these trends. However, current trends in LDCs are much less positive, suggesting that the targets for LDC inclusion will not be met until well after the 2020 target date. This risk that the digital divide will widen between LDCs and other countries, including other developing countries, is consistent with evidence from the ICT Development Index (which includes some of the same metrics) in Chapter 2. Affordability will be a critical factor in overcoming this divide, and detailed attention should be paid to the ICT Price Basket and the Agenda's three affordability targets.

The lack of evidence concerning trends for other targets, such as those concerned with gender, accessibility and the environment, makes it more difficult to assess how likely they are to be met by 2020. There is growing awareness of the gender digital divide, but its roots in structural inequalities, particularly concerned with income and educational attainment, mean that it is most likely to be addressed through measures that address those wider societal problems. The targets concerned with e-waste and GHG emissions require sustained attention by diverse stakeholders throughout ICT ecosystems. More data are needed in these areas in order to assess progress more fully.

The Connect 2020 Agenda provides a sound basis, too, for the development of ICT indicators that are relevant to the SDGs, both for measuring ICT sector infrastructure (SDG Target 9.c) and in other goals. Work is under way to develop appropriate indicators that build on those reviewed in this chapter. Work to date has demonstrated the importance of greater granularity in data collection and analysis, for example in assessing different mobile generations and broadband speeds, in disaggregating user data according to gender and other socio-economic categories, in differentiating between urban and rural areas, and in differentiating between LDCs and other developing countries. The nature of the digital networks and devices which deliver ICTs means that the volumes of data which could potentially be used to analyse and understand evolving ICT environments are constantly growing. Opportunities to build more sophisticated indicators and analytical models will increase, and ITU will work with other stakeholders to enhance the quality of available data sets and the sophistication of analysis throughout the implementation period for the SDGs.

Endnotes

1 The Millennium Development Goals can be found at http://www.un.org/millenniumgoals/.

2 Transforming our world: the 2030 Agenda for Sustainable Development, see: https://sustainabledevelopment.un.org/post2015/transformingourworld.

3 The ITU Plenipotentiary Conference is the top policy-making body of ITU. It is held every four years and sets the Union's general policies; adopts four-year strategic and financial plans; and elects the senior management team of the organization, the members of ITU Council, and the members of the Radio Regulations Board. For further information, see: http://www.itu.int/en/plenipotentiary/2014/Pages/default.aspx.

4 Data in this section are elaborated in ITU (2015a), and derived from those presented on the ITU Statistics website at http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx, also available in ITU (2015b).

5 Data in the following paragraph are derived from ITU tables published online at http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2015/ITU_Key_2005-2015_ICT_data.xls.

6 Source: EMC Digital Universe Study, 2014.

7 The following are member-agencies of the Partnership: ITU, OECD, UNCTAD, UNESCO Institute for Statistics, UNDESA, the World Bank, the UNU Institute for the Advanced Study of Sustainability, ECA, ECLAC, ESCAP, ESCWA, EUROSTAT, UNEP Secretariat of the Basel Convention, and ILO. The work of the Partnership is described at http://www.itu.int/en/ITU-D/Statistics/Pages/intlcoop/partnership/members.aspx.

8 The work of the Commission is described at http://www.broadbandcommission.org/Pages/default.aspx.

9 http://www.itu.int/net/pressoffice/press_releases/2013/08.aspx#.VdRDePmqqko.

10 The strong average decrease in fixed-broadband prices in the period 2008-2012 should not be interpreted as a sustained decrease of that magnitude in most countries, but rather as the result of very strong downward price corrections in several developing countries at a given point in time. Indeed, these price reductions reflect the particular situation in several developing countries, in which fixed broadband used to be a premium service (with prices corresponding to more than 100 per cent of GNI p.c.) until the first residential ADSL and WiMAX offers were launched during the period 2008-2012. The effect of these new offers was to drive prices down drastically in the year in which they became available.

11 https://gsmaintelligence.com/research/2015/06/closing-the-network-coverage-gaps-in-asia/508/; https://gsmaintelligence.com/research/2014/12/mobile-broadband-reach-expanding-globally/453/.

12 SDG 5.b aims to 'Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women': see Open Working Group (2014).

13 http://www.who.int/mediacentre/factsheets/fs352/en/.

14 http://www.itu.int/en/ITU-T/studygroups/com17/Pages/cybersecurity.aspx.

15 The conceptual framework is available at http://www.itu.int/en/ITU-D/Cybersecurity/Documents/GCI_Conceptual_Framework.pdf.

16 For further information on the different index indicators, see: http://www.itu.int/en/ITU-D/Cybersecurity/Documents/GCI_Country_Questionnaire.docx.

17 Partnership on Measuring ICT for Development (2015).

18 http://www.unep.org/newscentre/default.aspx?DocumentID=26816&ArticleID=35021.

19 http://gesi.org/SMARTer2020.

20 See: http://www.wipo.int/edocs/pubdocs/en/economics/gii/gii_2014.pdf.

21 See: http://www.gemconsortium.org/.

22 The Secretary-General's reports can be found at: http://unctad.org/en/Pages/CSTD/WSIS-UNSG-Report.aspx. The ECOSOC resolutions can be found at http://unctad.org/en/Pages/CSTD/WSIS-Resolutions.aspx.

[23] The modalities for the review can be found in General Assembly resolution 68/302, which can be found at: http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/68/302.

[24] Transforming our world: the 2030 Agenda for Sustainable Development, see: https://sustainabledevelopment.un.org/post2015/transformingourworld.

[25] In February 2015, the Partnership on Measuring ICT for Development submitted a joint proposal for ICT indicators to help track the Sustainable Development Goals and targets to the Expert Group Meeting on the indicator framework for the post-2015 development agenda, see: http://www.itu.int/en/ITU-D/Statistics/Documents/intlcoop/partnership/Partnership-Background-note-on-ICT-indicator-proposal-for-Expert-Group.pdf

[26] Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/intlcoop/sdgs/ITU-ICT-indiators-for-the-SDGs.pdf.

2 The ICT Development Index (IDI) – global analysis

2.1 Introduction to the IDI[1]

The ICT Development Index (IDI) is a composite index that combines 11 indicators into one benchmark measure that can be used to monitor and compare developments in information and communication technology (ICT) between countries and over time. The IDI was developed by ITU in 2008 in response to requests from ITU Member States to develop an overall ICT index, was first presented in the 2009 edition of the *Measuring the Information Society Report* (ITU, 2009), and has been published annually since then.[2] This chapter analyses IDI 2015, which is derived from data concerning the year 2014, and compares it with IDI 2010, compiled from data concerning the year 2010 (see below).

This opening section of the chapter briefly describes the main objectives, conceptual framework and methodology of the IDI.

The main objectives of the IDI are to measure:

- the *level and evolution over time* of ICT developments within countries and the experience of those countries relative to others;
- progress in ICT development *in both developed and developing countries*;
- the *digital divide*, i.e. differences between countries in terms of their levels of ICT development; and
- the *development potential* of ICTs and the extent to which countries can make use of them to enhance growth and development in the context of available capabilities and skills.

The Index is designed to be global and reflect changes taking place in countries at different levels of ICT development. It therefore relies on a limited set of data which can be established with reasonable confidence in countries at all levels of development.

Conceptual framework

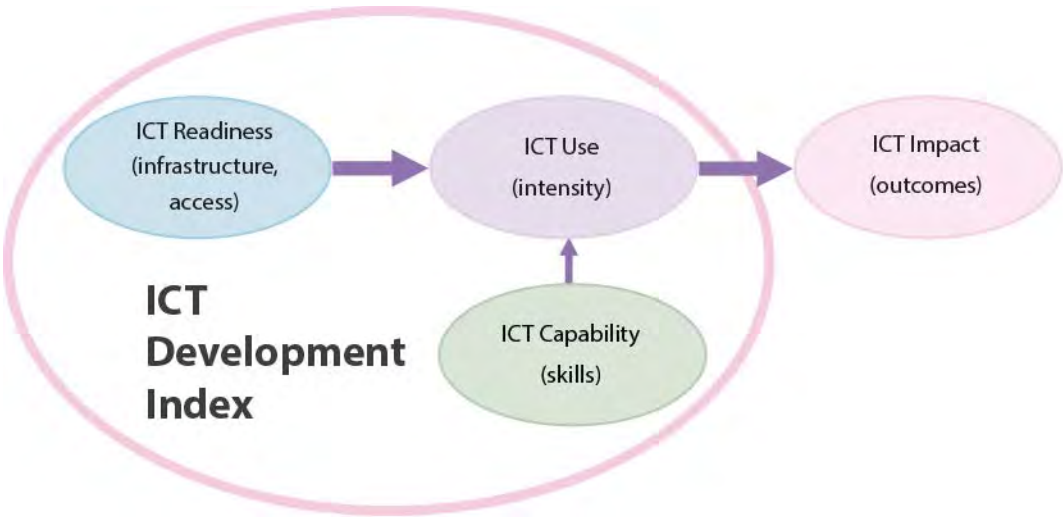
Recognizing that ICTs can, if applied and used appropriately, be development enablers is critical to countries that are moving towards information or knowledge-based societies, and is central to the IDI's conceptual framework. The ICT development process, and a country's evolution towards becoming an information society, can be depicted using the three-stage model illustrated in Figure 2.1:

- Stage 1: *ICT readiness* – reflecting the level of networked infrastructure and *access* to ICTs;
- Stage 2: *ICT intensity* – reflecting the level of *use* of ICTs in the society; and
- Stage 3: *ICT impact* – reflecting the results/outcomes of more efficient and effective ICT use.

Advancing through these stages depends on a combination of three factors: the availability of ICT infrastructure and *access*, a high level of ICT *use*, and the capability to use ICTs effectively, derived from relevant *skills*. These three dimensions – ***ICT access, ICT use*** and ***ICT skills*** – therefore form the framework for the IDI.

- The first two stages correspond to two major components of the IDI: *ICT access* and *ICT use*.
- Reaching the final stage, and maximizing the impact of ICTs, crucially depends on *ICT skills*. ICT – and other – skills determine the effective use that is made of ICTs, and are critical to leveraging their full potential for social and economic development. Economic growth and development will remain below potential if economies are not capable of exploiting new technologies and reaping their benefits. The IDI therefore also includes indicators concerned with capabilities within countries which affect people's ability to use ICTs effectively.

Figure 2.1: Three stages in the evolution towards an information society



Source: ITU.

A single indicator cannot track progress in all three of these components of ICT development, and it is therefore necessary to construct a composite index designed to capture the evolution of the information society as it goes through its different stages of development, taking into consideration technology convergence and the emergence of new technologies.

Based on this conceptual framework, the IDI is divided into the following three sub-indices, which are illustrated, together with their component indicators, in Figure 2.2:

- *Access sub-index*: This sub-index captures ICT readiness, and includes five infrastructure and access indicators (fixed telephone subscriptions, mobile-cellular telephone subscriptions, international Internet bandwidth per Internet user, households with a computer, and households with Internet access).

- *Use sub-index*: This sub-index captures ICT intensity, and includes three intensity and usage indicators (individuals using the Internet, fixed broadband subscriptions, and mobile-broadband subscriptions).

- *Skills sub-index*: This sub-index seeks to capture capabilities or skills which are important for ICTs. It includes three proxy indicators (adult literacy, gross secondary enrolment, and gross tertiary enrolment).

  As these are proxy indicators, rather than indicators directly measuring ICT-related skills, the skills sub-index is given less weight in the computation of the IDI than the other two sub-indices.[3]

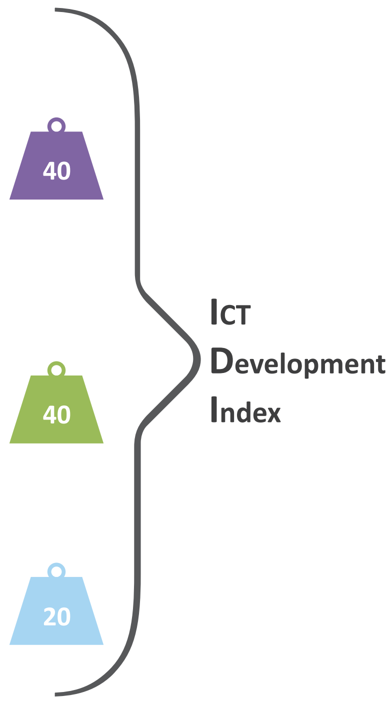
The choice of indicators included in these sub-indices reflects the corresponding stage of evolution to the information society. The indicators in each sub-index may therefore change over time to reflect technological developments related to ICTs and improvements in the availability and quality of data. For example, what was considered basic infrastructure in the past – such as fixed telephone lines – is fast becoming less essential because of the growth in mobile networks and fixed-mobile substitution. Similarly, while broadband has historically been considered an advanced technology, and is therefore included as an indicator in the use sub-index, it is now increasingly considered essential and may become more appropriate to the access sub-index. The significance of these factors for analysis of the current Index is considered in the text below.

Methodology

The IDI includes 11 indicators. A detailed definition of each indicator is provided in Annex 1.

Figure 2.2: ICT Development Index: indicators, reference values and weights

ICT access	Reference value	(%)
1. Fixed-telephone subscriptions per 100 inhabitants	60	20
2. Mobile-cellular telephone subscriptions per 100 inhabitants	120	20
3. International Internet bandwith (bit/s) per internet user	962'216*	20
4. Percentage of households with a computer	100	20
5. Percentage of households with Internet access	100	20
ICT use	**Reference value**	**(%)**
6. Percentage of Individuals using the Internet	100	33
7. Fixed-broadband subscriptions per 100 inhabitants	60	33
8. Active mobile-broadband subscriptions per 100 inhabitants	100	33
ICT skills	**Reference value**	**(%)**
9. Adult literacy rate	100	33
10. Secondary gross enrolment ratio	100	33
11. Tertiary gross enrolment ratio	100	33



Note: *This corresponds to a log value of 5.98, which was used in the normalization step.
Source: ITU.

The indicators used to calculate the IDI were selected on the basis of the following criteria:

- *The relevance of a particular indicator in contributing to the main objectives and conceptual framework of the IDI.* For example, the selected indicators must be relevant to both developed and developing countries, and should reflect, so far as possible, the framework's three components as described above.

- *Data availability and quality*. Data are required for a large number of countries, as the IDI is a global index. There is a shortage of ICT-related data, especially on usage, in the majority of developing countries. In addition, as indicators which are directly related to ICT skills are not available for most countries, it has been necessary to use proxy rather than direct indicators in the skills sub-index.

- *The results of various statistical analyses*. Principal components analysis (PCA) is used to examine the underlying nature of the data and explore whether their different dimensions are statistically well-balanced.

While the core methodology of the IDI has remained the same since it was first published, minor adjustments are made year on year in accordance with these criteria. This also reflects the dynamic nature of the ICT sector and related data availability. The indicators included in the IDI and its sub-indices are regularly reviewed by ITU, in consultation with experts. Indicator definitions and the IDI methodology are discussed in the ITU Expert Group on Telecommunication/ICT Indicators (EGTI) and ITU Expert Group on ICT Household Indicators (EGH).[4]

One important adjustment which has been made to the IDI for the current edition is a revision to the annual numbering of the Index, in order to make this consistent with the annual numbering of the *Measuring the Information Society Reports*. In the past, the annual number for the Index differed from that of the report in which it was published. Thus, for example, IDI 2013 was published in *Measuring the Information Society Report 2014* (ITU, 2014b). This has caused some confusion, and from this year forward the two annual numbers will coincide. The IDI published in this 2015 edition of *Measuring the Information Society Report* is therefore IDI 2015. It should be noted, however, that the data from which it is compiled relate to the end of 2014.

A number of other adjustments to the IDI have been made during the years between IDI 2010 and IDI 2015, and data for IDI 2010 in this report have been adjusted to take them into account. The following adjustments should be noted:

- *Percentage of individuals using the Internet.* The suggested reference period for latest Internet usage has been changed from the last twelve months to the last three months.
- *Percentage of households with a computer.* The definition of computer has been revised to include tablets and similar handheld devices.
- *Fixed-broadband subscriptions*. The definition of fixed broadband has been revised to include cable modem, DSL, fibre-to-the-home/building, other fixed-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband.
- The definition of *household access* has been revised such that, for a household to have access to a computer or the Internet, it must generally be available for use by all members of the household at any time, regardless of whether it is actually used.[5]

The 2015 IDI was computed using the same methodology as in the past, applying the following steps (see also Figure 2.2 and Annex 1):

- *Preparation of the complete data set.* This step included the filling in of missing values using a variety of statistical techniques.
- *Normalization of data*. This is required in order to transform the values of IDI indicators into the same unit of measurement. The chosen normalization method is the distance to a reference value, either 100 or a value obtained through an appropriate statistical procedure.
- *Rescaling of data*. The data were rescaled on a scale from 0 to 10 in order to compare the values of the indicators and the sub-indices.
- *Weighting of indicators and sub-indices*. Indicator weights were chosen based on PCA results. The access and use sub-indices were given equal weight (40 per cent each), while the skills sub-index was given lesser weight (20 per cent) as it is based on proxy indicators.

An assessment of the statistical approach taken to the IDI was undertaken for ITU during 2015 by the Composite Indicators Research Group of the European Commission's Joint Research Centre. The findings of this audit are summarized in Box 2.1.

This chapter presents the data for IDI 2015 as compared with those for IDI 2010. Previous editions of the *Measuring the Information Society Report* have compared each new year's data with results for the previous year. The completion of five years of analysis using the same core methodology (with data gathered in 2010, 2011, 2012, 2013 and 2014) means that it is now possible to assess longer-term trends than those which may become apparent over a single year.

The data for IDI 2010 presented in this report relate to 2010 data gathered in 2011, and published in their original form in the *Measuring the Information Society Report 2011* (ITU, 2011a). The data for IDI 2015 in the report were gathered in 2015 and refer to the end of 2014. The two data sets therefore cover a period of four years in elapsed time, during which five data sets were gathered (for the years 2010, 2011, 2012, 2013 and 2014).

It should be noted that some IDI 2010 values used in this report have changed from those published in 2011, for the following reasons:

- *Country data revisions.* As more accurate data become available, countries provide ITU with revised statistics for previous years. Taking these into consideration also allows ITU to identify inconsistencies and revise previous estimates.
- *Revision of the reference values for the indicators for mobile-cellular subscriptions per 100 inhabitants and international Internet bandwidth per Internet user.* A revision in the reference values for these indicators affects the IDI value.

Box 2.1: Assessment of the IDI

At ITU's invitation, the Econometrics and Applied Statistics Unit of the European Commission's Joint Research Centre (JRC) conducted an assessment of the IDI, focusing in particular on its conceptual and statistical coherence. The main goal of the exercise was to ensure that the IDI is a transparent, statistically credible and legitimate tool for improved policy-making.

The results of the analysis suggest that the conceptualized three-level structure of the IDI is statistically sound in terms of coherence and balance: the overall index as well as the three sub-indices – on ICT access, use and skills – are driven by all the underlying components. The IDI has a very high statistical reliability of 0.96 and captures the single latent phenomenon underlying the three main dimensions of the IDI conceptual framework.

The analysis further shows that the IDI country rankings are robust with respect to methodological changes in the data normalization method, weighting and the aggregation rule (a shift of less than ± 3 positions with respect to the simulated median in 96 per cent of the 167 countries).

The assessment concluded that the IDI was developed using international quality standards and tested using state-of-the-art statistical analyses. The added value of the IDI lies in its ability to summarize different aspects of ICT development in a more efficient and economical manner than is the case with a selection of 11 indicators taken separately. The results showed that, of the 167 countries included this year, for 26 per cent up to 52 per cent of the countries, the IDI ranking and any of the three sub-index rankings (access, use and skills) differ by ten positions or more. This is a desired outcome because it evidences the added value of the IDI as a benchmarking tool, inasmuch as it helps to highlight aspects of ICT development that do not emerge directly by looking into ICT access, ICT use and ICT skills separately.

At the same time, these results also point to the value of taking due account of the individual IDI sub-indices and indicators on their own merit. In so doing, country-specific strengths and bottlenecks in ICT development can be identified and used as an input for evidence-based policy-making. This is highlighted in the analysis of the IDI and each of its sub-indices included in sections 2.2 and 2.3 of this report.

A more detailed description of the JRC assessment is available in Annex 2 to this report.

- *Revision of the definitions of the indicators for the percentage of individuals using the Internet* (changing the reference period from the last twelve months to the last three months) *and for the percentage of households with a computer* (updating the definition of computer to include tablet and other handheld computers, while excluding smartphones).

- *Differences among countries included in the IDI.* The calculation of IDI rankings depends on the values for the other countries included. In each edition, some countries are excluded and others added, depending on data availability.

The remainder of the chapter is structured as follows:

- Section 2.2 presents the overall results of IDI 2015 at the global level and compares these with results from IDI 2010.

- Section 2.3 analyses findings and trends concerning the three sub-indices in greater detail.

- Section 2.4 considers the implications of these findings for the digital divide, comparing results and trends between developed and developing countries and looking specifically at outcomes for least developed countries (LDCs) and least connected countries (LCCs).

- Section 2.5 summarizes the main findings of the analysis at a global level.

Chapter 3 of the report analyses these findings and trends at a regional level, comparing results between ITU's six geographic regions. It also describes the experience of a number of individual countries which have high rankings or which have improved their rankings markedly during the five-year period. The experience of these more dynamic countries helps to illustrate factors which facilitate the relationship between ICT development and wider social and economic development.

2.2 Global IDI analysis

The results of IDI 2015 show that there continue to be great differences in the levels of ICT development between countries and regions around the world. IDI values range from a low of 1.17 in Chad to a high of 8.93 in the Republic of Korea (within a possible range from 0.0 to 10.0). The average IDI level among the 167 countries included in IDI 2015 was 5.03 – the first time since the Index was initiated that this figure has risen above the midpoint of the range. The average in last year's IDI was 4.77.

A comparison between IDI 2015 and earlier years shows that there has been continued progress in IDI performance over time. All countries included in the index in both years had higher IDI values in 2015 than in 2010, and almost all increased their IDI values in IDI 2015 over the previous year. The average IDI value has risen from 4.14 in IDI 2010 to 5.03 in IDI 2015 (Table 2.1), a rise of 0.89 points, although with smaller rises at the top and bottom of the distribution, among countries which already had high levels of connectivity in 2010 and among those countries which were least connected at that time.

Chart 2.1 illustrates the shifting balance in overall IDI values between 2010 and 2015. It shows that there has been an improvement in outcome figures overall, with some evening of the distribution as countries in the middle of the distribution have improved their rankings. Middle-ranking countries have generally achieved improvements in their IDI values comparable with those in higher-ranking countries between 2010 and 2015, including more substantial improvements within the use sub-index.

It is notable that the same countries – the Republic of Korea and Chad – were at the top and bottom of the distribution in 2015 as in 2010, and that the gap in IDI values between them was also the same, at 7.76 points. In spite of this, however, and as discussed below, there has been a widening of the gap in IDI values between middle-ranking countries and the group of LCCs at the bottom of the distribution.

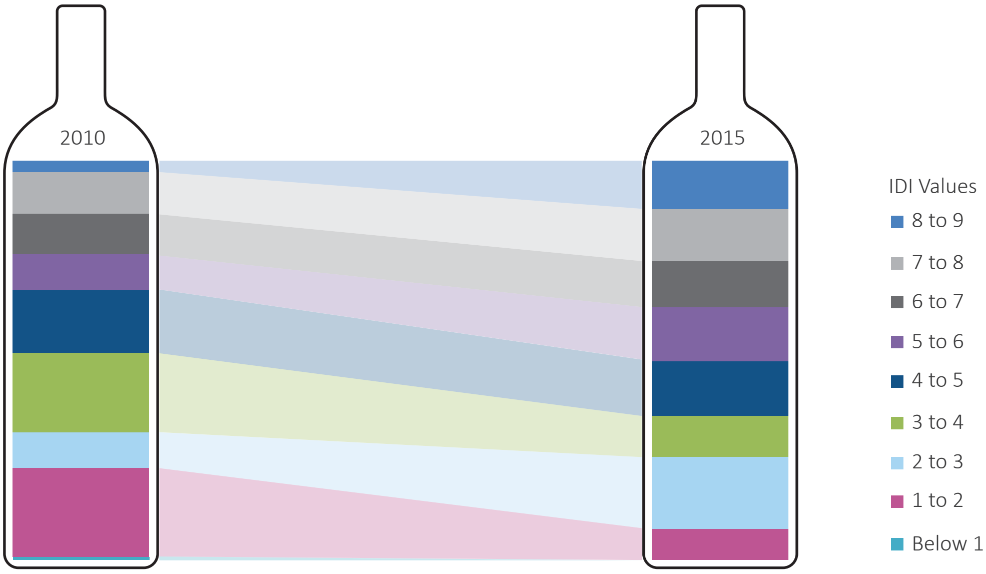
As discussed above, the IDI is divided into three sub-indices, concerned respectively with ICT access, ICT use and ICT skills. Of these three sub-indices, shown in Table 2.1, it is the one concerned with use that shows the greatest variation between countries in IDI 2015. Values for this sub-index have a higher standard deviation (StDev) and a higher coefficient of variation (CV) than those for the access and skills sub-indices. The use sub-index also shows the widest range of values (8.80) and the lowest average value (3.64). Two countries – Eritrea (0.03) and Chad (0.09) – returned values for this sub-index below 1.0, showing that extremely low levels of usage persist in some developing countries.

Table 2.1: IDI values and changes, 2010-2015

	IDI 2015						IDI 2010						Change in average value 2015-2010
	Average value*	Min.	Max.	Range	StDev	CV	Average value*	Min.	Max.	Range	StDev	CV	
IDI	5.03	1.17	8.93	7.76	2.21	44.01	4.14	0.88	8.64	7.76	2.08	50.32	0.89
Access sub-index	5.53	1.27	9.49	8.22	2.21	39.90	4.83	0.59	9.40	8.81	2.31	47.83	0.70
Use sub-index	3.64	0.03	8.83	8.80	2.52	69.14	2.21	0.01	8.02	8.01	2.10	95.28	1.43
Skills sub-index	6.81	2.17	9.92	7.75	2.00	29.38	6.61	1.81	9.91	8.10	2.07	31.36	0.19

Note: *Simple averages. StDev = Standard deviation. CV = Coefficient of variation.
Source: ITU.

Chart 2.1: Distribution of countries by IDI values, 2010 and 2015



Source: ITU.

However the use sub-index also shows greater improvement over the period between 2010 and 2015 than the other sub-indices, and has therefore had the greatest impact on the overall improvement in IDI values during the period. The average value for the use sub-index has grown since 2010 from 2.21 to 3.64, an increase of 1.43 points, while that for the access sub-index has grown from 4.83 to 5.53, an increase of 0.70 points. This difference in improvement rates between use and access sub-indices is evident in all regions and development categories, suggesting that good levels of ICT readiness have been achieved in many countries, and that most ICT growth is coming from increased use of the ICT infrastructure in place.

The overall IDI results for 2010 and 2015, on a country-by-country basis, are set out in Table 2.2, while results for the access, use and skills sub-indices are shown in Tables 2.3 to 2.5. The colours associated with different countries in Table 2.2 represent the high, upper, medium and lower quartiles, which are discussed in Section 2.4 below.

The country with the highest IDI ranking in 2015, as in 2010, is the Republic of Korea, with an overall IDI value of 8.93 (up from 8.64 in 2010). Eight of the top ten economies in the 2015 rankings are from Europe (Denmark, Iceland, the United Kingdom, Sweden, Luxembourg, Switzerland, the Netherlands and Norway), alongside one further economy in Asia (Hong Kong (China)), in addition to the Republic of Korea. The difference in overall IDI values between these top-ranking countries is relatively small, with less than 0.5 points between the first and tenth positions in the rankings. This reflects the high level of ICT development that has been achieved in most developed countries and some high-income developing economies, where there are continued high levels of investment in ICT infrastructure and innovation, as well as high levels of adoption of new services by consumers. More information about the experience of the two highest-ranking countries, the Republic of Korea and Denmark, is included in Chapter 3.

There has been relatively little change in the range of economies with the highest rankings since 2010. All ten of those with top ten IDI levels in IDI 2010 remained in the top 12 in IDI 2015, with Switzerland and Hong Kong (China) replacing Japan (ranked 11th in 2015) and Finland (12th in 2015) in the top ten. The average IDI value for the top ten countries in the Index increased over the period by 0.62 points, from 8.06 to 8.68, with the sharpest rise in rankings within the top ten having been achieved by the United Kingdom, which rose from tenth position in 2010 to fourth in 2015. The average value for the top ten countries in the access sub-index rose by 0.24 points, from 8.94 to 9.18, while that for the top ten countries in the use sub-index rose by 1.82 points, from 6.48 to 8.31.

Table 2.2: IDI overall rankings and ratings, 2015 and 2010

Economy	Rank 2015	IDI 2015	Rank 2010	IDI 2010
Korea (Rep.)	1	8.93	1	8.64
Denmark	2	8.88	4	8.18
Iceland	3	8.86	3	8.19
United Kingdom	4	8.75	10	7.62
Sweden	5	8.67	2	8.43
Luxembourg	6	8.59	8	7.82
Switzerland	7	8.56	12	7.60
Netherlands	8	8.53	7	7.82
Hong Kong, China	9	8.52	13	7.41
Norway	10	8.49	5	8.16
Japan	11	8.47	9	7.73
Finland	12	8.36	6	7.96
Australia	13	8.29	15	7.32
Germany	14	8.22	17	7.28
United States	15	8.19	16	7.30
New Zealand	16	8.14	19	7.17
France	17	8.12	18	7.22
Monaco	18	8.10	22	7.01
Singapore	19	8.08	11	7.62
Estonia	20	8.05	25	6.70
Belgium	21	7.88	24	6.76
Ireland	22	7.82	20	7.04
Canada	23	7.76	21	7.03
Macao, China	24	7.73	14	7.38
Austria	25	7.67	23	6.90
Spain	26	7.66	30	6.53
Bahrain	27	7.63	48	5.42
Andorra	28	7.60	29	6.60
Barbados	29	7.57	38	6.04
Malta	30	7.52	28	6.67
Qatar	31	7.44	37	6.10
United Arab Emirates	32	7.32	49	5.38
Slovenia	33	7.23	27	6.69
Czech Republic	34	7.21	33	6.30
Israel	35	7.19	26	6.69
Belarus	36	7.18	50	5.30
Latvia	37	7.16	34	6.22
Italy	38	7.12	31	6.38
Greece	39	7.09	35	6.20
Lithuania	40	7.08	39	6.02
Saudi Arabia	41	7.05	56	4.96
Croatia	42	7.00	42	5.82
Portugal	43	6.93	36	6.15
Poland	44	6.91	32	6.38
Russian Federation	45	6.91	46	5.57
Kuwait	46	6.83	45	5.64
Slovakia	47	6.82	40	5.96
Hungary	48	6.82	41	5.92
Uruguay	49	6.70	52	5.19
Bulgaria	50	6.52	47	5.45
Serbia	51	6.45	51	5.29
Argentina	52	6.40	54	5.02
Cyprus	53	6.37	44	5.75
Oman	54	6.33	68	4.41
Chile	55	6.31	59	4.90
Lebanon	56	6.29	77	4.18
Costa Rica	57	6.20	80	4.07
Kazakhstan	58	6.20	62	4.81
Romania	59	6.11	55	4.99
TFYR Macedonia	60	6.07	57	4.96
Brazil	61	6.03	73	4.29
Antigua & Barbuda	62	5.93	58	4.91
St. Kitts and Nevis	63	5.92	43	5.80
Malaysia	64	5.90	61	4.85
Montenegro	65	5.90	60	4.89
Moldova	66	5.81	74	4.28
Azerbaijan	67	5.79	76	4.21
St. Vincent and the Grenadines	68	5.69	63	4.69
Turkey	69	5.58	67	4.56
Trinidad & Tobago	70	5.57	65	4.58
Brunei Darussalam	71	5.53	53	5.05
Venezuela	72	5.48	71	4.36
Mauritius	73	5.41	72	4.31
Thailand	74	5.36	92	3.62
Colombia	75	5.32	83	3.91
Armenia	76	5.32	78	4.10
Bosnia and Herzegovina	77	5.28	75	4.28
Georgia	78	5.25	85	3.76
Ukraine	79	5.23	69	4.41
Dominica	80	5.12	66	4.56
Maldives	81	5.08	82	3.92
China	82	5.05	87	3.69
Grenada	83	5.05	64	4.67
Mongolia	84	5.00	97	3.52
Suriname	85	4.99	100	3.39
St. Lucia	86	4.98	70	4.39
Seychelles	87	4.96	81	3.98
South Africa	88	4.90	88	3.65
Panama	89	4.87	79	4.07
Ecuador	90	4.81	90	3.65
Iran (I.R.)	91	4.79	99	3.48
Jordan	92	4.75	84	3.82
Tunisia	93	4.73	93	3.62
Albania	94	4.73	89	3.65
Mexico	95	4.68	86	3.70
Cape Verde	96	4.62	107	3.14
Kyrgyzstan	97	4.62	112	3.02
Philippines	98	4.57	105	3.16
Morocco	99	4.47	96	3.55
Egypt	100	4.40	98	3.48
Fiji	101	4.33	102	3.28
Viet Nam	102	4.28	94	3.61
Dominican Rep.	103	4.26	101	3.38
Peru	104	4.26	91	3.64
Jamaica	105	4.23	95	3.60
El Salvador	106	4.20	110	3.10
Bolivia	107	4.08	113	3.00
Indonesia	108	3.94	109	3.11
Ghana	109	3.90	130	1.98
Tonga	110	3.82	111	3.08
Botswana	111	3.82	117	2.86
Paraguay	112	3.79	108	3.11
Algeria	113	3.71	114	2.99
Guyana	114	3.65	103	3.24
Sri Lanka	115	3.64	115	2.97
Belize	116	3.56	104	3.17
Syria	117	3.48	106	3.14
Namibia	118	3.41	120	2.63
Bhutan	119	3.35	128	2.02
Honduras	120	3.33	116	2.94
Guatemala	121	3.26	118	2.86
Samoa	122	3.11	121	2.43
Nicaragua	123	3.04	123	2.40
Kenya	124	3.02	126	2.09
Vanuatu	125	2.93	124	2.19
Sudan	126	2.93	127	2.05
Zimbabwe	127	2.90	132	1.97
Lesotho	128	2.81	141	1.74
Cuba	129	2.79	119	2.66
Cambodia	130	2.74	131	1.98
India	131	2.69	125	2.14
Senegal	132	2.68	137	1.80
Gabon	133	2.68	122	2.41
Nigeria	134	2.61	133	1.96
Gambia	135	2.60	129	1.99
Nepal	136	2.59	140	1.75
Côte d'Ivoire	137	2.51	142	1.74
Lao P.D.R.	138	2.45	135	1.92
Solomon Islands	139	2.42	139	1.78
Angola	140	2.32	144	1.68
Congo (Rep.)	141	2.27	136	1.83
Myanmar	142	2.27	150	1.58
Pakistan	143	2.24	138	1.79
Bangladesh	144	2.22	148	1.61
Mali	145	2.22	155	1.46
Equatorial Guinea	146	2.21	134	1.96
Cameroon	147	2.19	149	1.60
Djibouti	148	2.19	143	1.69
Uganda	149	2.14	151	1.57
Mauritania	150	2.07	146	1.63
Benin	151	2.05	147	1.63
Togo	152	2.04	145	1.64
Zambia	153	2.04	152	1.55
Rwanda	154	2.04	154	1.47
Liberia	155	1.86	161	1.24
Afghanistan	156	1.83	156	1.37
Tanzania	157	1.82	153	1.54
Mozambique	158	1.82	160	1.28
Burkina Faso	159	1.77	164	1.13
Congo (Dem. Rep.)	160	1.65	162	1.23
South Sudan	161	1.63	-	-
Guinea-Bissau	162	1.61	158	1.33
Malawi	163	1.61	159	1.33
Madagascar	164	1.51	157	1.34
Ethiopia	165	1.45	165	1.07
Eritrea	166	1.22	163	1.14
Chad	167	1.17	166	0.88

Source: ITU.

Table 2.3: IDI access sub-index rankings and ratings, 2015 and 2010

Economy	Rank 2015	Access 2015	Rank 2010	Access 2010
Luxembourg	1	9.49	1	9.40
Iceland	2	9.37	2	9.32
Hong Kong, China	3	9.32	3	9.06
United Kingdom	4	9.24	8	8.75
Germany	5	9.22	7	8.77
Switzerland	6	9.20	4	9.02
Malta	7	9.04	11	8.50
Netherlands	8	9.04	6	8.77
Korea (Rep.)	9	9.00	10	8.64
Sweden	10	8.90	5	8.99
Japan	11	8.85	15	8.03
France	12	8.77	14	8.15
Denmark	13	8.72	9	8.70
Singapore	14	8.64	12	8.38
Belgium	15	8.45	16	7.94
Australia	16	8.37	17	7.90
Norway	17	8.24	13	8.33
Ireland	18	8.24	18	7.87
Monaco	19	8.23	31	7.35
Austria	20	8.21	20	7.87
Qatar	21	8.13	32	7.33
Canada	22	8.13	21	7.86
New Zealand	23	8.08	19	7.87
Barbados	24	8.04	30	7.42
Israel	25	7.98	22	7.73
Slovenia	26	7.94	27	7.56
Andorra	27	7.89	26	7.57
Estonia	28	7.86	29	7.44
United Arab Emirates	29	7.86	42	6.83
Macao, China	30	7.85	23	7.73
United States	31	7.82	25	7.59
Finland	32	7.81	24	7.71
Spain	33	7.80	28	7.45
Bahrain	34	7.79	36	7.22
Portugal	35	7.77	33	7.32
Italy	36	7.71	34	7.32
Greece	37	7.71	37	7.11
Belarus	38	7.68	54	6.16
Hungary	39	7.54	39	6.87
St. Kitts and Nevis	40	7.47	35	7.31
Saudi Arabia	41	7.42	56	6.10
Czech Republic	42	7.41	40	6.86
Croatia	43	7.33	38	7.11
Kuwait	44	7.31	51	6.32
Serbia	45	7.28	45	6.69
Brunei Darussalam	46	7.25	43	6.83
Oman	47	7.24	68	5.39
Russian Federation	48	7.24	50	6.39
Latvia	49	7.23	48	6.65
Uruguay	50	7.15	55	6.15
Poland	51	7.15	41	6.85
Antigua & Barbuda	52	7.05	47	6.66
Slovakia	53	7.04	49	6.65
Lithuania	54	7.04	44	6.78
Cyprus	55	7.04	46	6.67
Kazakhstan	56	6.92	57	5.98
Bulgaria	57	6.85	58	5.96
St. Vincent and the G.	58	6.76	53	6.19
TFYR Macedonia	59	6.75	64	5.77
Montenegro	60	6.74	61	5.89
Moldova	61	6.70	70	5.35
Romania	62	6.69	60	5.92
Malaysia	63	6.61	52	6.24
Argentina	64	6.60	59	5.94
Seychelles	65	6.59	72	5.32
Lebanon	66	6.57	75	5.03
Trinidad & Tobago	67	6.56	62	5.87
Chile	68	6.55	65	5.67
Mauritius	69	6.48	71	5.33
Costa Rica	70	6.30	83	4.55
Brazil	71	6.28	76	5.01
Ukraine	72	6.27	74	5.23
Georgia	73	6.20	84	4.50
Grenada	74	6.14	63	5.81
Azerbaijan	75	6.11	77	4.90
Armenia	76	6.08	80	4.73
Maldives	77	6.03	69	5.38
Dominica	78	6.01	66	5.49
Turkey	79	6.00	73	5.27
Iran (I.R.)	80	5.97	82	4.62
Panama	81	5.72	78	4.87
Bosnia and Herzegovina	82	5.71	79	4.77
Jordan	83	5.69	81	4.62
Morocco	84	5.65	85	4.50

Economy	Rank 2015	Access 2015	Rank 2010	Access 2010
St. Lucia	85	5.55	67	5.44
Colombia	86	5.54	86	4.36
Venezuela	87	5.44	87	4.36
South Africa	88	5.31	91	4.29
China	89	5.25	99	4.08
Suriname	90	5.22	92	4.23
Ecuador	91	5.21	95	4.18
Thailand	92	5.20	93	4.20
Egypt	93	5.12	90	4.30
El Salvador	94	5.04	97	4.12
Tunisia	95	5.00	96	4.13
Mongolia	96	4.97	102	3.98
Cape Verde	97	4.90	114	3.48
Mexico	98	4.84	94	4.18
Syria	99	4.76	98	4.08
Peru	100	4.68	101	4.04
Fiji	101	4.63	100	4.06
Indonesia	102	4.60	115	3.47
Jamaica	103	4.57	88	4.33
Ghana	104	4.51	140	2.15
Albania	105	4.50	107	3.73
Paraguay	106	4.44	109	3.69
Viet Nam	107	4.43	89	4.31
Philippines	108	4.39	116	3.41
Bolivia	109	4.31	118	3.23
Algeria	110	4.27	110	3.64
Botswana	111	4.22	105	3.81
Tonga	112	4.20	108	3.69
Guyana	113	4.20	106	3.75
Sri Lanka	114	4.17	113	3.51
Guatemala	115	4.16	104	3.93
Kyrgyzstan	116	4.16	119	3.20
Namibia	117	4.14	120	3.18
Dominican Rep.	118	4.12	111	3.57
Honduras	119	4.05	103	3.95
Nicaragua	120	4.01	121	2.84
Gabon	121	3.91	117	3.35
Gambia	122	3.78	123	2.77
Cambodia	123	3.77	125	2.63
Belize	124	3.65	112	3.51
Bhutan	125	3.57	134	2.41
Senegal	126	3.51	129	2.60
Côte d'Ivoire	127	3.44	122	2.78
Mali	128	3.43	139	2.18
Sudan	129	3.35	137	2.30
Kenya	130	3.30	132	2.49
Samoa	131	3.27	127	2.61
Vanuatu	132	3.23	124	2.73
Lesotho	133	3.18	150	1.88
Pakistan	134	3.15	130	2.60
India	135	3.13	128	2.60
Benin	136	3.08	133	2.46
Lao P.D.R.	137	3.03	136	2.32
Nepal	138	2.92	149	1.90
Zimbabwe	139	2.89	142	2.09
Mauritania	140	2.88	131	2.54
Cameroon	141	2.83	152	1.82
Nigeria	142	2.82	135	2.33
Bangladesh	143	2.82	147	1.92
Equatorial Guinea	144	2.76	126	2.63
Mozambique	145	2.74	157	1.70
Congo (Rep.)	146	2.71	138	2.29
Angola	147	2.68	144	2.04
Afghanistan	148	2.64	148	1.92
Burkina Faso	149	2.63	151	1.84
Zambia	150	2.63	155	1.71
Liberia	151	2.59	160	1.64
Solomon Islands	152	2.59	153	1.75
Togo	153	2.59	143	2.07
Rwanda	154	2.54	156	1.71
Tanzania	155	2.48	145	2.03
Myanmar	156	2.47	162	1.40
Djibouti	157	2.44	141	2.14
Uganda	158	2.35	154	1.72
Guinea-Bissau	159	2.30	146	1.93
Cuba	160	1.98	163	1.38
Malawi	161	1.96	159	1.64
Ethiopia	162	1.90	161	1.45
Congo (Dem. Rep.)	163	1.83	164	1.14
Chad	164	1.74	165	1.13
Madagascar	165	1.67	158	1.64
South Sudan	166	1.28	-	-
Eritrea	167	1.27	166	1.09

Source: ITU.

Table 2.4: IDI use sub-index rankings and ratings, 2015 and 2010

Economy	Rank 2015	Use 2015	Rank 2010	Use 2010
Denmark	1	8.83	5	7.20
Norway	2	8.43	3	7.55
United Kingdom	3	8.42	12	5.99
Korea (Rep.)	4	8.42	1	8.02
Luxembourg	5	8.34	10	6.53
Sweden	6	8.32	2	7.57
Finland	7	8.21	4	7.32
Iceland	8	8.11	9	6.54
Switzerland	9	8.01	15	5.87
Japan	10	7.98	7	7.02
United States	11	7.86	14	5.90
Monaco	12	7.78	13	5.94
Netherlands	13	7.69	11	6.41
Estonia	14	7.66	24	4.79
New Zealand	15	7.63	20	5.36
Singapore	16	7.61	6	7.11
Australia	17	7.58	16	5.75
Bahrain	18	7.56	50	2.64
Hong Kong, China	19	7.55	19	5.40
France	20	7.23	17	5.66
Macao, China	21	7.22	8	6.55
United Arab Emirates	22	6.99	46	3.23
Germany	23	6.98	21	5.34
Qatar	24	6.93	29	4.48
Ireland	25	6.85	22	5.24
Canada	26	6.84	18	5.42
Belgium	27	6.76	28	4.53
Spain	28	6.62	34	4.27
Barbados	29	6.55	45	3.28
Austria	30	6.47	23	4.96
Andorra	31	6.41	30	4.45
Latvia	32	6.29	31	4.42
Czech Republic	33	6.29	26	4.61
Lithuania	34	6.10	42	3.60
Malta	35	6.05	33	4.39
Kuwait	36	6.03	37	4.07
Saudi Arabia	37	6.00	53	2.57
Slovakia	38	5.86	36	4.11
Croatia	39	5.85	47	3.21
Italy	40	5.74	35	4.25
Poland	41	5.62	27	4.60
Israel	42	5.57	25	4.65
Lebanon	43	5.54	75	1.88
Russian Federation	44	5.52	48	3.19
Slovenia	45	5.42	32	4.41
Uruguay	46	5.41	51	2.63
Belarus	47	5.40	55	2.46
Bulgaria	48	5.22	43	3.55
Hungary	49	5.19	41	3.62
Brazil	50	5.16	68	2.11
Portugal	51	5.14	39	3.70
Costa Rica	52	5.12	73	1.93
Greece	53	5.05	44	3.44
Oman	54	5.05	64	2.18
Cyprus	55	4.89	38	3.73
Chile	56	4.88	57	2.36
Argentina	57	4.76	62	2.22
Malaysia	58	4.76	52	2.59
TFYR Macedonia	59	4.76	49	3.03
Azerbaijan	60	4.70	71	1.99
Serbia	61	4.69	54	2.57
Kazakhstan	62	4.54	66	2.13
Romania	63	4.48	56	2.40
Thailand	64	4.28	103	1.02
Suriname	65	4.20	96	1.21
Trinidad & Tobago	66	4.08	58	2.32
Antigua & Barbuda	67	4.07	70	2.02
Moldova	68	4.02	84	1.61
Montenegro	69	3.91	67	2.13
St. Vincent and the G.	70	3.86	74	1.92
China	71	3.84	79	1.77
Colombia	72	3.83	83	1.61
Venezuela	73	3.80	59	2.28
Turkey	74	3.77	63	2.21
Bosnia and Herzegovina	75	3.74	65	2.17
St. Kitts and Nevis	76	3.71	40	3.65
Maldives	77	3.59	91	1.36
St. Lucia	78	3.55	69	2.09
Philippines	79	3.55	104	1.01
Kyrgyzstan	80	3.46	116	0.58
Albania	81	3.40	80	1.69
Mexico	82	3.37	81	1.67
Tunisia	83	3.37	86	1.51
South Africa	84	3.37	87	1.44
Cape Verde	85	3.26	98	1.18
Mauritius	86	3.25	76	1.85
Mongolia	87	3.20	111	0.75
Armenia	88	3.19	88	1.41
Dominica	89	3.11	61	2.23
Georgia	90	3.03	94	1.31
Viet Nam	91	3.01	85	1.51
Dominican Rep.	92	2.97	92	1.34
Morocco	93	2.95	72	1.99
Seychelles	94	2.94	78	1.83
Panama	95	2.92	77	1.83
Brunei Darussalam	96	2.90	60	2.25
Ecuador	97	2.90	93	1.34
Fiji	98	2.88	106	0.84
Jamaica	99	2.76	97	1.21
Egypt	100	2.71	89	1.39
Ghana	101	2.64	123	0.50
El Salvador	102	2.41	110	0.76
Botswana	103	2.37	134	0.28
Jordan	104	2.36	99	1.16
Bolivia	105	2.33	107	0.83
Grenada	106	2.28	82	1.67
Bhutan	107	2.27	121	0.53
Iran (I.R.)	108	2.19	114	0.60
Ukraine	109	2.17	95	1.27
Peru	110	2.11	90	1.37
Tonga	111	2.07	115	0.59
Zimbabwe	112	2.03	118	0.55
Nigeria	113	1.81	109	0.82
Indonesia	114	1.79	102	1.04
Belize	115	1.79	100	1.10
Namibia	116	1.77	105	0.89
Kenya	117	1.76	124	0.47
Sudan	118	1.73	113	0.66
Paraguay	119	1.71	108	0.83
Vanuatu	120	1.60	136	0.28
Guyana	121	1.57	101	1.08
Algeria	122	1.52	119	0.55
Lesotho	123	1.47	144	0.19
Sri Lanka	124	1.44	122	0.51
Senegal	125	1.42	131	0.31
Côte d'Ivoire	126	1.32	156	0.09
Samoa	127	1.31	142	0.24
Angola	128	1.28	128	0.39
Honduras	129	1.26	127	0.41
Guatemala	130	1.23	117	0.57
Syria	131	1.22	112	0.72
Nepal	132	1.14	135	0.28
Uganda	133	1.10	125	0.47
Cuba	134	1.00	120	0.53
India	135	0.85	132	0.30
Mauritania	136	0.85	147	0.16
Gambia	137	0.79	130	0.32
Cambodia	138	0.78	156	0.09
Nicaragua	139	0.77	126	0.43
Solomon Islands	140	0.75	140	0.25
Rwanda	141	0.73	138	0.27
Pakistan	142	0.69	133	0.29
Equatorial Guinea	143	0.66	143	0.21
Lao P.D.R.	144	0.64	141	0.24
Burkina Faso	145	0.63	158	0.08
Zambia	146	0.62	129	0.35
Mali	147	0.61	157	0.08
Bangladesh	148	0.60	149	0.14
Congo (Rep.)	149	0.60	145	0.17
Djibouti	150	0.59	137	0.27
Myanmar	151	0.58	166	0.01
South Sudan	152	0.57	-	-
Liberia	153	0.44	160	0.08
Ethiopia	154	0.38	163	0.03
Cameroon	155	0.37	148	0.14
Congo (Dem. Rep.)	156	0.36	164	0.02
Gabon	157	0.36	139	0.26
Togo	158	0.33	152	0.13
Malawi	159	0.33	154	0.10
Madagascar	160	0.33	161	0.06
Afghanistan	161	0.32	150	0.13
Mozambique	162	0.30	146	0.16
Benin	163	0.29	153	0.12
Tanzania	164	0.27	151	0.13
Guinea-Bissau	165	0.12	159	0.08
Chad	166	0.09	162	0.06
Eritrea	167	0.03	165	0.02

Source: ITU.

Table 2.5: IDI skills sub-index rankings and ratings, 2015 and 2010

Economy	Rank 2015	Skills 2015	Rank 2010	Skills 2010
Greece	1	9.92	1	9.91
Korea (Rep.)	2	9.82	2	9.87
Finland	3	9.76	3	9.77
Belarus	4	9.75	10	9.29
United States	5	9.57	5	9.52
Australia	6	9.51	9	9.29
Slovenia	7	9.44	4	9.53
Spain	8	9.42	12	9.19
Andorra	9	9.42	20	8.98
Iceland	10	9.35	11	9.25
New Zealand	11	9.29	7	9.39
Denmark	12	9.29	13	9.09
Argentina	13	9.28	27	8.76
Ukraine	14	9.25	15	9.06
Estonia	15	9.22	17	9.05
Netherlands	16	9.21	25	8.78
Lithuania	17	9.13	8	9.35
Norway	18	9.10	14	9.06
Russian Federation	19	9.04	30	8.67
Poland	20	9.02	18	9.02
Belgium	21	8.99	22	8.88
Austria	22	8.97	23	8.88
Ireland	23	8.93	19	8.99
Sweden	24	8.91	16	9.06
Venezuela	25	8.91	36	8.52
Israel	26	8.86	29	8.71
Canada	27	8.85	33	8.60
Hong Kong, China	28	8.84	51	8.13
Portugal	29	8.82	28	8.71
Latvia	30	8.76	21	8.97
Chile	31	8.70	39	8.45
Italy	32	8.69	26	8.77
Germany	33	8.69	50	8.17
Mongolia	33	8.69	52	8.12
Japan	35	8.68	34	8.57
Barbados	36	8.66	24	8.79
Czech Republic	37	8.66	35	8.56
Croatia	38	8.64	40	8.44
Hungary	39	8.62	32	8.65
France	40	8.58	37	8.50
Macao, China	41	8.49	44	8.37
Bulgaria	42	8.47	48	8.23
Monaco	43	8.46	38	8.46
United Kingdom	44	8.42	31	8.65
Saudi Arabia	45	8.41	64	7.48
Uruguay	46	8.40	43	8.39
Grenada	47	8.39	42	8.39
Switzerland	48	8.35	47	8.25
Turkey	49	8.35	56	7.81
Serbia	50	8.30	53	7.95
Slovakia	51	8.28	46	8.26
Romania	52	8.18	45	8.31
Costa Rica	53	8.18	68	7.38
Montenegro	54	8.17	41	8.42
Kazakhstan	55	8.07	55	7.85
Armenia	56	8.06	49	8.23
Cyprus	57	8.01	54	7.95
Cuba	58	7.99	6	9.47
Singapore	59	7.93	80	7.13
Colombia	60	7.87	58	7.62
Albania	61	7.85	65	7.43
Kyrgyzstan	62	7.85	62	7.51
Ecuador	63	7.83	77	7.19
Thailand	64	7.83	57	7.66
Georgia	65	7.76	79	7.16
Peru	66	7.70	67	7.40
Jordan	67	7.66	60	7.54
Moldova	68	7.63	63	7.50
Iran (I.R.)	69	7.61	85	6.97
Mauritius	70	7.59	76	7.21
Bosnia and Herzegovina	71	7.52	61	7.51
Kuwait	72	7.49	66	7.41
Bahrain	73	7.49	69	7.36
Antigua & Barbuda	74	7.41	78	7.17
Malta	75	7.40	59	7.60
Brunei Darussalam	76	7.34	81	7.10
Azerbaijan	77	7.34	71	7.25
Dominica	78	7.33	70	7.34
TFYR Macedonia	79	7.30	75	7.21
Luxembourg	80	7.29	73	7.24
Brazil	81	7.27	74	7.23
St. Vincent and the G.	82	7.24	72	7.24
Lebanon	83	7.23	83	7.06
St. Kitts and Nevis	84	7.22	84	7.06
Dominican Rep.	85	7.14	82	7.06
South Africa	86	7.13	95	6.81
Bolivia	87	7.11	91	6.88
Oman	88	7.09	88	6.93
China	89	7.07	99	6.72
Qatar	90	7.05	92	6.88
Panama	91	7.05	86	6.94
Mexico	92	6.99	98	6.80
Algeria	93	6.98	103	6.56
Philippines	94	6.97	87	6.94
Sri Lanka	95	6.96	94	6.81
Indonesia	96	6.93	106	6.54
United Arab Emirates	97	6.93	97	6.80
Tunisia	98	6.92	96	6.81
Belize	99	6.92	100	6.62
Cape Verde	100	6.77	110	6.36
Malaysia	101	6.75	102	6.57
Guyana	102	6.71	107	6.53
St. Lucia	103	6.71	90	6.89
Paraguay	104	6.66	105	6.54
Fiji	105	6.65	101	6.59
Tonga	106	6.56	93	6.85
Trinidad & Tobago	107	6.55	104	6.54
Viet Nam	108	6.54	109	6.43
Jamaica	109	6.51	89	6.90
Samoa	110	6.40	108	6.47
Egypt	111	6.34	115	6.05
Maldives	112	6.16	111	6.13
Suriname	113	6.12	114	6.05
El Salvador	114	6.12	117	5.75
Honduras	115	6.02	116	5.96
Botswana	116	5.92	112	6.13
Seychelles	117	5.76	118	5.61
Nicaragua	118	5.65	119	5.47
Guatemala	119	5.52	120	5.28
India	120	5.48	125	4.87
Solomon Islands	121	5.44	124	4.89
Syria	122	5.42	113	6.07
Myanmar	123	5.22	121	5.10
Namibia	124	5.20	122	5.02
Ghana	125	5.20	128	4.62
Morocco	126	5.12	127	4.80
Bhutan	127	5.07	137	4.20
Vanuatu	128	4.98	123	4.91
Kenya	129	4.97	131	4.54
Lao P.D.R.	130	4.94	132	4.45
Djibouti	131	4.90	144	3.66
Gabon	132	4.85	126	4.82
Nepal	133	4.85	134	4.41
Lesotho	134	4.78	129	4.57
Congo (Rep.)	135	4.75	136	4.23
Zimbabwe	136	4.65	130	4.57
Cambodia	137	4.60	133	4.43
Cameroon	138	4.58	139	4.06
Sudan	139	4.46	135	4.29
South Sudan	139	4.46	-	-
Togo	141	4.38	142	3.78
Bangladesh	142	4.28	140	3.94
Equatorial Guinea	143	4.22	138	4.15
Gambia	144	3.88	143	3.76
Congo (Dem. Rep.)	145	3.85	141	3.81
Uganda	146	3.81	149	3.45
Nigeria	147	3.79	147	3.51
Zambia	148	3.71	145	3.65
Angola	149	3.67	146	3.54
Rwanda	150	3.67	150	3.39
Tanzania	151	3.58	151	3.39
Madagascar	152	3.57	152	3.28
Senegal	153	3.54	153	3.20
Pakistan	154	3.54	154	3.19
Eritrea	155	3.52	148	3.45
Benin	156	3.50	156	2.99
Malawi	157	3.44	155	3.16
Liberia	158	3.24	158	2.80
Guinea-Bissau	159	3.23	163	2.61
Afghanistan	160	3.21	161	2.74
Côte d'Ivoire	161	3.04	157	2.95
Mali	162	3.04	160	2.75
Mozambique	163	3.00	162	2.68
Mauritania	164	2.90	159	2.78
Ethiopia	165	2.69	164	2.36
Burkina Faso	166	2.31	166	1.81
Chad	167	2.17	165	2.01

Source: ITU.

Not surprisingly, the same economies dominate the access and use sub-indices as dominate the overall Index. Eight of the ten economies ranked at the top of the overall Index are in the top ten in the access sub-index (with Germany and Malta replacing Denmark and Norway), while the same number, eight, are in the top ten in the use sub-index (with Finland and Japan replacing the Netherlands and Hong Kong (China)). There is, however, greater variation in the skills sub-index, which is derived from proxy indicators rather than from ICT-specific data.

Economies ranked in the top thirty of the distribution have also changed little between 2010 and 2015, with only two countries entering that tier (Barbados and Bahrain, replacing Slovenia and Israel, both of which remain in the top forty). Nineteen of the top thirty economies are from Europe, while others include high-income developed countries from other regions, such as the United States, Australia, Canada and New Zealand. Six are categorized as developing economies by the United Nations, including the country at the head of the list, the Republic of Korea, as well as Hong Kong (China), Singapore, Barbados, Macao (China) and Bahrain, although it should be noted that these are all high-income developing economies. The highest-ranking African country is Mauritius (73rd), and the highest ranking LDC is Bhutan (119th).

At the lower end of the rankings, thirteen countries have overall IDI values below 2.00, and 43 have values below 3.00. Of these, 32 are located on the African continent (of which 29 are in ITU's Africa region and three in the Arab States region), eight in Asia, two in the Pacific and one in the Caribbean. The lowest ten countries in the rankings are all LDCs in Africa. Here, too, there has been relatively little change over the period since 2010.

Nine of the ten lowest ranking countries in 2015 were also in that category in 2010, the additional country being South Sudan, which achieved independence in 2011 and was therefore not separately included in the 2010 data. It should also be noted that a significant number of LDCs are not included in the rankings because insufficient data were available for them across the range of indicators needed for the Index. Had sufficient data been available, some of these countries would probably have also featured among the LCCs.

Particular attention has been paid in previous *Measuring the Information Society Reports* to those countries which have achieved the greatest gains in IDI rankings year on year. This *Report*'s comparison over a longer period should smooth the impact of anomalies such as year-on-year variations in data reporting and allow for the more robust assessment of trends.

Trends can be measured in two ways: by changes in countries' rankings against other countries (changes in countries' relative standings), and by changes in the value of the IDI achieved in each country (changes in absolute or nominal values). The ten highest-ranking countries according to these two measures are shown in Table 2.6.

2.3 The access, use and skills sub-indices

Significant differences can be identified between the overall Index and the three sub-indices of which it is composed. As noted in Section 2.1, the access and use sub-indices each make up 40 per cent of the overall Index, with the remaining 20 per cent derived from the skills sub-index. While the access and use sub-indices are composed of ICT-specific indicators, the skills sub-index is composed of proxy indicators which are essentially concerned with educational attainment. It is therefore less directly related to ICTs than the other sub-indices.

Not surprisingly, given the overall composition of the Index, there is a strong level of association between rankings in the overall Index and those in the access and use sub-indices, while there is clearly a disparity between the overall Index and the skills sub-index, which is derived from proxy indicators.

The top ten economies in the overall IDI all fall within the top twenty in the access and use sub-indices. Eight of the ten economies at the top of the overall Index are among the top ten in the access sub-index. Denmark and Norway are the two countries which fall out of the top ten for that index, while the top ten for access also include Germany (14th in the overall Index) and Malta (30th). Denmark's relatively low position in the access sub-index is due to a marked decline in fixed telephone subscriptions in that country, and would therefore appear to be the result of fixed-

Table 2.6: Most dynamic countries – changes in IDI value and ranking, 2010-2015

Change in IDI ranking		
IDI rank 2015	Country	IDI rank change (2010-15)
57	Costa Rica	23
27	Bahrain	21
56	Lebanon	21
109	Ghana	21
74	Thailand	18
32	United Arab Emirates	17
41	Saudi Arabia	15
85	Suriname	15
97	Kyrgyzstan	15
36	Belarus	14
54	Oman	14

Change in IDI value (absolute)		
IDI rank 2015	Country	IDI value change (2010-15)
27	Bahrain	2.22
57	Costa Rica	2.14
56	Lebanon	2.12
41	Saudi Arabia	2.09
32	United Arab Emirates	1.94
54	Oman	1.92
109	Ghana	1.92
36	Belarus	1.88
74	Thailand	1.74
61	Brazil	1.74

Note: The experience of these and a number of other high-performing countries is discussed in more detail in Chapter 3.
Source: ITU.

mobile substitution rather than any reduction in actual access.

Eight of the ten economies at the top of the overall Index also fall into the top ten of the use sub-index with, in this case, the Netherlands and Hong Kong (China) making way for Japan and Finland (11th and 12th in the overall Index).

There is similarly broad consistency in the access and use sub-indices at the bottom of the distribution. Eight of the ten lowest-ranking countries in the access sub-index are the lowest-ranking countries in the Index as a whole, the seven lowest-ranking being wholly consistent between the two. Among the lowest-ranking IDI countries, only Burkina Faso and Mozambique record slightly higher access rankings, with Uganda and Cuba falling into the bottom ten. Nine of the ten lowest-ranking countries in the overall Index also fall into the bottom twenty of the use sub-index, with Burkina Faso again having a higher ranking than its peers.

There has been relatively little change in the top performers in the access and use sub-indices over the five-year period since 2010. Nine of the ten economies at the top of the access sub-index in 2010 are still within the top ten in 2015, with Denmark having fallen out of this group (for reasons cited above) to make way for Malta. Eight of the economies which were in the top ten of the use sub-index in 2010 remain in the top ten in 2015, with Singapore and Macao (China) being displaced by the United Kingdom and Switzerland. At the bottom of the distribution, only Liberia (recovering from civil war) and Myanmar have raised themselves out of the bottom ten in the access sub-index, although there has been a little more movement at the bottom of the use sub-index.

There is much more variation between the overall Index and the skills sub-index, which, as already mentioned, is derived from non-ICT-specific indicators. Only two of the economies in the top ten of the overall Index (the Republic of Korea and Iceland) fall within the top ten in this sub-index, while several of the top ten in the overall Index have relatively low rankings in the skills sub-index – for example, the United Kingdom is in 44th position, Switzerland in 48th and Luxembourg in 80th.

The following paragraphs look in more detail at some of the changes that have taken place within the access and use sub-indices, and in the individual indicators of which they are composed.

The access sub-index

Changes in the access sub-index between 2010 and 2015 have been less dynamic than those in the use sub-index. Countries at the top of the distribution already had very high access values in 2010 and thus had relatively little scope for further improvement in those values. The top-ranking country in the sub-index in both years, Luxembourg, increased its sub-index value from 9.40 to 9.49, while the second-ranking country in both years, Iceland, increased its value from 9.32 to 9.37. However, countries at the bottom of the distribution reported only limited improvements in terms of access, with one country, Madagascar, managing to increase its value by no more than 0.03 points (from 1.64 to 1.67).

The average improvement in sub-index scores over the period was 0.70 points, with most progress being made by countries in the middle of the distribution. The most dynamic countries in terms of access are shown in Table 2.7.

Ghana saw by far the highest improvement in this sub-index, raising its score by 2.37 points, from 2.15 to 4.51 between 2010 and 2015, and jumping 36 places to rank 104th. Five other countries – Oman, Costa Rica, Georgia, Lebanon and Belarus – increased their scores by more than 1.50 points. Double-digit improvements in the rankings were also made by five countries in the African region (Cabo Verde, Lesotho, Mozambique, Cameroon and Mali), three countries in the Arab States region (Saudi Arabia, the United Arab Emirates and Qatar), three in the Asia-Pacific region (Indonesia, Nepal and China) and one in Europe (Monaco). The specific factors behind these improvements in some of those countries are discussed Chapter 3.

These findings suggest that middle-ranking countries may, in terms of subscriptions, be closing the overall digital divide with countries towards the top of the distribution, but that they may at the same time be drawing away from countries, particularly LCCs, towards the bottom of the distribution which are persistently challenged when it comes to improving access levels. It would be easier to grasp the implications of this if a more detailed understanding were available of the data allowances and access speeds available to consumers in different countries.

Many developed economies and some developing countries already had very high rates of mobile-cellular access in 2010, and many more developing countries have attained such levels by 2015. Growth in this indicator worldwide between 2010 and 2015 saw the average value for mobile-cellular penetration within the IDI grow from 94 to 112 subscriptions per 100 inhabitants. Very rapid growth in mobile-cellular penetration in a few countries led to very large movements in this indicator, with a number of countries, including Cambodia, Mali, Costa Rica, Gabon, Suriname and South Africa, having substantially improved their indicator value compared with others in the Index. Meanwhile, a number of other countries – in particular, some in the Caribbean – fell substantially in relation to other countries where this indicator is concerned, affecting their position in the IDI as a whole.

Table 2.7: Most dynamic countries – access sub-index, 2010-2015

Change in access ranking		
Access rank 2015	Country	Access rank change (2010-15)
104	Ghana	36
47	Oman	21
133	Lesotho	17
97	Cape Verde	17
38	Belarus	16
41	Saudi Arabia	15
70	Costa Rica	13
29	United Arab Emirates	13
102	Indonesia	13
19	Monaco	12
145	Mozambique	12

Change in access value		
Access rank 2015	Country	Access value change (2010-15)
104	Ghana	2.37
47	Oman	1.85
70	Costa Rica	1.75
73	Georgia	1.71
66	Lebanon	1.54
38	Belarus	1.52
97	Cape Verde	1.41
61	Moldova	1.36
80	Iran (I.R.)	1.35
76	Armenia	1.35
41	Saudi Arabia	1.33

Source: ITU.

The indicator for fixed-telephone subscriptions is much less volatile than that for mobile subscriptions, although there has been a significant decline in the number of fixed-telephone subscriptions worldwide – by a compound average rate of 2.8 per cent across all economies included in the IDI during the period under review. The indicators for the proportions of households with a computer and households with an Internet connection are also less volatile than the indicator for mobile subscriptions. Only seven countries increased their share of households with a computer by more than 25 percentage points between 2010 and 2015 – one in Africa (Ghana), three in the Arab States region (Kuwait, Oman and Saudi Arabia) and three in the CIS region (Armenia, Georgia and Ukraine). Twelve countries increased their share of households with Internet access by more than 25 percentage points over the same period. Rates of household computer and Internet access more than doubled over the period in a number of countries, including some middle-income countries and a number of LDCs which started with very low levels of household participation in 2010.

The indicator for international Internet bandwidth per Internet user was more volatile, but is affected by the relationship between investment in new infrastructure and the growing use of mobile broadband. The countries which experienced the highest levels of growth in this indicator were Ghana, Lebanon, El Salvador and Suriname.

Some regions of the world, particularly East and West Africa, have seen substantial increases in bandwidth during the period under review, as new international infrastructure has come on stream. However, countries which experience high rates of growth in Internet use – either because of increases in the number of fixed-broadband subscriptions or mobile-broadband subscriptions, or because of other types of Internet access such as public Internet access facilities – are liable to fall in the rankings relative to other countries in regard to international bandwidth per Internet user unless they have benefited from substantial new investment in international infrastructure. Cambodia's increase in its percentage of Internet users (from 1.2 to 9 per cent) was thus countered by a substantial decrease in the international bandwidth available per Internet user, while Mali's more than threefold increase in the percentage of Internet users (from 2 to 7 per cent) was similarly offset by a fall in international bandwidth per Internet user.

The use sub-index

Changes in the use sub-index have been more dynamic than those in the access sub-index because of the rapid growth that has taken place in fixed- and mobile-broadband connectivity, and also because there has been greater scope for improvements even in economies which had relatively high rankings in 2010. This sub-index has therefore seen relatively high growth rates in sub-index values among economies at the top and middle of the distribution, while many of those towards the bottom have seen much less change. The average improvement in the use sub-index between IDI 2010 and IDI 2015 was 1.43, more than twice the average increase seen in the access sub-index. The average growth among the ten countries at the top of the distribution was 1.35 points, while countries towards the middle also had relatively high growth rates. The average growth rate for the ten countries at the bottom of the distribution, however, was a mere 0.14 points, suggesting that there may, in both the usage and access contexts, be a growing digital divide between the majority of countries and the LCCs at the bottom of the distribution.

The most dynamic performers in this sub-index are set out in Table 2.8. The highest growth rates in the sub-index were achieved by countries in the Arab States region (Bahrain, the United Arab Emirates, Lebanon, Saudi Arabia), the Americas region (Barbados, Costa Rica and Brazil) and by Thailand. Improvements by more than 2.0 points were recorded by a number of countries towards the top of the distribution, including the United Kingdom (up 2.43 points and nine places, from 12th to 3rd), Switzerland, Estonia, New Zealand and Hong Kong (China). The average increase for Europe was a substantial 1.69 points, while that for Africa lagged behind at 0.72 points, although individual African countries such as Ghana, South Africa and Cabo Verde scored highly. This again suggests that LCCs, which are also primarily LDCs, may be falling behind other countries in terms of the digital divide.

These findings also emphasize the high degree of influence of the usage sub-index on the IDI as a whole. This is particularly due to the mobile-

Table 2.8: Most dynamic countries – use sub-index, 2010-2015

Change in use ranking		
Use rank 2015	Country	Use rank change (2010-15)
64	Thailand	39
80	Kyrgyzstan	36
43	Lebanon	32
18	Bahrain	32
65	Suriname	31
126	Côte d'Ivoire	31
103	Botswana	31
79	Philippines	25
22	United Arab Emirates	24
87	Mongolia	24

Change in use value		
Use rank 2015	Country	Use rank change (2010-15)
18	Bahrain	4.91
22	United Arab Emirates	3.76
43	Lebanon	3.66
37	Saudi Arabia	3.43
64	Thailand	3.26
29	Barbados	3.26
52	Costa Rica	3.19
50	Brazil	3.05
65	Suriname	2.98
47	Belarus	2.95

Source: ITU.

broadband indicator, which was even more volatile between 2010 and 2015 than the indicator for mobile-cellular subscriptions in the access sub-index. Overall, mobile-broadband subscriptions increased from 11.5 per 100 inhabitants in 2010 to 37.2 in 2014, but there were very big differences between the performances of individual countries, reflecting the very low numbers of mobile-broadband subscriptions in many countries in 2010, when numerous countries had very little mobile-broadband availability. The performance of many countries rose or fell markedly in relation to other countries for this indicator. The indicator for fixed-broadband subscriptions was much less volatile between 2010 and 2015, reflecting the relatively small numbers of fixed-broadband subscriptions in the majority of countries.

Global Internet user penetration rose from 29.2 per cent to 40.6 per cent during the period under review. The sharpest increases in this indicator were achieved by countries in the Arab States region – Oman, Bahrain and Lebanon.

The skills sub-index

The IDI skills sub-index includes literacy and secondary/tertiary enrolment as proxies for the skills required to make effective use of ICTs within society. Potential improvements to this sub-index are currently being considered by EGTI. In 2014, a proposal was made by the UNESCO Institute for Statistics (UIS) to refine the skills sub-index by taking account of two new indicators: (i) learner-to-computer ratio; and (ii) gross enrolment ratio in programmes with computer-assisted instruction. The EGTI discussions are continuing during 2015.[6]

In practice, the average change in this sub-index in the period between 2010 and 2015 was just 0.19 points, reflecting the slower pace of change in the education as compared to the ICT sector. The position of most countries relative to others for each of the three indicators in the sub-index changed by relatively small margins, although a few countries recorded large changes, which may reflect changes in definition or the irregular updating of figures. Definitional changes are likely to account, for example, for the fall of 1.48 points recorded for Cuba, which had a significant impact on its overall standing in the IDI.

2.4 The IDI and the digital divide

One of the main objectives of the IDI is to assist the ITU membership and other stakeholders in addressing digital divides. Digital divides represent the difference in ICT development within and between countries, regions or socio-economic groupings. There has been widespread concern that, while the digital divide in basic services between developed and developing countries has diminished in recent years as a result of the spread of mobile telephony, digital divides in the availability of broadband networks and services may have been growing, particularly between developed and developing countries, and between the majority of developing countries and the LDCs (UNCTAD, 2015).[7]

As a composite index, the IDI provides a useful tool for comparing differences in ICT development between countries and regions which include both basic and more advanced access and use. Previous *Measuring the Information Society Report*s have compared these changes on a year-by-year basis. By comparing data from the 2010 and 2015 Indices, this year's report can examine longer-term trends concerning the digital divide.

It is worth noting a number of points which arise from the United Nations classification of countries into the developed and developing categories[8]. The developing-country group, as defined in UN data sets, includes a number of economies with high GNI per capita (GNI p.c.), including Singapore, Hong Kong (China) and oil-exporting countries in the Gulf Cooperation Council (GCC) region. Some of these – notably the Republic of Korea, Hong Kong (China) and Singapore – have become ICT champions with very high rankings in the IDI. Five countries defined by the UN as developing countries are also member countries of OECD (Chile, Israel, the Republic of Korea, Mexico and Turkey). The developed-country grouping, by contrast, includes relatively few countries with GNI p.c. levels which are significantly lower than average. As a result, outliers within the developing-country grouping tend to raise its average IDI level more substantially than outliers in the developed-country category lower the average for that grouping. The range of values among developing countries is also, in consequence, much greater than the corresponding range among developed countries.

IDI values by level of development are illustrated in Table 2.9 and Chart 2.2. These show that, while both developed- and developing-country groupings have improved their average IDI values since 2010, the gap between them is persistent. The nominal disparity between average developed- and developing-country values which was evident in 2010 is marginally higher in 2015 (3.29 points as against 3.24), although developing countries have closed the proportional gap between themselves and developed countries (to 44% from 50%). The data show that the rate of growth in both the access and use sub-indices has been faster in developing than in developed countries, reflecting their lower starting point. The gap between the averages for developed and developing countries in the access index has fallen from 3.42 points to 3.15. However, the corresponding gap in the use sub-index has grown from 3.26 to 3.71.

Particular attention should be paid in this context to two overlapping groups of countries, whose experience is insufficiently represented by the distinction between developed and developing countries above. These are the LDCs and the LCCs.

Least Developed Countries[9]

The IDI performance of LDCs has been generally poorer over the five years under review than that of higher- and middle-income developing countries. The bottom 20 countries in the IDI 2015 rankings are all LDCs, while the highest ranking LDC is Bhutan, in 119th place out of 167 countries. A comparison of LDCs with developing countries in general and with the total worldwide dataset, summarized in Table 2.10 and Chart 2.3, confirms that LDCs are falling behind in their overall IDI rankings.

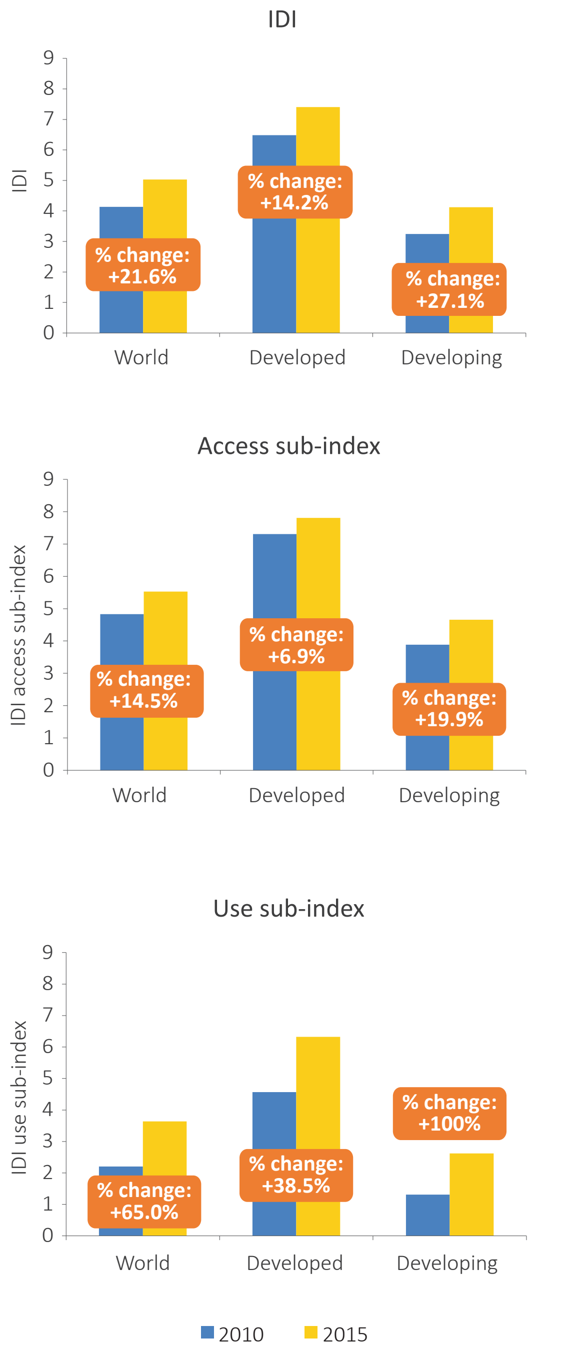
The average growth in IDI values worldwide between 2010 and 2015 was 0.89 points, with the corresponding figure for the developing countries

Table 2.9: IDI ratings by development status, 2010 and 2015

	IDI 2015						IDI 2010						Change in average value 2015-2010
	Average value*	Min.	Max.	Range	StDev	CV	Average value*	Min.	Max.	Range	StDev	CV	
World	5.03	1.17	8.93	7.76	2.21	44.01	4.14	0.88	8.64	7.76	2.08	50.32	0.89
Developed	7.41	4.73	8.88	4.15	1.03	13.95	6.48	3.65	8.43	4.78	1.17	18.10	0.92
Developing	4.12	1.17	8.93	7.76	1.87	45.27	3.24	0.88	8.64	7.76	1.64	50.43	0.88

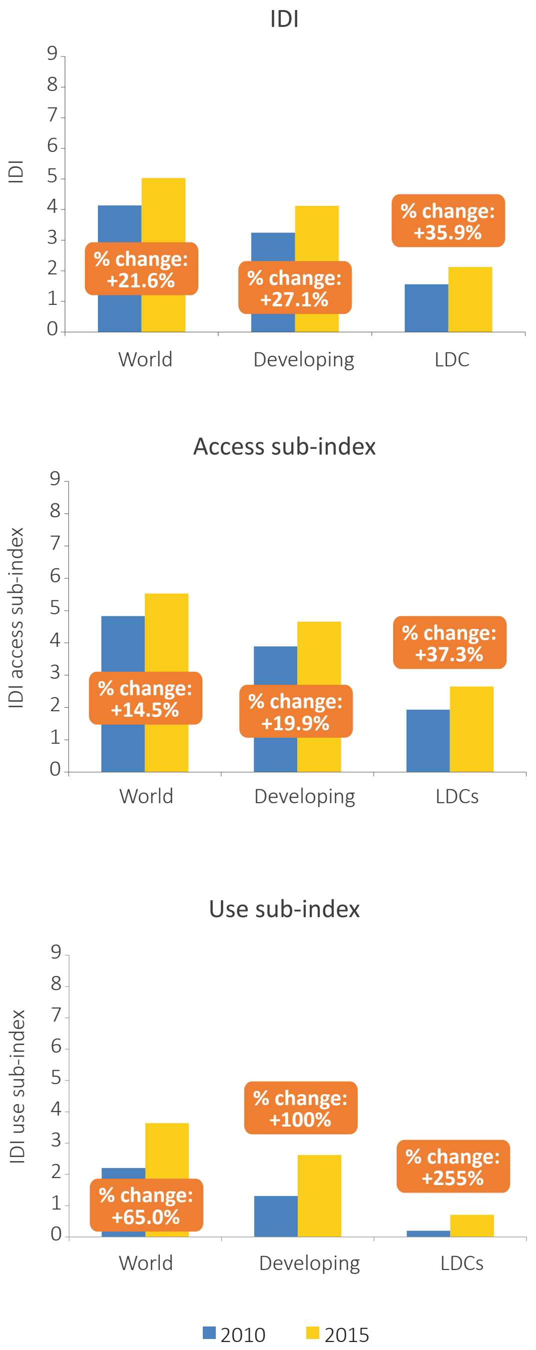
Note: *Simple averages. StDev= Standard deviation, CV= Coefficient of variation.
Source: ITU.

Chart 2.2: IDI ratings by development status, 2010 and 2015



Source: ITU.

Chart 2.3: IDI ratings for LDCs compared with global ratings and with all developing countries



Source: ITU.

as a group being almost identical at 0.88 points. The average growth in LDCs, however, was only 0.56 points. Although this represents a higher percentage growth, as LDCs began from a much lower starting point in 2010 (1.56 as against 3.24 for developing countries in general), it implies that the gap in the level of ICT development between the majority of developing countries and LDCs is growing. This is particularly important in view of the positive contribution that ICTs are seen as making to general social and economic development, since from that standpoint a widening digital divide will also tend to widen other development divides.

As shown in Chart 2.3, the divergence between LDCs and other countries is most substantial in

Table 2.10: IDI ratings for LDCs compared with global ratings and with all developing countries

Development status	2010				2015			
	Access	Use	Skills	IDI	Access	Use	Skills	IDI
World	4.83	2.21	6.61	4.14	5.53	3.64	6.81	5.03
Developed	7.31	4.57	8.67	6.48	7.81	6.32	8.76	7.41
Developing	3.89	1.31	5.83	3.24	4.66	2.62	6.06	4.12
LDCs	1.93	0.20	3.56	1.56	2.65	0.71	3.89	2.12

Source: ITU.

the use sub-index. LDCs underperform developing countries in general in the access sub-index (with an average growth of 0.72 points between 2010 and 2015 as against 0.77 points). In the use sub-index, however, the average LDC rating has increased by only 0.51 points as against 1.31 points in developing countries as a whole, and 1.43 points for the world. This reflects higher performance levels in middle-ranking developing countries than in LDCs, as well as higher performance levels among the high-income countries in the developing-country grouping. It implies that LDCs are failing to keep pace with other countries in the transition from ICT access through usage to intensity, which lies at the heart of the conceptual framework for the IDI which is illustrated in Figure 2.1.

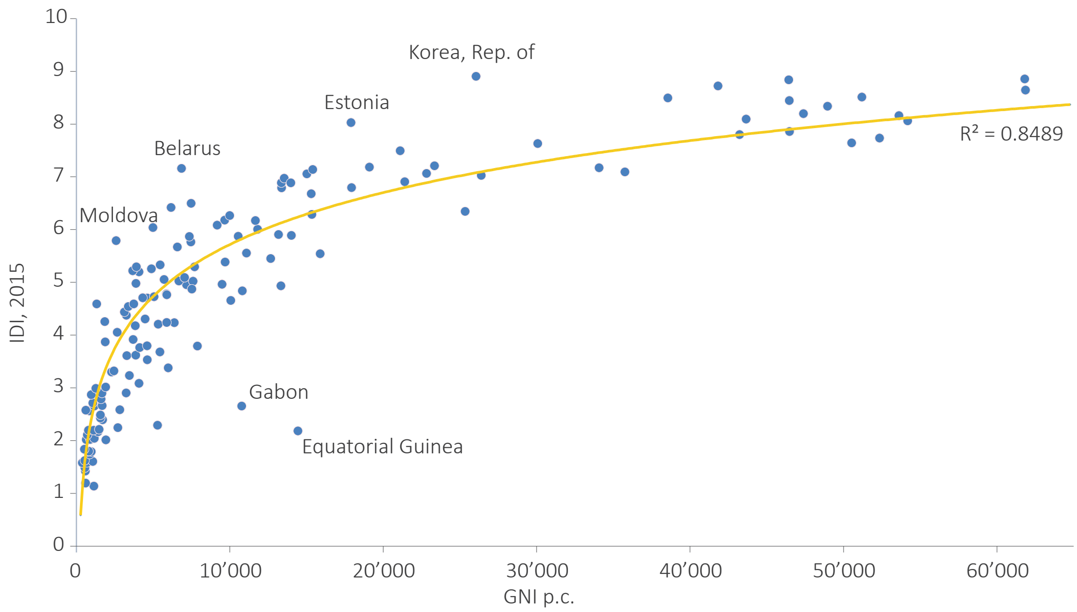
The relationship between the IDI and GNI p.c.

As noted above, one shortcoming of grouping countries by development status is that the developing countries category includes countries at very different levels of both economic and ICT development. It is useful, therefore, also to look at the relationship between IDI performance and GNI p.c.

Chart 2.4, which plots IDI 2015 outcomes against GNI p.c. data for 2013, shows that there is a strong and significant correlation between the two.

This suggests that the level of GNI p.c. (and of disposable income within societies) influences both investment in infrastructure and the adoption of ICT services, and that initiatives to stimulate ICT development may need to address the implications of this if they are to counteract

Chart 2.4: IDI and GNI p.c., 2015



Source: ITU.

the growing digital divide at the bottom of the IDI rankings. Outliers, which show significantly better or significantly weaker performance than might be expected from the data in Chart 2.4, are worth considering further because their experience may indicate policy and investment choices which are likely to be more or less effective in leveraging higher ICT performance. Notable outliers include the Republic of Korea, Estonia and Belarus, which outperform their GNI p.c. peers in the IDI, while two oil-exporting countries in Africa, Gabon and Equatorial Guinea, have significantly lower IDI values than their GNI p.c. peers.

In addition, as noted in the 2014 *Measuring the Information Society Report*, there is a strong and significant correlation between GNI p.c. and the percentage of a country's population living in urban areas (ITU, 2014b).[10] This suggests that the concentration of population in urban areas, where costs of infrastructure investment are lower than in rural areas, could also be a significant factor influencing IDI outcomes.

IDI performance quartiles and LCCs

As well as considering the relationship between development status and GNI p.c., it is useful to assess IDI results by comparing the outcome figures for countries grouped on the basis of their IDI outcome values. Table 2.11 sets out the IDI values for four quartiles, representing high, upper, medium and low IDI levels, as these quartiles were constituted in 2010 and 2015 (some countries are therefore in one quartile in 2010 but a different quartile in 2015). The lowest of these quartiles represents the LCCs.

These data show that the average IDI values for each of these four quartiles rose substantially between 2010 and 2015, by just under 35 per cent in the lowest quartile, by between 25 per cent and 30 per cent in the middle quartiles, and by a little over 12 per cent in the upper quartile, where the starting point was already a great deal higher. This reflects the considerable progress that has been made in IDI performance across the board over the period since 2010. However, the minimum value for the IDI in the lowest quartile (LCCs) has seen relatively little progress in absolute terms during the period, rising from just 0.88 in 2010 to 1.17 in 2015, i.e. an increase of 0.29 compared with increases of 0.79, 1.14 and 1.18 for the minimum values of the medium, upper and high quartiles, respectively. This suggests that there is a group of countries in the lowest quartile whose performance is sluggish relative not only to the IDI as a whole but also relative to other developing countries.

It is notable that there has been very little change in the composition of these quartiles between 2010 and 2015. Only four countries (Bahrain, the United Arab Emirates, Belarus and Saudi Arabia) have risen from the upper to the high quartile, at the top of the distribution, over the period under review (replacing Portugal, Poland, Slovakia and Hungary), while only three countries have risen from the low quartile (LCC status) to the medium quartile, at the bottom of the distribution (Ghana, Bhutan and Kenya, with Vanuatu, Cuba and Gabon falling into the lowest quartile in their place.) Similarly, there has been little change in the composition in the middle of the distribution, with only four countries moving each way between the upper and the medium quartiles. This suggests that, while there have been significant changes in the IDI performance of a number of individual countries, progress towards higher levels has been relatively consistent worldwide.

Table 2.11: IDI values by IDI quartile, 2010 and 2015

	IDI 2010					IDI 2015				
Group	**Countries**	**Average***	**Min.**	**Max.**	**Range**	**Countries**	**Average***	**Min.**	**Max.**	**Range**
High	42	7.02	5.82	8.64	2.82	42	7.90	7.00	8.93	1.93
Upper	41	4.74	3.91	5.80	1.88	41	5.95	5.05	6.93	1.88
Medium	42	3.19	2.14	3.82	1.69	42	4.13	2.93	5.00	2.08
Low	42	1.61	0.88	2.09	1.22	42	2.16	1.17	2.93	1.76
World	**167**	**4.14**	**0.88**	**8.64**	**7.76**	**167**	**5.03**	**1.17**	**8.93**	**7.76**

Note: * Simple averages.
Source: ITU.

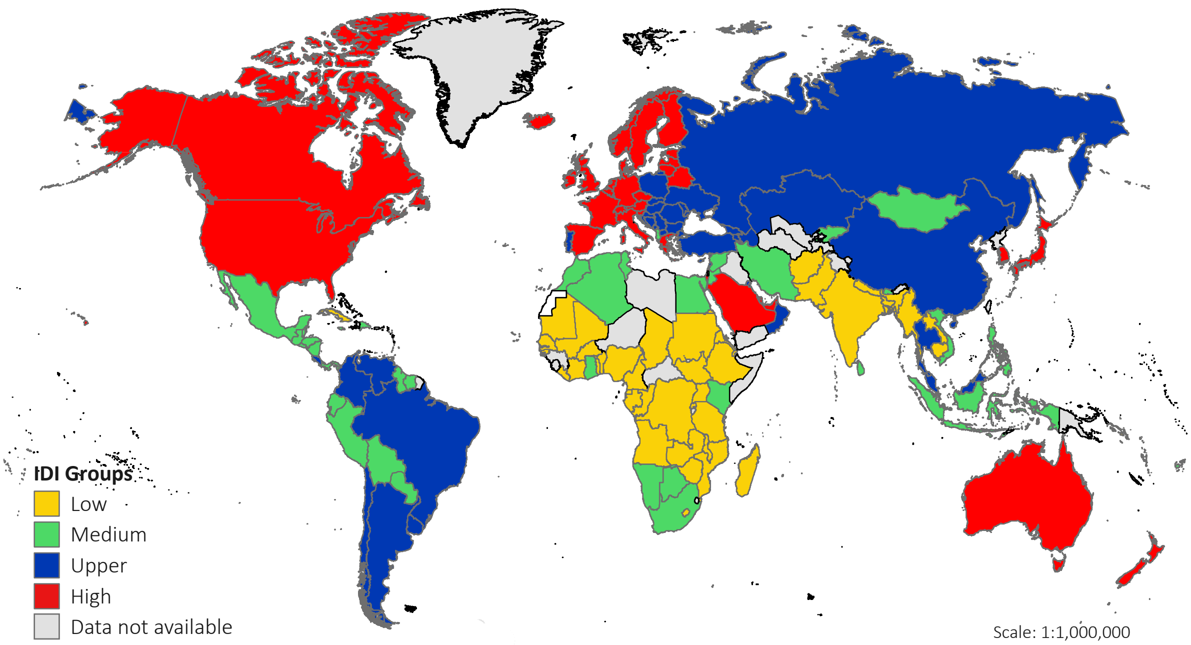
The geographical distribution of the four quartiles is illustrated in Figure 2.3. This shows that the high quartile is heavily concentrated in Europe, North America and high-income countries in the Pacific rim. The majority of LCCs, by contrast, are in Africa, with developing countries in other regions making up the majority of countries in the two middle quartiles.

This further confirms the relationship between IDI values and GNI p.c., and the apparent correlation between LCCs and LDCs. Of the 42 LCCs, 34 are also LDCs. Bhutan is the only LDC in the data set which does not fall in the lowest quartile. A further 13 LDCs do not have sufficient data to appear in the IDI data set and at least some of these may therefore have fallen into the LCC quartile had they been included in the IDI.

Chart 2.5 shows the difference in IDI performance between these quartiles in the global Index and in the access and use sub-indices between 2010 and 2015. Like Chart 2.3, this shows the extent of the gap in IDI performance between less- and more-developed countries. Higher rates of growth have been achieved in the use sub-index than in the access sub-index in all four quartiles, but very substantial gaps remain between them. In particular, it is notable that the gap in the use sub-index between the LCC quartile and the medium quartile immediately above it has grown substantially in the period under review, in spite of a higher rate of growth in the LCC quartile resulting from LCC countries' much lower baselines in 2010.

The indicator for mobile-broadband subscriptions has been the most influential indicator behind this result. The spread of smartphones and of 3G networks in rural areas of LDCs, which are, as noted above, substantially correlated with LCCs, may therefore help to address this gap over the next five years. Overall, however, these findings suggest that many countries in the LCC quartile may be locked into a persistent low performance level in the IDI which is associated with their general low level of economic development, and that specific policy approaches may be required to address this.

Figure 2.3: Quartiles by IDI value, 2015

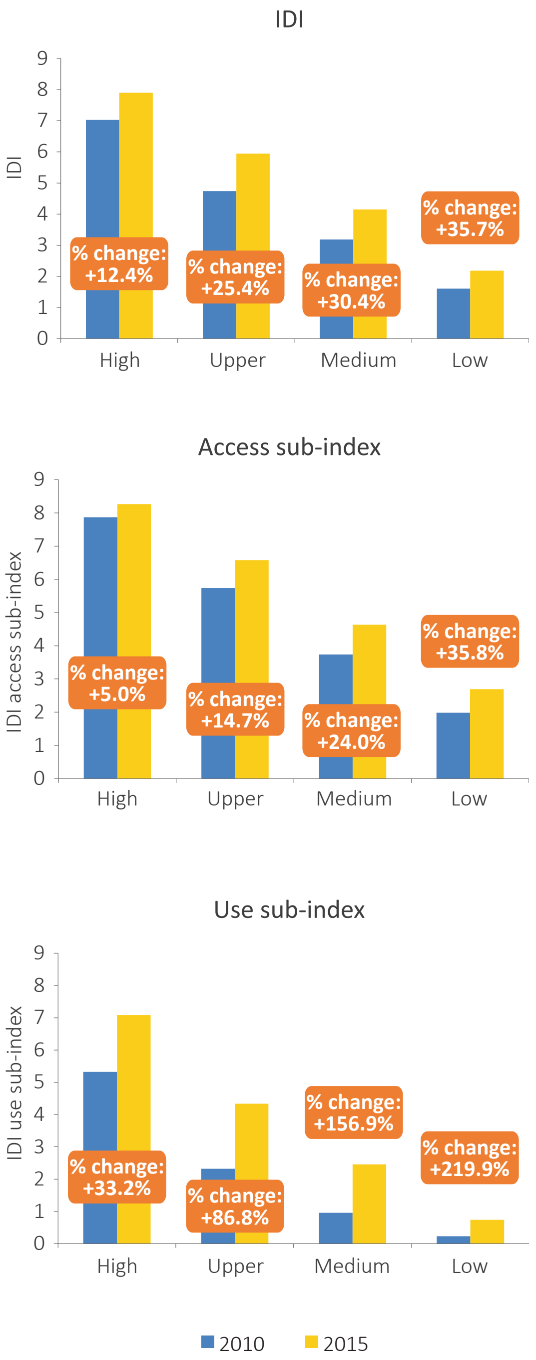


UNCS Disclaimer: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. Final status of the Abyei area is not yet determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

The base map for this infographic is based on the UNmap database of the United Nations Cartographic Section. UNmap is being updated on a continuous basis.

Source: ITU.

Chart 2.5: IDI values by IDI performance quartile, 2010 and 2015



Source: ITU.

2.5 Conclusion

The analysis of the ICT Development Index for 2015 in this chapter, and the comparisons drawn between it and the Index for 2010, confirm a number of observations made in Chapter 1 and, more broadly, about global trends in ICT markets and their relationship with development objectives.

The analysis reaffirms, firstly, the importance of assessing the broad ICT ecosystem, through a composite index, as well as considering individual elements of that index. An ecosystem approach to the ICT sector is particularly valuable because of the role of ICTs as cross-cutting enabling resources for other economic and social sectors, a role that will become increasingly apparent during implementation of the Post-2015 Development Agenda. The ability of ICTs to fulfil their catalytic potential for development depends not only on connectivity and access, but also on usage, types of usage and the ability of individuals and communities to exercise that usage to the full. The IDI provides a valuable foundation for comparing ICT development as a whole, as well as between countries, regions and developmental groupings, as these change over time.

The findings reported in this chapter show that there has been continued growth in ICT readiness around the globe. Every economy in the Index achieved a higher overall IDI rating in IDI 2015 than it had in 2010. The average global performance increased by a significant margin. There was significant improvement in most countries in both the access and use sub-indices, although greater improvement in most countries was made in usage indicators.

More specifically, in the access sub-index, there was a continued trend towards mass markets, and so towards the maximum indicator value, in mobile-cellular subscriptions. At the same time, it should be noted that the number of unique subscribers worldwide has been assessed by the GSM Association to be only around half the number of subscriptions (GSMA, 2015a),[11] so there is still significant improvement to be made. However, the indicator for fixed-telephone subscriptions was stagnant in most countries, reflecting the slight fall in global fixed-phone connections associated with fixed-mobile substitution.

There has been continuing growth in indicator values for households with a computer and households with Internet access. This growth has been broadly consistent across all regions, although there has been less growth in household access to a computer in Africa, where a high proportion of Internet access is still achieved through cybercafés and other public access facilities. Internet use is also estimated to have grown substantially in all countries over the period 2001 to 2015, with very high rates of growth being achieved in some countries at the bottom of the distribution.

There has been a relatively modest improvement in the level of fixed-broadband connectivity worldwide. The most dynamic indicator in the Index has been the one for mobile-broadband connectivity. This reflects the very low level of mobile broadband in most countries in 2010, but has been the most influential single factor in determining changes in overall IDI values in the period under review. The skills sub-index, which is made up of proxy indicators, has had relatively little influence on the overall IDI changes between 2010 and 2015.

The findings reported in this chapter also show the continued importance and, in some contexts, apparent growth of digital divides between regions and countries.

It is notable that, as most countries have improved their IDI values, overall IDI rankings have remained relatively stable during the period under review. Only 16 countries have improved their position in the rankings by ten or more places, and four by 20 or more places, while 17 countries have dropped ten or more places in the rankings, with only one having fallen by 20 or more places.

The highest IDI rankings are filled, in 2015 as in 2010, by high-income economies in Europe, North America and East Asia, although a number of these economies (in the Asia and Pacific region) are classified by the United Nations as developing countries. The lowest positions in the rankings, in 2015 as in 2010, are dominated by African countries, particularly LDCs. Overall, as illustrated in Chart 2.4, there is a strong correlation between IDI levels and GNI p.c., reflecting the importance of higher-value consumer markets in attracting infrastructure investment (in the access sub-index) and in generating demand for broadband and Internet services (in the use sub-index).

A central purpose of the IDI is to enable analysis and understanding of the digital divide between developed and developing countries and regions, and to point towards areas requiring or possibly susceptible to specific interventions. It is particularly important, therefore, to focus on the IDI performance of developing countries and countries below the average IDI distribution.

Overall trends between 2010 and 2015 suggest that middle-income developing countries are improving access and use indicators in the IDI in ways that should enable them to keep up with the pace of ICT development in high-income economies, but that there is a significant risk that the LCCs in the bottom quartile of the Index are falling behind other developing countries, particularly in the use sub-index. There has been very little change in the composition of the LCC quartile between 2010 and 2015, with only three countries rising from LCC to medium ranking. There is also a strong coincidence between LCCs and LDCs. Of the 42 LCCs, 34 are also LDCs, while a number of other LDCs do not appear in the IDI data set. This suggests that many countries in this grouping may be locked into a persistent low performance level in the IDI, associated with their general low level of economic development. If, as is frequently asserted, ICT development will be an important determinant of progress towards sustainable development during the next fifteen years, attention will need to be paid to this challenge in order to prevent a growing digital divide reinforcing other development divides between the majority of countries and LDCs.

Endnotes

1 This section is based on earlier editions of the *Measuring the Information Society Report*. The reader should also consult Annex 1 to this report, as well as the 2009 edition of *Measuring the Information Society* (ITU, 2009), which describe the methodology in more detail.

2 Previous reports can be accessed online at: http://www.itu.int/en/ITU-D/Statistics/Pages/publications/anapub.aspx.

3 Data on the indicators included in the skills sub-index are sourced from the UNESCO Institute for Statistics (UIS). See Annex 2 for more details on the definition of the indicators.

4 For more information on EGTI and EGH, see http://www.itu.int/en/ITU-D/Statistics/Pages/definitions.

5 Household surveys traditionally ask about the availability of assets in the household, such as television, electricity, refrigerator or piped water. A similar principle has been adopted for ICT equipment and services, i.e. that they should be available for use by household members at home, regardless of whether they are used. They do not need to be owned by the household.

6 For further information on EGTI, see http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/default.aspx.

7 See, for example, UNCTAD (2015), Chapter 3.

8 See http://unstats.un.org/unsd/methods/m49/m49regin.htm.

9 The list of LDCs in 2014 can be found at: http://www.un.org/en/development/desa/policy/cdp/ldc/ldc_list.pdf.

10 ITU (2014b), pp 60-61.

11 GSM Association (2015), pp 4ff.

3 The ICT Development Index (IDI) – regional and country analysis

3.1 Introduction

Chapter 2 described the ICT Development Index and compared findings from the 2015 and 2010 editions of the IDI at a global level. This chapter extends that analysis in two ways.

- Section 3.2 assesses IDI findings at a regional level.
- Section 3.3 explores findings for a number of individual countries, including those at the top of the IDI distribution and some from among those that have improved their position in the overall IDI rankings most dynamically since 2010.

3.2 Regional IDI analysis

ITU Member States are divided into six regions – Africa, the Americas, the Arab States, Asia and the Pacific, the CIS region[1] and Europe. These regions differ in a number of respects from those in other UN data series, including those published in the *Final WSIS Targets Review*, most notably where the Europe and Africa regions are concerned, and this should be borne in mind when undertaking any comparative analysis with other data sets.

The IDI 2015 data published in this volume are derived from the 167 economies for which both 2010 and 2015 data are available (166 economies for IDI 2010, with the addition of South Sudan, which was part of Sudan in 2010, for 2015). Of the 28 ITU Member States for which data were not available, seven are from sub-Saharan Africa, two from the Americas, five from the Arab States region, eight from Asia (including seven from the UN Oceania region), three from the CIS region and three from Europe.

Table 3.1 sets out the results of IDI 2010 and 2015 for each of the six ITU regions, while Chart 3.1 shows the distribution of the regional values for average, minimum and maximum IDI levels, compared with the global average.

These data show that the European region has the highest average IDI value, at 7.35 points, with only one country in the region (Albania) falling below the global average of 5.03 points. The average regional values for the CIS region, the Americas and the Arab States all now exceed the global average of 5.03. Africa has by far the lowest average IDI rating, at 2.53, less than half of that in every other region apart from Asia and the Pacific.

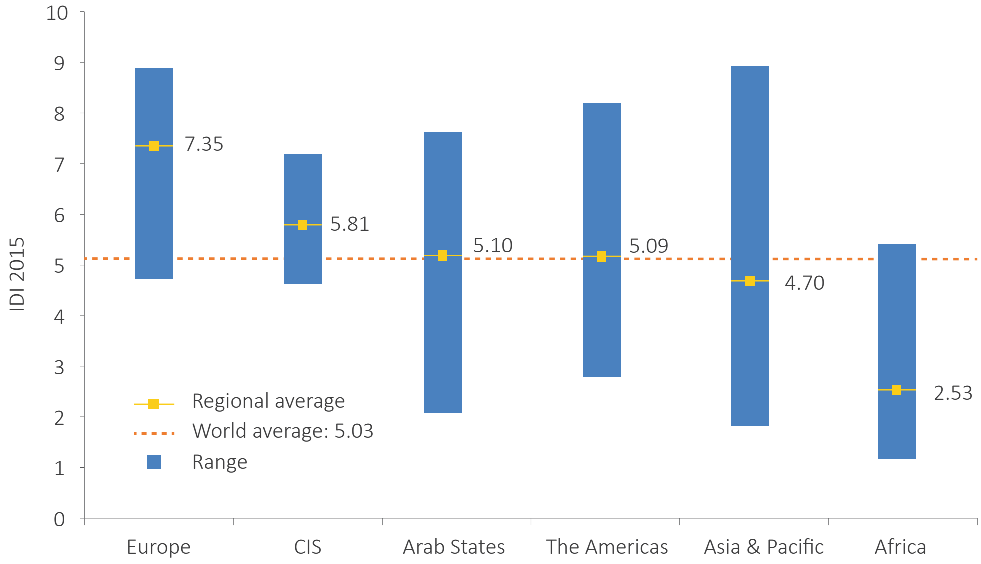
There is considerably more variation in some regions than in others. The CIS region shows the least range in IDI values, reflecting its relatively small number of countries and their relative homogeneity in terms of both ICT and more general economic development. The Europe region also has a relatively narrow range between its maximum and minimum IDI values, together with low standard deviation (StDev) and coefficient of variation (CV), reflecting relative ICT sector and general economic homogeneity. The IDI distribution within Africa is more variable, around

Table 3.1: IDI by region, 2015 and 2010

	IDI 2015						IDI 2010						Difference 2010-2015		
Region	**Max.**	**Min.**	**Range**	**Average***	**StDev**	**CV**	**Max.**	**Min.**	**Range**	**Average***	**StDev**	**CV**	**Range**	**Average***	**CV**
Europe	8.88	4.73	4.15	7.35	1.03	14.06	8.43	3.65	4.78	6.48	1.15	17.70	-0.63	0.87	-3.64
CIS	7.18	4.62	2.57	5.81	0.83	14.36	5.57	3.02	2.55	4.38	0.78	17.70	0.02	1.43	-3.34
Arab States	7.63	2.07	5.56	5.10	1.91	37.41	6.10	1.63	4.47	3.88	1.39	35.88	1.10	1.22	1.53
The Americas	8.19	2.79	5.39	5.09	1.36	26.73	7.30	2.40	4.90	4.17	1.18	28.27	0.49	0.92	-1.54
Asia & Pacific	8.93	1.83	7.10	4.70	2.23	47.47	8.64	1.37	7.27	3.85	2.23	57.82	-0.17	0.85	-10.35
Africa	5.41	1.17	4.24	2.53	1.07	42.53	4.31	0.88	3.44	1.87	0.80	42.89	0.81	0.65	-0.35

Note: *Simple averages. StDev = standard deviation. CV = coefficient of variation.
Source: ITU.

Chart 3.1: IDI by region compared with global average, 2015



Source: ITU.

much lower IDI values consistent with its lower average level of economic development. The range of IDI values is greater in the Americas and the Arab States, both of which are characterized by a wider range of GNI p.c. levels, and greatest in the Asia and Pacific region, which includes a number of top performers in the Index, such as the Republic of Korea, Hong Kong (China) and Japan, as well as a number of least connected countries (LCCs), such as Afghanistan, Myanmar and Bangladesh.

The rate of growth in average IDI values by region between 2010 and 2015 was highly influenced by the benchmark level set in 2010, and a comparison between data from these two years should therefore draw on both absolute and relative performance. Thus, Africa has experienced a growth rate of 35 per cent while raising its average value by 0.65 points (from 1.87 to 2.53), while Europe's growth rate of 13.4 per cent is the result of a rise of 0.87 points in its average value (from 6.48 to 7.35). Africa aside, the regions that have shown the highest rates of growth, both absolute and relative, between 2010 and 2015 are the CIS region and the Arab States. These findings suggest that, in spite of its relatively high rate of growth in IDI values over the period, Africa is not experiencing sufficient growth to reduce its relative disadvantage and so reduce the digital divide between it and other regions.

The difference between highest and lowest IDI values fell sharply in Europe between 2010 and 2015, as the value of the region's lowest-ranking country (Albania) increased by more than that of its highest-ranking country (Denmark), which was already quite close to the maximum in 2010. The range of IDI values increased most dramatically in Africa, where the lowest-ranking country (Chad) improved its value much less than the highest-ranking country (Mauritius).

Comparisons between minimum and maximum values, however, are easily influenced by outliers and therefore less valuable than those between standard deviation (StDev) and coefficient of variation (CV). CV values fell in all regions other than the Arab States between 2010 and 2015, while those for StDev rose in all regions other than Europe (where it fell) and the Asia-Pacific region (where it effectively remained unchanged). The most dramatic changes in these indicators were in the Arab States, which saw significant increases in both StDev and CV, reflecting the substantial rises in IDI ratings and rankings that were achieved by a group of high-income oil-exporting countries, of which three (Bahrain, the United Arab Emirates and Saudi Arabia) rose from the upper to the high quartile of the overall distribution.

Table 3.2 illustrates the five highest- and lowest-ranking countries in each region in terms of IDI, in order to provide further insights into differences in ICT development.

The top four European countries are from Northern Europe, and European countries, including all five Nordic countries, fill nine of

Table 3.2: Highest- and lowest-ranking countries by region

Regional IDI rank	Country	IDI	Global IDI rank
Europe			
1	Denmark	8.88	2
2	Iceland	8.86	3
3	United Kingdom	8.75	4
4	Sweden	8.67	5
5	Luxembourg	8.59	6
36	TFYR Macedonia	6.07	60
37	Montenegro	5.90	65
38	Turkey	5.58	69
39	Bosnia and Herzegovina	5.28	77
40	Albania	4.73	94
Asia & Pacific			
1	Korea (Rep.)	8.93	1
2	Hong Kong, China	8.52	9
3	Japan	8.47	11
4	Australia	8.29	13
5	New Zealand	8.14	16
28	Solomon Islands	2.42	139
29	Myanmar	2.27	142
30	Pakistan	2.24	143
31	Bangladesh	2.22	144
32	Afghanistan	1.83	156
The Americas			
1	United States	8.19	15
2	Canada	7.76	23
3	Barbados	7.57	29
4	Uruguay	6.70	49
5	Argentina	6.40	52
29	Belize	3.56	116
30	Honduras	3.33	120
31	Guatemala	3.26	121
32	Nicaragua	3.04	123
33	Cuba	2.79	129

Regional IDI rank	Country	IDI	Global IDI rank
Arab States			
1	Bahrain	7.63	27
2	Qatar	7.44	31
3	United Arab Emirates	7.32	32
4	Saudi Arabia	7.05	41
5	Kuwait	6.83	46
12	Algeria	3.71	113
13	Syria	3.48	117
14	Sudan	2.93	126
15	Djibouti	2.19	148
16	Mauritania	2.07	150
CIS			
1	Belarus	7.18	36
2	Russian Federation	6.91	45
3	Kazakhstan	6.20	58
4	Moldova	5.81	66
5	Azerbaijan	5.79	67
5	Azerbaijan	5.79	67
6	Armenia	5.32	76
7	Georgia	5.25	78
8	Ukraine	5.23	79
9	Kyrgyzstan	4.62	97
Africa			
1	Mauritius	5.41	73
2	Seychelles	4.96	87
3	South Africa	4.90	88
4	Cape Verde	4.62	96
5	Ghana	3.90	109
33	Malawi	1.61	163
34	Madagascar	1.51	164
35	Ethiopia	1.45	165
36	Eritrea	1.22	166
37	Chad	1.17	167

Source: ITU.

the top twelve positions in the global rankings. The nine countries towards the bottom of the European distribution are all from south-eastern Europe, and the lowest five are outside the common telecommunications regulatory framework of the European Union. However, all but one of these lower performing countries has an IDI level above the world average and is in the high and upper quartile of the overall distribution.

The top five countries in the Asia and Pacific region (three high-income economies in East Asia and two in Oceania) are all within the IDI top twenty economies worldwide. The five lowest-ranking countries in the region, however, are among the LCCs. Four of these are large countries, while one is a small Pacific-island State. The lowest-ranking country in the region, Afghanistan, is a least-developed country (LDC) that has experienced a long period of disruptive conflict.

The top five countries in the Americas are more widely distributed in the global rankings, reflecting differences between countries in North America, the Caribbean and Central and South America. All but one of the lowest-ranking countries in the region, from Central America and the Caribbean, falls within the middle and lower quartiles of the overall distribution.

The top five countries among the Arab States are all oil and gas exporting countries belonging to the Gulf Cooperation Council (GCC). Three of these – Bahrain, the United Arab Emirates and Saudi Arabia – feature among the most dynamic countries in the IDI between 2010 and 2015. All but one of the countries from this region with IDIs towards the bottom of the distribution are from north Africa (and would be included in the Africa region in other UN data sets). The fifth country among those with low IDIs, Syria, which has been experiencing civil conflict, has fallen significantly in the rankings since 2010.

All of the countries within the CIS region are within the top 100 IDI rankings (although it should be noted that data are not available for three countries in this region). The CIS has the narrowest overall range of rankings of any region.

The Africa region shows by far the lowest performance levels of any region, with no country in the high quartile and only one country (Mauritius) in the upper half of the overall distribution. The five countries with the lowest IDI levels in Africa, all of which are LDCs, are also the five countries at the bottom of the global rankings. Altogether, 29 of the 37 countries from the Africa region in the Index fall into the lower quartile of IDI rankings. Data were not available from a further seven African countries. These results suggest that there is a considerable ongoing challenge in ensuring that African countries, particularly LDCs, can overcome the digital divide and derive maximum benefit from ICTs for their development.

Some of the similarities and differences between regions can be explored in more detail by comparing spider charts of the average ratings achieved in the different regions against each of the indicators in the Index. The spider charts for each region are grouped within Chart 3.2, together with a world chart to enable comparison with global average ratings. In considering these charts, it should be noted that, because they are averaged distributions, they do not reflect the range of values between outliers at the top and bottom of the distribution, which is particularly significant in the Asia-Pacific region.

These spider charts show clearly the following three distinct IDI rating and trend patterns since 2010, as reflected in the preceding discussion:

- In one region – Europe – the distribution of IDI values reflects high levels of performance across the board, with relatively small increases towards maximum values for access and usage, and with the most significant increase in values being derived from the indicator for mobile-broadband subscriptions.

- Four regions – the Americas, the Arab States, the Asia and Pacific region and the CIS region – have broadly similar average distributions, beginning from significantly lower levels for access and use indicators than those in Europe, and with broadly comparable increases in those indicators over the period under consideration. These regions generally have much lower values for fixed-telephone subscriptions than Europe. The most significant areas of growth in indicator values since 2010 have been those for mobile-broadband subscriptions, Internet users and households with Internet access.

- One region – Africa – shows a differently-shaped overall distribution, reflecting its much lower baselines in 2010 as well as differences in the relative distribution of particular ICT resources – for example, the extremely low average rating for fixed-telephone subscriptions, and more rapid growth, from a lower baseline, in mobile-cellular subscriptions. In this region, on average, it is the growth in mobile-cellular subscriptions and international Internet bandwidth per user that have been the most dynamic indicators, rather than growth in mobile-broadband subscriptions or number of Internet users (although these two indicators have also

Chart 3.2: Average IDI rating for each indicator, world regions, 2010 and 2015

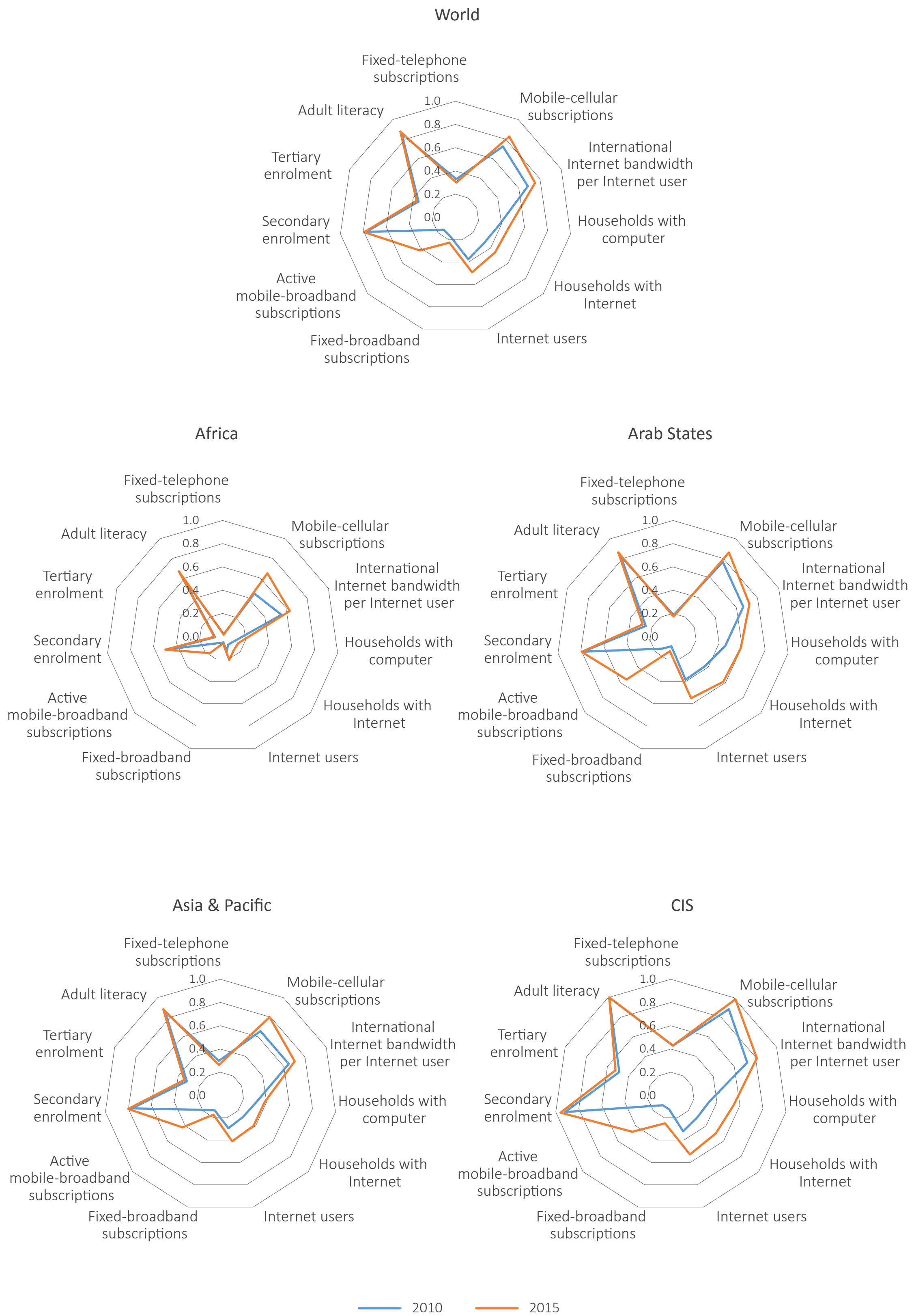
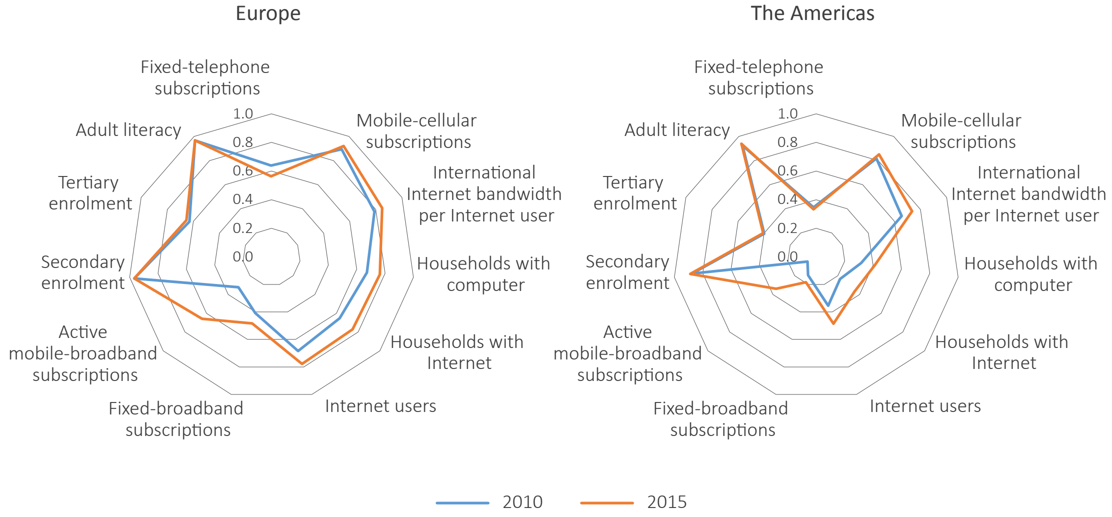


Chart 3.2: Average IDI rating for each indicator, world regions, 2010 and 2015 (continued)



Source: ITU.

seen significant growth). This is on account of the lower baseline for mobile-cellular subscriptions in Africa in 2010, the impact of the new submarine cables that have since landed along the East and West African coasts, and the high cost in lower-income countries of broadband subscriptions, which are beyond the reach of Africa's more numerous low-income households.

The limited significance of the skills indicators on the majority of IDI values is evident from a comparison between these charts, although changes in these indicators have significantly affected the IDI ratings and rankings of a small number of individual countries.

The averaged results for each region described above should be borne in mind while reading the following paragraphs, which outline the results for each region in more detail.

Africa

The IDI values for Africa are set out in Table 3.3 and Chart 3.3. As noted above, this region shows by far the lowest IDI performance levels of any region. Only one country, Mauritius, had an IDI value above the global average in IDI 2015, and only four countries – Mauritius, Seychelles, South Africa and Cape Verde – ranked in the top 100 out of 167, or exceeded the average value for developing countries in IDI 2015.

Altogether, 29 out of 37 African countries ranked as LCCs in the bottom quartile of the overall distribution, including the 11 countries with the lowest overall Index rankings. A number of African LDCs are not included in the IDI for 2015 owing to a lack of data, including the country which recorded the lowest ranking in IDI 2013 (the Central African Republic). These findings illustrate the extent to which Africa continues to lag behind other regions in ICT development, and the consequent importance of addressing the region's ongoing digital divide.

While all countries in the region showed an improvement in IDI levels between 2010 and 2015 (as was the case in other regions), only a minority saw substantial improvements in their IDI rankings between 2010 and 2015. The most significant improvements occurred in Ghana (up 21 places), Lesotho (up 13 places), Cape Verde (up 11 places) and Mali (up ten places). Nigeria, the region's most populous country and largest economy in terms of nominal GDP, which has seen substantial investment in ICTs in recent years, ranked only 134th, almost exactly the same as in 2010, while South Africa, its second largest economy, had the same ranking, 88th, in both years.

Arab States

IDI ratings for the Arab States region are set out in Table 3.4 and Chart 3.4, where they are compared with the global average and averages for developed and developing countries. The top

Table 3.3: IDI rankings, Africa region, 2015

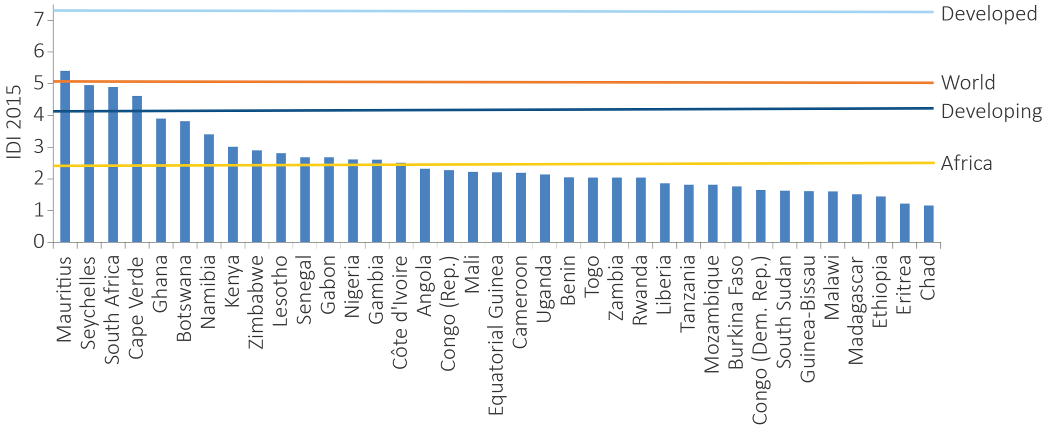
Economy	Regional rank 2015	Global rank 2015	IDI 2015	Global rank 2010	IDI 2010	Global rank change 2015-2010
Mauritius	1	73	5.41	72	4.31	-1
Seychelles	2	87	4.96	81	3.98	-6
South Africa	3	88	4.90	88	3.65	0
Cape Verde	4	96	4.62	107	3.14	11
Ghana	5	109	3.90	130	1.98	21
Botswana	6	111	3.82	117	2.86	6
Namibia	7	118	3.41	120	2.63	2
Kenya	8	124	3.02	126	2.09	2
Zimbabwe	9	127	2.90	132	1.97	5
Lesotho	10	128	2.81	141	1.74	13
Senegal	11	132	2.68	137	1.80	5
Gabon	12	133	2.68	122	2.41	-11
Nigeria	13	134	2.61	133	1.96	-1
Gambia	14	135	2.60	129	1.99	-6
Côte d'Ivoire	15	137	2.51	142	1.74	5
Angola	16	140	2.32	144	1.68	4
Congo (Rep.)	17	141	2.27	136	1.83	-5
Mali	18	145	2.22	155	1.46	10
Equatorial Guinea	19	146	2.21	134	1.96	-12
Cameroon	20	147	2.19	149	1.60	2
Uganda	21	149	2.14	151	1.57	2
Benin	22	151	2.05	147	1.63	-4
Togo	23	152	2.04	145	1.64	-7
Zambia	24	153	2.04	152	1.55	-1
Rwanda	25	154	2.04	154	1.47	0
Liberia	26	155	1.86	161	1.24	6
Tanzania	27	157	1.82	153	1.54	-4
Mozambique	28	158	1.82	160	1.28	2
Burkina Faso	29	159	1.77	165	1.13	6
Congo (Dem. Rep.)	30	160	1.65	162	1.23	2
South Sudan	31	161	1.63	-	-	-
Guinea-Bissau	32	162	1.61	158	1.33	-4
Malawi	33	163	1.61	159	1.33	-4
Madagascar	34	164	1.51	157	1.34	-7
Ethiopia	35	165	1.45	166	1.07	1
Eritrea	36	166	1.22	164	1.14	-2
Chad	37	167	1.17	167	0.88	0
Average			**2.53**		**1.89**	

Source: ITU.

five countries in this region in IDI 2015 – Bahrain, Qatar, the United Arab Emirates, Saudi Arabia and Kuwait – are all oil-rich high-income economies that are members of the GCC. These countries all have IDI levels over 6.50 and appear in the top 50 countries in the global rankings for 2015. Two other countries in the region – Oman and Lebanon – also exceed the global average value in 2015.

These countries at the top of the rankings have seen higher-than-average improvements in their IDI levels since 2010, with five of them achieving improvements that are among the most dynamic worldwide. Bahrain improved its position in the global rankings by 21 places, from 48th to 27th, between 2010 and 2015; the UAE, Saudi Arabia and Oman by 17, 15 and 14 places, respectively;

Chart 3.3: IDI values, Africa region, 2015



Source: ITU.

Table 3.4: IDI rankings, Arab States region, 2015

Economy	Regional rank 2015	Global rank 2015	IDI 2015	Global rank 2010	IDI 2010	Global rank change 2015-2010
Bahrain	1	27	7.63	48	5.42	21
Qatar	2	31	7.44	37	6.10	6
United Arab Emirates	3	32	7.32	49	5.38	17
Saudi Arabia	4	41	7.05	56	4.96	15
Kuwait	5	46	6.83	45	5.64	-1
Oman	6	54	6.33	68	4.41	14
Lebanon	7	56	6.29	77	4.18	21
Jordan	8	92	4.75	84	3.82	-8
Tunisia	9	93	4.73	93	3.62	0
Morocco	10	99	4.47	96	3.55	-3
Egypt	11	100	4.40	98	3.48	-2
Algeria	12	113	3.71	114	2.99	1
Syria	13	117	3.48	106	3.14	-11
Sudan	14	126	2.93	127	2.05	1
Djibouti	15	148	2.19	143	1.69	-5
Mauritania	16	150	2.07	146	1.63	-4
Average			**5.10**		**3.88**	

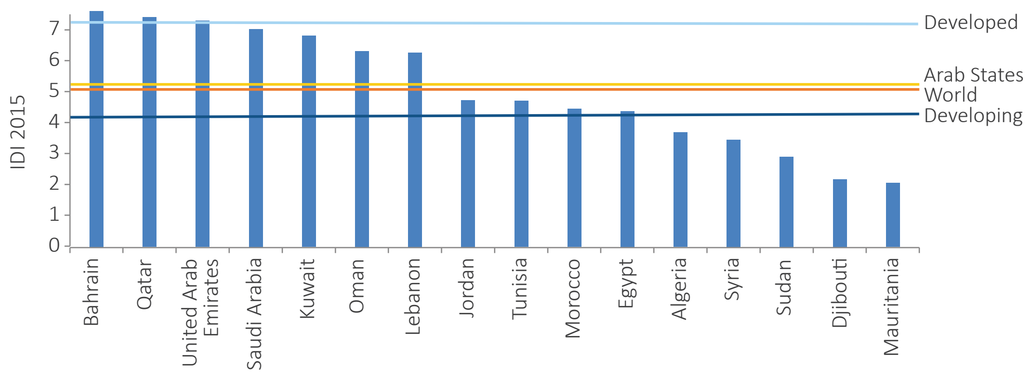
Source: ITU.

and Lebanon by 21 places. The improvement in the rankings by Bahrain and Lebanon was exceeded globally only by Costa Rica. Much less progress was achieved at the lower end of the scale, however. A number of countries in the region saw their IDI rankings fall, with substantial falls for Syria, which has experienced extensive conflict during the period (down 11 places), and Jordan (down eight places).

Even more concerning, in terms of the digital divide, is the growing differential in IDI values which can be observed between GCC Member States and other countries in the region. Those values rose in the GCC countries by an average of 1.78 points between 2010 and 2015, while in non-GCC countries they rose by an average of only 0.89 points (or 0.75 points if high-performing Lebanon is excluded). This suggests that there is a growing digital divide between the GCC Member States and most of the other countries in the region.

The strong performance of the GCC countries reflects the association between IDI and GNI p.c. discussed in Chapter 2, while the performance of countries lower down the rankings, particularly

Chart 3.4: IDI values, Arab States region, 2015



Source: ITU.

the region's LDCs (Sudan, Djibouti and Mauritania), reflects the experience of lower-income countries in other regions. This growing digital divide within the region has been noted with concern by the United Nations Economic and Social Commission for Western Asia (ESCWA).[2]

Asia and the Pacific

Asia and the Pacific is the most diverse region in terms of ICT development, reflecting the stark differences in levels of economic development between OECD member countries and other high-income economies, on the one hand, and LDCs on the other. IDI values for this region are set out in Table 3.5 and Chart 3.5.

The IDI rankings in the region are headed by seven economies – the Republic of Korea, Hong Kong (China), Japan, Australia, New Zealand, Singapore and Macao (China) – which have IDI levels above 7.50 and which rank among the top 25 economies worldwide. These include the global leader, the Republic of Korea. All of these economies were also near the top of the IDI rankings in 2010, although there has been a significant drop in the rankings of Singapore (down eight places from 11th to 19th) and Macao (China) (down ten places from 14th to 24th) during this period. The average nominal growth in IDI rates in these seven countries since 2010 is 0.70 points, much less than that of the highest performers in the Arab States region, reflecting the starting position of these countries towards the high end of potentially achievable values.

There is a substantial gap in IDI values and rankings between these high-performing economies and the next-highest-ranking countries in the Asia-Pacific region. A further five countries in the region – Malaysia, Brunei Darussalam, Thailand, Maldives and China – have IDI rankings within the top half of the distribution, while another three – Mongolia, Iran and the Philippines – fall within the top hundred. Several of these countries have risen significantly in the rankings over the half-decade, including Thailand (up 18 places), Mongolia (up 13 places), Iran (up eight places) and the Philippines (up seven places), while there has been one substantial fall (Brunei Darussalam, down 18 places). These eight middle-ranking countries have seen an average improvement of 1.25 in their IDI values between 2010 and 2015, higher than any of the economies above them in the regional rankings other than Hong Kong (China).

The remaining 17 countries in the region, with IDI rankings below 100, form a diverse group encompassing very large countries including India, Indonesia, Pakistan and Bangladesh, as well as small island States such as Samoa, Vanuatu and the Solomon Islands. These countries have experienced an average improvement of 0.72 in their IDI values over the period 2010-2015, less than the corresponding figure for the group of countries above them in the rankings, but starting from a lower base. The sharpest rise in the rankings within this group of countries came from Bhutan (up nine places) and Myanmar (up eight places), while significant falls were recorded by Vietnam (down eight places), India (down six places) and Pakistan (down five places).

Commonwealth of Independent States (CIS)

IDI values for the CIS region are set out in Table 3.6 and Chart 3.6. As noted above, the CIS region has

Table 3.5: IDI rankings, Asia and the Pacific, 2015

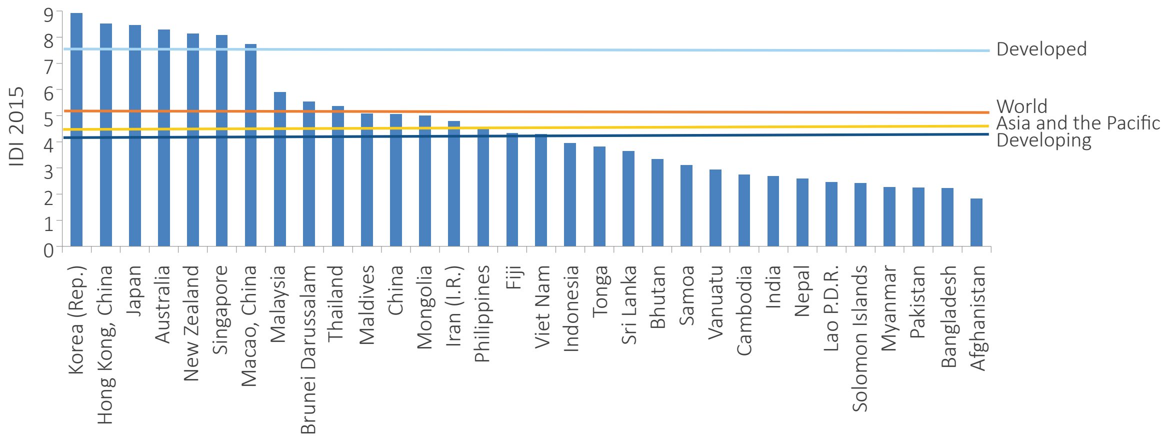
Economy	Regional rank 2015	Global rank 2015	IDI 2015	Global rank 2010	IDI 2010	Global rank change 2015-2010
Korea (Rep.)	1	1	8.93	1	8.64	0
Hong Kong, China	2	9	8.52	13	7.41	4
Japan	3	11	8.47	9	7.73	-2
Australia	4	13	8.29	15	7.32	2
New Zealand	5	16	8.14	19	7.17	3
Singapore	6	19	8.08	11	7.62	-8
Macao, China	7	24	7.73	14	7.38	-10
Malaysia	8	64	5.90	61	4.85	-3
Brunei Darussalam	9	71	5.53	53	5.05	-18
Thailand	10	74	5.36	92	3.62	18
Maldives	11	81	5.08	82	3.92	1
China	12	82	5.05	87	3.69	5
Mongolia	13	84	5.00	97	3.52	13
Iran (I.R.)	14	91	4.79	99	3.48	8
Philippines	15	98	4.57	105	3.16	7
Fiji	16	101	4.33	102	3.28	1
Viet Nam	17	102	4.28	94	3.61	-8
Indonesia	18	108	3.94	109	3.11	1
Tonga	19	110	3.82	111	3.08	1
Sri Lanka	20	115	3.64	115	2.97	0
Bhutan	21	119	3.35	128	2.02	9
Samoa	22	122	3.11	121	2.43	-1
Vanuatu	23	125	2.93	124	2.19	-1
Cambodia	24	130	2.74	131	1.98	1
India	25	131	2.69	125	2.14	-6
Nepal	26	136	2.59	140	1.75	4
Lao P.D.R.	27	138	2.45	135	1.92	-3
Solomon Islands	28	139	2.42	139	1.78	0
Myanmar	29	142	2.27	150	1.58	8
Pakistan	30	143	2.24	138	1.79	-5
Bangladesh	31	144	2.22	148	1.61	4
Afghanistan	32	156	1.83	156	1.37	0
Average			**4.70**		**3.85**	

Source: ITU.

the fewest countries of any region, only nine of which have been included in IDI 2015.

The average increase in IDI values in this region over the five-year period (1.43 points) is significantly above the average increase for the world as a whole (0.89 points). Belarus is the highest-ranked country, at 36th, with an IDI level of 7.18 in 2015, having risen by 1.88 points and 14 places, and having overtaken the Russian Federation, since 2015. It is the only country in the region within the highest quartile of global rankings. The Russian Federation is in second place within the region, with an IDI level of 6.91 and a global ranking of 45th. All nine of the countries in this region fall below the average developed-country IDI value of 7.41 for 2015. However, all but one – Kyrgyzstan in Central Asia – have rankings in the top half of the distribution and a value for IDI 2015 which is above the global average. Kyrgyzstan has, however, experienced the greatest rise in ranking since 2010 (up 15 places), while only one country in the region, Ukraine, has experienced a fall in its global rankings, during a period of conflict.

Chart 3.5: IDI values, Asia and the Pacific, 2015



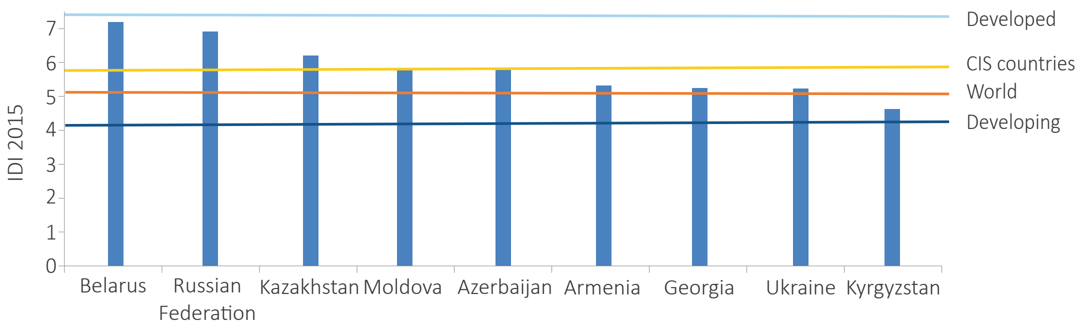
Source: ITU.

Table 3.6: IDI rankings, CIS region, 2015

Economy	Regional rank 2015	Global rank 2015	IDI 2015	Global rank 2010	IDI 2010	Global rank change 2015-2010
Belarus	1	36	7.18	50	5.30	14
Russian Federation	2	45	6.91	46	5.57	1
Kazakhstan	3	58	6.20	62	4.81	4
Moldova	4	66	5.81	74	4.28	8
Azerbaijan	5	67	5.79	76	4.21	9
Armenia	6	76	5.32	78	4.10	2
Georgia	7	78	5.25	85	3.76	7
Ukraine	8	79	5.23	69	4.41	-10
Kyrgyzstan	9	97	4.62	112	3.02	15
Average			**5.81**		**4.38**	

Source: ITU.

Chart 3.6: IDI values, CIS region, 2015



Source: ITU.

Europe

All countries in the Europe region, apart from Albania, have IDI values above the global average of 5.03 and fall within the high and upper quartiles of the Index, reflecting the region's high levels of economic development and GNI p.c. Eight of the ten countries at the top of the global rankings, and 13 of the top 20, are from this region, which is a slight increase on 2010, and all of these top European countries have IDI levels above 8.0. IDI ratings for all countries in the region are set out in Table 3.7 and Chart 3.7.

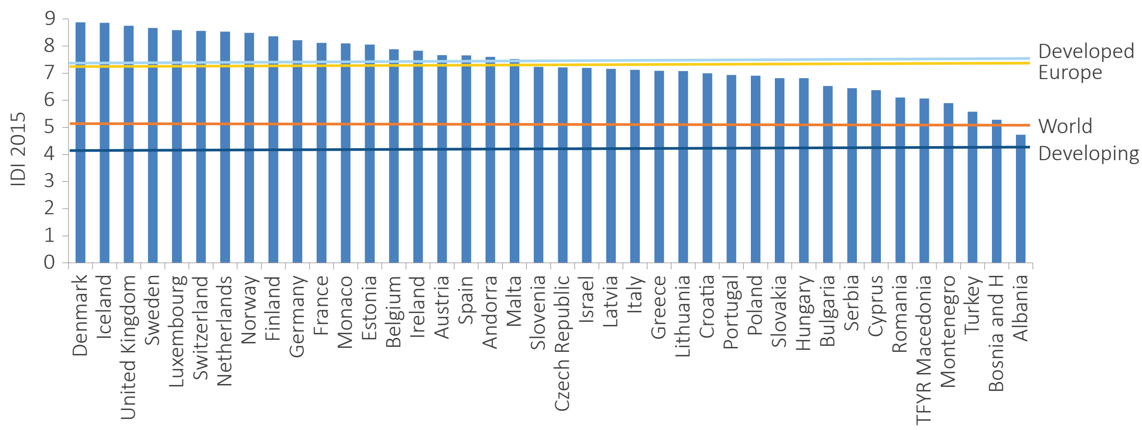
Table 3.7: IDI rankings, Europe region, 2015

Economy	Regional rank 2015	Global rank 2015	IDI 2015	Global rank 2010	IDI 2010	Global rank change 2015-2010
Denmark	1	2	8.88	4	8.18	2
Iceland	2	3	8.86	3	8.19	0
United Kingdom	3	4	8.75	10	7.62	6
Sweden	4	5	8.67	2	8.43	-3
Luxembourg	5	6	8.59	8	7.82	2
Switzerland	6	7	8.56	12	7.60	5
Netherlands	7	8	8.53	7	7.82	-1
Norway	8	10	8.49	5	8.16	-5
Finland	9	12	8.36	6	7.96	-6
Germany	10	14	8.22	17	7.28	3
France	11	17	8.12	18	7.22	1
Monaco	12	18	8.10	22	7.01	4
Estonia	13	20	8.05	25	6.70	5
Belgium	14	21	7.88	24	6.76	3
Ireland	15	22	7.82	20	7.04	-2
Austria	16	25	7.67	23	6.90	-2
Spain	17	26	7.66	30	6.53	4
Andorra	18	28	7.60	29	6.60	1
Malta	19	30	7.52	28	6.67	-2
Slovenia	20	33	7.23	27	6.69	-6
Czech Republic	21	34	7.21	33	6.30	-1
Israel	22	35	7.19	26	6.69	-9
Latvia	23	37	7.16	34	6.22	-3
Italy	24	38	7.12	31	6.38	-7
Greece	25	39	7.09	35	6.20	-4
Lithuania	26	40	7.08	39	6.02	-1
Croatia	27	42	7.00	42	5.82	0
Portugal	28	43	6.93	36	6.15	-7
Poland	29	44	6.91	32	6.38	-12
Slovakia	30	47	6.82	40	5.96	-7
Hungary	31	48	6.82	41	5.92	-7
Bulgaria	32	50	6.52	47	5.45	-3
Serbia	33	51	6.45	51	5.29	0
Cyprus	34	53	6.37	44	5.75	-9
Romania	35	59	6.11	55	4.99	-4
TFYR Macedonia	36	60	6.07	57	4.96	-3
Montenegro	37	65	5.90	60	4.89	-5
Turkey	38	69	5.58	67	4.56	-2
Bosnia and Herzegovina	39	77	5.28	75	4.28	-2
Albania	40	94	4.73	89	3.65	-5
Average			**7.35**		**6.48**	

Source: ITU.

While the region as a whole has very high IDI levels and rankings, positions at the top of the regional rankings are mostly held by countries in Northern and Western Europe, while those towards the bottom of the rankings are mostly in Southern and Eastern Europe. The five Nordic countries – Denmark, Iceland, Sweden, Norway and Finland – all rank within the top nine in the region and the top twelve worldwide. Denmark, which is Europe's top performer with an IDI value of 8.88, was the

Chart 3.7: IDI ratings, Europe region, 2015



Source: ITU.

highest performing country the previous year, as reported in the 2014 edition of the *Measuring the Information Society Report*. Its ranking this year has fallen below that of the Republic of Korea, following a fall in fixed telephone penetration. The region's most populous country, Germany, ranks 14th worldwide, with an IDI value of 8.22, but has a higher ranking (fifth) in the access sub-index. The United Kingdom has achieved the greatest improvement since 2010, rising six places to fourth in the global rankings, with an IDI value that has risen 1.13 points to 8.75.

The lowest 14 rankings in the region are held by countries on the Mediterranean and in Eastern Europe, including five of the countries that were formerly parts of Yugoslavia. While only Norway and Finland have lost significant ground to other countries at the top of the rankings, falling five and six places respectively, more countries from the south and east of the region have done so, including Poland (down 12 places), Israel and Cyprus (each down nine places), and Portugal, Slovakia and Hungary (each down seven places). Nevertheless, all countries in the region have continued to see improvements in their IDI values, with an average increase of 0.87 points since 2010. This is a highly positive performance given that all but one country in the region was already in the upper half of the distribution in that year.

The Americas

The United States, Canada and Barbados lead the IDI rankings in the Americas, which are set out in Table 3.8 and Chart 3.8, with IDI values of 8.19, 7.76 and 7.57, respectively. These three countries rank within the top quartile of IDI 2015, with global rankings of 15th, 23rd and 29th, respectively.

The three countries at the top of the regional rankings significantly outperform all other countries in the region, with IDI levels approaching one whole point above the next highest regional performer, Uruguay. As many as 29 of the region's countries fall within the upper and medium quartiles, in the middle of the global rankings, with only one, Cuba, among the LCCs.

Of all the regions, countries in the Americas region have experienced some of the most significant changes, both upward and downward, in IDI ranking over the five-year period. The most dynamic country worldwide has been Costa Rica, which rose 23 places in the Index between 2010 and 2015. Other substantial rises were achieved by Suriname (up 15 places), Brazil (up 12 places), Barbados (up nine places) and Colombia (up eight places). At the same time, a number of countries, particularly in the Caribbean, have seen their IDI rankings fall sharply, including St. Kitts and Nevis (down 20 places), Grenada (down 19 places), St. Lucia (down 16 places), Dominica (down 14 places) and Jamaica (down ten places). Other significant falls were recorded for Peru (down 13 places), Belize (down 12 places), Guyana (down 11 places), and Panama and Cuba (both down ten places). The reductions in several of these countries appear to be driven by reductions in the reported level of mobile-cellular subscriptions, while that in Cuba is partly accounted for by a fall in its rating for tertiary enrolment). The average increase in IDI level was substantially higher for countries in mainland Latin America (1.09 points) than for Caribbean and Caribbean-facing countries (0.73 points).

Table 3.8: IDI rankings, Americas region, 2015

Economy	Regional rank 2015	Global rank 2015	IDI 2015	Global rank 2010	IDI 2010	Global rank change 2015-2010
United States	1	15	8.19	16	7.30	1
Canada	2	23	7.76	21	7.03	-2
Barbados	3	29	7.57	38	6.04	9
Uruguay	4	49	6.70	52	5.19	3
Argentina	5	52	6.40	54	5.02	2
Chile	6	55	6.31	59	4.90	4
Costa Rica	7	57	6.20	80	4.07	23
Brazil	8	61	6.03	73	4.29	12
Antigua & Barbuda	9	62	5.93	58	4.91	-4
St. Kitts and Nevis	10	63	5.92	43	5.80	-20
St. Vincent and the Grenadines	11	68	5.69	63	4.69	-5
Trinidad & Tobago	12	70	5.57	65	4.58	-5
Venezuela	13	72	5.48	71	4.36	-1
Colombia	14	75	5.32	83	3.91	8
Dominica	15	80	5.12	66	4.56	-14
Grenada	16	83	5.05	64	4.67	-19
Suriname	17	85	4.99	100	3.39	15
St. Lucia	18	86	4.98	70	4.39	-16
Panama	19	89	4.87	79	4.07	-10
Ecuador	20	90	4.81	90	3.65	0
Mexico	21	95	4.68	86	3.70	-9
Dominican Rep.	22	103	4.26	101	3.38	-2
Peru	23	104	4.26	91	3.64	-13
Jamaica	24	105	4.23	95	3.60	-10
El Salvador	25	106	4.20	110	3.10	4
Bolivia	26	107	4.08	113	3.00	6
Paraguay	27	112	3.79	108	3.11	-4
Guyana	28	114	3.65	103	3.24	-11
Belize	29	116	3.56	104	3.17	-12
Honduras	30	120	3.33	116	2.94	-4
Guatemala	31	121	3.26	118	2.86	-3
Nicaragua	32	123	3.04	123	2.40	0
Cuba	33	129	2.79	119	2.66	-10
Average			**5.09**		**4.17**	

Source: ITU.

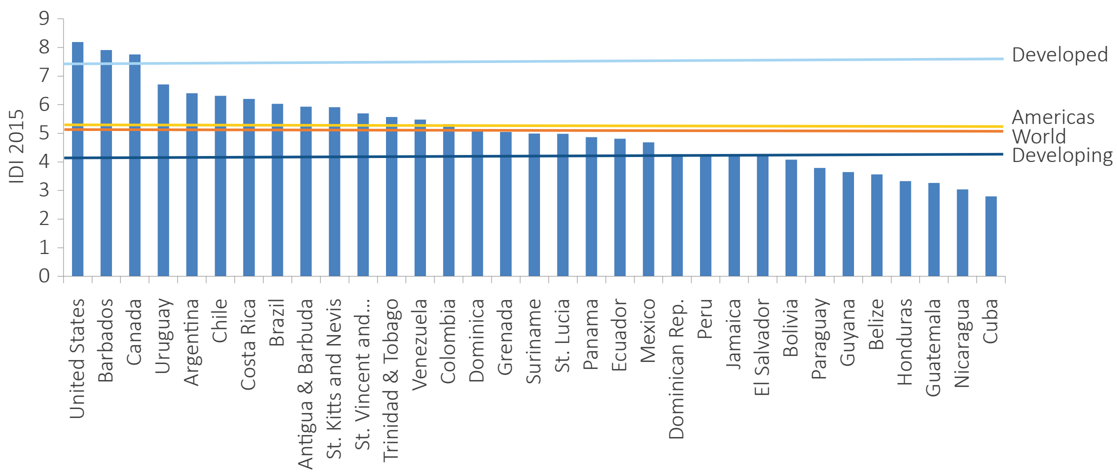
3.3 Top performers and dynamic countries

This section of the chapter looks at the experience of a number of individual countries which are at the top of the Index or have improved their position in the IDI rankings most dynamically during the period between 2010 and 2015.

The following paragraphs look in more detail at the experience of a number of the highest-performing and most dynamic countries. The charts in this section illustrate the experience of these countries in spider charts which compare the changes in their ratings between IDI 2010 and IDI 2015 for each of the fifteen indicators included in the Index. The charts help to illustrate the ways in which these high-performing and dynamic countries have improved their performance during the period.

Chart 3.9 presents spider charts for three countries at or near the top of the overall IDI rankings, namely the Republic of Korea, Denmark and the United Kingdom.

Chart 3.8: IDI values, Americas region, 2015



Source: ITU.

The two highest-performing countries in the Index in 2015 are the Republic of Korea and Denmark. As might be expected of countries with very high overall Index scores, these countries show high levels of attainment across all indicators in all three sub-indices.

The **Republic of Korea's** ICT and IDI achievements in recent years are outlined further in Box 3.1. The country shows very high scores for all indicators in 2015. Figures for skills indicators in the country were already at, or almost, 1.00 (100 per cent) in 2010, and have remained at that level since then. There have been significant rises in scores for the proportion of citizens with mobile-cellular subscriptions and for international Internet bandwidth per user. Almost all of the country's households have Internet access, while 87.9 per cent of the population are estimated to be Internet users.

The second highest performer in the overall Index in both 2010 and 2015 was a Nordic country – Sweden in 2010, and **Denmark** in 2015. Denmark's experience is described further in Box 3.2.

The composition of Denmark's overall Index performance shows some noteworthy differences when compared with that of the Republic of Korea. Denmark has higher levels of performance in three of the five access indicators, falling behind only in the proportion of households with Internet access (although it has significantly more households with a computer) and in fixed-telephone subscriptions (which have fallen from 47.1 to 33.3 per 100 inhabitants between IDI 2010 and IDI 2015). International Internet bandwidth per Internet user in Denmark is notably higher than in the Republic of Korea. The fall in the number of fixed-telephone subscriptions reflects the global decline in this indicator. The other area in which Denmark falls significantly behind the Republic of Korea is in one of the proxy indicators for ICT skills, namely tertiary enrolment.

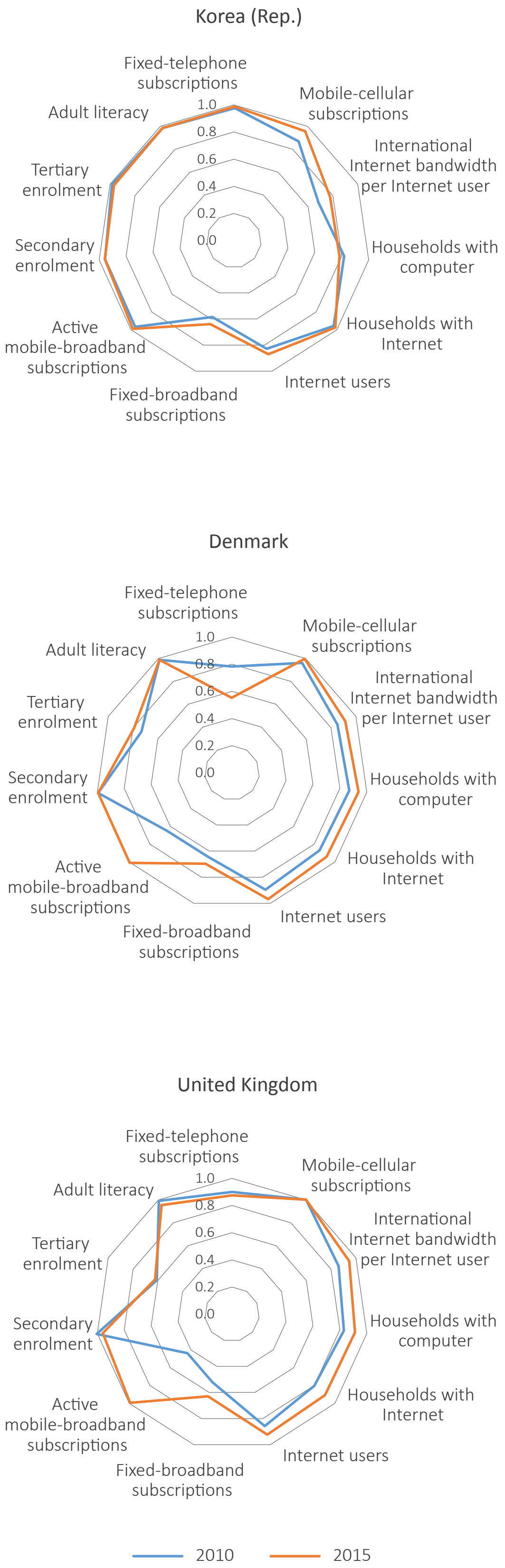
The principal area of improvement in Denmark's performance since 2010 has been in mobile-broadband penetration, which has risen from 63.9 to 115.8 per 100 people during the period, catching up with and slightly overtaking the Republic of Korea's performance. The main area other than tertiary enrolment in which there is scope for improvement in the IDI level in the future is, as in the Republic of Korea, the penetration of fixed-broadband subscriptions, which was 41.4 per cent in 2015.

These comparisons between the Republic of Korea and Denmark reflect the broader differences between high-performing countries in East Asia and Northern Europe illustrated in Chart 3.2.

The most dynamic rise among the IDI's top-ranking countries was that of the **United Kingdom**, resulting almost entirely from a higher rate of growth in the indicator for mobile-broadband subscriptions, which more than doubled between 2010 and 2015.

Data from Ofcom's consumer surveys show that the percentage of the population using data services on mobile phones more than doubled (from 26 to 57 per cent) over the period under consideration, although the final figure was still far

Chart 3.9: IDI ratings for top-ranking countries, 2010 and 2015



Source: ITU.

from saturation levels, despite the large number of mobile-broadband subscriptions reached (99 per 100 inhabitants in IDI 2015). The rise in mobile-broadband subscriptions and users coincides with a significant increase in smartphone uptake, from 39 per cent of adults with a smartphone in 2012 to 61 per cent in 2014 (Ofcom, 2014a).

In parallel with the increase in mobile-broadband uptake, there were significant qualitative improvements in the mobile-broadband services offered in the United Kingdom. For instance, the operator Everything Everywhere launched the country's first commercial LTE service in 2012, and the other UK mobile-network operators followed suit, with Vodafone and O2 offering LTE services in 2013, and Three offering 4G services in 2014. The increase in LTE coverage (up to 70 per cent in 2014) has been matched by rapid consumer uptake, with over 6 million estimated LTE subscriptions by March 2014, as against fewer than 0.5 million a year earlier (Ofcom, 2014b).

As noted above, while all countries within the Index have shown increases in their IDI levels over the five-year period between 2010 and 2015, relatively few have moved substantially up or down in their Index rankings during the same period. Only 16 countries have moved up by ten or more places in the rankings – four in Africa, five in the Arab States, two in the Asia-Pacific region, three in the Americas and two in the CIS region – while 17 economies have moved down by the same margin – two in Africa, one in the Arab States, two in Asia and the Pacific, one in the CIS region, one in Europe, and ten in the Americas.

Substantial changes in IDI levels are likely to be concentrated towards the middle of the distribution because of the limited scope for movement as countries approach maximum or escape low levels of performance. This explains, for example, why countries at the top and bottom of the distribution, such as those in the European and African regions, have generally recorded lower changes in IDI value than those in the middle of the distribution.

Table 3.9 presents IDI outcomes for the most dynamic countries within the Index over the period 2010 to 2015, i.e. the ten countries that have increased the most their IDI ranking or their IDI value. Four countries have improved their value by more than 2.00 points during this period

Box 3.1: ICT and IDI developments in the Republic of Korea

The Republic of Korea has consistently held one of the top positions in the IDI rankings, owing to its early adoption of advanced ICTs. It was, along with Japan, one of the first countries to launch commercial 3G services, as well as being a forerunner in connecting households with fibre-optic cable. It has long had a strong and innovative ICT industry which has contributed to building an enduring ICT ecosystem. Other factors that have contributed to the country's strong performance include high levels of education, government awareness of and support for ICT projects, and an "ICT culture", meaning that the country's citizens display a high degree of ICT awareness and an eagerness to adopt new technologies.[3]

This year, the Republic of Korea ranks first in the overall IDI, after ranking second last year. It ranks ninth in the access sub-index, fourth in the use sub-index and second in the skills sub-index, excelling in all categories. In particular, it has the highest percentage worldwide of households with Internet access (98.49 per cent), meaning that almost all households are connected.

Since 2010, the Republic of Korea has seen the initial launch and subsequent proliferation of long-term evolution (LTE) services, beginning in Seoul in 2011 and expanding elsewhere in the country in 2012 and 2013. LTE traffic accounted for 9.5 per cent of total mobile-communication traffic in 2012, rising sharply to 72.8 per cent by the end of 2013, this being a reflection of the country's rapid switchover to LTE networks (Korea Communications Commission, 2013). In June 2013, moreover, a mere two years after the commercial launch of LTE, SK Telekom launched the world's first commercial LTE advanced network, the speed of which – already twice that of the country's initial LTE network – was further increased in 2014. By April 2014, as much as 77 per cent of the country's total mobile-communication traffic went through LTE or LTE advanced networks (Ministry of Science, ICT & Future Planning (MSIP and KISA, 2014). However, these developments had only a limited impact on the national indicator for mobile-broadband penetration since this was already at 97.7 per cent in 2010. The new technologies contributed to improving the speed and quality of networks rather than expanding the subscriber base.

Internet use in the Republic of Korea increased from an already high value of 83.7 per cent in IDI 2010 to 87.9 per cent in IDI 2015. Data from the latest household survey carried out by MSIP and KISA show that a broad majority of Internet users (95.1 per cent) access the Internet using a smartphone or smartpad (MSIP and KISA, 2015). While there are still Internet non-users (defined by KISA and MSIP as those among the population aged three and over who have not used the Internet in the past month), the proportion of non-users continues to decline. The main reason cited for non-use among this group is lack of interest in or need to use the Internet, rather than affordability.

– Bahrain, Lebanon and Saudi Arabia in the Arab States region, and Costa Rica in the Americas. Of these, Costa Rica, Lebanon and Bahrain have all climbed by twenty or more positions in the rankings, as has Ghana, the leading African country in terms of IDI improvement.

The most substantial falls in IDI rankings between 2010 and 2015 were recorded by St. Kitts and Nevis (down 20 places), Grenada (down 19 places) and Brunei Darussalam (down 18 places). The lowest rates of change in IDI values were recorded by Eritrea (up 0.09 points), St. Kitts and Nevis (up 0.12 points) and Cuba (up 0.13 points).

Five of the most dynamic countries in the IDI rankings identified in Table 3.9 are located in the Arab States region, of which four – **Bahrain, the United Arab Emirates, Saudi Arabia** and **Oman** – are GCC Member States located in the Arabian peninsula. Of these four, Bahrain began the period with the highest IDI ranking (48th), rising 21 places to 27th in 2015, and has achieved the highest increase in its IDI level (up 2.22 points). The spider charts for these countries, shown in Chart

Box 3.2: ICT and IDI developments in Denmark

Denmark ranks second in the IDI, having been top of the rankings published in the 2014 edition of the *Measuring the Information Society Report*. It has moved up two places from fourth in IDI 2010, raising its IDI value in the process from 8.18 to 8.88. Denmark ranks first in the use sub-index, 13th in the access sub-index and 12th in the skills sub-index. Within the use sub-index, it has the third-highest fixed-broadband penetration at 41.38 subscriptions per 100 inhabitants, and the ninth-highest mobile-broadband penetration at 115.77 subscriptions per 100 inhabitants. Almost all households have access to a computer and an Internet connection at home (94.99 per cent and 93.12 per cent, respectively), and Denmark has the third-highest percentage of individuals using the Internet in the world, at 95.99 per cent.

The roll-out of LTE networks in the country is among the most important ICT developments since 2010. TeliaSonera was one of the first operators worldwide to launch commercial LTE services, and by the end of 2011 it had covered 85 per cent of the population in Copenhagen, Aarhus, Aalborg and Odense.[4] By the end of 2014, LTE coverage in Denmark was widespread, with LTE services being offered by all four mobile-network operators as well as other service providers (European Commission, 2015).

The rapid development of LTE networks within the country was facilitated by the regulator's decision to refarm, allocate and assign new spectrum to mobile operators. In particular, the 2.5 GHz band was assigned in 2010, the 900/1800 MHz bands were refarmed and two new licences assigned in 2010, and the 800 MHz band was auctioned in 2012 and made available as of January 2013.[5] Extensive infrastructure upgrades have contributed to further increases in the relatively uniform distribution of broadband coverage. Fixed-broadband coverage is 99 per cent, while LTE mobile-broadband coverage increased from 74 per cent in 2013 to 99 per cent in 2015, well above the European Union average of 59 per cent (European Commission, 2015).

Denmark's national broadband strategy aims to enable all households and businesses to have access to at least 100 Mbps download speeds by 2020. An estimated 70 per cent of all households and businesses had access to infrastructure that could support such speeds by mid-2013, an increase from 60 per cent in the previous year (Danish Business Authority, 2013). Data on the uptake of high-speed broadband plans shows that currently 33 per cent of all fixed-broadband subscriptions are at speeds above 30 Mbps (compared with an EU average of 26 per cent), and that 3 per cent of all connections are at speeds above 100 Mbps (European Commission, 2015).

3.10, show that they have had broadly similar experiences over the period 2010 to 2015, with substantial improvements in the usage sub-index driving their overall improvement in performance. The experience of Saudi Arabia is described further in Box 3.3.

In the access sub-index, all four countries began the period with very high levels of mobile-cellular subscriptions, which have been maintained. Penetration levels for fixed-telephone subscriptions have remained largely unchanged, at significantly lower levels than for mobile-cellular subscriptions, reflecting the prevalence of fixed-mobile substitution – in Bahrain, for example, the penetration of fixed-telephone subscriptions is only 21.2 per hundred people. In all four countries, however, there have been significant improvements in levels of Internet access, as reflected in the indicators for households with a computer and households connected to the Internet. The levels for households with Internet access in the United Arab Emirates, Saudi Arabia and Oman were all lower than they were in Bahrain in 2010, but had overtaken Bahrain's performance by 2015. The rise in computer and Internet access in Oman represents the most important driver increasing the IDI in that country, alongside the rise in active mobile-broadband subscriptions.

Box 3.3: ICT and IDI developments in Saudi Arabia

Saudi Arabia improved its IDI value from 4.96 in IDI 2010 to 7.05 in IDI 2015, raising its global ranking over the same period from 56th to 41st. As in most countries, it saw the greatest improvement in the use sub-index. However, the indicator reflecting the highest growth was one of those within the access sub-index, namely the percentage of households with Internet access, which rose from below 55 per cent in 2010 to over 90 per cent in 2015.

Progress in both ICT access and use has been facilitated by the government's implementation in 2006 of the country's universal access and universal service policy, leading to a universal service fund (USF) programme roll-out in 2010. The USF was introduced to finance the expansion of networks and services to "commercially unprofitable, underserved zones" (MCIT, Saudi Arabia, 2006). Funded by a one per cent share of designated operators' revenues and some additional government sources, the USF has helped to bring affordable ICT services, and in particular Internet access, to such remoter areas. The USF target is to bring fixed and/or mobile services, as well as Internet access, to every village with over 100 inhabitants (ITU, 2013). By 2014, 82 per cent of villages, amounting to a population of over 4 million people, had been connected (MCIT, Saudi Arabia, 2014). The USF project, which is expected to cover the remaining target population by the end of 2015, has contributed to broadband deployment and Internet usage in rural and underserved areas.

The biggest improvements in IDI rankings in the GCC countries have been driven by two of the indicators in the use sub-index: those for Internet users and for active mobile-broadband subscriptions. Bahrain rose from 50th position in the rankings for the use sub-index in 2010 to 18th position in 2015, while the UAE rose from 46th position to 22nd. These improvements were driven in particular by growth in the proportion of mobile-broadband subscriptions. There has been little change in the indicator for fixed-broadband subscriptions. While consistent with the indicator for fixed-telephone subscriptions, this may indicate that the speed and data allowances available to end users are lower in these countries than in high-performing countries in other regions.

The skills sub-index for Bahrain, the UAE and Oman is virtually unchanged between 2010 and 2015, with very high levels of literacy and secondary enrolment but relatively low tertiary enrolment.

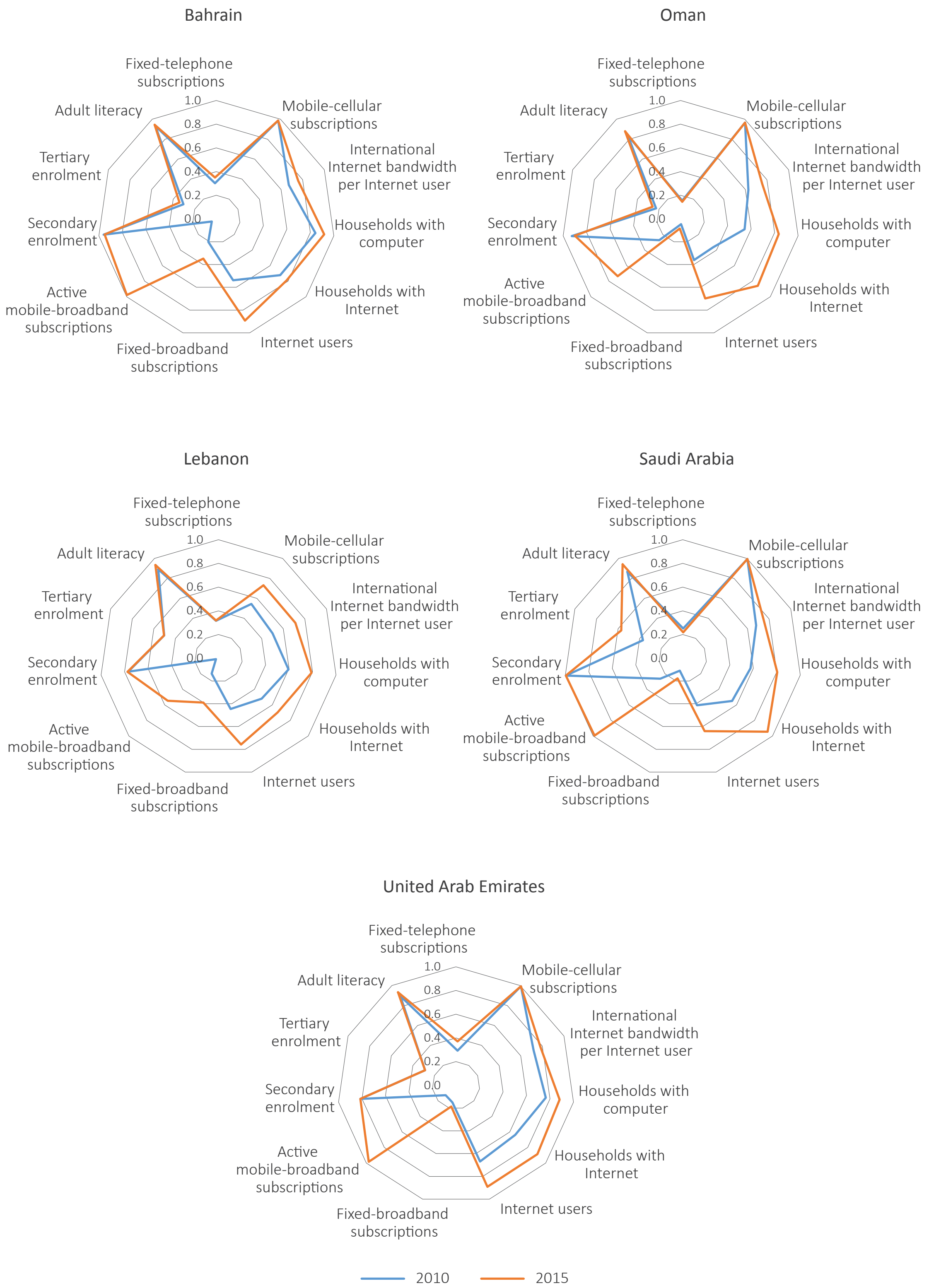
Table 3.9: Most dynamic countries

Change in IDI ranking			
IDI rank 2015	Country	IDI rank change (2010-15)	Region
57	Costa Rica	23	Americas
27	Bahrain	21	Arab States
56	Lebanon	21	Arab States
109	Ghana	21	Africa
74	Thailand	18	Asia & Pacific
32	United Arab Emirates	17	Arab States
41	Saudi Arabia	15	Arab States
85	Suriname	15	Americas
97	Kyrgyzstan	15	CIS
36	Belarus	14	CIS
54	Oman	14	Arab States

Change in IDI value			
IDI rank 2015	Country	IDI value change (2010-15)	Region
27	Bahrain	2.22	Arab States
57	Costa Rica	2.14	Americas
56	Lebanon	2.12	Arab States
41	Saudi Arabia	2.09	Arab States
32	United Arab Emirates	1.94	Arab States
54	Oman	1.92	Arab States
109	Ghana	1.92	Africa
36	Belarus	1.88	CIS
74	Thailand	1.74	Asia & Pacific
61	Brazil	1.74	Americas

Source: ITU.

Chart 3.10: IDI ratings for dynamic countries, Arab States region, 2010 and 2015



Source: ITU.

Saudi Arabia, however, shows a significant improvement in tertiary enrolment.

The spider map for the other Arab States country that is one of the most dynamic in the IDI, namely **Lebanon**, also included in Chart 3.10, shares many of these characteristics, albeit from a lower base

Box 3.4: ICT and IDI developments in Lebanon

Lebanon stands out in the global comparison for being the country with the second-largest improvement in IDI ranking, and the third in terms of IDI value in the period 2010-2014. The most notable increases were recorded in international bandwidth per Internet user and fixed-broadband subscriptions per 100 inhabitants.

Lebanon has benefited from the construction of the India-Middle East-Western Europe (I-ME-WE) 13 000 km submarine cable that connects Mumbai (India) to Marseille (France), with a branch of the cable reaching Lebanon.[6] This project became operational in 2011 and mitigated the shortage of international connectivity that had constrained the Internet market in Lebanon. International Internet bandwidth per Internet user grew from 1.3 kbit/s/user in 2010 to 23.9 kbit/s/user in 2014.

In addition, the Ministry of Telecommunications, through the state-owned operator Ogero, which owns and operates the backbone infrastructure for all telecom networks in Lebanon, has undertaken several initiatives to improve the national backbone network (Hoballah, 2010). These measures to enhance the national and international telecommunication infrastructure have been aimed at ensuring the connectivity needed to enable the take-off of mobile broadband, subscriptions for which rose from 9.6 per 100 inhabitants in 2011 to 53.5 by the end of 2014.

Fixed-broadband subscriptions increased from 7.6 per 100 inhabitants in 2010 to 22.8 per 100 inhabitants in 2014, making Lebanon the Arab State with the highest fixed-broadband penetration. This increase in fixed-broadband subscriptions followed the award to private cable operators in 2014 of 43 new licences authorizing them to provide Internet services. This was an important regulatory milestone, given the relevance of cable subscriptions in the country, and the main driver for the fixed-broadband growth observed. Indeed, by the end of 2014 more than 50 per cent of all fixed-broadband subscriptions were through cable.

The rest of the fixed-broadband market is served by the State-owned incumbent Ogero, and by private operators offering fixed-wireless and DSL services. Unlike the mobile-cellular and fixed-telephone markets, which are State-owned monopolies, competition has been allowed in the fixed-broadband market by mandating local loop unbundling (LLU) to the incumbent operator.[7] Since LLU wholesale rates are regulated and the dominant operator is State-owned, the evolution of the broadband market is significantly dependent on policy and regulatory decisions. For instance, Decree 6297, issued in September 2011, cancelled low-speed broadband packages, making the new entry-level package, at 1 Mbit/s, 70 per cent cheaper than the previous 1 Mbit/s package. The decree also reduced HDSL package prices by 40 per cent and substantially lowered the prices of international connectivity (by 92 per cent for 1024 kbit/s, and by 86 per cent for 2048 kbit/s) (TRA, Lebanon, 2011).

in 2010 when it was ranked 77th worldwide, as against 56th in 2015. As in most countries, there has been virtually no change in the skills sub-index outcomes for Lebanon over the five-year period. However, this country has seen significant changes in both the access and use sub-indices, the score in the former rising from 5.03 to 6.57 points (raising it from 75th to 66th position), and in the latter from 1.88 to 5.54 points (up from 75th to 43rd position). Unlike the GCC States, it had a relatively low score for mobile-cellular subscriptions in 2010, its performance on this indicator having risen from 65.97 to 88.35 per cent over the period since 2010, and it recorded similar improvements in all of the other access indicators apart from fixed-telephone subscriptions which, in line with experience worldwide, remained stagnant. However, Lebanon has seen a substantial improvement in the number of Internet users (up from 43.7 to 74.7 per cent) and fixed-broadband subscriptions (almost trebling during the period).

Further information about Lebanon's experience is highlighted in Box 3.4.

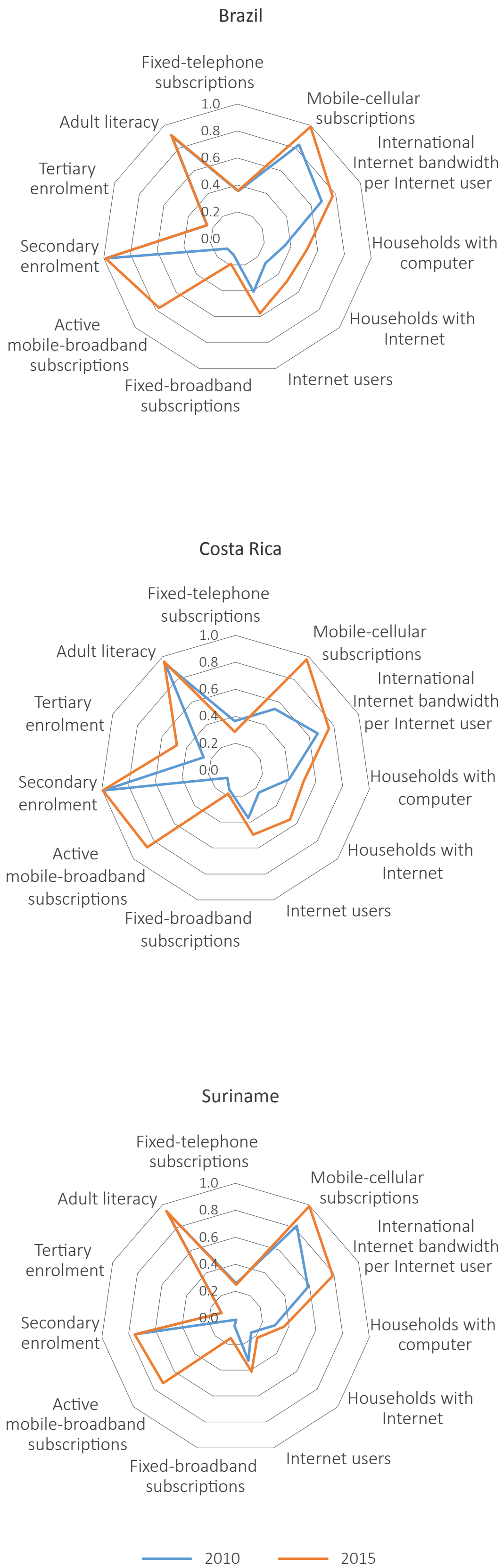
More diverse experiences than those in the Arab States region are to be seen in the results for the three most dynamic countries from the Americas region, which are illustrated in Chart 3.11. Two of these are relatively small countries: Costa Rica, in Central America, which recorded the highest rise of any country in the overall rankings between 2010 and 2015 (up 23 points), and Suriname, a Caribbean-facing country on the northern coast of South America. The third, Brazil, is the largest country in South America. Suriname's performance since 2010 contrasts markedly with that of a number of other Caribbean countries whose position in the rankings fell during this period. The experiences of Costa Rica and Brazil are outlined further in Boxes 3.5 and 3.6.

Costa Rica and **Suriname** have both seen the penetration of mobile-cellular subscriptions rise towards the maximum Index level since 2010, while also experiencing increases in the other access indicators and in the density of Internet users. The proportion of Internet users rose from 36.5 to 49.4 per cent in Costa Rica, while that for households connected to the Internet more than doubled, from 24.1 to 55.0 per cent. However, the greatest increase in indicator levels, and the most influential factor in terms of both countries' overall IDI performance, has been the growth in active mobile-broadband subscriptions, of which there were very few in 2010.

There were fewer countries with dynamic improvements in IDI rankings in the Asia-Pacific and CIS regions. Spider charts for Belarus, Kyrgyzstan and Thailand are presented in Chart 3.12.

The highest-performing countries in the CIS and Asia-Pacific regions, **Kyrgyzstan** and **Thailand**, show a very similar pattern of change to other developing countries described earlier. Both countries have experienced virtually no change in the proxy indicators within the skills sub-index; have seen significant, though not spectacular, growth in indicators within the access sub-index and in Internet usage; but have shown very high growth, from close to zero in 2010, in the indicator for active mobile-broadband subscriptions. The experience of these two countries is explored further in Boxes 3.7 and 3.8.

Chart 3.11: IDI ratings for dynamic countries, Americas region, 2010 and 2015



Source: ITU.

Box 3.5: ICT and IDI developments in Costa Rica

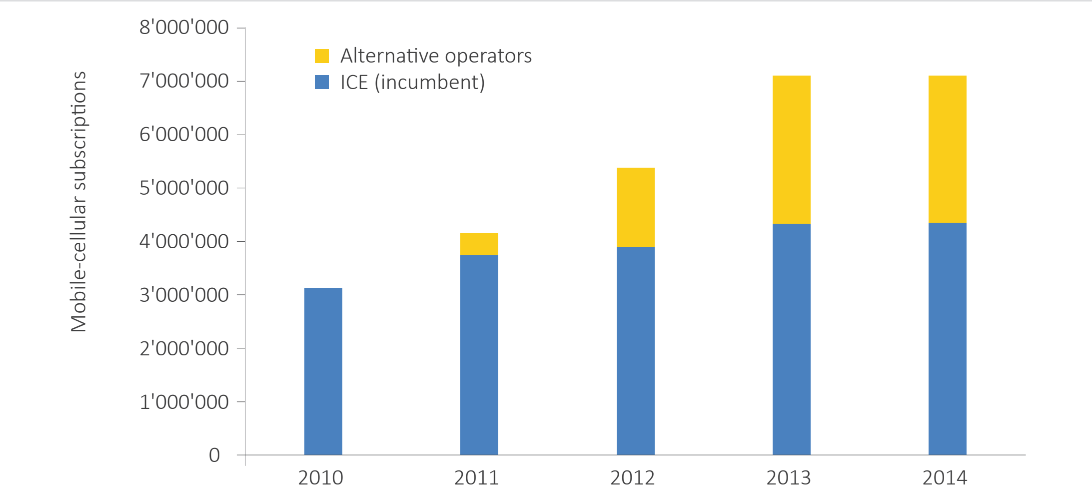
Costa Rica stands out as the country recording the largest improvement in global IDI ranking in the period under review. It has also seen the second-largest increase in IDI value. The country made significant improvements in all IDI access and use indicators except for fixed-telephone subscriptions. Not surprisingly, mobile-cellular and mobile-broadband subscriptions saw the highest growth of all IDI indicators in the period, together with the percentage of households with Internet access.

Liberalization of the telecommunication market led to the entry of new mobile operators in November 2011, spurring subscription growth.

New entrants in the mobile market – including transnational operators Claro and Telefónica, as well as two smaller mobile virtual-network operators – launched highly competitive prepaid mobile-cellular offers which attracted new customers who had previously not had a mobile subscription. Although most growth was concentrated in the alternative operators (69 per cent of net additions in the period 2010-2014), the incumbent operator also saw a significant rise in subscriptions, which suggests that competition benefited all players in the market. As illustrated in Chart Box 3.5, mobile-cellular penetration more than doubled from 67 per cent in IDI 2010 to 144 per cent in IDI 2015, while mobile-broadband penetration increased tenfold, reaching 87 per cent by the end of 2014. Strong increases in investment were also recorded in 2012 and 2013, and, although investment receded in 2014, it remained higher than its pre-2012 level.

The introduction of competition in the mobile market occurred in parallel with the take-off of mobile-broadband services, thereby contributing to the significant increase in the percentage of households with Internet access (up from 24 per cent in 2010 to 55 per cent in 2014). The growth in the proportion of Internet users among the population was also significant, although less rapid (up from 37 to 49 per cent in the period 2010 to 2014). This suggests that mobile broadband is not only bringing new people online, but also making the Internet available at home for people who had previously accessed it elsewhere. This hypothesis is reinforced by the data from ICT household surveys, which show that one-third of households with Internet access in Costa Rica relied on mobile-broadband access in 2012.

Chart Box 3.5: Mobile-cellular subscriptions in Costa Rica, by operator, 2010-2014



Source: ITU, based on data from the Superintendencia de Telecomunicaciones, Costa Rica (2014).

Box 3.6: ICT and IDI developments in Brazil

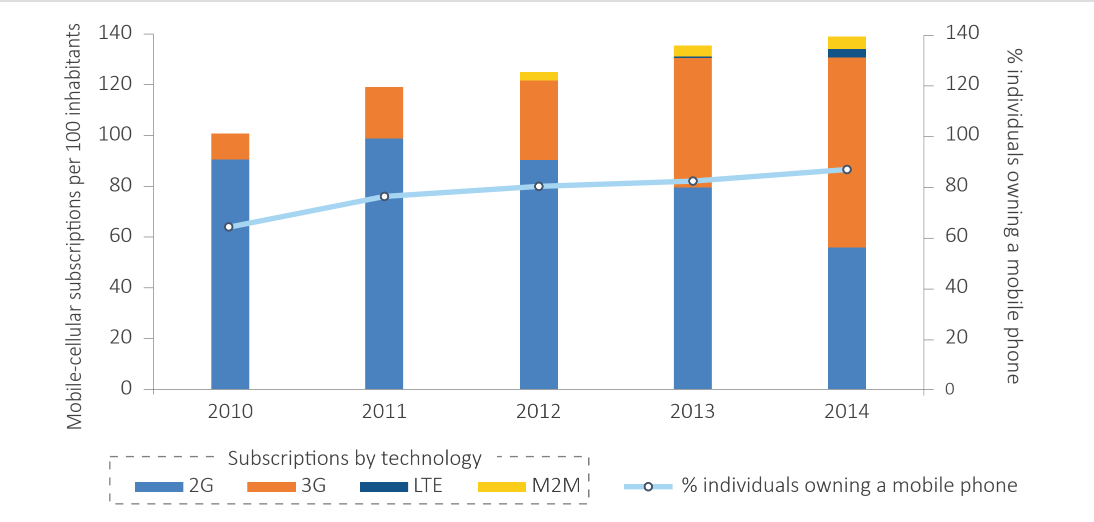
Brazil is the most dynamic South American country in the IDI, and features in the global top ten in terms of IDI value change. Because the country is so large, these substantial increases in its IDI indicators have affected large numbers of people.

The highest growth rate among IDI indicators in Brazil was that for mobile-broadband subscriptions, the number of which rose by 137 million, while mobile-broadband penetration increased from 10.6 per cent in IDI 2010 to 78.1 per cent in IDI 2014. This increase in mobile-broadband uptake was made possible by upgrading the cellular-market base from 2G to 3G (see Chart Box 3.6). The allocation of new spectrum to mobile broadband facilitated this transition, as did coverage obligations. In the 3G auctions held in 2007 and 2010, the regulator ANATEL attached coverage obligations to licences, resulting in 68 per cent of Brazilian municipalities (and around 89 per cent of the population) now being covered by a 3G signal. Licences issued in the LTE spectrum auction that took place in 2012 likewise stipulated that all cities with a population above 500 000 inhabitants should be covered by May 2014 (ANATEL, 2015), and all cities with over 30 000 inhabitants by 2017 (MiniCom, Brazil, 2014).

Mobile-cellular subscriptions continued to rise alongside mobile broadband. Although mobile-cellular penetration was already above 100 per cent in Brazil by 2010, a significant part of the population did not then own or use a mobile phone. Further growth in mobile-cellular subscriptions since 2010 has led to increases in both mobile phone ownership (up from 64 per cent in 2010 to 84 per cent in 2014) and usage (up from 79 per cent in 2010 to 86 per cent in 2014).

Fixed-broadband subscriptions have also increased significantly, with 9.1 million net additional subscriptions driving fixed-broadband penetration from 7.2 per cent in IDI 2010 to 11.5 per cent in IDI 2015. This increase has coincided with an almost 50 per cent reduction in the price of entry-level broadband plans in 2010-2011, and with the first offers under the basic fixed-broadband package defined in the *Programa Nacional de Banda Larga* (PNBL, the Brazilian Broadband Plan).[8]

Chart Box 3.6: Mobile-cellular subscriptions by technology and percentage of individuals owning a mobile phone, Brazil, 2010-2014



Source: ITU, based on data from ANATEL (2015) and CETIC's Portal de Visualização de Dados (http://data.cetic.br).

Box 3.6: ICT and IDI developments in Brazil (continued)

The increase in mobile- and fixed-broadband subscriptions discussed above is reflected in the growth in the proportion of households with Internet access (up from 27.1 per cent in 2010 to 48 per cent in 2014, as against an average 12 percentage point increase worldwide). Alongside this increase in the proportion of households connected to the Internet, there was also a notable rise in the proportion of households with a computer (up from 34.9 per cent in 2010 to 51.9 per cent in 2014, as against an average nine percentage point increase worldwide). The progress achieved in these two indicators corresponds to one of the main objectives set by the PNBL in 2010, namely to increase the number of households with a computer connected to the Internet.[9]

Box 3.7: ICT and IDI developments in Kyrgyzstan

Kyrgyzstan has experienced significant improvements in almost all IDI areas between 2010 and 2015.

The growth in international Internet bandwidth has been particularly significant. New optical-fibre links with China and Kazakhstan were completed in 2013. Developed by the operator Elcat, an optical-fibre link was established between Nura (China) and Karamyk (Kyrgyzstan) with a capacity of 2.5 Gbps, upgradeable to 40 Gbps. Another fibre connection was established between Bishkek (Kyrgyzstan) and Chaldovar (Kazakhstan) with an initial capacity of 2.5 Gbps, upgradeable to 40 Gbps (UNESCAP, 2014). Additional projects throughout 2014 built fibre lines towards Tajikistan, Uzbekistan and China (East Horizon, 2014). Measures such as these have helped to increase competition and reduce prices while strengthening international connectivity.

Government efforts to unlock commercial broadband frequencies in 2012 have enabled greater Internet access for rural areas in Kyrgyzstan, with rapid implementation in schools (East Horizon, 2014). Broadband and data services continue to attract increasing interest in the mobile market, and are expected to undergo steady growth with adequate development.

The only exception to this growth in IDI indicators has been the level of fixed-telephone subscriptions, which fell by 14.1 per cent between 2010 and 2015. Despite the evident growth in the IDI, there still remains limited household Internet access in the country, many of whose people continue to rely on public access points. It is estimated that some 50 per cent of users access the Internet in cybercafés (East Horizon, 2014).

As in most other countries, there has been very little change in Ghana's performance against the proxy indicators used in the skills sub-index between 2010 and 2015. Improvements in the access and use sub-indices are, however, revealing, showing generally high levels of growth over the period, although Ghana's performance remains substantially below that observed in the leading countries in other developing regions. Ghana's experience in stimulating ICT and achieving this growth in its IDI ranking is explored further in Box 3.9.

As noted above, the average IDI performance in Africa is well below that in other regions. As a result, while there are similarities with other high-performing developing countries, the experience of Africa's most dynamic IDI performer, **Ghana**, also shows significant variations from the pattern revealed by those countries. Although ranked below 100th in the global rankings, Ghana is also the second highest-ranking country in mainland sub-Saharan Africa, behind only South Africa among its regional peers. Its ratings are illustrated in Chart 3.13.

Box 3.8: ICT and IDI developments in Thailand

Thailand's IDI ranking improved by 18 places between 2010 and 2015, rising from 92nd to 74th position, while its IDI value rose from 3.62 to 5.36. The country has made good progress in both use and access sub-indices, but stands out in particular for its achievements in mobile broadband. It was relatively late in awarding 3G mobile-broadband licences, doing so in December 2012 to three competing carriers, namely Advanced Info Service (AIS – Thailand's largest mobile provider), Total Access Communication (DTAC) and True Corp. High demand for services put pressure on wireless-broadband providers to offer competitive prices, especially after the introduction of mobile-number portability in 2011. Competitive pressure also helped to spread 3G population coverage, with both AIS and DTAC reporting around 80 per cent coverage by the end of 2013 (GSMA, 2014a).

The mobile-broadband market in Thailand has faced rising demand for 3G services, as well as demand for 4G from heavier data users (GSMA, 2015b). Thai providers have responded to this by experimenting with trials and soft launches of LTE connections in densely-populated areas. Although LTE spectrum has yet to be awarded, both AIS[10] and True Corp[11] offer limited LTE plans using existing 3G spectrum. The future award of mobile spectrum in the 900 MHz and 1800 MHz bands, which are suitable for LTE, should further drive the wireless-broadband market (GSMA, 2015b).

At the end of 2014, Thailand's Government formally announced its adoption of a digital economy policy framework. This includes the proposed establishment of a national broadband committee and specific targets for connecting businesses and homes, including a broadband network to every village and home over the next two to three years. It highlights the importance of expanding the country's infrastructure network, based on the roll-out of both mobile and fixed broadband, and on public-private partnerships.[12]

3.4 Conclusion

The IDI demonstrates the very wide range of ICT environments within the world community, from economies with very high levels of ICT performance to Least Connected Countries which are still seeking to progress from basic access to ICT intensity and impact. Each individual economy faces different challenges, related to its geography, infrastructure requirements and social and economic structure, and to the financial resources and capabilities available to its people. While issues of national context are crucial to policy development, it is also possible for governments and ICT businesses to draw on the experience of other countries when developing their plans for the deployment and take-up of telecommunications, broadband and Internet.

The experience of countries which have achieved higher rates of progress against the IDI is valuable within this context. Assessments such as those made in this chapter illustrate the importance, in facilitating access to and use of ICTs, of building strategic approaches to ICT deployment and implementation, integrating the implementation of infrastructure with demand for services such as e-government, ensuring that communications devices and services are affordable, and building the skills base that is required to maximize the effective use of ICTs. Understanding how and why individual countries have achieved more dynamic rates of growth within the IDI can help others as they seek to design and adopt their own strategies in pursuit of dynamic growth in ICTs.

Box 3.9: ICT and IDI developments in Ghana

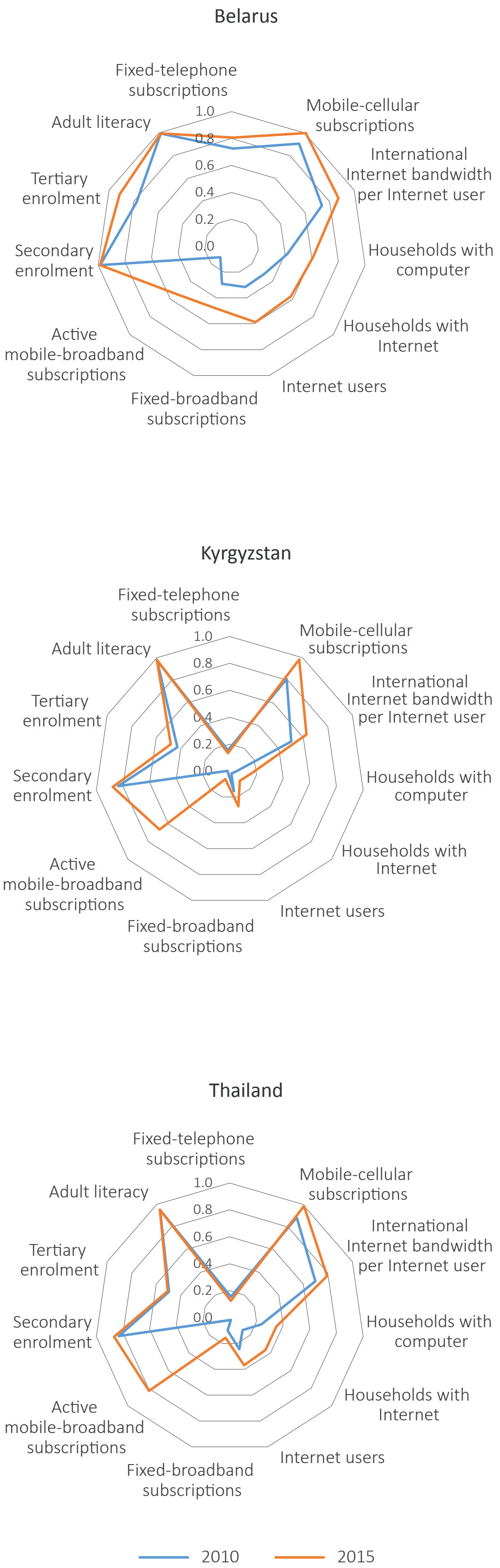
The sharpest rate of growth in Ghana has been achieved in mobile-cellular subscriptions, which have risen from 71.9 to 114.8 per 100 inhabitants since 2010. At the same time, there has been almost no change in the level of penetration of fixed-phone subscriptions, which have been effectively displaced by mobile connections, suggesting that this indicator of ICT development may no longer be as helpful as was previously the case.

Ghana has also experienced substantial growth in other access indicators, with the number of Internet users having more than doubled and the proportion of households with Internet access having increased more than fivefold. The improvement in international bandwidth that is evident from Figure 2.23 is associated with the landing of additional submarine cable capacity along the West African coast since 2010, this having also reduced the cost of Internet access, an important factor in increasing usage. As in the other developing countries described above, Ghana has also seen a very substantial increase in the level of penetration of mobile-broadband subscriptions, likewise facilitated by the growth in international bandwidth per Internet user, albeit from very low levels in 2010.

Ghana's Government has long identified ICTs as an important enabler for economic development, establishing ICT policies and specific targets for access, affordability and use (Gyaase and Taki, 2014). Growth in ICTs in Ghana has been reinforced by strong government commitment to the expansion of ICT services, including the identification of targets, through a National Telecom Policy adopted in 2005, and liberalization of the market and increased competition since 2010 (Alliance for Affordable Internet, 2014).

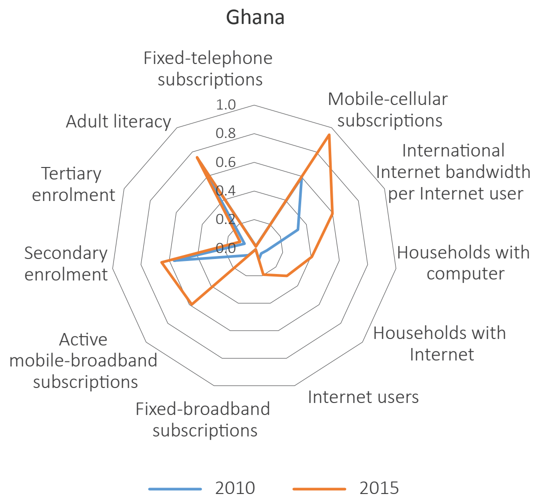
The country's improvements in Internet penetration and growth in mobile-broadband penetration were highlighted in the 2012 edition of this *Report* (ITU, 2012). Ghana has also experienced impressive growth in international Internet bandwidth per Internet user since 2010. Increased competition and lower prices were brought about through the construction of four fibre-optic submarine cables that landed in Ghana between 2010 and 2013. While Ghana was initially linked through only one fibre-optic cable, SAT-3, competition subsequently increased with the landing of the Main One Cable, Glo-1, WACS and ACE. Together, these five submarine cables have increased Ghana's available fibre-optic bandwidth capacity to 15 Terabits per second (although less than 5 per cent of this capacity is used) and reduced prices (National Communications Authority, Ghana, 2015). Further ICT price reductions are expected following the Ghanaian Government's waiving, in its 2015 budget, of the 20 per cent import duty on smartphones, which constituted 35 per cent of their cost.[13]

Chart 3.12: IDI ratings for dynamic countries, CIS and Asia-Pacific regions, 2010 and 2015



Source: ITU.

Chart 3.13: IDI ratings for Ghana, 2010 and 2015



Source: ITU.

Endnotes

[1] Georgia exited the Commonwealth on 18 August 2009 but is included in the ITU/BDT administrative region for the CIS countries.

[2] ESCWA (2013), pp 171ff.

[3] For more information on the IDI performance of the Republic of Korea prior to 2010, see Box 2.3 in ITU (2010).

[4] http://www.teliasonera.com/en/newsroom/press-releases/2012/6/telia-customers-in-denmark-to-benefit-from-growing-4g-network/.

[5] For more information on spectrum assignments in Denmark, see: http://danishbusinessauthority.dk/auction-and-public-tender-licences.

[6] http://www.tra.gov.lb/NewsDetails.aspx?pageid=1916.

[7] See TRA's website for more information on the structure of the Lebanese telecommunication markets: http://www.tra.gov.lb/Market-Data-Facts-and-figures.

[8] A basic fixed-broadband package (1 Mbit/s at RS35 per month, approximatively USD 15/month) is to be commercially available in all Brazilian cities in 2014 (MiniCom, Brazil, 2014).

[9] Several initiatives were undertaken in the framework of PNBL to promote the uptake of computers and the Internet, including the tax exemption of computers, tablets and smartphones produced in the country, as well as the exemption from all federal taxes of access terminals in rural areas (*ibid.*).

[10] http://www.ais.co.th/4g/home-en.html.

[11] http://truemoveh.truecorp.co.th/truemoveh4g/en/index.html.

[12] AEG Advisory (2015) and http://business.asiaone.com/news/infrastructure-takes-centre-stage-panel-convenes-thailands-digital-economy.

[13] http://a4ai.org/ghana-drops-import-tax-on-smartphones-following-advocacy-by-a4ai-ghana-coalition/.

4 Monitoring the price and affordability of ICTs

4.1 Introduction

The cost and affordability of ICT services remain a determining factor for ICT uptake.[1] There is ample evidence that, despite a consistent drop in ICT prices over recent years, the relatively high price of ICT services remains a major barrier to ICT usage, particularly for those ICT services that are far from reaching global coverage, such as broadband services.

Policy-makers in most countries recognize the importance of making ICT services affordable because ICTs have an impact on social and economic development that goes beyond the ICT sector itself. Indeed, this was recognized at the ITU Plenipotentiary Conference convened in Busan in 2014, which endorsed a shared global vision envisaging "an information society, empowered by the interconnected world, where telecommunications/ICTs enable and accelerate social, economic and environmentally sustainable growth and development for everyone" (ITU, 2014d).

Technological progress, liberalization, privatization and competition, together with the economies of scale derived from global standards, have made more efficient network infrastructure available at lower cost. Regulation is the main lever by which governments can influence competition in a given market, and many national regulatory authorities intervene in telecommunication/ICT markets following a two-phased approach: first, regulating wholesale markets; and then, if wholesale regulation is insufficient, regulating retail markets directly. For instance, mobile interconnection rates are regulated in most countries (86 per cent in 2014, according to the ITU Tariff Policies Survey), whereas retail price regulation is applied only in some countries (35 per cent of countries regulated retail mobile voice services in 2014, according to the ITU Tariff Policies Survey).

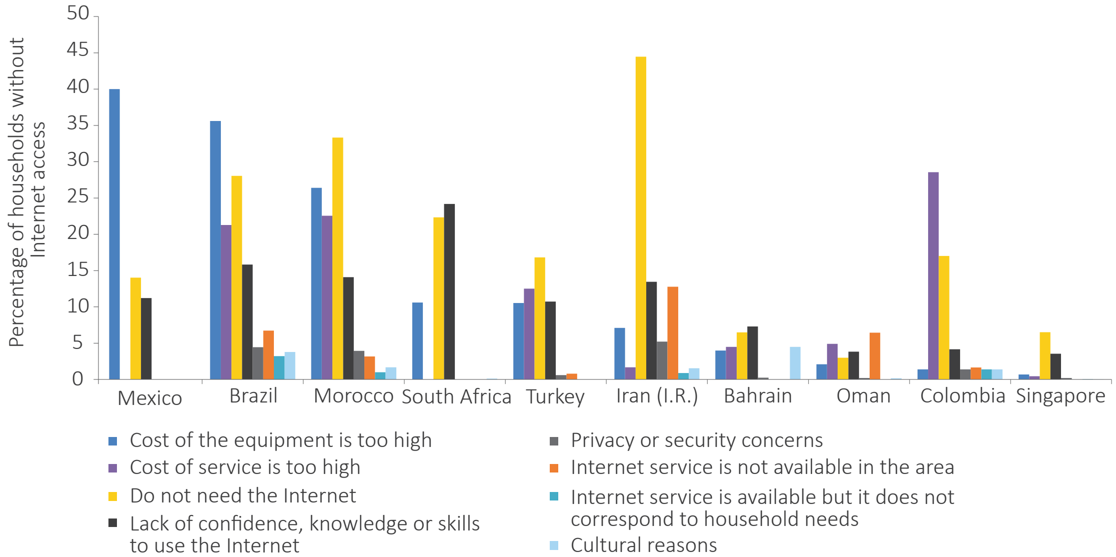
Other examples of regulatory actions that have an impact on competition and pricing include introducing mobile number portability and regulating wholesale prices for local loop access. Recent concrete examples include the Spanish regulator CNMC's revision of the limit on wholesale ADSL prices,[2] Israel's reduction of fixed-line interconnection rates,[3] and new mobile number portability regulation in Kazakhstan,[4] Senegal[5] and the United Arab Emirates (UAE).[6]

Countries, as well as international and regional organizations, are monitoring not only the price of ICT services but also their impact on ICT adoption. In the European Union, household surveys on ICT uptake include a question on barriers to Internet access at home. According to the 2014 Digital Agenda Scoreboard, which measures the progress of the European digital economy, "... the three most important reasons for households not having Internet access are that it is not needed (49 %), due to a lack of skills (37 %) and because the equipment (30 %) and access (26 %) costs are too high. All three reasons have become increasingly important over time. However, cost reasons have gained substantially in importance over the last year. Looking at different household types, cost factors are substantially more important reasons for not having Internet access at home amongst households with children and those on low incomes."[7]

Outside the European Union, only a small (but growing) number of countries collect data on barriers to Internet access. In 2013, ITU started collecting data on barriers to household Internet access at the international level, and the Partnership on Measuring ICT for Development added this indicator to its core list of indicators.

Available data from 2013 confirm that the costs of ICT equipment and services remain an important barrier in countries that track this information. In Mexico, Brazil and Colombia, populations covered by the survey indicate that either equipment costs or service costs are the most important reason for not having Internet access at home (Chart 4.1). In Morocco and Turkey, most people say that they "do not need the Internet", but costs remain the second most important reason for households remaining offline. In high-income economies such as Singapore and Bahrain, costs are less of an issue. Only in Oman is the unavailability of the service the most frequently cited barrier to

Chart 4.1: Barriers to household Internet access (as a percentage of households without Internet access), 2013



Note: Multiple answers regarding reasons for lack of Internet access are possible.
Source: ITU Yearbook of Statistics, 2014.

Internet access, which suggests that connecting the unconnected is more often an issue of prices, ICT skills and relevant content than of rolling out infrastructure.

Other stakeholders and international organizations have also highlighted the need to monitor and address the affordability of ICT services in order to ensure that more people, and in particular vulnerable groups at risk of being left behind (including low-income population groups and women), are able to join the information society. ICT prices are taken into consideration and form part of the following debates and initiatives:

- The importance of the affordability of ICT services has also been recognized at the highest international level, within the debate on the post-2015 development agenda. Indeed, under Sustainable Development Goal 9, which is about promoting infrastructure, industrialization and innovation, Target 9.c. calls for increased access to ICTs and affordable access to the Internet in least developed countries (LDCs).

- To increase the level of broadband uptake and allow more people to benefit from the information society, the Broadband Commission for Digital Development has made the affordability of broadband services a key objective and identified a clear target that countries should strive to achieve (see Box 5 for further information on this target).

- Affordability indicators are also part of several ICT indices, including the World Economic Forum's Networked Readiness Index (NRI), which takes into account the affordability of prepaid mobile calls and fixed broadband Internet access.

- GSMA, the industry association of mobile operators, found that among women, cost remained the greatest barrier to owning and using a mobile phone.[8]

- The Alliance for Affordable Internet (A4AI), a coalition of private sector, public sector and civil society organizations, has made affordable access to both mobile and fixed-line Internet in developing countries its main focus.

ITU collects and publishes price data for fixed-telephone, mobile-cellular and fixed- and mobile-broadband services, and has adapted its price data collection to ICT trends (Box 4.1).

This chapter will look first at the development of fixed- and mobile-cellular prices over the period 2008-2014, in absolute and relative terms, in USD, international dollars (PPP$) and as a percentage of GNI p.c. (Box 4.2), for both developed and developing countries. It will include the

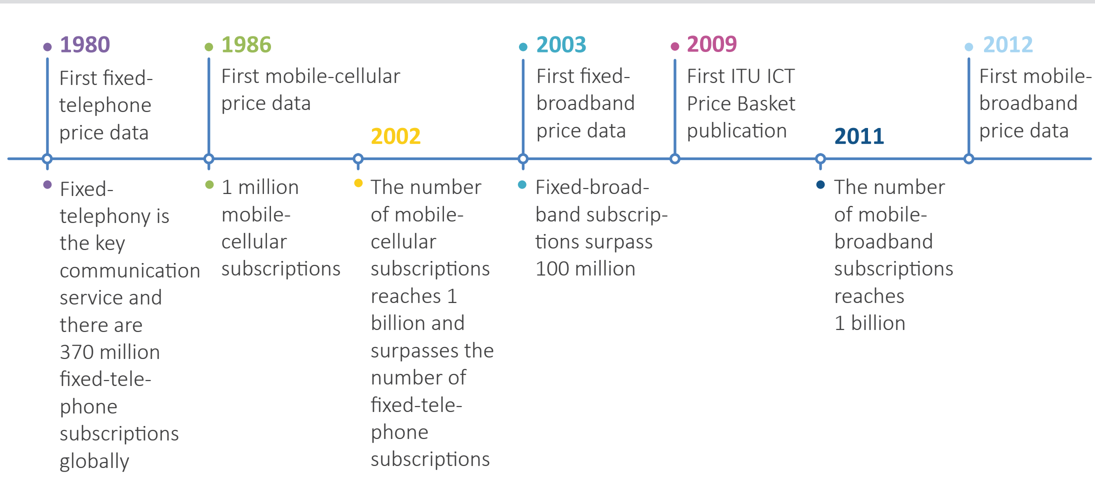
Box 4.1: Adapting ITU's price data collection to ICT developments

ITU has been tracking ICT prices for over 30 years (Figure Box 4.1). Price data collections have been adapted to ICT developments and the availability and prevalence of services. While data on fixed-telephone prices (monthly connection, subscription charges and per-minute call prices) go back to 1980, ITU's first mobile-cellular prices are available from the mid-1980s. Selected data on fixed-broadband prices are available from 2003, when fixed-broadband technologies were just starting to take off. Since 2008, when the number of fixed-broadband subscriptions had grown to over 400 million globally, ITU has been collecting comprehensive fixed-broadband prices for all countries. Since 2012, and with the rapid increase in mobile broadband, ITU has been collecting price data for different prepaid and postpaid mobile-broadband services.

In 2009, ITU published the first edition of the ICT Price Basket (IPB), the composite benchmarking tool that combines fixed-telephone, mobile-cellular and fixed-broadband tariffs into one measure and compares it across countries. IPB rankings are based on the relative price of these three services as a percentage of gross national income per capita (GNI p.c.) and the latest IPB is presented in Table 4.11 at the end of this chapter. The table includes end-of-2014 data for each of the three price sets contained in the IPB, as well as the IPB ranking combining the three sub-baskets expressed in terms of GNI p.c. The IPB remains relevant as a basic benchmarking tool that allows countries to assess their relative affordability of ICT prices, evaluate progress over time and identify challenges and shortcomings.

At the same time, recent ICT developments highlight major growth in mobile networks and services, and a shift from voice to data, with important developments in fixed- and mobile-broadband markets. Some countries in fact no longer offer fixed-telephone services, while others provide them mainly as bundled services, making the collection of fixed-telephone prices increasingly challenging. ITU's price data analysis has shifted accordingly, with greater emphasis on the fixed- and mobile-broadband services.

Figure Box 4.1: Timeline of ITU's ICT price data collection



Source: ITU.

presentation of the 2014 fixed- and mobile-cellular sub-baskets and country rankings and show some regional differences in the affordability of mobile-cellular prices. This will be followed by a more in-depth analysis of prices in the fixed- and mobile broadband market over the same period, which will highlight some pricing trends in the dynamic mobile-broadband services segment.

Box 4.2: Prices and affordability – relative and absolute ICT price values

Throughout this chapter, prices are expressed in both absolute and relative terms and in three complementary units:

- In USD, using the IMF annual rates of exchange.
- In international dollars (PPP$), using purchasing power parity (PPP) conversion factors instead of market exchange rates. The use of PPP exchange factors helps to screen out price and exchange-rate distortions, thus providing a measure of the cost of a given service taking into account purchasing power equivalences between countries.[9]
- As a percentage of countries' monthly GNI p.c. (Atlas method).[10] Prices are expressed as a percentage of GNI p.c. in order to show them in relation to the size of each country's economy, thus reflecting the affordability of each ICT service at a country level.

The methodological details of the IPB and the collection of mobile-broadband prices are available in Annex 3 to this report. Annex 5 includes the statistical tables of prices used to compute the ICT Price Basket.

Country rankings will be presented for the different fixed- and mobile-broadband sub-baskets, with the latter including both prepaid and postpaid packages and computer-based and handset-based plans. The analysis of fixed-broadband prices will include a discussion on changes in broadband speeds (offered for minimum broadband plans) and developments in terms of the data volume included in broadband offers. It will also review the achievements of the Broadband Commission's affordability target on fixed-broadband prices. A regional analysis will be provided for both fixed- and mobile-broadband services.

ITU's ICT price data collection and analysis over recent years has consistently pointed to falling prices and more affordable ICT services. However, in 2015, in many of the world's poorest countries, services remain unaffordable. Broadband Internet prices, in particular, remain high and unaffordable in the great majority of LDCs, and policies must be geared towards bringing down prices if more people are to join the information society.

4.2 Fixed-telephone and mobile-cellular prices

Fixed-telephone prices

Although fixed-line penetration reached its highest global level of 19.2 per cent in 2006 and has since been falling (to an estimated 14.4 per cent by the end of 2015), fixed telephony remains an important communication service in developed countries and in (mainly) urban areas of the developing world. In addition, it is still a basic service for medium-sized to large organizations (both public and private).

The great majority of people in the developing countries, in particular those in rural and remote areas, do not have access to the fixed-telephone network. Fixed networks have been overtaken by mobile-cellular networks, in terms both of geographical coverage and number of subscriptions.[11] In a few countries, the mobile network has entirely replaced the traditional fixed-line network.[12] This shift is confirmed by the growth in mobile traffic, with mobile voice call minutes largely outnumbering fixed voice call minutes across developed and developing countries. International voice call minutes remain an exception, as more international calls continue to be made over the fixed network, particularly in developed countries. This is due to the often relatively higher mobile prices compared to fixed prices for international calls and highlights the impact of prices on uptake and usage patterns.

ITU price data show that the fixed-telephone basket is relatively affordable compared to the mobile-cellular and (even more so) broadband baskets. At the same time, fixed prices have also shown the most moderate falls over the years,[13] with the exception of more significant decreases in the LDCs. Fixed-telephone price data for the period 2008-2014 confirm this trend, and, globally, price changes have been small in terms of USD, PPP$ and percentage of GNI p.c. (Chart 4.2).

A number of more nuanced trends can be discerned in terms of relative and absolute fixed-telephone prices.

- PPP-adjusted prices are fairly similar across the developed and developing countries and LDCs, ranging from PPP$ 18 to PPP$ 22 per month in 2014. This indicates that, on average, fixed-telephone services have the same price, taking into account the different purchasing power of currencies across countries. While the difference is relatively small, developing countries actually pay least and developed countries most, in terms of their PPP.

- In the LDCs, PPP-adjusted prices for the fixed-telephone basket were somewhat higher in 2008 (when they were on average PPP$ 23.7, compared with PPP$ 19 in the developed and developing regions), but have dropped and converged to prices similar to those in more developed countries.

- Since 2013, the fixed-telephone basket has represented on average less than 5 per cent of GNI p.c. in both developed and developing countries. Since 2008, prices have become slightly more affordable in developing countries and particularly so in the LDCs, where fixed-telephone prices represented on average close to 20 per cent of GNI p.c. in 2008, falling to about 12 per cent in 2013. This downward trend did not continue, however, and fixed telephony did not become more affordable in 2014.

- While the developed world has the highest fixed-telephone prices in both USD and PPP$, the fixed-telephone basket has represented only around 1 per cent of GNI p.c. since 2008. This highlights the fact that fixed-telephone services were and remain affordable in developed countries.

The country comparison and ranking of fixed-telephone prices in 2014 (see Table 4.1) shows that prices are not only relatively low but that the price differences between countries are small, at least compared to the differences observed in broadband prices (see Section 4.3): in close to one-third of all countries, the fixed-telephone basket represents less than 1 per cent of GNI p.c., and in the great majority of countries (86 per cent) the fixed-telephone basket corresponds to less than 5 per cent of GNI p.c. At the other end of the scale, 5 per cent of countries have fixed-telephone baskets that represent more than 20 per cent of GNI p.c.

While mobile-cellular and broadband prices tend to be most affordable in high-income economies, the most affordable fixed-telephone prices are found in the Islamic Republic of Iran, Cuba and Venezuela. This is due mainly to the fact that some governments keep control over the (sole) fixed-telephone operator and subsidize the service in order to keep prices low. In general, the fixed-line market has been much less open to competition, and basic telephony remains a monopoly in about one-third of all countries worldwide,[14] with cross-subsidies keeping prices low. Countries that have liberalized the market have ended cross-subsidies for fixed-telephone services and allowed for the deregulation of retail fixed-telephone prices.

Like the other price baskets, the bottom of the fixed-telephone basket ranking is dominated by low-income economies and LDCs. Not surprisingly, low-ranking countries where prices remain high in comparison to GNI p.c. levels are those where fixed-telephone penetration continues to be very low and is limited largely to urban areas. For example, in the Central African Republic, Malawi, Burkina Faso and Madagascar, fixed-telephone penetration was still less than 1 per cent in 2014.

Chart 4.2: Fixed-telephone basket, as a percentage of GNI p.c. (top graph), in USD (middle graph), and PPP$ (bottom graph), 2008-2014

Note: Simple averages. Based on 140 economies for which data on fixed-telephone prices were available for 2008-2014.
Source: ITU.

Table 4.1: Fixed-telephone sub-basket, 2014

		Fixed-telephone sub-basket			
Rank	Economy	as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*
1	Iran (I.R.)	0.05	0.25	0.76	5'774
2	Cuba	0.05	0.27		6'010
3	Venezuela	0.12	1.22	1.60	12'537
4	Qatar	0.13	9.07	12.32	86'703
5	Macao, China	0.16	8.39	11.35	64'639
6	Singapore	0.19	8.69	9.10	53'986
7	Moldova	0.21	0.43	1.04	2'468
8	Kuwait	0.23	8.79	13.54	46'046
9	Kazakhstan	0.27	2.62	5.23	11'538
10	Russian Federation	0.28	3.26	7.48	13'836
11	Bahrain	0.29	4.76	8.12	19'881
12	Korea (Rep.)	0.30	6.47	7.45	25'894
13	Norway	0.30	25.99	16.48	102'597
14	Andorra	0.31	10.55		40'974
15	UAE	0.33	10.62	14.60	38'713
16	Belarus	0.33	1.86	5.69	6'723
17	Suriname	0.40	3.10	5.25	9'361
18	Hong Kong, China	0.44	14.19	18.23	38'382
19	Switzerland	0.44	33.56	19.95	90'589
20	Brunei Darussalam	0.45	12.39	18.91	32'976
21	United States	0.45	20.20	20.20	53'417
22	Trinidad & Tobago	0.46	6.01	7.51	15'744
23	Luxembourg	0.47	27.60	21.15	69'810
24	Oman	0.48	10.17	19.43	25'381
25	Azerbaijan	0.52	3.19	7.60	7'343
26	Australia	0.55	29.70	21.43	65'335
27	Sweden	0.58	29.69	22.09	61'648
28	Japan	0.58	22.48	21.25	46'284
29	Malta	0.60	10.45	11.79	20'959
30	Saudi Arabia	0.60	13.20	26.96	26'234
31	Uzbekistan	0.62	0.97		1'878
32	Mauritius	0.64	5.11	8.24	9'560
33	Israel	0.65	18.36	15.14	33'896
34	Canada	0.66	28.89	24.71	52'158
35	Denmark	0.67	34.57	23.03	61'608
36	Germany	0.70	27.40	24.92	47'203
37	Iceland	0.72	27.64	22.27	46'244
38	Austria	0.76	31.71	27.53	50'340
39	Georgia	0.76	2.27	4.99	3'556
40	France	0.78	28.11	23.82	43'476
41	Maldives	0.78	3.62	4.71	5'594
42	Uruguay	0.79	9.97	12.45	15'165
43	Seychelles	0.79	8.72	13.05	13'197
44	Estonia	0.81	12.05	14.35	17'762
45	Armenia	0.84	2.64	5.71	3'796
46	Finland	0.85	34.51	26.07	48'771
47	Netherlands	0.85	36.22	30.33	51'009
48	Latvia	0.87	11.04	20.56	15'275
49	China	0.89	4.85	7.92	6'553
50	Yemen	0.89	0.98	2.19	1'329
51	Bahamas	0.90	16.25	14.29	21'548
52	Ukraine	0.92	3.02	11.19	3'956
53	Lithuania	0.93	11.50	16.83	14'885
54	Egypt	0.95	2.49	8.63	3'137
55	Guyana	0.97	3.04	4.67	3'746
56	Slovenia	1.00	19.34	21.65	23'197
57	Malaysia	1.01	8.74	17.99	10'420
58	Belgium	1.03	39.59	33.24	46'294
59	United Kingdom	1.03	35.87	27.65	41'638
60	Costa Rica	1.06	8.45	12.45	9'540
61	St. Kitts and Nevis	1.09	12.61	15.55	13'876
62	Sri Lanka	1.10	2.91	8.10	3'167
63	Lebanon	1.11	9.10		9'860
64	Cyprus	1.16	24.27	24.71	25'185
65	Kyrgyzstan	1.17	1.17	3.40	1'209
66	Antigua & Barbuda	1.18	12.78	15.55	13'037
67	Indonesia	1.19	3.54	9.57	3'576
68	Greece	1.21	22.81	23.79	22'667
69	Ireland	1.21	43.38	33.62	43'047
70	Slovakia	1.22	18.07	24.20	17'792
71	Italy	1.23	36.54	32.94	35'584
72	Viet Nam	1.24	1.80	4.44	1'738
73	Turkey	1.25	11.38	18.74	10'959
74	New Zealand	1.27	38.16	29.36	36'089
75	Croatia	1.27	14.20	19.68	13'407
76	Bhutan	1.30	2.52	7.92	2'328
77	Algeria	1.30	5.78	13.51	5'325
78	Thailand	1.32	5.85	14.55	5'335
79	Romania	1.33	10.00	17.31	9'041
80	Spain	1.33	33.17	33.01	29'910
81	Montenegro	1.33	8.05	13.19	7'243
82	Portugal	1.40	24.84	28.43	21'249
83	Tunisia	1.43	5.01	11.29	4'196
84	Ecuador	1.45	6.94	12.16	5'754
85	Mongolia	1.46	4.59	11.73	3'766
86	Serbia	1.48	7.45	13.33	6'044
87	Czech Republic	1.58	24.98	35.83	18'951
88	Equatorial Guinea	1.60	19.11	26.98	14'306
89	Poland	1.70	18.74	31.13	13'227
90	Barbados	1.73	22.00	17.74	15'219
91	Albania	1.77	6.64	12.34	4'505
92	Panama	1.81	16.08	27.37	10'689
93	Hungary	1.81	19.99	32.38	13'247
94	Swaziland	1.84	4.58	11.05	2'987
95	Bulgaria	1.86	11.38	21.59	7'353
96	India	1.87	2.45	8.52	1'568
97	Jordan	1.88	7.73	16.11	4'945
98	Brazil	1.90	18.50	24.28	11'678
99	St. Vincent	2.02	10.86	14.39	6'454
100	Botswana	2.05	13.29	24.44	7'762
101	Chile	2.07	26.28	38.13	15'215
102	Ethiopia	2.08	0.81	2.28	470
103	TFYR Macedonia	2.15	8.70	17.16	4'865
104	Dominica	2.15	12.39	16.53	6'923
105	Grenada	2.15	13.41	17.51	7'483
106	Mexico	2.18	18.07	25.67	9'930
107	Guatemala	2.23	6.21	11.85	3'337
108	Ghana	2.24	3.30	10.79	1'768
109	St. Lucia	2.28	13.41	16.58	7'053
110	Sudan	2.28	2.95	6.60	1'548
111	Peru	2.29	11.98	21.06	6'264
112	Fiji	2.39	8.69	13.12	4'366
113	Namibia	2.45	11.98	23.32	5'864
114	Paraguay	2.52	8.42	15.83	4'006
115	Morocco	2.56	6.42	12.92	3'017
116	Bosnia and H.	2.56	10.18	17.69	4'775
117	South Sudan	2.67	2.11		949
118	Jamaica	2.71	11.76	18.25	5'215
119	Afghanistan	2.74	1.57	4.56	689
120	South Africa	2.79	17.23	36.19	7'403
121	El Salvador	2.92	9.03	17.18	3'716
122	Colombia	2.96	18.68	30.74	7'582
123	Bangladesh	2.96	2.49	7.05	1'009
124	Nigeria	3.06	6.91	12.13	2'707
125	Dominican Rep.	3.08	14.77	29.56	5'764
126	Honduras	3.61	6.56	12.82	2'178
127	Cape Verde	3.62	10.91	18.97	3'616
128	Samoa	3.70	12.22	15.13	3'966
129	Angola	3.75	16.15	18.57	5'165
130	Lao P.D.R.	3.86	4.66	12.01	1'449
131	Nepal	4.11	2.50	8.37	729
132	Zambia	4.12	6.20	13.84	1'808
133	Lesotho	4.14	5.17	13.51	1'499
134	Micronesia	4.39	12.00		3'277
135	Nicaragua	4.57	6.81	17.40	1'788
136	Cambodia	4.80	3.80	9.82	949
137	Kiribati	5.17	11.27		2'617
138	Pakistan	5.21	5.90	20.56	1'359
139	Gabon	5.69	50.48	69.76	10'639
140	Philippines	5.79	15.77	36.15	3'267
141	Gambia	5.88	2.45	8.86	500
142	Timor-Leste	5.95	19.72	29.28	3'976
143	Belize	6.26	23.49	40.34	4'505
144	Sierra Leone	6.34	3.48	7.42	659
145	Burundi	6.34	1.37	3.54	260
146	S. Tome & Principe	6.74	8.24	13.08	1'469
147	Haiti	7.38	4.98	10.00	809
148	Papua New Guinea	7.68	12.92	14.04	2'018
149	Solomon Islands	8.21	10.94	10.50	1'598
150	Congo (Rep.)	8.97	19.35	30.35	2'587
151	Uganda	9.68	4.84	11.43	599
152	Eritrea	11.18	4.56		490
153	Bolivia	11.33	24.05	53.57	2'547
154	Marshall Islands	12.75	45.75		4'306
155	Kenya	13.19	12.74	28.31	1'159
156	Zimbabwe	14.22	10.18	18.62	859
157	Senegal	14.33	12.53	25.53	1'049
158	Vanuatu	15.12	39.40	33.26	3'127
159	Côte d'Ivoire	16.74	20.21	42.25	1'449
160	Mali	18.00	10.04	22.12	669
161	Tanzania	18.06	12.93	30.29	859
162	Togo	18.98	8.38	17.68	529
163	Benin	19.37	12.74	26.91	789
164	Chad	20.88	17.90	31.94	1'029
165	Burkina Faso	22.68	14.16	31.25	749
166	Mozambique	24.74	12.57	24.54	609
167	Comoros	28.92	20.23	33.83	839
168	Liberia	29.30	10.00	18.44	410
169	Mauritania	32.32	28.52	71.84	1'059
170	Niger	35.43	11.80	25.70	400
171	Malawi	47.04	10.57	38.63	270
172	Madagascar	47.38	17.36	54.70	440
173	Central African Rep.	93.77	24.98	44.47	320
	Argentina**		2.30		
	Somalia**		2.50		
	Djibouti**		7.65	13.06	
	San Marino**		20.90	20.19	
	Monaco**		21.44		
	Liechtenstein**		33.09		

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
** Country not ranked because data on GNI p.c. are not available for the last five years.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Mobile-cellular prices

Key drivers for strong growth in the mobile-cellular markets have been technological advances, prepaid payment methods and a marked fall in prices driven largely by a high degree of market liberalization and economies of scale. As the number of mobile-cellular subscriptions approaches 7.3 billion and mobile population coverage reaches close to 95 per cent globally, prices continue to fall. Mobile-cellular price data from 2008-2014 confirm that, globally, prices have continued to decrease in terms of USD and PPP$, as well as relative to the percentage of GNI p.c. (see Chart 4.3). Prices correspond to the monthly cost of a prepaid low-user basket including voice and SMS services (see Annex 2 for more information on the composition of the mobile-cellular basket).

The following key trends, among others, can be observed in terms of relative and absolute mobile-cellular prices.

- Between 2013 and 2014, prices continued to fall across both developed and developing regions, in relative as well as in absolute terms, albeit at lower rates than in previous years. Even in the developed countries, where mobile-cellular use has become relatively inexpensive, the mobile-cellular basket value has decreased in USD and PPP$ values and as a percentage of GNI p.c. (from an average of 1.5 per cent to 1.4 per cent).

- By 2014, the mobile-cellular basket represented on average 5.6 per cent of GNI p.c. in developing countries, down from 11.6 per cent in 2008. In the LDCs, mobile-cellular prices have become much more affordable, with the 2014 basket corresponding to 14 per cent of GNI p.c., compared to 29 per cent in 2008. In the developed countries, the basket represented on average 1.4 per cent of GNI p.c., compared to 2.4 per cent in 2008.

- As with fixed-telephone prices, mobile-cellular prices adjusted by PPP factors are remarkably and consistently similar on average across the developed and developing countries and LDCs. This suggests that, on average, mobile-cellular services have the same price when considering the different purchasing power of currencies across countries.

Table 4.2 ranks a total of 184 countries in terms of affordability of the mobile-cellular sub-basket and its price as a percentage of GNI p.c. The ranking highlights the fact that most high-income and developed countries are at the top of the list, while the world's low-income, developing countries have mobile-cellular prices that are relatively less affordable.

While there is a strong correlation between GNI p.c. and mobile-cellular prices, some countries offer much more affordable services than their GNI p.c. levels would lead us to predict, suggesting that they have successfully managed to drive competition and provide regulatory incentives for lower pricing. These countries include Sri Lanka (ranked 12th), as well as the Islamic Republic of Iran (ranked 17th), Costa Rica (21st), China (34th) and Mauritius (35th). Some other countries, on the other hand, continue to have relatively high mobile-cellular prices compared to their GNI p.c. levels, suggesting that more targeted policies, including those aiming to promote more competition, could be considered. Countries with relatively high prices relative to their GNI p.c. include a number of small island developing states (SIDS): Kiribati, Cabo Verde, Tuvalu, Vanuatu, the Marshall Islands, and Saint Vincent and the Grenadines. In these countries, small population size and particular aspects of geography may limit the number of operators able to compete sustainably in the market, highlighting some of the challenges that these small economies are facing.[15]

A regional analysis of mobile-cellular prices reveals some differences across and within regions.

CIS: A low-user basket has a price ranging between USD 5 and USD 10 per month in most countries of the Commonwealth of Independent States (CIS) (Chart 4.4). Indeed, the CIS is the most homogeneous region when it comes to mobile-cellular prices, which is explained by the relatively low number of countries included in the region[16] and by the prevalence of transnational operators such as MTS and VimpelCom, which offer their services in several CIS countries. In PPP terms, prices are significantly higher than in USD, and the regional average is comparable to that of the Arab States, thus showing that mobile-cellular prices are on average similar in both regions if differences in purchasing power of local currencies are taken into account. When the GNI p.c. of each country is taken into account in order to assess the

Chart 4.3: Mobile-cellular basket, as a percentage of GNI p.c. (top graph), in USD (middle graph), and PPP$ (bottom graph), 2008-2014

Note: Simple averages. Based on 140 economies for which data on mobile-cellular prices were available for 2008-2014.
Source: ITU.

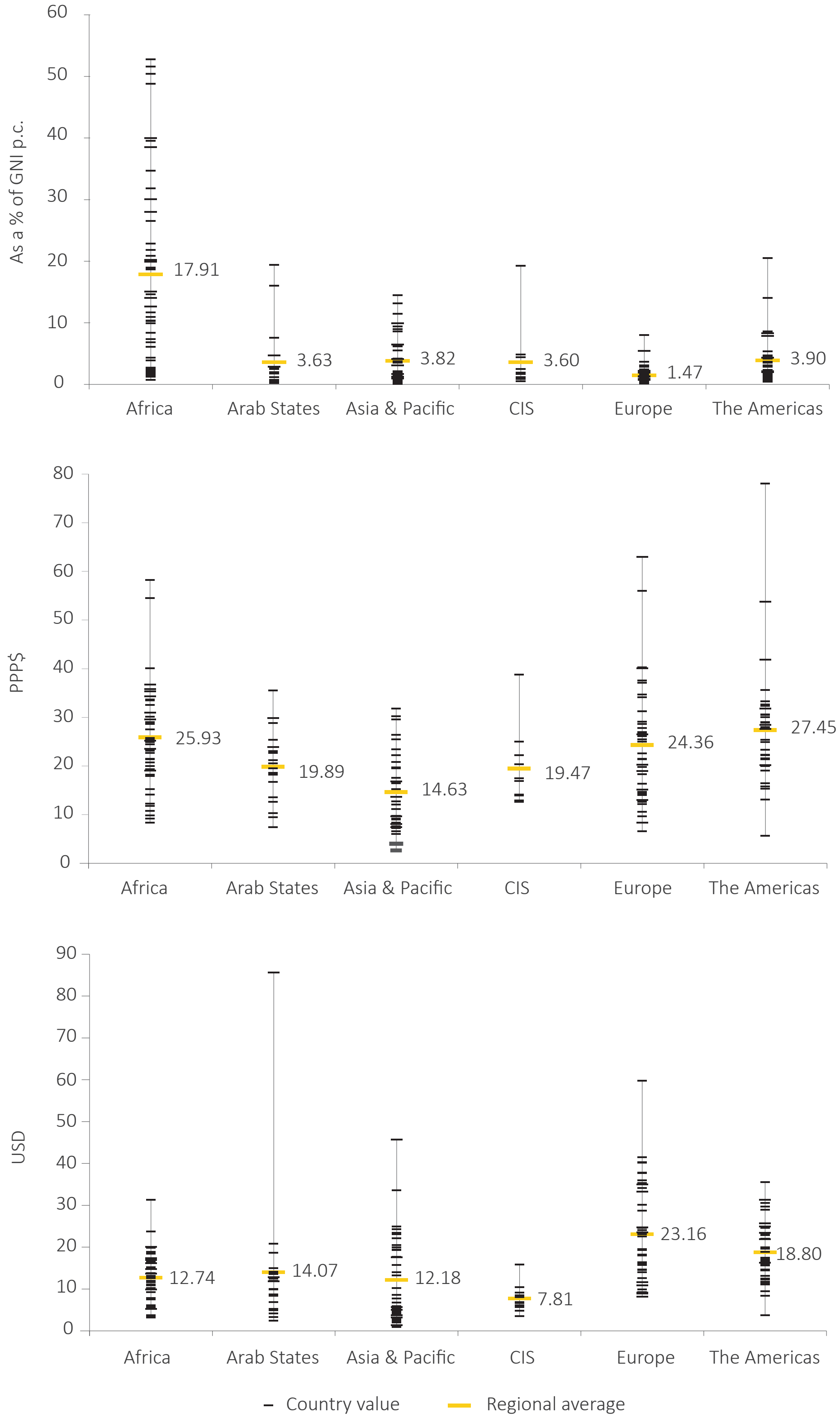
Table 4.2: Mobile-cellular sub-basket, 2014

Rank	Economy	Mobile-cellular sub-basket as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*
1	Macao, China	0.10	5.36	7.25	64'639
2	Hong Kong, China	0.19	5.96	7.66	38'382
3	Singapore	0.19	8.63	9.04	53'986
4	Denmark	0.19	9.88	6.58	61'608
5	Qatar	0.26	18.68	25.38	86'703
6	Norway	0.27	23.18	14.69	102'597
7	UAE	0.31	9.89	13.59	38'713
8	Luxembourg	0.31	18.31	14.03	69'810
9	Australia	0.33	17.69	12.77	65'335
10	Austria	0.33	14.01	12.16	50'340
11	Finland	0.34	14.01	10.58	48'771
12	Sri Lanka	0.37	0.97	2.69	3'167
13	Sweden	0.38	19.50	14.51	61'648
14	Kuwait	0.39	15.01	23.12	46'046
15	Cyprus	0.39	8.23	8.38	25'185
16	Oman	0.41	8.74	16.70	25'381
17	Iran (I.R.)	0.42	2.01	6.09	5'774
18	Germany	0.46	18.02	16.39	47'203
19	United Kingdom	0.47	16.45	12.68	41'638
20	Switzerland	0.48	36.02	21.41	90'589
21	Costa Rica	0.48	3.84	5.67	9'540
22	Greece	0.49	9.29	9.69	22'667
23	New Zealand	0.52	15.76	12.13	36'089
24	Russian Federation	0.53	6.09	13.97	13'836
25	Italy	0.54	15.92	14.35	35'584
26	Libya	0.61	6.89	12.69	13'497
27	Iceland	0.64	24.67	19.87	46'244
28	Saudi Arabia	0.65	14.13	28.86	26'234
29	Malaysia	0.68	5.87	12.08	10'420
30	Canada	0.68	29.76	25.46	52'158
31	Brunei Darussalam	0.71	19.40	29.60	32'976
32	Lithuania	0.72	8.88	12.99	14'885
33	Bahrain	0.73	12.05	20.54	19'881
34	China	0.75	4.07	6.65	6'553
35	Mauritius	0.77	6.11	9.85	9'560
36	United States	0.80	35.62	35.62	53'417
37	Poland	0.83	9.11	15.14	13'227
38	Latvia	0.86	10.89	20.28	15'275
39	Japan	0.87	33.64	31.80	46'284
40	Belgium	0.88	34.14	28.66	46'294
41	Kazakhstan	0.89	8.52	16.99	11'538
42	Korea (Rep.)	0.90	19.32	22.24	25'894
43	Portugal	0.90	16.01	18.33	21'249
44	Bahamas	0.97	17.48	15.37	21'548
45	Netherlands	0.98	41.47	34.73	51'009
46	Czech Republic	1.00	15.80	22.67	18'951
47	Mongolia	1.01	3.16	8.08	3'766
48	Ukraine	1.06	3.50	12.98	3'956
49	Slovakia	1.08	16.05	21.50	17'792
50	Andorra	1.11	37.73		40'974
51	France	1.11	40.27	34.11	43'476
52	Ireland	1.12	40.33	31.26	43'047
53	Belarus	1.19	6.66	20.43	6'723
54	Turkmenistan	1.20	6.88		6'873
55	Venezuela	1.20	12.56	16.47	12'537
56	Tunisia	1.20	4.21	9.48	4'196
57	Jordan	1.20	4.96	10.33	4'945
58	Trinidad & Tobago	1.22	16.04	20.04	15'744
59	Maldives	1.23	5.73	7.46	5'594
60	Slovenia	1.25	24.09	26.96	23'197
61	Israel	1.25	35.34	29.14	33'896
62	Seychelles	1.26	13.85	20.73	13'197
63	Mexico	1.34	11.12	15.80	9'930
64	Malta	1.35	23.51	26.51	20'959
65	Panama	1.41	12.59	21.43	10'689
66	Spain	1.52	37.80	37.62	29'910
67	Bhutan	1.52	2.95	9.26	2'328
68	Botswana	1.53	9.89	18.19	7'762
69	Estonia	1.58	23.32	27.78	17'762
70	Uruguay	1.58	19.99	24.97	15'165
71	St. Kitts and Nevis	1.64	18.96	23.37	13'876
72	South Africa	1.66	10.23	21.49	7'403
73	Bangladesh	1.68	1.42	4.01	1'009
74	Indonesia	1.69	5.05	13.67	3'576
75	Azerbaijan	1.71	10.49	25.01	7'343
76	Croatia	1.73	19.32	26.79	13'407
77	Thailand	1.76	7.83	19.49	5'335
78	Iraq	1.80	10.07	19.61	6'713
79	Chile	1.81	22.98	33.33	15'215
80	Pakistan	1.88	2.12	7.41	1'359
81	Namibia	1.89	9.21	17.94	5'864
82	Montenegro	1.92	11.61	19.01	7'243
83	Georgia	1.94	5.75	12.67	3'556
84	Jamaica	1.94	8.45	13.10	5'215
85	Barbados	1.97	24.98	20.15	15'219
86	Equatorial Guinea	1.99	23.77	33.55	14'306
87	Egypt	2.01	5.24	18.18	3'137
88	Suriname	2.09	16.33	27.66	9'361
89	India	2.14	2.80	9.74	1'568
90	Antigua & Barbuda	2.15	23.40	28.47	13'037
91	Hungary	2.24	24.75	40.10	13'247
92	Gabon	2.25	19.93	27.54	10'639
93	Brazil	2.27	22.05	28.95	11'678
94	Peru	2.36	12.30	21.64	6'264
95	Ghana	2.45	3.61	11.80	1'768
96	Turkey	2.47	22.56	37.16	10'959

Rank	Economy	Mobile-cellular sub-basket as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*
97	Lebanon	2.54	20.87		9'860
98	Armenia	2.56	8.10	17.49	3'796
99	Sudan	2.58	3.33	7.47	1'548
100	Nigeria	2.73	6.16	10.81	2'707
101	Algeria	2.88	12.78	29.85	5'325
102	Serbia	2.90	14.60	26.11	6'044
103	Dominica	2.90	16.74	22.33	6'923
104	Dominican Rep.	3.02	14.50	29.01	5'764
105	Romania	3.09	23.28	40.32	9'041
106	Lao P.D.R.	3.11	3.76	9.70	1'449
107	Colombia	3.12	19.71	32.43	7'582
108	Viet Nam	3.12	4.53	11.18	1'738
109	TFYR Macedonia	3.13	12.67	25.00	4'865
110	Paraguay	3.54	11.81	22.19	4'006
111	Tonga	3.56	13.30	15.23	4'486
112	Ecuador	3.58	17.17	30.09	5'754
113	Bosnia and H.	3.69	14.67	25.50	4'775
114	Grenada	3.74	23.34	30.48	7'483
115	Philippines	3.76	10.24	23.47	3'267
116	Kenya	3.90	3.77	8.37	1'159
117	Nepal	4.11	2.49	8.37	729
118	Guyana	4.21	13.15	20.23	3'746
119	Timor-Leste	4.24	14.04	20.84	3'976
120	Angola	4.33	18.62	21.41	5'165
121	St. Lucia	4.38	25.74	31.83	7'053
122	Moldova	4.44	9.13	22.24	2'468
123	St. Vincent	4.58	24.61	32.63	4'775
124	Morocco	4.73	11.90	23.93	3'017
125	El Salvador	4.76	14.73	28.03	3'716
126	Kyrgyzstan	4.86	4.90	14.17	1'209
127	Bolivia	5.38	11.43	25.46	2'547
128	Bulgaria	5.42	33.22	63.03	7'353
129	Fiji	5.51	20.04	30.25	4'366
130	Swaziland	6.12	15.22	36.73	2'987
131	Marshall Islands	6.19	22.22		4'306
132	Samoa	6.23	20.59	25.48	3'966
133	Micronesia	6.46	17.63		3'277
134	Congo (Rep.)	6.86	14.80	23.21	2'587
135	Zambia	7.42	11.19	24.96	1'808
136	Yemen	7.58	8.39	18.66	1'329
137	Guatemala	7.89	21.93	41.86	3'337
138	Albania	8.03	30.14	56.01	4'505
139	Belize	8.34	31.30	53.75	4'505
140	Ethiopia	8.39	3.28	9.19	470
141	Tanzania	8.43	6.03	14.14	859
142	Cambodia	8.62	6.82	17.62	949
143	Honduras	8.63	15.66	30.61	2'178
144	Vanuatu	8.98	23.40	19.75	3'127
145	Tuvalu	9.41	45.73		5'834
146	Afghanistan	9.91	5.69	16.51	689
147	South Sudan	9.93	7.85		949
148	S. Tome & Principe	10.32	12.63	20.03	1'469
149	Cape Verde	10.41	31.38	54.55	3'616
150	Lesotho	10.98	13.71	35.82	1'499
151	Kiribati	11.46	24.99		2'617
152	Rwanda	11.70	6.14	15.25	629
153	Gambia	12.67	5.27	19.10	500
154	Solomon Islands	13.18	17.56	16.85	1'598
155	Côte d'Ivoire	14.03	16.93	35.40	1'449
156	Haiti	14.06	9.48	19.06	809
157	Papua New Guinea	14.48	24.36	26.47	2'018
158	Guinea	14.67	5.62	12.31	460
159	Cameroon	15.10	16.22	34.34	1'289
160	Mauritania	16.00	14.12	35.56	1'059
161	Burkina Faso	18.68	11.66	25.74	749
162	Senegal	18.94	16.56	33.73	1'049
163	Tajikistan	19.26	15.88	38.78	989
164	Comoros	19.45	13.60	22.75	839
165	Uganda	19.93	9.96	23.55	599
166	Chad	20.23	17.34	30.95	1'029
167	Nicaragua	20.54	30.60	78.21	1'788
168	Benin	20.92	13.76	29.06	789
169	Sierra Leone	21.86	12.01	25.59	659
170	Mozambique	22.89	11.63	22.71	609
171	Mali	26.55	14.81	32.61	669
172	Zimbabwe	28.05	20.08	36.74	859
173	Guinea-Bissau	30.04	14.75	29.59	589
174	Eritrea	31.87	13.00		490
175	Burundi	34.72	7.51	19.39	260
176	Togo	38.48	16.98	35.84	529
177	Niger	39.57	13.18	28.70	400
178	Liberia	39.99	13.65	25.17	410
179	Malawi	48.86	10.98	40.13	270
180	Madagascar	50.45	18.48	58.25	440
181	Central African Rep.	51.64	13.76	24.50	320
182	Congo (Dem. Rep.)	52.76	18.89	30.18	430
	Somalia**		2.53		
	Myanmar**		4.84	16.70	
	Djibouti**		12.46	21.27	
	Nauru**		23.10		
	San Marino**		28.79	27.82	
	Argentina**		28.96		
	Liechtenstein**		34.95		
	Monaco**		59.80		
	Syria**		85.62		

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
** Country not ranked because data on GNI p.c. are not available for the last five years.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Chart 4.4: Mobile-cellular prices as a percentage of GNI p.c. (top chart), in USD (middle chart) and PPP$ (bottom chart) by region, 2014



Note: Each horizontal dash represents the price in one country in the region. The yellow marks signal the regional average.
Source: ITU.

affordability of mobile-cellular services, the average price of a mobile-cellular service in terms of GNI p.c. is very similar in the CIS, Arab States, Asia and the Pacific, and the Americas, thus suggesting that the affordability of the service is similar in these regions.

Arab States: Mobile-cellular services cost between USD 5 and USD 20 per month in most Arab States. Prices in PPP terms have a slightly wider range, from PPP$ 10 to PPP$ 30. An analysis of prices relative to GNI p.c. levels shows that in most Arab States mobile-cellular prices correspond to less than 5 per cent of GNI p.c. and that the service is therefore quite affordable. The exceptions are Comoros, Mauritania and Yemen, which are the LDCs with the lowest GNI p.c. levels in the region.

Nevertheless, the example of Sudan, the remaining LDC among the Arab States, shows that affordable mobile-cellular services are possible despite low economic levels, but only if entry-level mobile-cellular plans are offered at prices below USD 5 per month.

Africa: Mobile-cellular services cost between USD 5 and USD 20 per month in most African countries, a price range similar to that observed in the Arab States. Extending the price analysis to take into consideration purchasing power parities reveals that differences are more accentuated in Africa than the USD prices would suggest. Indeed, the cost of a prepaid mobile-cellular service falls within the range PPP$ 10 – PPP$ 40 in most African countries, which is similar to the price differences in PPP terms that are observed in Europe and the Americas, apart from some outliers.[17] But a regional comparison of prices relative to GNI p.c. levels gives a very different picture: Africa stands out as the region with the least affordable mobile-cellular prices because, although USD and PPP$ prices are similar to those in other regions, GNI p.c. levels in Africa are much lower.[18] Data from Africa show that only ten countries in the region have mobile-cellular prices that are at least as affordable as the average in other regions (averages in all other regions are below 4.0 per cent of GNI p.c.). The top ten countries with the most affordable mobile-cellular prices in Africa include the economies with the highest GNI p.c. in the region, such as Equatorial Guinea, Seychelles, Gabon, Mauritius, Botswana and South Africa, all of which have a GNI p.c. of above USD 7 000. Ghana (see Box 4.3), Kenya and Nigeria, despite having lower GNI p.c. levels, are also among the top ten African countries with the most affordable mobile-cellular services because of the low mobile-cellular prices offered (less than USD 6.5 per month in these three countries). This shows that the affordability of mobile-cellular services does not depend solely on a country's economic development and that competition and regulation can play an important role in making the service more affordable in many African countries. Nevertheless, in countries where GNI p.c. levels are very low, there are some limits to the effects of policy and regulatory action in the mobile market as a stimulus to make mobile-cellular prices affordable. For instance, very low mobile-cellular prices in USD terms in Ethiopia (USD 3.3 per month, but 8.4 per cent of GNI p.c.), Gambia (USD 5.3, 12.7 per cent of GNI p.c.) and Guinea (USD 5.6, 14.7 per cent of GNI p.c.) have not sufficed to make the service as affordable as it is in most other regions.

Asia and the Pacific: mobile-cellular prices range from USD 2 to USD 25 in most countries in Asia and the Pacific. The region is home to some of the most aggressive prepaid mobile-cellular offers in the world (less than USD 2 per month in Sri Lanka and Bangladesh), as well as some markets in which almost all subscriptions are postpaid (the case of the Republic of Korea and Japan) and where competition therefore occurs at the higher end of the demand curve. In PPP terms, Asia and the Pacific has the lowest average price of all regions. This highlights the fact that, despite the diversity of countries within the region, mobile-cellular prepaid services are offered at competitively low prices in almost all these countries. Variations are wider within the region when prices are considered relative to GNI p.c. levels, and 30 per cent of countries in Asia and the Pacific have mobile-cellular prices that represent more than 5 per cent of GNI p.c. These include Vanuatu, Tuvalu, Kiribati and Papua New Guinea, where regulatory and policy action faces the challenges of the small population size and the particular geography of these island economies.

The Americas: mobile-cellular prices range from USD 9 to USD 30 in the Americas, and the regional average is higher than in all other regions except Europe. Such price differences reflect the diverse economic and market conditions in countries within the region. For instance, in Costa Rica the effective liberalization of the mobile

Box 4.3: Ghana's steady way to low prices and high mobile penetration

Ghana's mobile-cellular market combines a number of key ingredients that have created a conducive regulatory environment, increased competition, brought down prices and fostered high penetration. In 2015, the country ranks 97th globally on the mobile-cellular sub-basket and 8th in Africa. Despite the country's low GNI p.c. of less than USD 2 000, Ghana has managed to make ICTs, and in particular mobile services, widely available and affordable.

Ghana's mobile-cellular market has witnessed a decade of sustained growth. In 2012, the country reached 100 per cent penetration and by 2014, penetration stood at 115 per cent, well above the African average of 73 per cent.

Ghana was an early adopter of deregulation, and competition goes back to the mid-1990s. It was one of the first countries to offer mobile-cellular services in 1992.[19] In 2015, this country of 27 million people is serviced by no less than six mobile cellular operators, including five GSM operators: South Africa's MTN (Scancom), the United Kingdom's Vodafone, Luxembourg's Millicom/Tigo, Nigeria's Glo and India's Bharti Airtel. MTN leads with a market share of 46 per cent, followed by Vodafone (23 per cent), Tigo (14 per cent), Airtel (12 per cent) and Glo (5 per cent). Sudatel-owned Expresso, providing CDMA services, holds 0.4 per cent of the mobile voice market.[20] Operators offer a number of low-user adjusted pricing plans and special offers in particular to attract Ghana's low-income user base.

Another driving force for competition was the introduction of mobile number portability (MNP) in 2011. MNP allows subscribers to switch between operators while keeping their existing number. In February 2015, the independent regulator (NCA) announced that the "milestone of 2 million successful porting requests processed for Ghana consumers" had been reached. The same announcement highlighted the fact that "95 per cent of all porting requests were completed in five minutes or less, and no customer was charged to port their number".[21]

The NCA has effectively managed interconnection between operators, spectrum allocation and access to the international gateway.[22] The Government has identified national ICT policies setting out means for regulating telecommunication prices, and set a number of targets for universal service and access and for quality of service, with provisions to monitor progress towards the achievement of these targets.[23] A 2014 review of 23 universal service funds (USFs) in Africa commends Ghana for its transparency and use of best practice in the development and administration of its fund (GSMA, 2014b).

Source: ITU.

market in 2011 turned the market inside out, from a predominantly postpaid to a dynamic prepaid-led mobile market (Superintendencia de Telecomunicaciones, Costa Rica, 2014). On the other hand, in the United States (prepaid-mobile basket at USD 35.6 per month), fewer than 25 per cent of total subscriptions are prepaid and most innovative offers are for all-bundled postpaid family plans.[24] In PPP terms, most countries in the region have prices in the range PPP$ 15 – PPP$ 35, and the average is the highest of all regions, which suggests that there is scope for further reductions in mobile-cellular prices in the Americas. Nevertheless, prices relative to GNI p.c. levels are below 5 per cent in most countries in the region, so that mobile-cellular services are already moderately affordable in most countries. Countries where mobile-cellular prices correspond to more than 5 per cent of GNI p.c. include Guatemala, Belize, Honduras, Haiti and Nicaragua. In these countries, policy and regulatory attention should be focused on achieving lower mobile-cellular prices, particularly in Belize and Haiti, the countries with the lowest mobile-cellular penetration in the region.

Europe: prepaid mobile-cellular prices in European countries vary between USD 9 and USD 40, the widest range of all regions. Differences in PPP terms are similar, but caution must be exercised when analysing these results because of the particularities of mobile-cellular markets within the region. Indeed, in most European countries, mobile-cellular subscriptions are mostly postpaid and plans tend to be bundled (voice, SMS and data). This makes the prepaid low-user mobile-cellular basket less representative in Europe than in other regions. Nevertheless, cheap pay-as-you-go offers are available in some European countries where prepaid still represents about half of the total market, for example in Cyprus, Lithuania and Poland, all with prices at around USD 9 per month. Despite the variation in mobile-cellular prices, Europe is the region with the most affordable mobile-cellular services when GNI p.c. levels are factored in. This is largely explained by the overall high levels of GNI p.c., which make Europe the region with the highest average GNI p.c. and the lowest differences in GNI p.c. levels between countries, together with the CIS.[25] As a result, mobile-cellular prices correspond to less than 1 per cent of GNI p.c. in half of European countries, and to less than 3 per cent of GNI p.c. in nine out of ten countries in the region.

4.3 Fixed-broadband prices

While in many developing countries, and especially in remote and rural areas, mobile-broadband has become the dominant, and often the only available, broadband access technology, fixed-broadband remains very important. Fixed-broadband subscriptions still tend to provide not only higher speeds but also a more reliable connection. In a recent report, the Organisation for Economic Co-operation and Development (OECD) highlighted the importance of the fixed-broadband network for the development of the information and Internet economy (OECD, 2014).[26]

Global fixed-broadband price trends

Fixed-broadband services have ceased to become cheaper or more affordable and remain, as of early 2015, relatively expensive and unaffordable for large parts of the world's population. Some more detailed findings from ITU's fixed-broadband price data include the following (see Chart 4.5).

- While fixed-broadband prices fell throughout the world until 2013, the trend has since changed. Overall, fixed-broadband prices are stagnating and the service is even becoming more expensive in a number of developing countries. In more than half the countries for which ITU has fixed-broadband price data for 2013 and 2014, the service became either more expensive as a percentage of GNI p.c. or remained the same. These developments, which distinguish fixed-broadband services from all other services for which ITU collects data, are alarming, since higher fixed-broadband prices will remain a major barrier to further uptake.

- In developing countries, fixed-broadband prices remain relatively high, and actually became less affordable during last year. In 2014, the ITU basket in developing countries represented an average of 29 per cent of GNI p.c., up from 25 per cent a year earlier. Globally, the fixed-broadband basket as a percentage of GNI p.c. grew from 17.9 to 20.8 per cent. This average conceals huge differences between individual countries but shows that, in many developing countries, the service remains out of reach for many people, especially those with low incomes. In

Table 4.3: Fixed-broadband prices as a percentage of GNI p.c., by region, 2014

Region	Average	Standard deviation	Minimum	Maximum	Median
Europe	1.3	0.7	0.5	3.5	1.1
CIS	3.6	2.9	0.7	10.7	3.2
Americas	7.4	11.8	0.4	63.5	4.5
Arab States	9.2	17.5	0.3	71.3	2.8
Asia & Pacific	16.0	39.1	0.3	221.7	4.4
Africa	178.3	398.3	1.4	2194.2*	39.2

Note: Based on 165 economies for which 2013 data on fixed-broadband prices were available. *The high maximum value for Africa is due to a few outliers, in particular the very high price for fixed broadband in the Central African Republic.
Source: ITU.

Chart 4.5: Fixed-broadband basket: as a percentage of GNI p.c. (top graph), in USD (middle graph) and PPP$ (bottom graph), 2008-2014

Note: Simple averages. Based on 144 economies for which 2008-2014 data on fixed-broadband prices are available. Excludes Cuba.
Source: ITU.

the LDCs, the average grew from 70 to 98 per cent, a sharp increase that will certainly not improve the already very low uptake of fixed-broadband in the world's poorest countries.

- PPP-adjusted prices also highlight how expensive the service remains in the world's LDCs, where the 2014 basket costs on average as much as PPP$ 130, compared to PPP$ 26.8 in the developed regions.

- In developed countries, the fixed-broadband basket has been relatively affordable for a number of years, but prices are no longer falling. Between 2008 and 2013, the price of the fixed-broadband basket as a percentage of GNI p. c. fell from 2.3 to 1.4. That figure remained unchanged in 2014.

- While prices for fixed-broadband services are comparable in absolute USD terms across developed and developing countries, they remain much higher in terms of PPP-adjusted values: in 2014, fixed-broadband services in developed countries cost PPP$ 27, compared to PPP$ 65 in developing countries. This is not the case for fixed-telephone and mobile-cellular prices (for which PPP$ values are almost the same in developed and developing regions). This shows that in developing countries, fixed-broadband services remain expensive and suggests that greater efforts should be made to bring down prices in developing countries, at least to PPP-adjusted values similar to those in developed countries.

Country-level data on fixed-broadband prices reveal a very strong link between a country's GNI p.c. and the affordability of the service (Table 4.4). Based on a calculation of the different ITU sub-baskets, which take into account GNI p.c. levels, it is generally true that the higher a country's GNI p.c., the more affordable the service. However, the link is particularly strong for fixed broadband, and in countries with very low income levels fixed-broadband services remain largely unaffordable. In about 30 per cent of developing countries the fixed-broadband basket represents more than 10 per cent of GNI p.c.; in eight countries it represents more than 100 per cent.

The countries ranked at the top of the fixed-broadband basket – those in which the service is cheapest in terms of GNI p.c. – are all high-income economies. The list is topped by Kuwait, Macao (China), the United States, the United Kingdom, Switzerland and Japan. The top ten economies all have GNI p.c. levels of above USD 40 000. With the exception of three countries – the Islamic Republic of Iran, Ukraine and Romania (see Box 4.4) – the economies ranked within the top 50 have GNI p.c. levels of above USD 10 000. The Russian Federation also stands out for having entry-level fixed-broadband services that are relatively affordable compared to the country's income level.

Countries ranked at the bottom, on the other hand, are low-income countries, most of them LDCs. Many of the countries with the least affordable fixed-broadband prices are also SIDS, such as the Solomon Islands, Kiribati, Comoros, Haiti and Cuba. The service also remains unaffordable in many of the world's landlocked developing countries (LLDCs), including Rwanda, Chad, Burundi and Burkina Faso. In these countries, fixed-broadband prices tend to be high and infrastructure limited, partly owing to the limited availability of international Internet bandwidth, which remains a key element of Internet access. Cuba, Iraq and Equatorial Guinea, but also Antigua and Barbuda, stand out for having somewhat higher GNI p.c. levels but also high prices, which suggests that either market regulation is not optimized or that other circumstances, such as the continued political instability in Iraq, keep prices high.

While in 2014 fixed-broadband prices stopped falling, and actually increased in the world's LDCs, only a limited number of countries offer better (higher) speeds, as well as more data for money. This suggests that higher prices do not usually come with higher or better quality connections. In 2014, the most common entry-level fixed-broadband speed was still 5 Mbit/s for developed countries and 1 Mbit/s for developing countries (Chart 4.6). In the LDCs the most common plan in 2014 remained the basic 256 kbit/s connection, and only three LDCs – Bhutan, Cambodia and Timor-Leste – offer the basic fixed-broadband connection with speeds above 1 Mbit/s.

Table 4.4: Fixed-broadband sub-basket, 2014

Rank	Economy	Fixed-broadband sub-basket as % of GNI p.c.	USD	PPP$	Speed in Mbit/s	Cap per month in GB	GNI p.c., USD, 2014*
1	Kuwait	0.29	11.25	17.33	1	Unlimited	46'046
2	Macao, China	0.32	17.28	23.37	4	Unlimited	64'639
3	United States	0.37	16.32	16.32	2	Unlimited	53'417
4	United Kingdom	0.47	16.45	12.68	17	10	41'638
5	Switzerland	0.49	37.11	22.06	5	Unlimited	90'589
6	Japan	0.53	20.59	19.46	12	900	46'284
7	Austria	0.61	25.41	22.06	8	Unlimited	50'340
8	Andorra	0.61	20.80		0.5	2	40'974
9	Norway	0.61	52.21	33.10	6	Unlimited	102'597
10	Luxembourg	0.66	38.48	29.48	8	2	69'810
11	Ireland	0.67	23.88	18.51	100	30	43'047
12	Hong Kong, China	0.68	21.67	27.85	200	Unlimited	38'382
13	Russian Federation	0.68	7.82	17.94	15	100	13'836
14	Singapore	0.70	31.49	32.97	100	Unlimited	53'986
15	France	0.77	27.86	23.60		Unlimited	43'476
16	Iceland	0.84	32.46	26.15	12	5	46'244
17	Sweden	0.85	43.58	32.42	10	Unlimited	61'648
18	Belgium	0.88	33.83	28.41	30	100	46'294
19	Finland	0.88	35.69	26.96	10	Unlimited	48'771
20	Iran (I.R.)	0.88	4.24	12.84	0.26	2	5'774
21	Qatar	0.89	64.01	86.99	1	Unlimited	86'703
22	Denmark	0.90	46.15	30.75	25	Unlimited	61'608
23	Trinidad & Tobago	0.94	12.33	15.41	0.25	Unlimited	15'744
24	Italy	0.98	29.06	26.20	7	Unlimited	35'584
25	Canada	1.00	43.35	37.09	5	40	52'158
26	Cyprus	1.01	21.28	21.67	2	Unlimited	25'185
27	Netherlands	1.01	43.12	36.10	10	Unlimited	51'009
28	Czech Republic	1.06	16.81	24.12	2	Unlimited	18'951
29	Uruguay	1.08	13.64	17.03		5	15'165
30	Kazakhstan	1.12	10.77	21.49	1	10	11'538
31	Poland	1.12	12.36	20.54	0.5	Unlimited	13'227
32	Bahrain	1.12	18.62	31.74	2	25	19'881
33	Latvia	1.14	14.46	26.93	5	Unlimited	15'275
34	Turkey	1.15	10.46	17.23	1	1	10'959
35	Ukraine	1.15	3.79	14.04	5	Unlimited	3'956
36	Romania	1.15	8.66	14.99	100	Unlimited	9'041
37	Germany	1.18	46.37	42.18	16	Unlimited	47'203
38	Israel	1.21	34.10	28.11	5	Unlimited	33'896
39	Saudi Arabia	1.21	26.40	53.93	2	Unlimited	26'234
40	Australia	1.21	65.80	47.48	8	50	65'335
41	Oman	1.23	26.01	49.69	2	Unlimited	25'381
42	Greece	1.23	23.30	24.30	4	Unlimited	22'667
43	Lithuania	1.24	15.34	22.46	100	Unlimited	14'885
44	Spain	1.28	31.95	31.79	1	5	29'910
45	Brazil	1.30	12.66	16.62	1	Unlimited	11'678
46	Slovenia	1.30	25.21	28.21	1	Unlimited	23'197
47	Korea (Rep.)	1.32	28.49	32.80	50	Unlimited	25'894
48	Slovakia	1.34	19.90	26.66	2	300	17'792
49	Estonia	1.43	21.23	25.28	5	Unlimited	17'762
50	Seychelles	1.44	15.79	23.62	1.02	1.5	13'197
51	Belarus	1.57	8.79	26.96	2	Unlimited	6'723
52	Portugal	1.61	28.51	32.63	12	Unlimited	21'249
53	Sri Lanka	1.63	4.29	11.95	2	2.5	3'167
54	Venezuela	1.65	17.19	22.53	1	Unlimited	12'537
55	Tunisia	1.67	5.83	13.15	2	Unlimited	4'196
56	Bahamas	1.67	29.99	26.37	1	Unlimited	21'548
57	UAE	1.68	54.19	74.50	0.51	Unlimited	38'713
58	Albania	1.77	6.64	12.34	1	1	4'505
59	Malta	1.79	31.18	35.16	30	Unlimited	20'959
60	New Zealand	1.79	53.92	41.49		80	36'089
61	Panama	1.80	16.04	27.30	1	Unlimited	10'689
62	Costa Rica	1.82	14.49	21.37	1	Unlimited	9'540
63	Bulgaria	1.86	11.40	21.62	15	Unlimited	7'353
64	Brunei Darussalam	1.87	51.30	78.28	1	Unlimited	32'976
65	Bosnia and H.	1.99	7.94	13.80	2	2	4'775
66	Viet Nam	2.00	2.89	7.15	2.5	1.00	1'738
67	Croatia	2.02	22.57	31.29	4	15	13'407
68	Azerbaijan	2.08	12.75	30.39	1	Unlimited	7'343
69	Libya	2.10	23.58	43.40	0.51	20	13'497
70	Lebanon	2.13	17.51		2	40	9'860
71	Chile	2.21	28.04	40.67	4	Unlimited	15'215
72	Hungary	2.22	24.51	39.69	10	Unlimited	13'247
73	Mongolia	2.28	7.15	18.26	1	Unlimited	3'766
74	South Africa	2.46	15.20	31.94	2	10	7'403
75	Mauritius	2.87	22.83	36.82	0.51	Unlimited	9'560
76	Colombia	2.93	18.48	30.41	1	Unlimited	7'582
77	Maldives	2.94	13.71	17.84	2	5	5'594
78	Malaysia	3.10	26.89	55.36	1	Unlimited	10'420
79	Indonesia	3.11	9.27	25.09	0.5	Unlimited	3'576
80	Montenegro	3.13	18.88	30.92	1	1	7'243
81	St. Kitts and Nevis	3.17	36.67	45.20	2	Unlimited	13'876
82	Mexico	3.17	26.26	37.30	5	Unlimited	9'930
83	TFYR Macedonia	3.18	12.90	25.45	4	30	4'865
84	Armenia	3.19	10.10	21.81	1	Unlimited	3'796
85	Barbados	3.35	42.50	34.28	6	Unlimited	15'219
86	Gabon	3.42	30.34	41.92	0.51	Unlimited	10'639
87	Serbia	3.48	17.52	31.34	5	Unlimited	6'044
88	Sudan	3.51	4.53	10.15	0.51	2	1'548
89	Cape Verde	3.55	10.71	18.62	2	3.40	3'616
90	China	3.58	19.53	31.92	1	Unlimited	6'553
91	Thailand	3.63	16.13	40.14	6	Unlimited	5'335
92	Peru	4.02	20.99	36.91	1	Unlimited	6'264
93	Egypt	4.05	10.60	36.74	8	5	3'137
94	Ecuador	4.20	20.16	35.33	3	Unlimited	5'754
95	Turkmenistan	4.30	24.65		2	1	6'873
96	Dominican Rep.	4.32	20.74	41.50	1.00	Unlimited	5'764
97	Algeria	4.35	19.31	45.11	0.51	Unlimited	5'325
98	Pakistan	4.36	4.94	17.22	1.00	10	1'359
99	Bhutan	4.43	8.59	26.95	2.00	4	2'328
100	Morocco	4.68	11.78	23.70	4.00	Unlimited	3'017
101	Grenada	4.71	29.39	38.38	2.00	Unlimited	7'483
102	Uzbekistan	4.73	7.40		0.25	1.17	1'878
103	Suriname	4.77	37.23	63.07	6.14	Unlimited	9'361
104	Georgia	4.78	14.16	31.20	10.00	Unlimited	3'556
105	Botswana	5.00	32.32	59.45	0.51	Unlimited	7'762
106	Antigua & Barbuda	5.06	54.94	66.85	1.00	Unlimited	13'037
107	Fiji	5.10	18.54	28.00	10.00	5	4'366
108	India	5.28	6.90	24.04	2.00	1.5	1'568
109	Bangladesh	5.28	4.44	12.59	0.25	2	1'009
110	Moldova	5.54	11.40	27.76	30.00	Unlimited	2'468
111	Jamaica	5.68	24.68	38.29	1.00	Unlimited	5'215
112	El Salvador	5.83	18.07	34.39	1.00	Unlimited	3'716
113	Paraguay	6.12	20.44	38.42	0.75	Unlimited	4'006
114	St. Lucia	6.16	36.20	44.77	2.00	Unlimited	7'053
115	St. Vincent	6.26	33.65	44.61	1.00	Unlimited	6'454
116	Dominica	6.57	37.91	50.57	2.00	Unlimited	6'923
117	Bolivia	6.75	14.33	31.91	0.30	Unlimited	2'547
118	Guatemala	6.93	19.27	36.79	1.00	Unlimited	3'337
119	Lesotho	7.31	9.12	23.83	1.00	1	1'499
120	Jordan	7.35	30.28	63.10	1.00	10	4'945
121	Guyana	7.76	24.21	37.26	0.25	Unlimited	3'746
122	Philippines	8.27	22.50	51.59	3.00	Unlimited	3'267
123	Namibia	9.41	45.98	89.53	0.26	Unlimited	5'864
124	Yemen	9.46	10.47	23.28	0.26	9	1'329
125	South Sudan	9.69	7.66		0.51	2	949
126	Tonga	9.83	36.74	42.07		5	4'486
127	Tuvalu	9.92	48.23			Unlimited	5'834
128	Equatorial Guinea	10.18	121.36	171.29	0.26	Unlimited	14'306
129	Kyrgyzstan	10.66	10.74	31.07	0.50	Unlimited	1'209
130	Nepal	11.09	6.74	22.61	0.50	7	729
131	Angola	11.57	49.81	57.24	0.26	Unlimited	5'165
132	Lao P.D.R.	11.84	14.29	36.85	0.50	Unlimited	1'449
133	Micronesia	12.09	33.00		0.25	Unlimited	3'277
134	Honduras	12.12	22.00	43.01	0.50	Unlimited	2'178
135	Cambodia	12.64	10.00	25.83	2.00	Unlimited	949
136	Samoa	12.85	42.46	52.55	2.00	3	3'966
137	Belize	13.32	50.00	85.88	0.26	Unlimited	4'505
138	Marshall Islands	13.92	49.95		0.25	Unlimited	4'306
139	Mauritania	14.25	12.57	31.66	0.26	Unlimited	1'059
140	Timor-Leste	14.79	49.00	72.75	2.00	6	3'976
141	Ghana	15.68	23.11	75.51	4.00	20	1'768
142	Nicaragua	16.10	23.99	61.31	0.50	Unlimited	1'788
143	Nigeria	17.02	38.40	67.39	1.00	5	2'707
144	Swaziland	23.21	57.77	139.38	0.26	6	2'987
145	Vanuatu	23.52	61.29	51.74	0.25	Unlimited	3'127
146	Tanzania	25.28	18.10	42.41	0.51	Unlimited	859
147	S. Tome & Principe	27.10	33.17	52.60	1.00	12	1'469
148	Papua New Guinea	30.92	52.00	56.51	4.00	1	2'018
149	Côte d'Ivoire	31.07	37.50	78.41	0.26	Unlimited	1'449
150	Ethiopia	32.74	12.81	35.88	0.51	2	470
151	Iraq	34.49	192.97	375.98	0.26	Unlimited	6'713
152	Zimbabwe	34.92	25.00	45.74	0.26	10	859
153	Kenya	35.32	34.11	75.81	0.26	Unlimited	1'159
154	Cuba	35.94	180.00		0.25	Unlimited	6'010
155	Cameroon	37.67	40.45	85.67	0.26	Unlimited	1'289
156	Afghanistan	38.01	21.84	63.30	0.25	Unlimited	689
157	Mozambique	40.82	20.73	40.50	0.51	Unlimited	609
158	Senegal	41.65	36.41	74.17	1.00	Unlimited	1'049
159	Zambia	43.14	65.01	145.03	0.26	Unlimited	1'808
160	Congo (Rep.)	45.36	97.81	153.43	0.26	Unlimited	2'587
161	Haiti	63.50	42.82	86.07	0.25	Unlimited	809
162	Burkina Faso	71.27	44.50	98.22	0.26	Unlimited	749
163	Comoros	71.34	49.89	83.44	0.51	Unlimited	839
164	Benin	76.88	50.56	106.80	0.51	Unlimited	789
165	Sierra Leone	78.45	43.10	91.82	1.00	Unlimited	659
166	Mali	85.58	47.73	105.12	0.26	Unlimited	669
167	Gambia	86.35	35.94	130.21	0.26	Unlimited	500
168	Togo	102.20	45.09	95.20	0.26	Unlimited	529
169	Kiribati	103.32	225.35		0.25	Unlimited	2'617
170	Malawi	111.22	25.00	91.35	0.26	Unlimited	270
171	Guinea-Bissau	119.42	58.66	117.64	0.26	Unlimited	589
172	Madagascar	168.45	61.70	194.49	8.00	Unlimited	440
173	Niger	180.70	60.17	131.07	0.26	Unlimited	400
174	Eritrea	214.13	87.35		0.26	Unlimited	490
175	Solomon Islands	221.74	295.35	283.42	0.26	12	1'598
176	Burundi	238.96	51.72	133.45	0.26	Unlimited	260
177	Uganda	600.60	300.00	709.41	0.26	Unlimited	599
178	Chad	698.62	599.05	1068.99	0.26	Unlimited	1'029
179	Rwanda	830.94	435.81	1083.17	0.51	Unlimited	629
180	Congo (Dem. Rep.)	1111.08	397.74	635.57	0.51	2	430
181	Central African Rep.	2194.18	584.53	1040.74	0.26	Unlimited	320
	Myanmar**		21.50	74.22	0.50	Unlimited	
	San Marino**		22.09	21.34	20.00	Unlimited	
	Liechtenstein**			27.29		3.00	Unlimited
	Djibouti**		31.61	53.96	0.26	5	
	Argentina**		41.73		3.00	Unlimited	
	Monaco**		46.30		60.00	Unlimited	
	Nauru**		72.11		0.50	10	
	Somalia**		80.00		0.26	15	
	Syria**		84.63		0.26	Unlimited	

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
** Country not ranked because data on GNI p.c. are not available for the last five years.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Box 4.4: Romania's Neighbourhood Networks increase competition and bring down prices

Romania ranks 36th on the fixed-broadband price basket and stands out since it ranks higher than some European countries (Germany, Greece and Spain) and non-European countries (Saudi Arabia, Australia and the Republic of Korea) with much higher GNI p.c. levels. The entry-level fixed-broadband plan, which costs less than USD 9 (corresponding to a relatively low 1.1 per cent of GNI p.c.), is not only affordable but also offers unlimited data at very high speeds (100 Mbit/s). The EU's Digital Agenda Scoreboard 2014 has highlighted Romania as one of the European leaders (together with Sweden, Latvia and Finland) in terms of offering the highest proportion of ultrafast broadband access (at 100 Mbit/s and above) (EU, 2014).

A key factor in the success of Romania's affordable and fast Internet access has been the country's "Neighborhood Networks", a unique networking scheme that has been developed to overcome limited broadband connectivity. Until Romtelecom, Romania's incumbent telecommunication provider, launched DSL services relatively late (in 2005), small, low-cost local area networks (LANs) run by small Internet service providers (ISPs) emerged to satisfy user demand and to connect homes within a neighbourhood. Networks are often deployed using aerial fibre resulting in very high connection speeds. As more people joined these networks, they expanded to cover most urban spaces, and the large number of LANs has increased competition and brought down prices. Consequently, and unlike many countries where the incumbent provider has wide command over the market, broadband service providers in Romania remain diverse, with intra- and inter-modal competition (Broadband Commission, 2012b). Also, by contrast with most European countries, where the fixed-broadband market is dominated by DSL, most subscriptions in Romania are based on FTTH/B technology.

While broadband services in Romania are fast and cheap, the country has a mediocre fixed-broadband penetration rate (18.5 per cent in 2014, compared to the European average of 29 per cent). One important challenge that remains for Romania with regard to fixed broadband connectivity concerns the rural areas. Neighbourhood Networks are concentrated in urban areas, and many rural areas have little or no broadband coverage. The fixed telephone network is also concentrated in urban areas, which hampers the deployment of rural DSL services. Finally, very low population density and lower income levels in rural areas have made it more difficult to attract investors. In response, Romania, in cooperation with the European Regional Development Fund (ERDF) has initiated the Ro-NET Project, which is expected to cover 783 out of 2 268 Romanian localities that lack fixed-broadband connectivity. The project is expected to help reduce Romania's digital urban/rural divide and to "bring the Internet closer to around 130 000 households with 400 000 inhabitants, 500 businesses and 2 800 public institutions".[27]

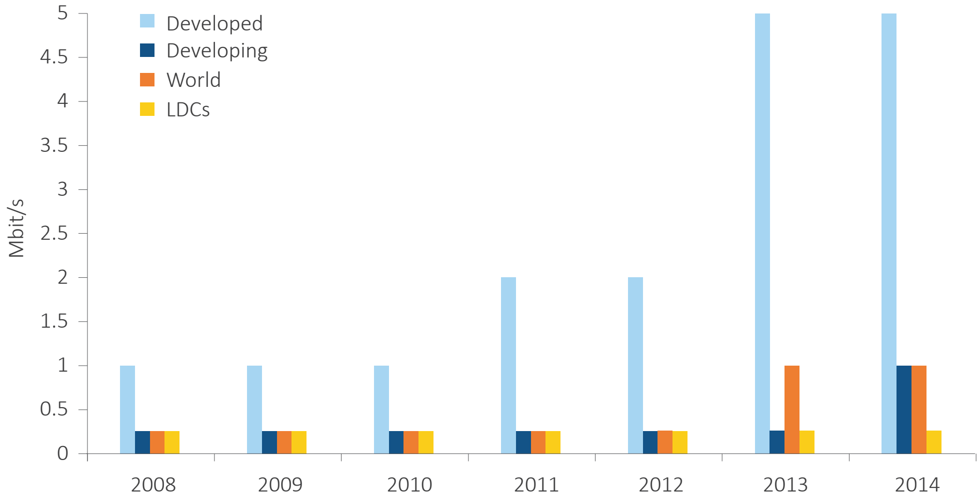
Source: ITU.

In terms of the cap (the monthly data allowance included in the basic fixed-broadband plan considered by ITU), there were also relatively few changes between 2013 and 2014. In over two-thirds (70 per cent) of countries, the basic entry-level fixed-broadband basket in 2014 offered an unlimited data allowance, compared to 65 per cent of countries in 2013. A very limited number of countries saw a decrease in the cap, and in about 20 countries, the cap increased. More detailed information on the differences in speeds and the cap for each region are provided in Charts 4.8-4.11 below.

Regional fixed-broadband prices

Regional comparisons can help identify the strengths, weaknesses and dynamics that characterize ICT prices in different parts of the world. At the same time, fixed-broadband prices vary greatly not only between but also within regions (Table 4.3). Major differences in terms of

Chart 4.6: Most common entry-level fixed-broadband speed, globally and by level of development, 2008-2014



Note: Based on 144 economies for which 2008-2014 data on fixed-broadband prices were available.
Source: ITU.

average prices point to the limitations of regional averages and the need to look at and understand intra-regional and country-level prices.

Europe clearly remains the region with the most affordable prices in terms of GNI p.c. It is also the region with the least pronounced differences between countries. By 2014, the basic fixed-broadband connection in Europe represented 1.3 per cent of GNI p.c. High-speed Internet access is most affordable for people in the United Kingdom, Switzerland and Austria. In countries with the least affordable service (Serbia, The Former Yugoslav Republic of Macedonia, Montenegro and Hungary), the average price of the plan represented between 2.2 and 3.5 per cent of GNI p.c. In all other European countries, it represented 2 per cent or less of average GNI p.c. This makes Europe the only region in which all countries have reached the Broadband Commission target of offering basic fixed-broadband services for a price below 5 per cent of GNI p.c. (see also Box 4.5).

Although Europe offers its citizens the most affordable fixed-broadband prices, it does not have the cheapest fixed-broadband prices in terms of USD or PPP$ (Chart 4.3). The fixed-broadband basket costs on average USD 25.8, more than twice as much as in the CIS but less than in the other ITU regions. In terms of PPP-adjusted prices, the service costs on average PPP$ 26, slightly more than in the CIS but less than in the Americas, Asia and the Pacific, the Arab States and Africa.

None of the European countries offer fixed-broadband services at the minimum threshold of 256 kbit/s (Chart 4.8). Only Poland offers a 512 kbit/s plan, and 1 Mbit/s plans are on offer in Turkey, Spain, Slovenia, Montenegro and Albania. All other countries offer plans of at least 2 Mbit/s and half of the European countries included in the data collection offer speeds of 7 Mbit/s or higher. Very high speeds of 100 Mbit/s are advertised in Romania, Lithuania and Ireland. The most common entry-level fixed-broadband speed in the region is 5 Mbit/s.

Although Europe has one of the most developed telecommunication markets, with high access and usage levels and relatively low ICT prices, the region does not have a particularly high percentage of countries with unlimited basic fixed-broadband plans compared to the global average. In Europe, two-thirds (66 per cent) of countries have entry-level fixed-broadband plans that are unlimited, compared to over 70 per cent globally. At the same time, only three countries (Turkey, Albania and Montenegro) offer the minimum cap of 1 Gigabit (GB).

The **CIS** stands out for having the cheapest fixed-broadband services in terms of USD and PPP$. There are relatively small price variations within the region, and fixed-broadband services are relatively affordable in most countries. The region's 2014 fixed-broadband basket average stands at 3.6 per cent of GNI p.c., more than twice as high as Europe's but much lower than any of the other

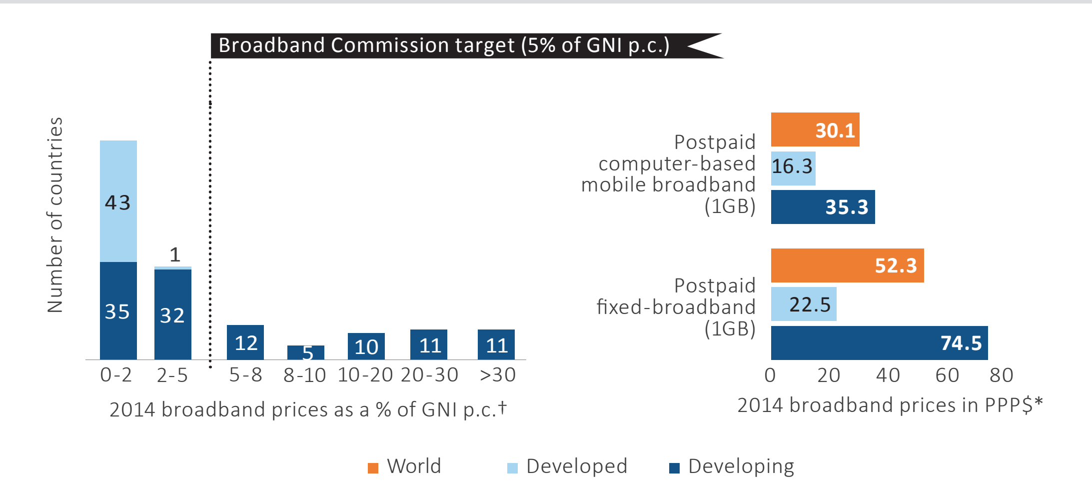
Box 4.5: 111 countries meet the Broadband Commission's target for broadband price affordability

In 2010, the Broadband Commission for Digital Development,[28] the ITU/UNESCO-led initiative to increase awareness about the importance of broadband for achieving international development goals, including the MDGs, identified four specific ICT targets. Target 2 is about *making broadband affordable: By 2015, entry-level broadband services should be made affordable (less than 5 per cent of average monthly income) in developing countries through adequate regulation and market forces*.

By early 2015, a total of 111 countries, including all of the world's developed countries and 67 developing countries, had achieved that target (Chart Box 4.5, left). This result, which is based on comparable fixed- and mobile-broadband prices for 160 economies worldwide, further highlights the fact that mobile-broadband services tend to be cheaper. While 102 countries had achieved the Commission's target in terms of fixed-broadband prices, 105 countries had achieved it in terms of mobile-broadband prices. While currently only a limited number of countries have achieved the broadband target thanks lower mobile-broadband prices, this is liable to change in the near future. With mobile-broadband service prices continuing to fall, while in many countries fixed-broadband service prices are seeing little change,[29] mobile broadband is expected to help more countries achieve the target.

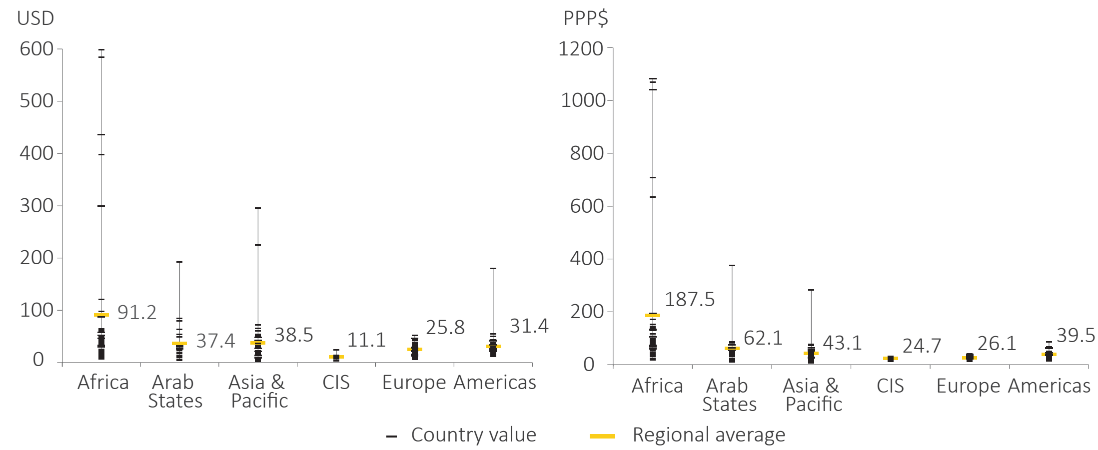
The available data also show that the global average price of a basic fixed-broadband plan (52.3 PPP$) is 1.7 times higher than the average price of a comparable mobile-broadband plan (30 PPP$). In developing countries, the average monthly fixed-broadband price (74.5 PPP$) is three times higher than in developed countries (PPP$ 22.5) (Chart Box 4.5, right).

Chart Box 4.5: Number of countries in 2014 that had achieved the Broadband Commission target to make broadband affordable (left), and fixed- and mobile-broadband prices compared, PPP$, 2014 (right)



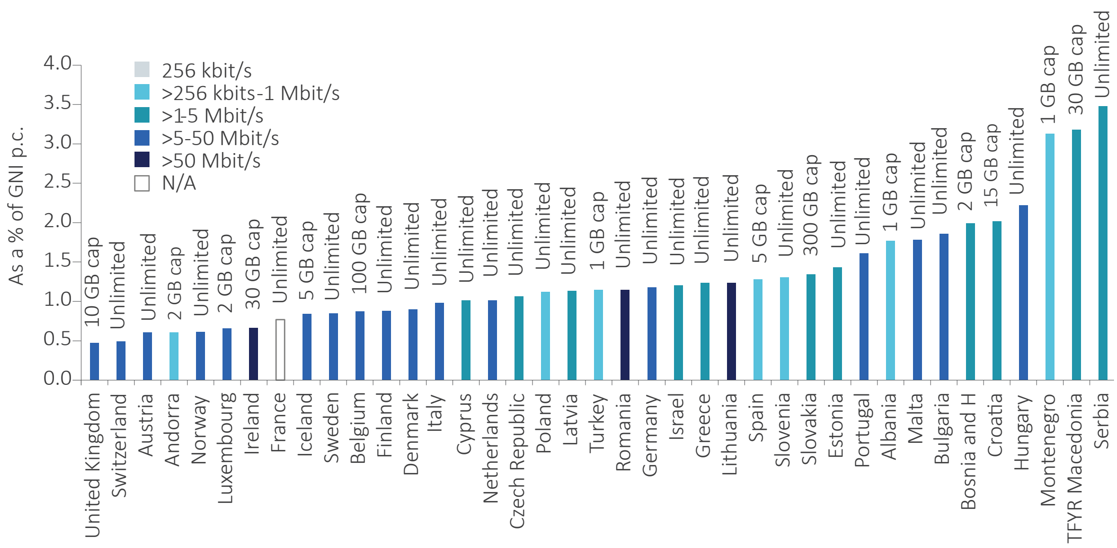
Note: + Either fixed broadband or mobile broadband. *Based on simple averages including data for 160 countries.
Source: ITU.

Chart 4.7: Fixed-broadband prices by region, 2014, in USD, (left) and in PPP$ (right)



Note: Each horizontal dash represents the price in one country in the region. The yellow marks signal the regional average.
Source: ITU.

Chart 4.8: Fixed-broadband prices as a percentage of GNI p.c., broadband speeds and caps in Europe, 2014



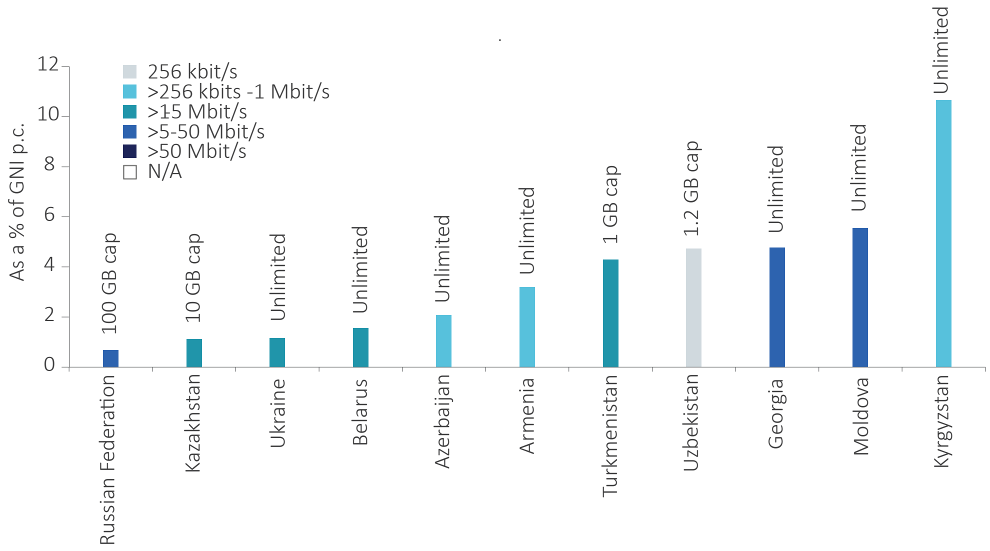
Note: Broadband speeds and caps/month refer to the advertised speeds and the amount of data included in the entry-level fixed-broadband subscription.
Source: ITU. GNI p.c. values are based on World Bank data.

regions. Average USD prices for fixed-broadband services are particularly low in the CIS and stood at USD 11.1 as at 2014, much lower than in any of the other regions. PPP-adjusted prices in the CIS stood at PPP$ 24.7, compared to PPP$ 26.1 in Europe and close to PPP$ 40 in the Americas and in Asia and the Pacific (Chart 4.7).

In terms of GNI p.c., differences within the region are relatively small, except for Moldova and Kyrgyzstan. Although the costs of fixed-broadband services in these two countries are not particularly high in terms of USD values, incomes remain relatively low and Moldova's and Kyrgyzstan's 2014 fixed-broadband sub-baskets represent 5.5 and 10.7 per cent of GNI p.c., respectively. Apart from this, the CIS region has managed to make entry-level fixed-broadband services relatively affordable. They are most affordable in the Russian Federation, Kazakhstan and Ukraine, where the fixed-broadband basket represents 0.7, 1.1 and 1.1 per cent of GNI p.c., respectively (Chart 4.9).

Seven of the 11 CIS countries for which fixed-broadband prices are available offer unlimited data plans, and the Russian basket includes 100 GB of free data allowance. Only Turkmenistan and

Chart 4.9: Fixed-broadband prices as a percentage of GNI p.c., broadband speeds and caps in the CIS countries, 2014



Note: Broadband speeds and caps/month refer to the advertised speeds and the amount of data included in the entry-level fixed-broadband subscription.
Source: ITU. GNI p.c. values are based on World Bank data.

Uzbekistan offer minimum data allowances of 1 GB.

The most common entry-level fixed-broadband speed in the CIS region is 2 Mbit/s, and only Uzbekistan's basic fixed-broadband service is limited to 256 kbit/s. Speeds are much higher (10 Mbit/s or above) in Moldova, Russia and Georgia, and in all three countries the basic connection speed increased markedly between 2013 and 2014. In Moldova, the speed increased from 20 to 30 Mbit/s, while the service also became more affordable.

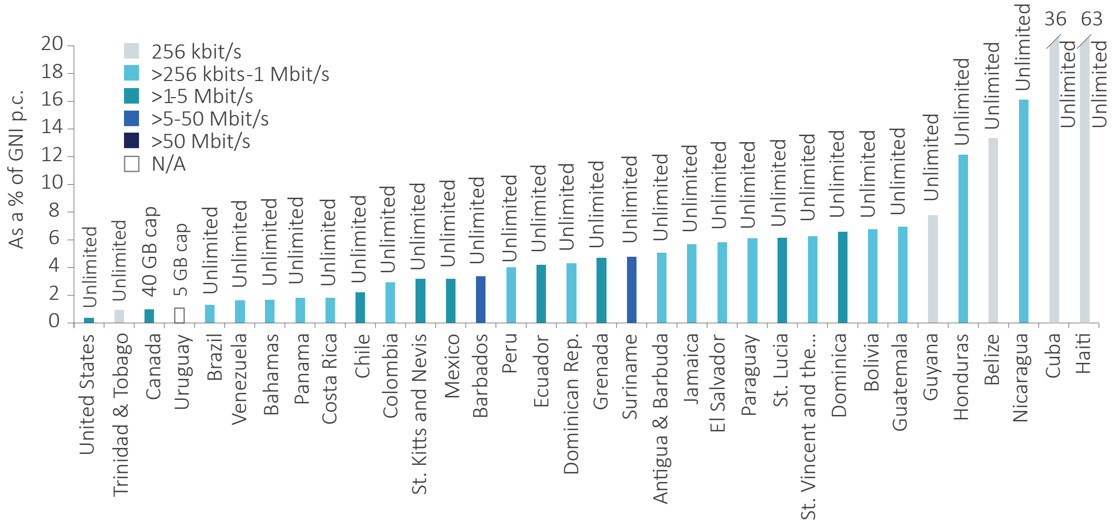
In the **Americas**, the average price of the fixed-broadband basket represents 7.4 per cent of GNI p.c., but that figure conceals large variations within the region. The region is home to countries where fixed-broadband services are among the world's most affordable: in the United States, Trinidad and Tobago and Canada, fixed-broadband prices represent 1 per cent or less of GNI p.c., and more than half the countries included in the data collection, among them Uruguay, Brazil, Venezuela, Chile and Mexico, offer a service at prices corresponding to less than 5 per cent of GNI p. c. Elsewhere in the region, on the other hand, the service remains relatively unaffordable. In the Central American countries of Honduras, Belize and Nicaragua, the fixed-broadband basket value stood at between 12 and 16 per cent of GNI p.c. Cuba and Haiti had the least affordable fixed-broadband services, with prices in 2014 representing 35.9 and 63.5 per cent of GNI p.c. respectively (Chart 4.10).

The fixed-broadband basket costs on average USD 31.4, or PPP$ 39.5, more than in Europe and the CIS region but less than in Asia and the Pacific, the Arab States and Africa. While there are some important differences in USD values, the PPP-adjusted values show less variation, highlighting the stark differences in GNI p.c. levels between countries within the region (Chart 4.7).

The Americas region has the highest percentage of countries offering basic fixed-broadband services with unlimited data caps: 33 out of 35 countries offer subscribers no limits on data for their basic monthly subscription. Caps are applied only in Canada (40 GB) and Uruguay (5 GB).

While unlimited data plans in the region give Internet users an advantage compared to other regions, speeds are relatively limited. The most popular advertised speed is 1 Mbit/s and basic plans in nine countries, including Cuba,[30] Bolivia, Honduras and Trinidad and Tobago, offer either 256 kbit/s or 512 kbit/s connections. Only Suriname, Barbados, Canada, Mexico and Chile offer basic fixed-broadband services with speeds of above 2 Mbit/s.

Chart 4.10: Fixed-broadband prices as a percentage of GNI p.c., broadband speeds and caps, in the Americas, 2014



Note: Broadband speeds and caps/month refer to the advertised speeds and the amount of data included in the entry-level fixed-broadband subscription.
Source: ITU. GNI p.c. values are based on World Bank data.

In the **Arab States**, the average relative and absolute prices for fixed-broadband services conceal wide variations within the region, in part due to the major differences that exist between the region's high-income oil-exporting countries and the rest. Fixed-broadband services in the region cost on average USD 37.4, but the PPP-adjusted price is a high PPP$ 62.1 (Chart 4.7). This reflects somewhat higher relative prices for the service but also the very high price in Iraq, an outlier in the region, with some of the world's highest fixed-broadband prices in both USD and PPP$. In terms of PPP$, Iraq has the highest prices outside Africa.

Fixed-broadband services have become very affordable in the wealthy Gulf Cooperation Council (GCC) States of Kuwait, Qatar, Bahrain, Saudi Arabia, Oman and the UAE, where the fixed-broadband basket represents less than 2 per cent of GNI p.c. With a fixed-broadband basket value of 1.7 per cent of GNI p.c., Tunisia has also brought down prices to a relatively affordable level. The price of the service corresponds to less than 5 per cent of GNI p.c. in Libya, Lebanon, Sudan, Egypt, Algeria and Morocco. In Iraq and Comoros, the service remains unaffordable, representing 34.5 and 71.3 per cent of the respective average GNI p.c. levels (Chart 4.11).

More than half of the Arab States, including Morocco, Tunisia, Oman and Algeria, offer basic fixed-broadband services with unlimited data volumes. Data caps are applied in Egypt (5 GB), Bahrain (25 GB) and Lebanon (40 GB), but have increased significantly since 2013 in all three countries.

The most common entry-level fixed-broadband speed in the region is 265 kbit/s, offered in Mauritania, Yemen, Djibouti, Iraq, Somalia and Syria. Only in Egypt and Morocco are the basic fixed-broadband plans advertised at speeds of above 2 Mbit/s.

Asia and the Pacific is one of the most diverse regions in the world by many criteria (income, population, languages, and so on), and this diversity is also reflected in the absolute and relative prices paid by citizens for fixed-broadband services. It is home to economies with the most affordable fixed-broadband services, including Macao (China), Japan, Hong Kong (China) and Singapore, where the price of the fixed-broadband basket represents less than 1 per cent of GNI p.c. Prices have become relatively affordable and lie below 5 per cent of GNI p.c. in about half the countries in the region, including Indonesia, China, Thailand and Pakistan. India and Bangladesh, both with a fixed-broadband basket value of 5.3, are very close to this target. Countries with the least affordable basket include the region's LDCs, Lao People's Democratic Republic and Cambodia, and many SIDS, where the high cost of international

Chart 4.11: Fixed-broadband prices as a percentage of GNI p.c., broadband speeds and caps, in the Arab States, 2014

Note: Broadband speeds and caps/month refer to the advertised speeds and the amount of data included in the entry-level fixed-broadband subscription.
Source: ITU. GNI p.c. values are based on World Bank data.

Internet bandwidth often keeps retail prices very high. In the Solomon Islands and Kiribati, the price of a fixed-broadband connection represents more than twice the average GNI p.c. In Afghanistan, Papua New Guinea, and Vanuatu, prices also remain very high in terms of GNI p.c., and services remain largely unaffordable (Chart 4.12).

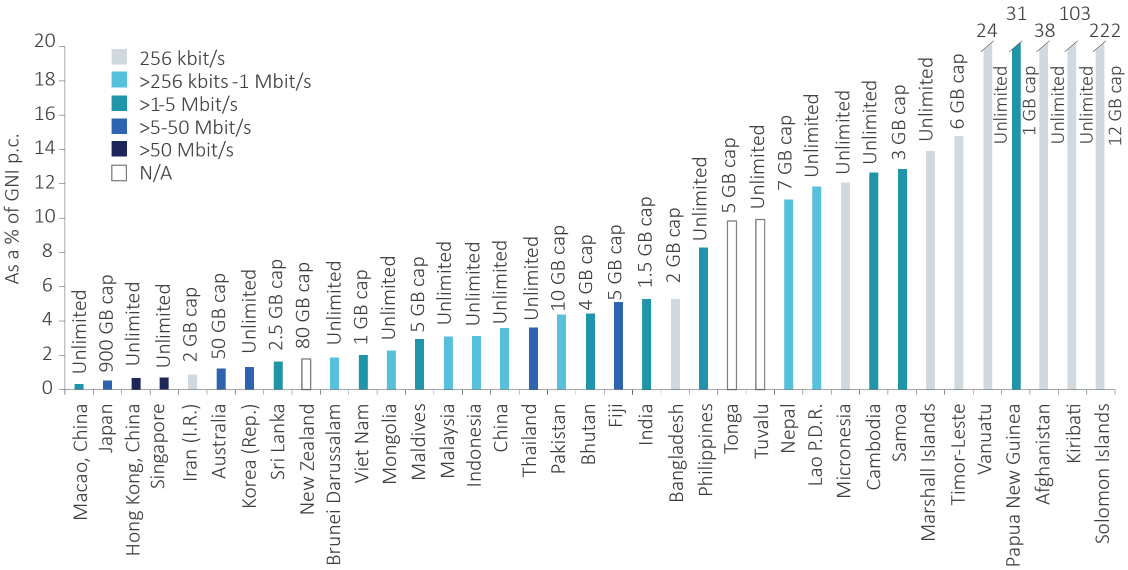
The Asia and the Pacific region has the second highest average fixed-broadband prices in USD, at USD 38.5. This average hides important differences within the region, including some outliers (Kiribati and Solomon Islands), where USD fixed-broadband prices are very high, at between USD 225 and 295. In terms of PPP-adjusted prices, the regional fixed-broadband basket stands at PPP$ 43.1, with similar intra-regional differences in prices (Chart 4.7).

Fixed-broadband speeds in the Asia and the Pacific region vary as much as prices. While the most common entry-level fixed-broadband speed in the region is 2 Mbit/s, there are important differences between countries. Hong Kong (China), Singapore and the Republic of Korea have basic broadband plans offering speeds of 200 Mbit/s, 100 Mbit/s and 50 Mbit/s, respectively. Speeds in Japan, Australia, Thailand and Fiji exceed 6 Mbit/s. Four developing economies (Micronesia, Bangladesh, the Islamic Republic of Iran and Vanuatu) offer the minimum 256 kbit/s, and several other countries, including Indonesia and Lao People's Democratic Republic, offer speeds of 512 kbit/s.

Less than half the entry-level fixed-broadband plans in Asia and the Pacific offer unlimited data download volumes. Most of the countries without caps are high-income economies with developed Internet markets, including Singapore, Hong Kong (China), the Republic of Korea and Macao (China), but also include China, Cambodia and the Philippines. Some SIDS, including Micronesia and Vanuatu, do not have caps but do have relatively low speeds (256 kbit/s). Japan (900 GB), New Zealand (80 GB) and Australia (50 GB) have entry-level fixed-broadband plans with relatively high caps compared to the most restricted caps applied in Papua New Guinea, Viet Nam and India.

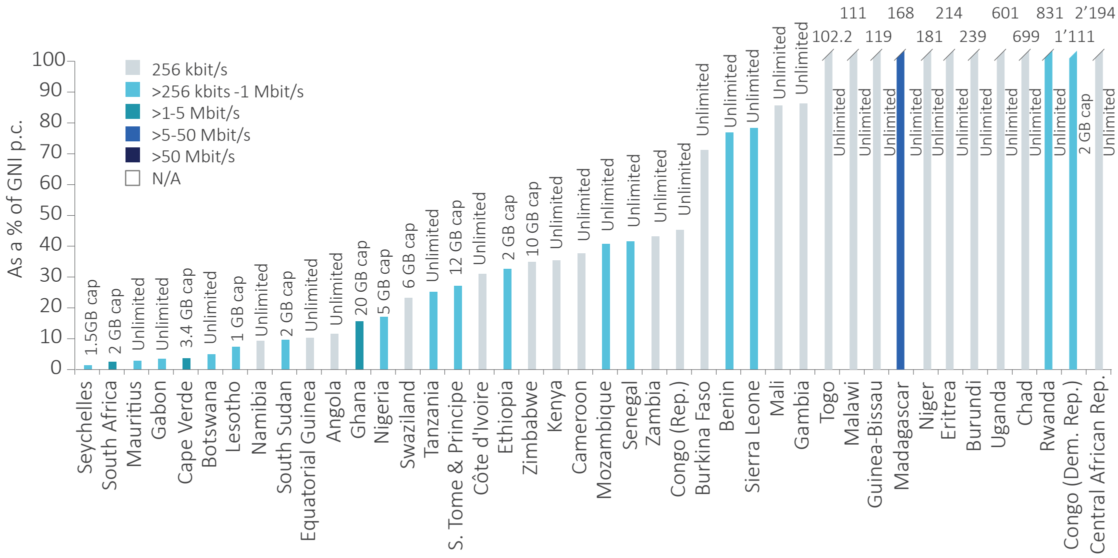
Africa has few countries with affordable entry-level fixed-broadband plans and many where the service remains beyond the reach of most people. Six African countries – Seychelles, South Africa, Mauritius, Gabon, Cabo Verde and Botswana - offer basic fixed-broadband plans at prices corresponding to 5 per cent or less of average GNI p.c. In most countries, the price of the service represents more than ten per cent of GNI p.c. In almost half of the African LDCs,[31] including Uganda, Rwanda and the Central African Republic, the price actually exceeds average GNI p.c. levels. Very high

Chart 4.12: Fixed-broadband prices as a percentage of GNI p.c., broadband speeds and caps, in Asia and the Pacific, 2014



Note: Broadband speeds and caps/month refer to the advertised speeds and the amount of data included in the entry-level fixed-broadband subscription.
Source: ITU. GNI p.c. values are based on World Bank data.

Chart 4.13: Fixed-broadband prices as a percentage of GNI p.c., broadband speeds and caps, in Africa, 2014



Note: Broadband speeds and caps/month refer to the advertised speeds and the amount of data included in the entry-level fixed-broadband subscription.
Source: ITU. GNI p.c. values are based on World Bank data.

prices in the region go hand in hand with very low fixed-broadband penetration levels (Chart 4.13).

Africa is also the region with the highest prices in terms of USD as well as PPP$-adjusted prices (Chart 4.7). The high relative and absolute prices, particularly in a number of very low-income economies, will deter the great majority of citizens from subscribing to the service.

Minimum broadband speed offers remain the most popular for entry-level fixed-broadband plans in Africa. Almost 30 per cent of African countries offer speeds of 256 kbit/s, and close to 20 per cent of countries have 512 kbit/s plans. Advertised speeds of 2 Mbit/s are on offer in Cabo Verde and South Africa at relatively reasonable prices. Ghana's basic broadband plan is marketed at 4 Mbit/s speeds. Although Madagascar's entry-level plan has a speed of 8 Mbit/s (the highest advertised speed in the region), its high price of USD 62, or 168 per cent of GNI p.c., suggests that it will not be affordable for large parts of the population.

More than two-thirds of fixed-broadband plans in Africa are sold as unlimited data packages, although the relatively slow broadband speed in most countries may in fact prevent most users from taking advantage of data-intensive services or applications. Indeed, all countries with advertised speeds of 2 Mbit/s or more impose caps.

4.4 Mobile-broadband prices

Mobile broadband is the only de facto option for accessing broadband Internet services for most of the population in developing countries, given the limited capacity and reach of fixed infrastructure in the developing world. Indeed, mobile-broadband penetration stands at over 20 per cent in almost half of the countries of the developing world and is growing strongly, whereas fixed-broadband penetration lies below 2 per cent in one out of two developing countries, and below 1 per cent in 85 per cent of LDCs.[32]

ITU estimates that 3G coverage reaches 69 per cent of the world population in 2015, and that 43 per cent of the global population are Internet users. This suggests that, today, mobile broadband has the potential to bring online a quarter of the global population, and to do so at broadband speeds that enable access to advanced online services such as e-education, e-health and e-government. Given that mobile-broadband infrastructure is already largely in place and will be expanded in the coming years, affordability remains the key to unlocking the potential of broadband services in many developing countries.

Operators have realized that they have a big stake in the success of mobile-broadband services: in terms of expanding the Internet market to previously untapped segments of the population, promoting customer loyalty in view of the ever-increasing competition in mobile markets, and balancing the loss of revenues from traditional mobile services (voice, SMS). Policy-makers and regulators are also playing their part and have stepped up a gear in spectrum allocation and assignment for mobile-broadband technologies,[33] thereby contributing to the deployment of mobile-broadband networks.

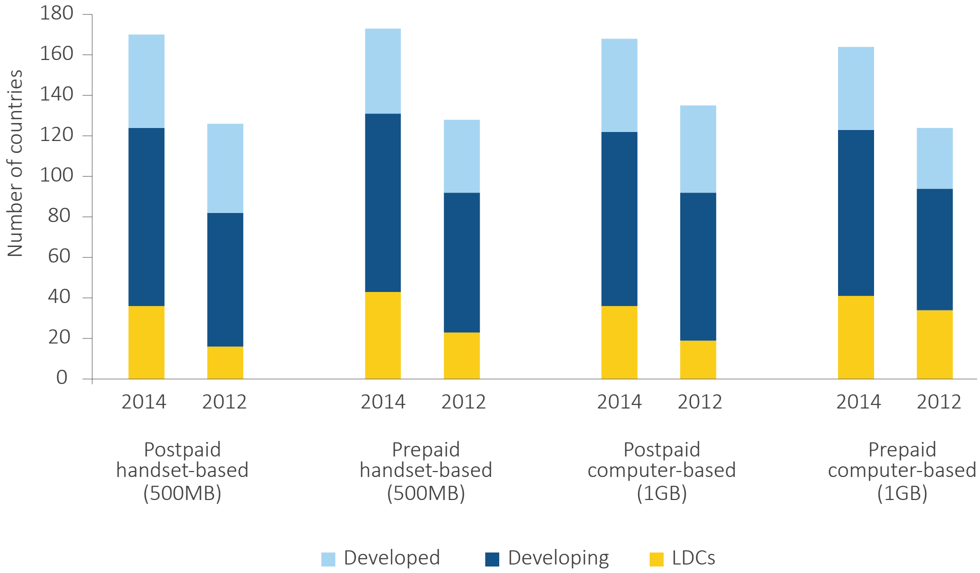
The initiatives from both public and private stakeholders have led mobile broadband to become the most dynamic telecommunication market segment, enjoying sustained double-digit growth rates in subscription figures over the past eight years. Indeed, progress has continued as the different types of mobile-broadband service become available in more and more countries (Chart 4.14). For instance, in 2014, prepaid mobile-broadband services were available in 45 economies which did not offer such services in 2012. Likewise, prepaid computer-based services became available in 40 economies during the same period. The increase in mobile-broadband service availability was particularly remarkable in LDCs, with the number of LDCs offering prepaid handset-based mobile-broadband services having almost doubled in the period 2012 to 2014, from 23 to 43 countries.

The increasing availability of mobile-broadband services reflects the upgrading of narrowband mobile networks, such as GPRS and EDGE, to mobile-broadband networks in several developing countries,[34] as well as the launch of new types of mobile-broadband service in those countries where the choice of plans was previously limited.[35]

In the high-growth and rapidly-evolving mobile-broadband market, innovation is also being seen in pricing schemes and in the types of plan and device for which the service is offered (Figure 4.2). In addition to segmentation by type of device and by postpaid/prepaid plans, different pricing schemes are on offer for data usage, particularly in handset-based mobile-broadband plans (which are by far the most prevalent in terms of number of subscriptions).

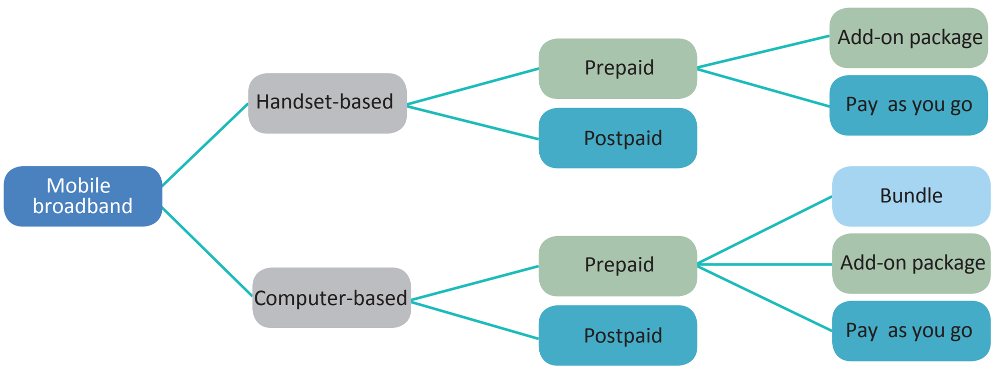
For prepaid handset-based mobile-broadband plans, apart from pay-as-you-go data rates priced per MB, data packages (in some cases bundled with voice and SMS services) are offered with differing validity periods ranging from an hour to several months. These packages tend to be cheaper than the pay-as-you-go prices per MB but oblige the customer to pay for the entire package upfront.[36] In some cases, such prepaid

Chart 4.14: Availability of mobile-broadband services by type of service, by level of development, 2014 and 2012



Note: A mobile-broadband service is counted as having been available if it was advertised on the website of the dominant operator or prices were provided to ITU through the ICT Price Basket Questionnaire.[37]
Source: ITU.

Figure 4.2: Mobile-broadband services by type of device/plan



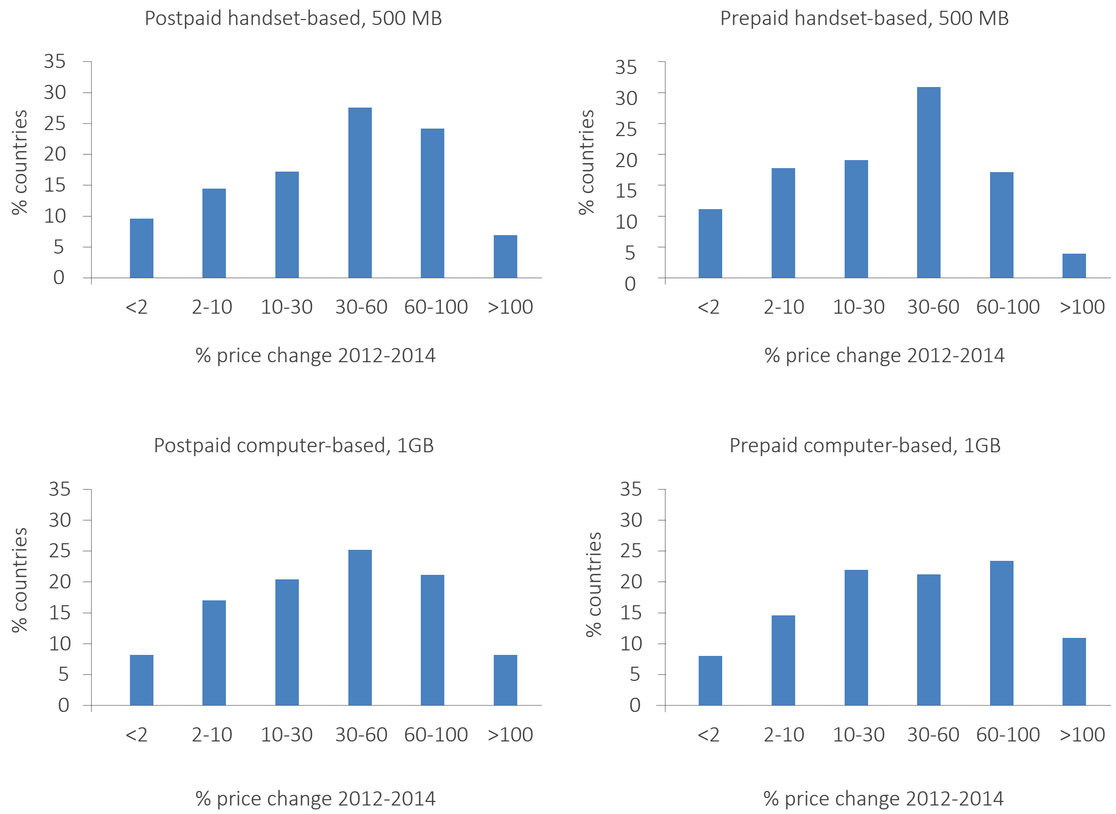
Source: ITU.

packages are automatically renewed at the end of the validity period, making them very similar in practice to postpaid plans, except that the customer has no commitment period and can opt out without a penalty.

For postpaid handset-based mobile-broadband plans, the data consumption can be part of a monthly bundle including voice and SMS, and yet be cheaper than any other data-only offers.[38] In most cases, however, the cheapest option when considering only the cost of Internet access is to take a data-only package that can be added to any regular postpaid plan, or to combine several such data-only packages to reach the desired monthly allowance.

The variety of pricing schemes and the dynamism of the mobile-broadband market are reflected in prices, which in this market are far more volatile than for other telecommunication services. This is not only the result of changes in the monthly data allowance (e.g. customers paying more in exchange for larger data allowances), but also of frequent pricing scheme revision by operators. Indeed, mobile-broadband prices per MB fluctuated by more than 30 per cent during the period 2012-2014 in half of the countries for which data was available (Chart 4.15). By contrast, in only one out of four countries did those prices vary by less than 10 per cent during the same period. This illustrates the fact that stability is the exception

Chart 4.15: Variation in the USD price per MB, by type of mobile-broadband service, 2012-2014



Note: Percentages are calculated on the basis of the total number of countries with price data for at least two years in the period 2012-2014: 145 economies for postpaid handset-based, 500MB; 152 economies for prepaid handset-based, 500 MB; 147 economies for postpaid computer-based, 1 GB; and 137 economies for prepaid computer-based, 1 GB.
Source: ITU.

rather the norm where mobile-broadband prices are concerned.

One of the main reasons for the frequent changes in mobile-broadband prices is the absence of clear market leaders in most countries. Unlike previous telecommunication services, mobile broadband started to grow strongly in a context of several consolidated mobile-cellular operators capable of offering the service in each market. As a result, competition in mobile-broadband services has from the outset been strong, and leadership in the mobile-cellular market has not always been transferred (or at least not to the same extent) into the mobile-broadband market.[39]

The differing types of mobile-broadband service may, moreover, lead to sub-segmentation of the market, so that, for instance, the operator with more handset-based subscriptions may be different from the one with more computer-based subscriptions.[40] Indeed, computer-based mobile-broadband services have more in common with fixed-broadband services (shared use, larger screen, more data consumption) than with handset-based mobile-broadband services (individual use, smaller screen, less data consumption), and, as a result, the uptake and pricing trends often differ.

Mobile-broadband price trends need to be analysed with caution, since the final price of each basket is highly sensitive to how well the pricing scheme of the dominant mobile-broadband operator in each country fits the basket. As a result, year-to-year changes for a specific country may reflect changes in the data allowance of a given package, or a change in the market leader and consequent application of a different pricing scheme, rather than actual changes in the overall pricing levels. For these reasons, the analysis of mobile-broadband price trends presented in the following section is limited to general trends, since robust pricing-trend indications can be extracted only at an aggregated level.

Global mobile-broadband price trends

A comparison of the average mobile-broadband prices per service in 2013 and 2014 (Chart 4.16) leads to the following conclusions:

- Average prices for the four types of mobile-broadband plan decreased (both in USD and PPP$), resulting in mobile broadband becoming from 20 to 30 per cent more affordable globally between 2013 and 2014, depending on the service. This finding is confirmed by the decrease in prices expressed as a percentage of GNI p.c.

- The largest decrease in prices occurred in LDCs, where average prices for all types of mobile-broadband service were reduced by more than 25 per cent between 2013 and 2014 (both in USD and PPP$). The strongest drop was seen in prepaid mobile-broadband plans, suggesting that competition and/or demand is stronger in this segment in LDCs. The reduction brought mobile-broadband prices in LDCs close to the levels of developing and developed countries at the end of 2014: USD 13 – USD 14 for handset-based plans with a 500 MB monthly data allowance, and around USD 20 for computer-based plans with 1 GB. However, prices relative to GNI p.c. in LDCs are on average still twice as high compared with the average for all developing countries, and twenty times higher than for developed countries, suggesting that the affordability of mobile-broadband services is still a major issue in LDCs.

- Between 2013 and 2014, developing countries saw a reduction in mobile-broadband prices (in USD) of between 15 and 25 per cent, depending on the service. Despite this remarkable decrease, prices in PPP terms are on average more than 50 per cent higher in developing than in developed countries. Prices in terms of GNI p.c. in developing countries show that prepaid mobile-broadband plans have reached the affordability levels of mobile-cellular plans: mobile-cellular services were on average 30 per cent more affordable than mobile-broadband services in 2013, while mobile-cellular plans were only 2 per cent more affordable than mobile-broadband plans in 2014.[46] Caution must be exercised when comparing the low-user mobile-cellular basket and the 500 MB handset-based mobile-broadband basket, considering what each basket includes and how this enables different ICT applications (Box 4.6). Based on the ITU baskets, computer-based mobile-broadband plans remain significantly less affordable than handset-based plans in developing countries, highlighting the ongoing challenge to offer larger data allowances at affordable prices in the developing world.

- Developed countries saw an average decrease in mobile-broadband prices similar to that in developing countries, in the 15 to 25 per cent range for prices in USD. This decrease has led mobile broadband to become (on average) the cheapest among the four ITU price baskets in the developed world. Moreover, the comparison with fixed-telephony, mobile-cellular and fixed-broadband prices (see sections 4.2 and 4.3) shows that mobile broadband is the only service for which average prices in USD in developed countries are similar to or even lower than in developing countries, and the trend suggests that they are still falling. This explains why mobile broadband has become so affordable in the developed world, with average prices corresponding to less than 1 per cent of GNI p.c for all services except prepaid computer-based, which is probably the less common type of mobile-broadband service in developed countries.

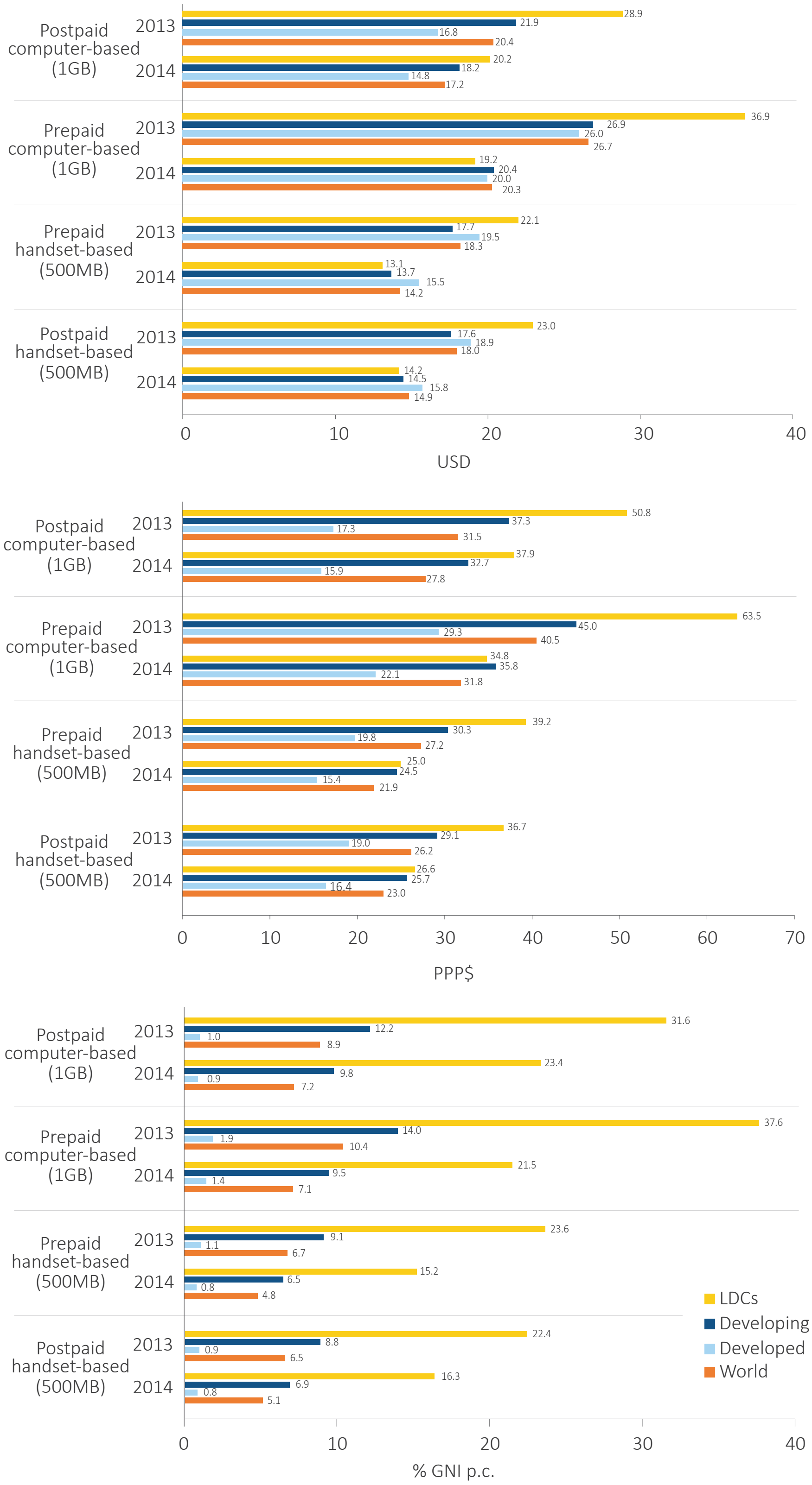
Chart 4.17 presents an aggregated comparison of 2013 and 2014 prices, in local currency, so that the effects of exchange rate fluctuations or changes in the GNI p.c. are screened from the analysis of pricing trends.

The results of this analysis provide additional insights that are not captured in the averages.

- For about half of the countries surveyed, mobile-broadband prices in local currency did not change between 2013 and 2014.

- In those countries where prices changed, mobile-broadband prices decreased in most cases (about 30 per cent of countries), although they also increased in a few countries (around 15 per cent of countries).

Chart 4.16: Mobile-broadband prices, in USD (top), PPP$ (center) and as a percentage of GNI p.c. (bottom), world and by level of development, 2013-2014



Note: Simple averages. Based on 119 economies for which 2013 and 2014 data on mobile-broadband prices were available for the four types of data plan. The respective averages include: 22 LDCs, 84 developing countries and 35 developed countries.
Source: ITU.

Box 4.6: How much service for your mobile-broadband package?

ITU collects mobile-broadband prices for two monthly data allowances: 500 MB per month and 1 GB per month. In reality, operators sell mobile-broadband data in quantities ranging from only a few megabytes (MB) to several gigabytes (GB). To put these packages into perspective, it is necessary to understand the amount of data needed for the delivery of different online mobile-broadband activities, including services and applications. This is particularly important given that mobile-broadband services have been hailed as a key development tool that can enable the delivery of services to remote locations and which has great potential for social development. Examples include the delivery of m-learning and e-health services via mobile-broadband networks to remote and rural areas. Mobile broadband can help overcome the mobility limitations of patients and the lack of medical experts in rural areas. But how much data are needed to deliver such services?

The answer is: it depends. Data consumption varies considerably according to the type of Internet activity. Sending a basic WhatsApp message may consume 20 kB, but streaming a high-quality video may require 7000 kB per minute. Internet activities with low data consumption include browsing webpages with low graphical content, posting a text message in a social network or sharing a low-resolution image or a text file. Internet activities that are more data-hungry include music, radio and video streaming, Skype audio and video calls, and exchanging high-quality pictures or files with rich graphical content.

Figure Box 4.6 provides examples of what a user can do with a mobile-broadband plan with either 500 MB or 1 GB per month.[41] It shows that a 500 MB per month allowance enables only modest use of data-hungry Internet applications, which in many cases are those with the greatest development potential. The analysis also highlights the fact that data consumption depends not only on the type of mobile application used, but also on the level of quality selected. In addition, more information can be delivered to the smaller screen of a mobile phone than to a computer screen, which, being considerably larger, requires more data if the user is to perceive a similar image quality as on the mobile screen. In real terms, this is what 500 MB per month – the smaller of the packages for which ITU collects price data – will allow for:

- Streaming: Users can watch 140 minutes of standard quality Internet video (i.e. 4.5 minutes per day per month) and listen to 190 minutes of radio streams (6.3 minutes per day). A user preferring to stream high quality video and audio will find the said amounts reduced to 65 minutes (2.2 minutes per day) of radio and 60 minutes (2 minutes per day) of video.

- M-learning: A student can watch 320 minutes of school courses (i.e. review materials of two school subjects at Grade 4)[42], at the rate of a little over ten minutes per day, and do the corresponding tests from home. In addition, the student's parents could watch two hours of an e-learning course on child nutrition (about one-third of the total duration of the course).[43]

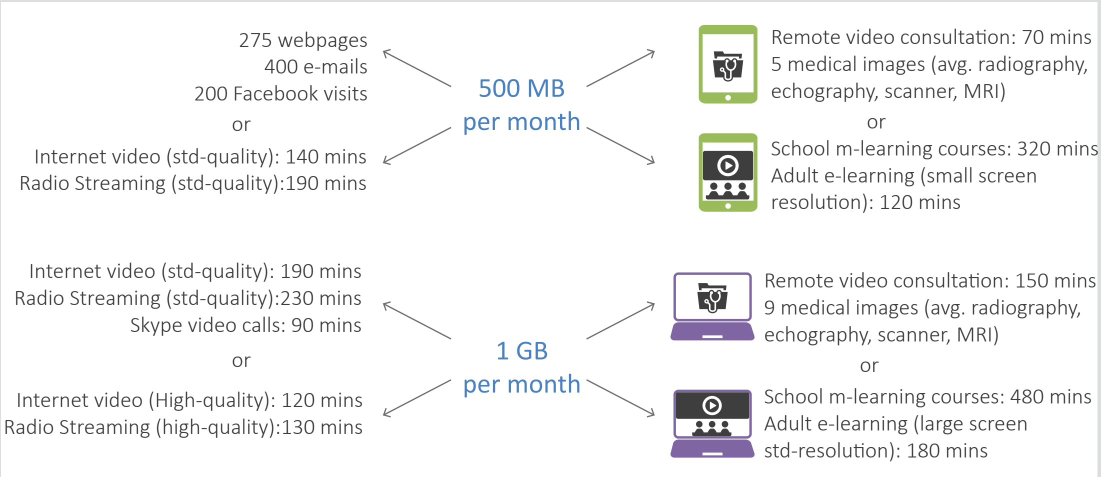
- M-health: A doctor can carry out 70 minutes of remote visits (involving a video conversation via Skype) per month (2 minutes per day) and send/receive five medical images to/from medical specialists in a hospital located in another town.[44]

Apart from the monthly data allowance, other characteristics of the plan need to be considered when determining which services are effectively enabled by mobile broadband. For instance, streaming a video would require 500 kbit/s of download speed, which is more than the transfer rates achieved by UMTS. A Skype call would need only 100 kbit/s upload/download speeds, but would on the other hand require low latency (i.e. no transmission delay).[45]

Box 4.6: How much service for your mobile-broadband package? (continued)

All these factors need to be taken into consideration in the cost-benefit analysis and when assessing the potential impact of mobile broadband on social and economic development.

Figure Box 4.3: Mobile-broadband data usage examples, 500 MB and 1 GB per month



Source: ITU.

- In those countries where prices decreased, price reductions were strong (most of them corresponding to a price drop of over 30 per cent in local currency).

- Conversely, in those countries where prices rose, the increases were more moderate (in most cases below 30 per cent). This explains the overall decrease in the average mobile-broadband prices.

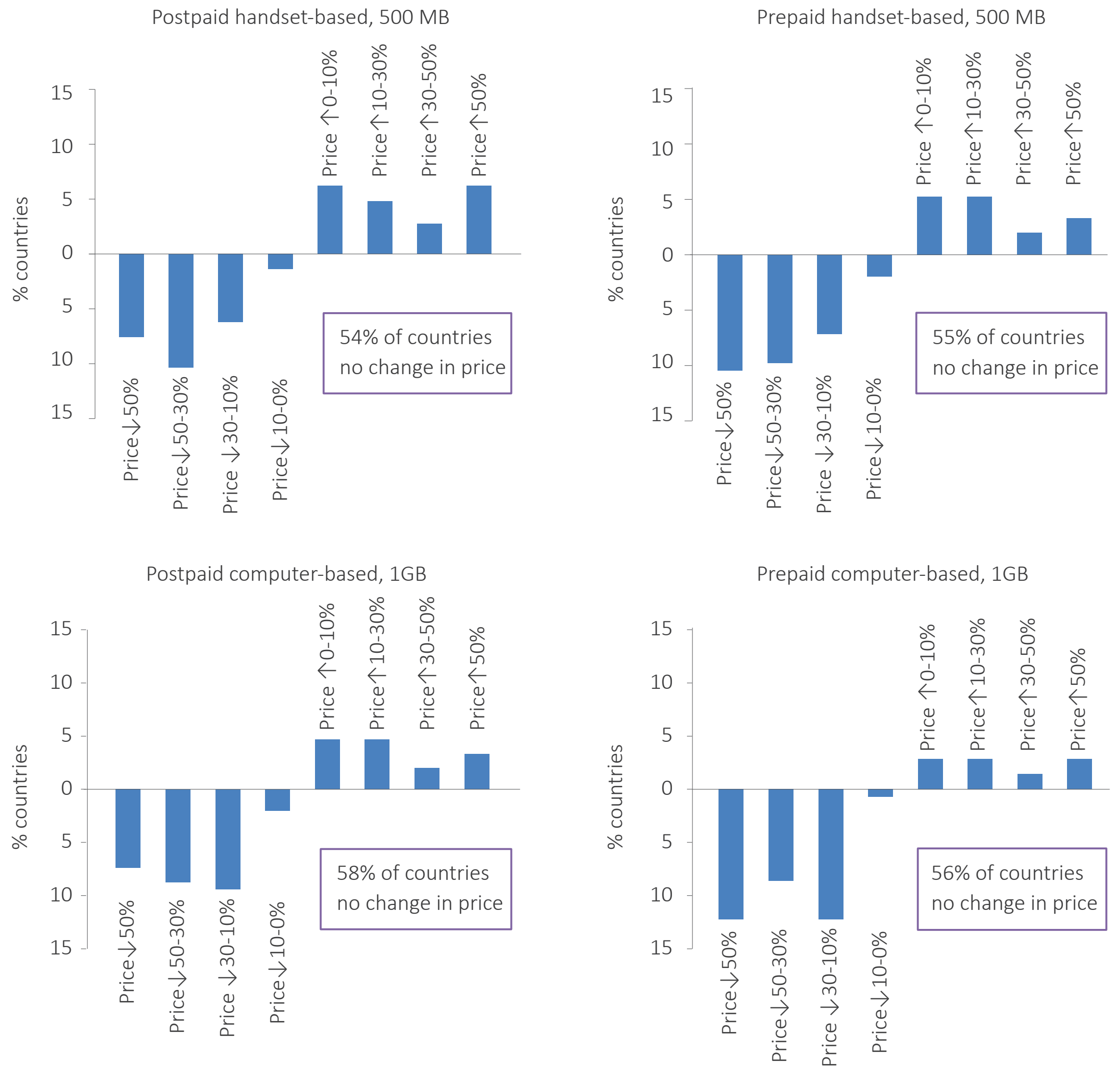
These findings hold true for all types of mobile-broadband plan and provide a more nuanced overview of the mobile-broadband price trends. A more detailed analysis requires the examination of country data, and is presented in the next section on the basis of the 2014 mobile-broadband prices.

The analysis of the 2014 mobile-broadband prices shows that the cost of a prepaid handset-based mobile-broadband plan with a 500 MB monthly data allowance ranged from less than USD 2 in Pakistan and Bhutan to more than USD 40 in several countries, including Denmark, Cyprus, Israel and the United States (Table 4.8). This variation reflects differences in income and in the mode of contracting mobile broadband, as well as the different characteristics of the services offered.

For instance, postpaid handset-based mobile-broadband plans with 500 MB per month cost less than USD 30 in Cyprus, Denmark and Israel (Table 4.7), highlighting the fact that the prices offered for postpaid plans in these countries are far more competitive. In the United States, prepaid and postpaid mobile-broadband plans include unlimited voice and text and are offered on LTE networks, thus allowing for higher speeds. These differences are often linked to the different trends in mobile-cellular markets: in most developed countries, mobile plans are predominantly postpaid and data services are contracted as part of large bundles, whereas in the majority of developing countries prepaid is by far the most common mode of contracting mobile services and all-inclusive bundles are the exception.

The price of a computer-based mobile-broadband plan with 1 GB per month also varies widely across countries: from USD 3 in Cambodia and Sri Lanka to more than USD 50 in several developing countries (Table 4.9 and Table 4.10). This is particularly the case of prepaid computer-based mobile-broadband plans, which cost more than USD 50 in as many as 13 countries. These facts tally with the finding that prepaid computer-based plans tend to be introduced at a later stage in

Chart 4.17: Percentage change in mobile-broadband prices in local currency, percentage of countries, 2013-2014



Note: Percentages are calculated on the basis of the total number of countries with price data for 2013 and 2014: 145 economies for postpaid handset-based, 500MB; 153 economies for prepaid handset-based, 500MB; 149 economies for postpaid computer-based, 1GB; and 139 economies for prepaid computer-based, 1GB.
Source: ITU.

mobile-broadband markets (Chart 4.14), and that price decreases therefore occur later than in other mobile-broadband services.

The comparison of the prices for the different mobile-broadband plans shows that those countries with low mobile-broadband prices for a given service tend to have low mobile-broadband prices for the other services. Indeed, there is a strong link between the prepaid and postpaid prices for handset-based mobile broadband (correlation of 0.73 for PPP prices), as well as between prepaid and postpaid prices for computer-based mobile broadband (correlation of 0.76 for PPP prices). This means that, for instance, a country with high prices for prepaid handset-based services tends also to have high prices for postpaid handset-based services, and vice versa.

Regional mobile-broadband analysis

The comparison of prices having regard to the purchasing power of local currencies makes it possible to highlight those countries that stand out for having the lowest mobile-broadband prices in each region (Table 4.5). The following observations can be made based on the 2014 prices:

- The cheapest mobile-broadband prices in PPP$ are found in countries in Europe and in Asia and the Pacific, for all mobile-broadband

Table 4.5: Top three countries with the cheapest mobile-broadband services in each region, PPP$, 2014

Prepaid handset-based 500MB											
Europe	PPP$	Asia & Pacific	PPP$	The Americas	PPP$	Arab States	PPP$	CIS	PPP$	Africa	PPP$
Estonia	3.16	Cambodia	5.17	Uruguay	10.75	Sudan	7.81	Moldova	6.94	Mozambique	6.23
Lithuania	3.94	Pakistan	5.17	Paraguay	11.79	Tunisia	13.28	Belarus	9.90	Guinea	7.81
Iceland	4.76	Bhutan	5.35	Costa Rica	12.03	Bahrain	13.60	Kazakhstan	11.02	Cape Verde	10.46

Postpaid handset-based 500MB											
Europe	PPP$	Asia & Pacific	PPP$	The Americas	PPP$	Arab States	PPP$	CIS	PPP$	Africa	PPP$
Finland	2.91	Sri Lanka	4.16	Bahamas	13.19	Sudan	3.55	Moldova	6.94	Guinea	7.81
Iceland	4.76	Cambodia	5.17	Uruguay	13.38	Tunisia	7.97	Belarus	9.90	Mozambique	9.28
Austria	5.76	Australia	6.50	Barbados	14.52	Bahrain	13.60	Armenia	10.39	Tanzania	9.89

Prepaid computer-based 1GB											
Europe	PPP$	Asia & Pacific	PPP$	The Americas	PPP$	Arab States	PPP$	CIS	PPP$	Africa	PPP$
Poland	5.27	Cambodia	6.46	Barbados	15.73	Morocco	11.97	Moldova	8.68	Mozambique	9.97
Austria	5.76	Sri Lanka	7.16	Uruguay	16.12	Egypt	12.25	Kazakhstan	11.02	Cape Verde	12.34
Lithuania	6.19	Bhutan	10.18	United States	21.77	Sudan	13.20	Belarus	13.68	Burundi	16.68

Postpaid computer-based 1GB											
Europe	PPP$	Asia & Pacific	PPP$	The Americas	PPP$	Arab States	PPP$	CIS	PPP$	Africa	PPP$
Austria	5.76	Cambodia	6.44	Uruguay	11.71	Egypt	14.08	Kazakhstan	11.02	Mauritius	10.53
Lithuania	6.76	Sri Lanka	8.38	Barbados	14.52	Tunisia	19.92	Belarus	13.68	Tanzania	12.72
Romania	7.75	Indonesia	12.54	United States	16.32	Libya	21.70	Moldova	17.35	Mozambique	13.02

Source: ITU.

services. Specific countries that stand out in these regions and worldwide for having the lowest mobile-broadband prices are Austria and Lithuania, and Cambodia and Sri Lanka, respectively.

- Some countries in the CIS and in the Africa region have remarkably low mobile-broadband prices, for example Moldova for both prepaid and postpaid handset-based mobile-broadband services, and Mozambique for prepaid handset-based mobile-broadband services. These two countries are examples of how competition can drive mobile-broadband prices down, even in a context in which investment is required to upgrade networks or extend coverage.[47,48]

- There is no country from the Americas that stands out for having particularly low mobile-broadband prices as compared with those of other regions, although Uruguay can be singled out as the country with the least expensive mobile-broadband prices for several mobile-broadband services. The same finding applies to the Arab States, except for Sudan, which offers some of the world's least expensive handset-based mobile-broadband plans.

The aggregate analysis of prices in terms of GNI p.c. (Table 4.6) shows that there are large differences in affordability across and within regions. The results confirm that **Europe** is the region with the most affordable mobile-broadband prices, and differences across countries in Europe are small in terms of GNI p.c. This is largely explained by the high GNI p.c. levels in the region,[49] but also by the relatively low mobile-broadband prices in most European countries.

The **CIS** region comes second in terms of the most affordable mobile-broadband prices, and the average for all mobile-broadband services corresponds to less than 5 per cent of GNI p.c., which is the affordability target set by the Broadband Commission for Digital Development (Box 4.5). Taking into account that GNI p.c. levels in the CIS region are not particularly high (on average, lower than in all regions except for Africa), this finding illustrates the fact that most CIS countries enjoy affordable mobile-broadband prices.

Table 4.6: Average mobile-broadband prices and ranges by region, as a percentage of GNI p.c., 2014

Region	Postpaid handset-based 500MB			Prepaid handset-based 500MB			Postpaid computer-based 1GB			Prepaid computer-based 1GB		
	Min.	Max.	Average*	Min.	Max.	Average*	Min.	Max.	Average*	Min.	Max.	Average*
Europe	0.09	1.99	0.81	0.14	2.62	0.82	0.16	3.99	0.90	0.16	17.46	1.56
CIS	0.45	16.44	3.35	0.45	16.44	3.70	0.57	16.44	4.83	0.57	16.44	4.92
The Americas	0.85	32.80	4.55	0.59	32.80	4.39	0.37	32.80	4.88	0.49	32.80	6.24
Asia & Pacific	0.17	30.54	4.39	0.26	27.99	4.28	0.35	68.80	7.53	0.49	55.99	6.77
Arab States	0.23	37.81	5.15	0.30	37.81	5.22	0.23	56.71	7.93	0.38	37.81	6.07
Africa	1.43	58.60	15.77	1.43	58.60	15.20	0.82	172.86	30.33	1.43	172.86	29.50

Note: *Simple averages based on 149 countries for which price data for all mobile-broadband services were available.
Source: ITU.

Average prices in the **Americas** region represent less than 5 per cent of GNI p.c. for all mobile-broadband services, except for prepaid computer-based mobile broadband. However, the range of prices within this region is rather wide, pointing to large differences in mobile broadband affordability.

The **Asia-Pacific** region has average prices that correspond to less than 5 per cent of GNI p.c. for handset-based mobile-broadband services, but prices are above that threshold for computer-based mobile broadband. Moreover, there are large differences in prices as a percentage of GNI p.c. within the region, particularly for computer-based mobile-broadband services. These findings suggest that providing affordable mobile-broadband access with large data allowances is still an issue in several countries within the region.

The average mobile-broadband prices in the **Arab States** region represent more than 5 per cent of GNI p.c. for all mobile-broadband services. The fact that the region's low-income countries have similar mobile-broadband prices to those of the high-income countries means that prices in terms of GNI p.c. in low-income Arab States are high and drive the region's average up.

The **Africa** region stands out as the region in which mobile-broadband services are the least affordable. Indeed, the average corresponds to more than 15 per cent of the GNI p.c. for handset-based mobile broadband, and about 30 per cent of the GNI p.c. for computer-based mobile broadband. This highlights the fact that mobile broadband is still not affordable in most countries of the Africa region, and suggests that current mobile-broadband usage for most of Africa's population is limited to cheaper plans in the market, with lower data allowances or time-metered offers, which greatly limit the potential impact of mobile broadband.

The high prices in terms of GNI p.c. in the Africa region are largely explained by the low GNI p.c. levels. For instance, Mozambique stands out in the region as having the lowest mobile-broadband prices in PPP$ (Table 4.5), but in terms of GNI p.c., prices in the country correspond to more than 5 per cent of the GNI p.c. for each mobile-broadband basket, on account of the low GNI p.c. (USD 609 per year). Nevertheless, it is worth mentioning that prepaid handset-based mobile broadband is the mobile-broadband service that may have more of an impact in developing countries, and that in Mozambique the cost of this service represents 6.3 per cent of GNI p.c., which is close to the Broadband Commission's affordability target of 5 per cent. This is already an encouraging achievement for an LDC.

A detailed regional analysis of prepaid handset-based mobile-broadband prices as a percentage of GNI p.c. provides additional insights into the affordability of the mobile-broadband service, which holds the greatest potential for development. The reason for selecting this basket (out of the four mobile-broadband services) is that handset-based subscriptions are much more widespread than computer-based subscriptions, and most handset-based subscriptions in the world are prepaid. This suggests that the affordability of prepaid handset-based mobile-broadband services will be a key enabling factor if the "mobile miracle" (i.e. the mass uptake of regular mobile-cellular services) is to be replicated in the broadband arena. Based on a regional comparison, the following points can be highlighted:

Africa:

- Prepaid handset-based mobile-broadband prices represent less than 5 per cent of GNI p.c. in only one out of five countries in the Africa region (Chart 4.18), and therefore in most countries the service is rather unaffordable.

- The most affordable prepaid handset-based mobile-broadband services are found in those African countries with the highest GNI p.c. levels, such as Gabon, Mauritius, Seychelles and South Africa. However, the prices in Cabo Verde and Ghana, which have much lower GNI p.c. levels, are as affordable as in those countries, thus illustrating that it is not only a matter of economic development, but also of efficient regulation, policy-making and private initiative.

- Other countries with low GNI p.c. levels that nevertheless stand out for low prepaid handset-based mobile-broadband prices include Gambia, Guinea, Kenya and Mozambique. If low prices are maintained, these countries could reach the 5 per cent affordability target in the short or mid-term.

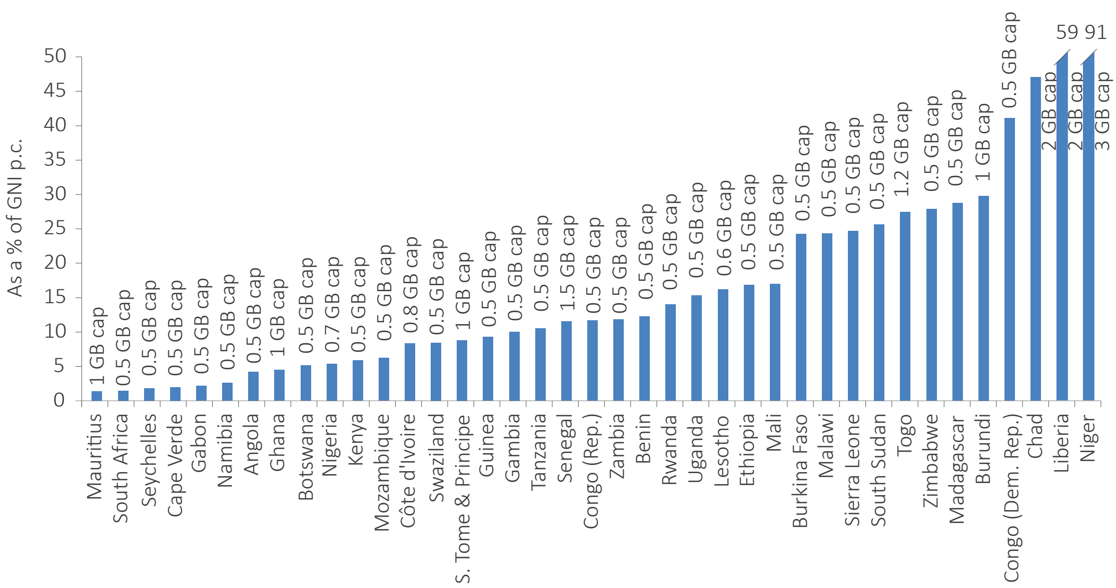
- In Chad, Liberia and Niger, prepaid handset-based mobile-broadband plans with a 30-day validity period include large data allowances (2 GB or more). As a result, prices in those countries correspond to over 40 per cent of GNI p.c., making them the most unaffordable worldwide. This suggests that the very low mobile-broadband penetration in those countries is to a great extent due to the unaffordability of the service.

Arab States:

- Prepaid handset-based mobile-broadband prices represent less than 5 per cent of GNI p.c. in the majority of Arab States, and less than 1 per cent in the GCC countries (Chart 4.19). This confirms that the service is affordable in most countries of the region, including Sudan, which, despite being an LDC and having a low GNI p.c., offers prepaid handset-based prices corresponding to less than 3.5 per cent of GNI p.c. Other countries that stand out for having low prepaid handset-based mobile-broadband prices include Egypt and Tunisia.

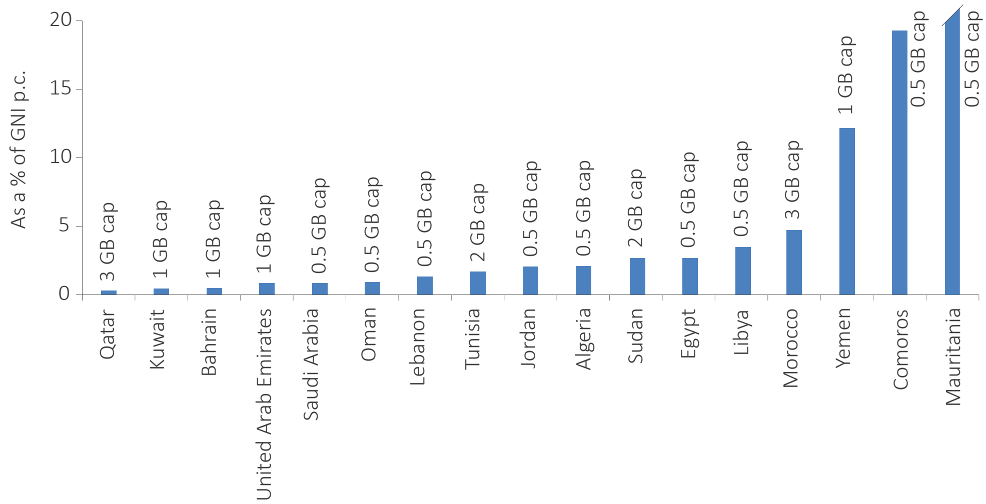
- Comoros, Mauritania and Yemen are the only Arab States included in the comparison in which prepaid handset-based mobile-broadband prices are largely unaffordable. This tallies with the lower rates of mobile-broadband penetration in those countries (less than 15 per cent, whereas all other countries with price data have mobile-broadband

Chart 4.18: Prepaid handset-based mobile-broadband prices (500 MB per month) as a percentage of GNI p.c. in the Africa region, 2014



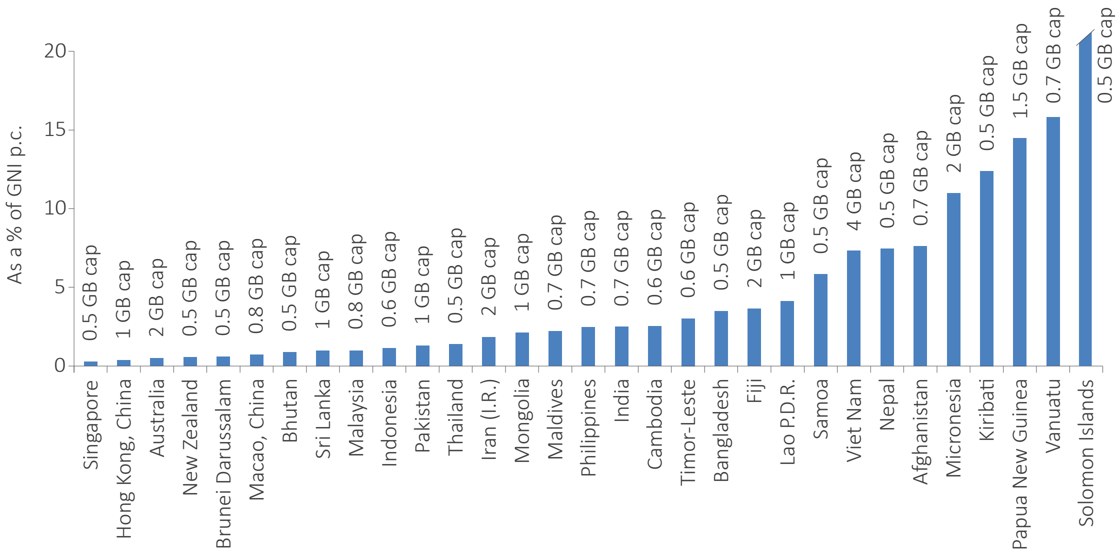
Source: ITU. GNI p.c. values are based on World Bank data.

Chart 4.19: Prepaid handset-based mobile-broadband prices (500 MB per month) as a percentage of GNI p.c. in the Arab States region, 2014



Source: ITU. GNI p.c. values are based on World Bank data.

Chart 4.20: Prepaid handset-based mobile-broadband prices (500MB per month) as a percentage of GNI p.c. in the Asia-Pacific region, 2014



Note: Japan and the Republic of Korea are not included in the comparison because more than 95 per cent of mobile subscriptions in these countries are postpaid, with prepaid prices therefore being of little relevance.
Source: ITU. GNI p.c. values are based on World Bank data.

penetration rates above 20 per cent). This suggests that affordability of the service is one of the main barriers to mobile-broadband uptake in Comoros, Mauritania and Yemen.

Asia and the Pacific:

- In three out of four countries in the region, prepaid handset-based mobile-broadband prices represent less than 5 per cent of GNI p.c. (Chart 4.20). This is the case not only in the high-income economies that top the ranking – Singapore, Hong Kong (China) and Australia – but also in several LDCs: Bhutan, Cambodia (Box 4.7), Timor-Leste, Bangladesh and Lao P.D.R. These countries are outstanding examples of the fact that affordable mobile-broadband services are also possible in LDCs and low-income countries. Other LDCs in Asia and the Pacific with moderately affordable prepaid handset-based mobile-broadband prices include Nepal and Afghanistan.

Box 4.7: Cambodia's mobile-broadband market

Cambodia stands out for having the lowest computer-based mobile-broadband prices in USD worldwide according to the ITU baskets, and the third cheapest handset-based mobile-broadband prices. Even in relation to the country's GNI p.c., mobile-broadband prices are relatively low, corresponding to less than 5 per cent of GNI p.c. However, mobile-broadband uptake is in its early stages in Cambodia, with penetration at 14 per cent compared with a mobile-cellular penetration of more than 155 per cent. High mobile-cellular uptake, strong competition and relatively low prices in the mobile-broadband market, coupled with the recent progress in the deployment of mobile-broadband networks in Cambodia, suggest that mobile-broadband adoption could take off in the country in the coming years.

There are five operators offering mobile-broadband services to meet the demand of Cambodia's 15.4 million inhabitants, and competition is strong, with no operator having more than 35 per cent of the mobile-broadband market share.[50] Metfone, the dominant operator in the mobile-cellular market, has gained some momentum following its acquisition of Beeline Cambodia in March 2015[51] and the extension of its 3G network, which covered 70 per cent of the country by the beginning of 2015.[52]

The third operator in the mobile-broadband market, Smart, was the first, in January 2014, to launch LTE services, and has since expanded its LTE network, achieving the milestone of LTE deployment to all of Cambodia's 25 provinces in June 2015.[53] The smallest operator offering mobile-broadband services in Cambodia, Excell, was acquired by the Singapore-based South East Asia Telecom (SEATEL) Group in 2013. SEATEL has also been investing in the roll-out of an LTE network, its objective being to shut down Excell's 3G network and replace it with the new LTE network by the end of June 2015.[54]

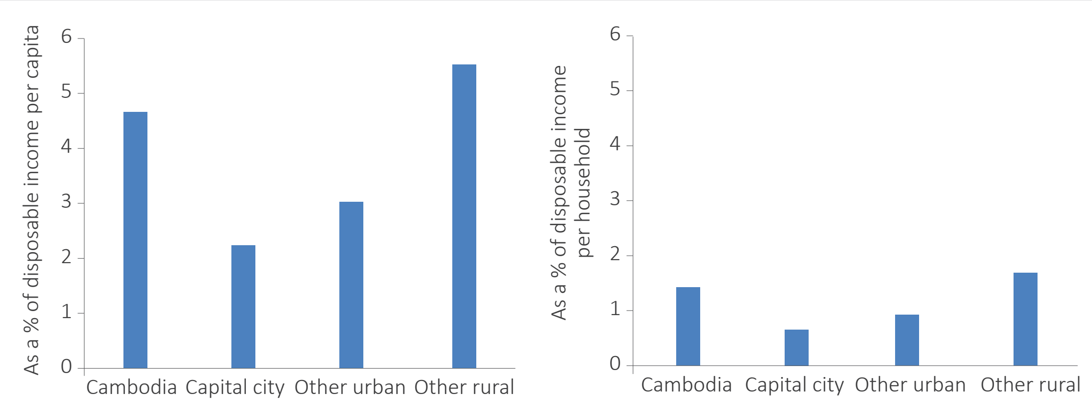
According to GSMA Intelligence, there were 4.8 million mobile-broadband-capable connections in Cambodia by the end of 2014, while ITU data show that only 2.1 million of them were actually making active use of mobile-broadband services. This highlights the fact that the service has to be affordable in order to bridge the difference between potential and actual customers. This is particularly true given the recent network roll-outs that will expand the potential customer base.

In 2013, Cambodia's average monthly consumption per capita on communications amounted to USD 1.24 (National Institute of Statistics of Cambodia, 2014). This compares with USD 2.00 per month for a handset-based mobile-broadband subscription, meaning that an average consumer previously not subscribing to mobile-broadband services would need to multiply by 2.5 the average expenditure in communication to start using 500MB of mobile broadband per month. In order to determine the extent to which such an increase in consumption would be possible for the population in Cambodia, mobile-broadband prices are shown as a percentage of median disposable income per capita (handset-based plans) and per household (computer-based plans) in Chart Box 4.7.[55]

Data show that computer-based mobile-broadband plans are very affordable and correspond to less than 2 per cent of the average household's disposable income. Handset-based mobile-broadband plans are somewhat less affordable if their costs are considered personal rather than shared per household, although prices would still correspond to less than 5 per cent of median disposable income in Cambodia. The differences in income between rural and urban areas make mobile-broadband plans less affordable in rural areas, particularly for handset-based mobile-broadband plans.

Box 4.7: Cambodia's mobile-broadband market (continued)

Chart Box 4.7: Handset-based mobile-broadband (500 MB/month) prices as a percentage of disposable income per capita (left), and computer-based mobile-broadband (1 GB/month) prices as a percentage of disposable income per household (right), Cambodia



Note: Disposable income refers to the median value.
Source: ITU. Data on disposable income sourced from National Institute of Statistics of Cambodia (2014).

- In the majority of Pacific SIDS, the affordability of prepaid handset-based mobile-broadband services remains an issue. This is particularly the case in Kiribati, Micronesia, Papua New Guinea, the Solomon Islands and Vanuatu, where the price of the service represents more than 10 per cent of GNI p.c. Nevertheless, the example of Fiji, the SIDS in the region with the highest mobile-broadband penetration (over 40 per cent), shows that more affordable prepaid handset-based mobile-broadband prices are possible, even in the challenging context of SIDS, and that they can lead to higher mobile-broadband uptake.

Commonwealth of Independent States (CIS):

Prepaid handset-based mobile-broadband prices are very affordable in the majority of CIS countries (Chart 4.21).

- The service represents less than 1 per cent of GNI p.c. not only in the Russian Federation and Kazakhstan, the two countries with the highest income, but also in Belarus and Azerbaijan, which have lower income levels.

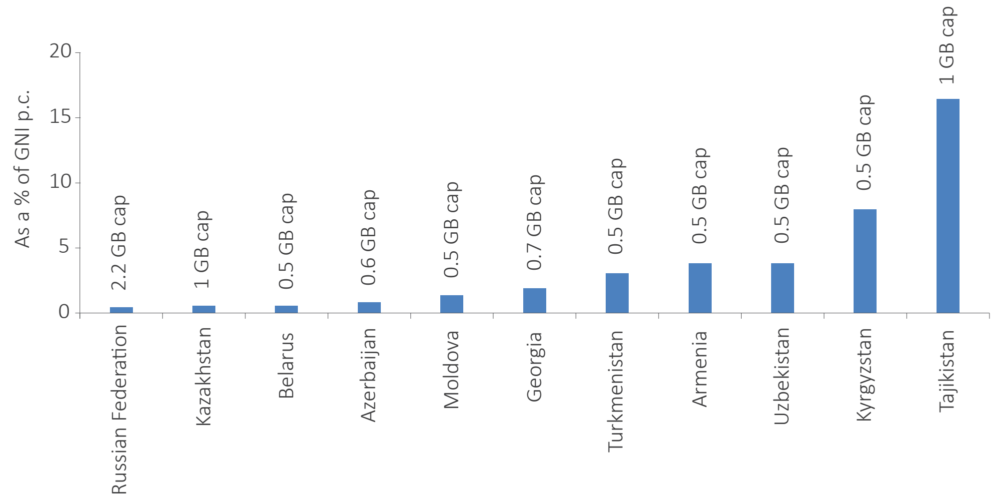
- Kyrgyzstan and Tajikistan are the only CIS countries in which prepaid handset-based mobile-broadband represents more than 5 per cent of GNI p.c. Prices are the least affordable in Tajikistan, which is also the CIS country included in the comparison with the lowest mobile-broadband penetration.

Europe:

- All European countries included in the comparison offer prepaid handset-based mobile-broadband plans representing less than 3 per cent of GNI p.c. (Chart 4.22), making them very affordable. This finding confirms that Europe is by far the region with the most affordable mobile-broadband services, even in the case of prepaid services, which in many European countries are less common than postpaid services.

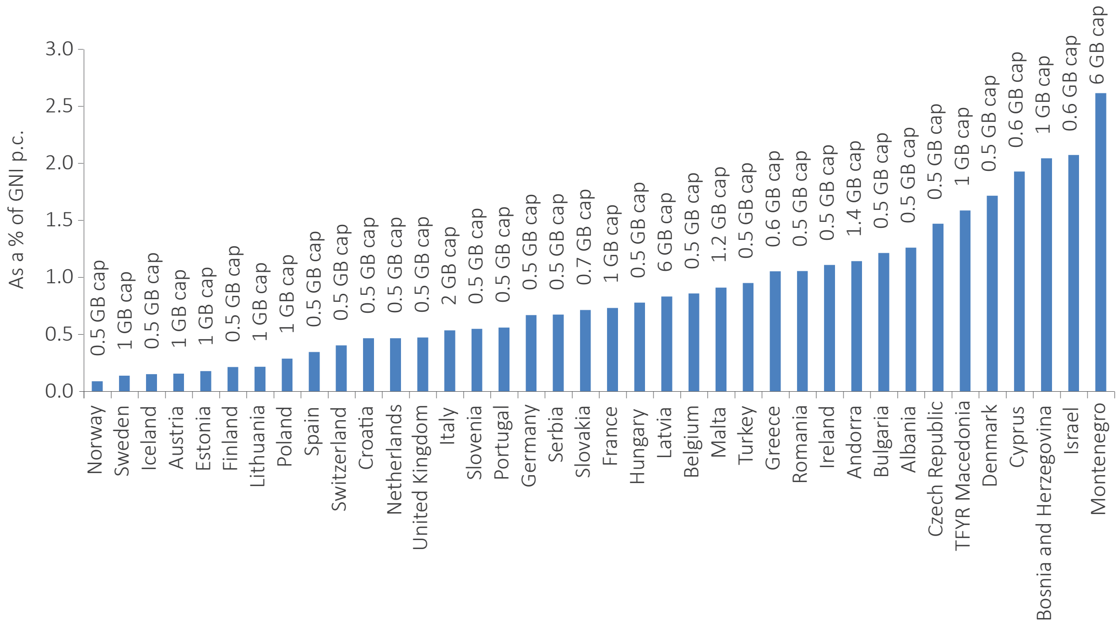
- Eight out of the top ten countries with the most affordable prepaid handset-based mobile-broadband prices worldwide are in Europe. They include Norway, Sweden, Iceland, Austria and Estonia, where the price of the service corresponds to less than 0.2 per cent of GNI p.c.

Chart 4.21: Prepaid handset-based mobile-broadband prices (500MB per month) as a percentage of GNI p.c. in the CIS region, 2014



Source: ITU. GNI p.c. values are based on World Bank data.

Chart 4.22: Prepaid handset-based mobile-broadband prices (500 MB per month) as a percentage of GNI p.c. in the Europe region, 2014



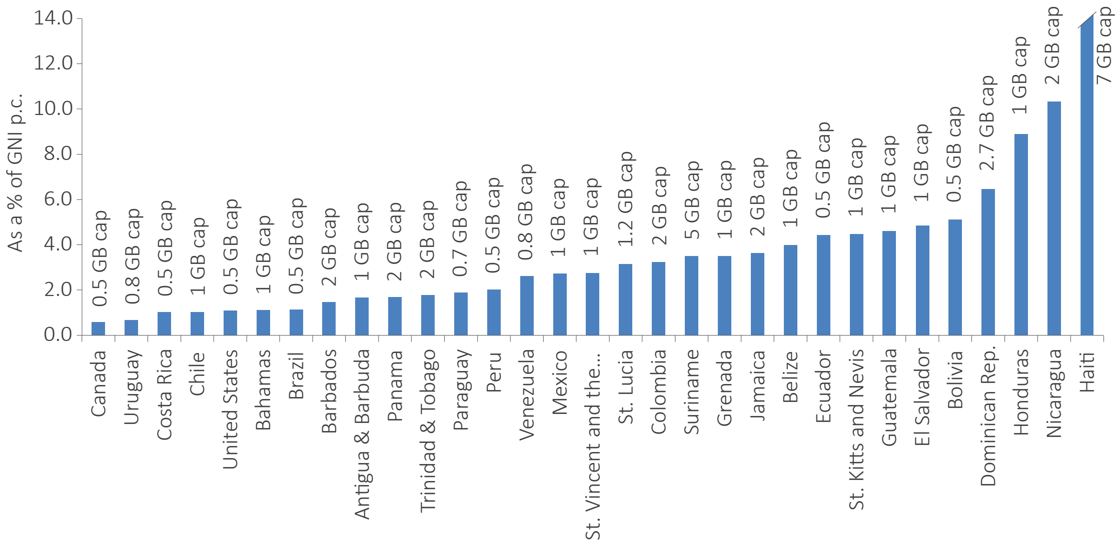
Source: ITU. GNI p.c. values are based on World Bank data.

The Americas:

- Almost all countries in the Americas region have mobile-broadband prices that represent less than 5 per cent of GNI p.c. (Chart 4.23). The most affordable services are offered not only in the region's high-income countries, such as Canada, which tops the ranking, but also in countries with lower income levels, such as Uruguay, Costa Rica and Brazil. Another country that stands out for offering affordable prepaid handset-based mobile-broadband services is Paraguay.

- The only countries in which prepaid handset-based mobile-broadband prices clearly correspond to more than 5 per cent of GNI p.c. are the Dominican Republic, Honduras, Nicaragua and Haiti. Since all four countries have mobile-cellular markets that are predominantly prepaid, more affordable prepaid handset-based mobile-broadband

Chart 4.23: Prepaid handset-based mobile-broadband prices (500 MB per month) as a percentage of GNI p.c. in the Americas region, 2014



Source: ITU. GNI p.c. values are based on World Bank data.

plans could greatly contribute to further mobile-broadband uptake. Indeed, the Dominican Republic has a mobile-broadband penetration that is only half the regional average, and GNI p.c. levels suggest that more affordable prices are possible. In Honduras, the mobile-broadband market is at an earlier stage of development and could benefit greatly from more affordable prices. Lastly, mobile-broadband penetration is below 2 per cent in Nicaragua and almost 0 in Haiti, highlighting the fact that cheaper plans with lower data allowances and longer validity periods are needed for mobile broadband to take off in these countries.

4.5 International mobile roaming prices

International mobile roaming has been on regulatory radar screens for several years, as roaming charges are often deemed to be excessively high and lacking in transparency, with consumers all too often suffering "bill shock".[56] Industry studies confirm that, depending on the home network of the roaming client and the visited country network, applicable roaming tariffs can vary by as much as a factor of five if not more (GSMA, 2012). Roaming fees also depend on the prices negotiated in inter-operator agreements. However, the addressable market of potential roaming clients continues to grow as the industry expands both network coverage and the number of available roaming routes.[57]

A comprehensive data set on international mobile roaming charges is hard to compile and would require inputs on a large number of dimensions: multiple roaming destinations, multiple operator tariffs, on-net calls, off-net calls, special bundles and other relevant commercial offers. The lack of data hampers a global comprehensive analysis of roaming price trends. However, data collected by regulators from a number of emerging regional initiatives allows estimates of average regional roaming prices per main destination.

Several regulatory initiatives have emerged in recent years with a view to reducing roaming prices, better informing consumers and preventing "bill shock". As from 2007, the European Union, together with Iceland, Liechtenstein and Norway, has been setting price limits for intra-EU roaming tariffs with the aim of achieving a European single market in electronic communications. As a result, European mobile roaming prices fell significantly in the period 2007-2013, by over 80 per cent for retail calls and SMS, and by over 90 per cent for data roaming.[58] Despite this, however, a 2014 survey commissioned by the European Commission showed that 47 per cent of Europeans travelling to other EU countries still avoid using mobile Internet, with over 25 per cent simply switching off their mobile phones for fear of "bill shock".[59]

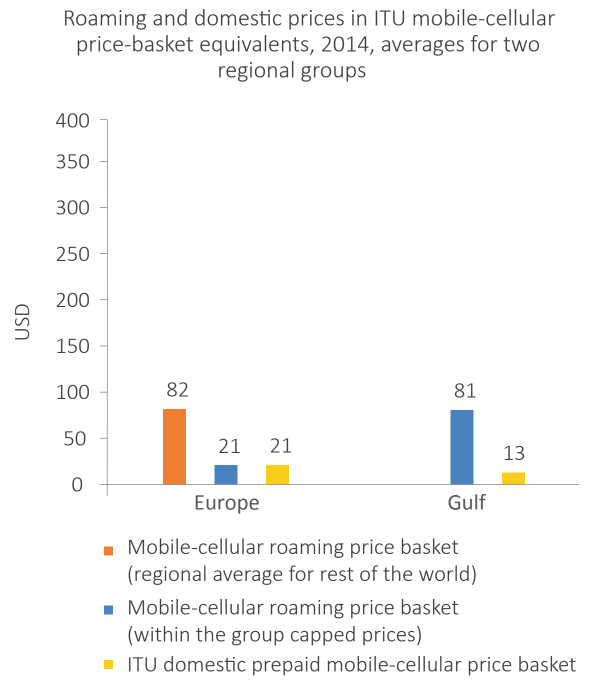
To inform policy-makers, the Board of European Regulators for Electronic Communications (BEREC) collects and publishes mobile-roaming prices[60] averaged for the group of countries in which the Eurotariff regulation applies. Chart 4.24 plots a number of calculated values based on the ITU mobile-cellular price basket (for placing calls and sending SMS texts), comparing roaming and domestic prices. The ITU price basket for European mobile-roaming tariffs stood at USD 21 for the actual Eurotariff price caps and at USD 82 for the rest of the world (non-Eurotariffs). The capped roaming tariff was thus very similar to the average European domestic prices for a pre-paid mobile-cellular price basket (both around USD 21); the European roaming tariff for the rest of the world (non-regulated) was nearly four times the domestic value.

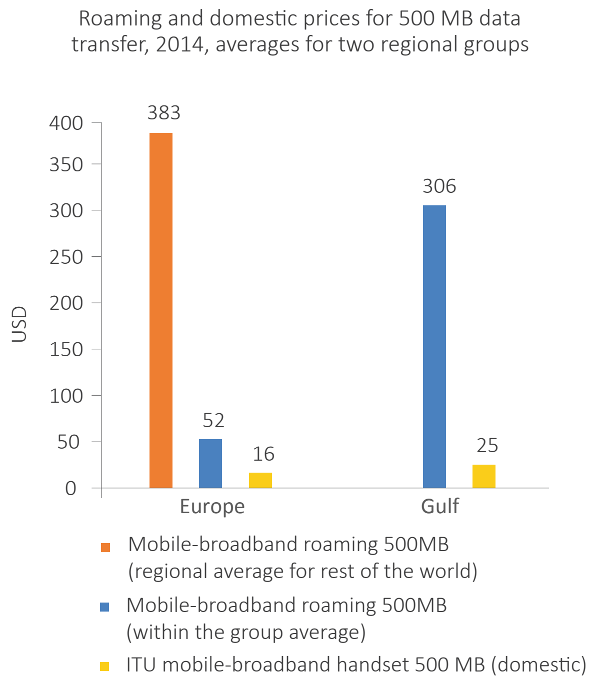
As from 2012, European regulators also started capping prices for data transfer while roaming. In the third quarter of 2014, European retail roaming prices for transferring 500 MB averaged USD 52 for countries within the group and as much as USD 383 for the rest of the world, i.e. three and 23 times, respectively, higher than the calculated average European domestic rate of USD 16.

Another region which regulates roaming prices is the Gulf, where GCC[61] regulators introduced caps for intra-group mobile roaming tariffs in 2012. The GCC regulation targets only retail and wholesale voice services. The ITU price basket was used to calculate a comparable roaming price basket for the Gulf countries. The calculated value of the GCC-capped intra-group mobile roaming price basket was USD 81,[62] more than six times higher than the average GCC domestic prepaid mobile-cellular price basket (USD 13). In terms of tariffs for data transfer, currently not capped, using 500 MB while roaming in the GCC area costs USD 306, considerably more than the domestic GCC average of USD 25.

The regulatory initiatives described above have sought to reduce roaming charges for intra-group privileged destinations: intra-European and intra-GCC in this case. A possible criticism of such an approach is that it could lead to so-called "waterbed effects", with operators constrained by price caps in one market responding by increasing any of the other unregulated tariffs, such as those for other roaming destinations or for other services (Sutherland, 2010, and GSMA, 2012). The comprehensive tariff data collections needed to assess such effects are a challenge. As a result,

Chart 4.24: International mobile roaming and domestic prices in Europe and the Gulf, 2014





Note: Average regional prices were used for SMS in the calculation of the GCC-capped mobile-cellular roaming price basket. The mobile-cellular roaming basket includes the cost of making calls and sending SMS texts while abroad. Data on the GCC regional averages for both – the mobile-cellular roaming price basket and the mobile-broadband roaming prices – are not available.
Source: ITU, based on BEREC, GCC Roaming Working Group and ITU data.

existing research is inconclusive as to whether waterbed effects occur because of roaming regulation, and some recent papers find that the unintended effects of regulation on mobile-customers' bills may be negligible in the long term (Genakos and Valletti, 2014).

Mobile-network operators have also been forthcoming in offering roaming discounts. A long celebrated example has been that of Zain, an operator which, having acquired a large geographical footprint in East Africa, was able to leverage its network assets to offer its customers in 2006 a "One Network" solution, free from surcharges when roaming on-net in the region. The offer appeared in a market where nearly all mobile-cellular subscriptions were prepaid and consumers avoided high roaming charges by simply swapping SIM cards when crossing the border (Surtherland, 2010). The subsequent purchase of Zain's network by Bharti Airtel had the effect of extending "One Network" in 2010 to Bangladesh, India and Sri Lanka, as well as another 17 African countries.[63]

More recently, a number of commercial offers have emerged that aim to capitalize on mobile roaming. For example, China Mobile offers a USD 38 prepaid roaming SIM card[64] that allows consumers to receive calls at local rates while travelling abroad in a list of countries designated in the offer, with tariffs that are up to 80 per cent lower for calls to the home country and local calls, as well as more favourable data roaming packages. In the United States, T-Mobile announced in 2013 a new postpaid plan, eliminating roaming surcharges for data and text messages in more than 100 countries and with a simplified call rate per minute of USD 0.2. Average speeds for this plan limit the amount of data transfer per day, and consumers can purchase additional speed packages as an add-on.[65] In France, Bouygues, Free and Orange each have innovative postpaid offers with lower roaming rates for a limited voice and data package.[66]

Roaming customers have several options for reducing their mobile costs while abroad. These include the simple acquisition of a local SIM card (also known as plastic roaming); connecting to local public Wi-Fi and using over-the-top applications such as Skype, WhatsApp, Facebook Messenger, Viber, etc.; and newer multi-IMSI SIM offerings, which include multiple carrier agreements and local data pricing in multiple priority markets on a single SIM card (see, for example, Cubic Telecom[67] and Telna North America[68]). However, these alternatives are less than perfect substitutes for international mobile roaming, as they require either an extra effort on the part of the customer, such as buying a SIM card upon arrival in a foreign country, or limited use of the service, such as using mobile services only when within range of a Wi-Fi network.

Pricing for international mobile roaming has implications beyond the simple shifting of revenues between service providers and customers. Prohibitive pricing can stifle economic and social activity when it prevents people from connecting while abroad, limiting access to information and other technology resources. International and regional cooperation on mobile roaming can help ensure that the benefits of lower roaming prices are enjoyed by many.

Table 4.7: Mobile-broadband prices, postpaid handset-based, 500MB, 2014

		Mobile-broadband, postpaid handset-based (500 MB)				
Rank	Economy	as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*	Monthly data allowance (MB)
1	Finland	0.09	3.85	2.91	48'771	500
2	Iceland	0.15	5.91	4.76	46'244	500
3	Austria	0.16	6.63	5.76	50'340	1'024
4	Australia	0.17	9.01	6.50	65'335	500
5	Luxembourg	0.18	10.61	8.13	69'810	500
6	Norway	0.18	15.71	9.96	102'597	1'000
7	Qatar	0.23	16.48	22.40	86'703	1'000
8	Sweden	0.28	14.43	10.73	61'648	3'072
9	Singapore	0.35	15.71	16.45	53'986	2'048
10	Portugal	0.37	6.62	7.58	21'249	500
11	Andorra	0.41	13.86		40'974	1'024
12	Macao, China	0.41	22.29	30.15	64'639	500
13	Switzerland	0.43	32.53	19.34	90'589	500
14	Russian Federation	0.45	5.21	11.96	13'836	2'250
15	Netherlands	0.47	19.90	16.66	51'009	500
16	United Kingdom	0.47	16.45	12.68	41'638	1'024
17	Bahrain	0.48	7.98	13.60	19'881	1'000
18	Korea (Rep.)	0.48	10.45	12.03	25'894	500
19	Belgium	0.52	19.90	16.71	46'294	1'024
20	Denmark	0.52	26.55	17.69	61'608	1'024
21	Lithuania	0.53	6.54	9.57	14'885	1'024
22	Croatia	0.55	6.09	8.44	13'407	1'024
23	France	0.55	19.89	16.85	43'476	1'024
24	New Zealand	0.55	16.59	12.77	36'089	500
25	Hong Kong, China	0.56	18.06	23.21	38'382	1'000
26	Sri Lanka	0.57	1.49	4.16	3'167	500
27	Kazakhstan	0.57	5.52	11.02	11'538	1'024
28	Poland	0.57	6.34	10.53	13'227	3'072
29	Belarus	0.58	3.23	9.90	6'723	500
30	Estonia	0.58	8.61	10.26	17'762	1'536
31	Spain	0.59	14.59	14.52	29'910	800
32	Slovenia	0.62	11.94	13.36	23'197	1'024
33	Latvia	0.62	7.95	14.80	15'275	600
34	Slovakia	0.63	9.27	12.42	17'792	700
35	Hungary	0.78	8.60	13.93	13'247	500
36	Greece	0.79	14.86	15.50	22'667	750
37	Brunei Darussalam	0.80	22.10	33.72	32'976	2'048
38	Azerbaijan	0.83	5.10	12.15	7'343	600
39	Bahamas	0.84	15.00	13.19	21'548	500
40	UAE	0.84	26.96	37.06	38'713	1'000
41	Israel	0.84	23.76	19.59	33'896	3'072
42	Uruguay	0.85	10.71	13.38	15'165	1'024
43	Saudi Arabia	0.85	18.67	38.13	26'234	500
44	China	0.89	4.88	7.98	6'553	500
45	Cyprus	0.95	19.90	20.26	25'185	1'024
46	Turkey	0.95	8.68	14.30	10'959	500
47	Malaysia	0.99	8.56	17.61	10'420	800
48	Germany	1.01	39.74	36.15	47'203	500
49	Tunisia	1.01	3.53	7.97	4'196	1'024
50	Romania	1.06	7.96	13.78	9'041	500
51	Czech Republic	1.06	16.81	24.12	18'951	1'500
52	Ireland	1.11	39.80	30.84	43'047	1'024
53	Japan	1.11	42.81	40.47	46'284	500
54	Montenegro	1.12	6.75	11.06	7'243	750
55	Bulgaria	1.22	7.46	14.16	7'353	500
56	Sudan	1.23	1.59	3.55	1'548	1'000
57	Oman	1.23	26.01	49.69	25'381	500
58	Chile	1.24	15.76	22.87	15'215	600
59	Suriname	1.26	9.85	16.69	9'361	1'024
60	Bhutan	1.30	2.53	7.93	2'328	500
61	Lebanon	1.34	11.00		9'860	500
62	Thailand	1.38	6.13	15.24	5'335	500
63	Moldova	1.39	2.85	6.94	2'468	500
64	Canada	1.41	61.30	52.44	52'158	500
65	Barbados	1.42	18.00	14.52	15'219	2'048
66	Mauritius	1.43	11.40	18.38	9'560	1'000
67	Kuwait	1.47	56.23	86.65	46'046	30'720
68	United States	1.47	65.33	65.33	53'417	1'024
69	South Africa	1.48	9.12	19.16	7'403	500
70	Albania	1.52	5.69	10.57	4'505	500
71	Costa Rica	1.52	12.07	17.81	9'540	500
72	Malta	1.52	26.53	29.92	20'959	500
73	Armenia	1.52	4.81	10.39	3'796	1'500
74	Italy	1.52	45.11	40.67	35'584	1'100
75	Indonesia	1.56	4.64	12.54	3'576	1'624
76	Serbia	1.57	7.91	14.14	6'044	5'120
77	TFYR Macedonia	1.59	6.44	12.70	4'865	1'024
78	Panama	1.68	14.99	25.51	10'689	1'024
79	Peru	1.69	8.81	15.49	6'264	500
80	Seychelles	1.78	19.61	29.34	13'197	500
81	Mexico	1.81	14.97	21.27	9'930	500
82	Colombia	1.81	11.44	18.82	7'582	500
83	Turkmenistan	1.84	10.53		6'873	500
84	Iran (I.R.)	1.84	8.87	26.85	5'774	2'048
85	Georgia	1.91	5.66	12.48	3'556	700
86	Viet Nam	1.96	2.84	7.01	1'738	500

		Mobile-broadband, postpaid handset-based (500 MB)				
Rank	Economy	as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*	Monthly data allowance (MB)
87	Bosnia and H.	1.99	7.94	13.80	4'775	500
88	Jordan	2.05	8.45	17.61	4'945	500
89	Algeria	2.10	9.31	21.74	5'325	500
90	Mongolia	2.10	6.60	16.86	3'766	1'024
91	Trinidad & Tobago	2.13	27.94	34.91	15'744	5'000
92	Gabon	2.17	19.21	26.55	10'639	500
93	Maldives	2.20	10.27	13.36	5'594	700
94	Paraguay	2.35	7.84	14.74	4'006	500
95	Antigua & Barbuda	2.35	25.56	31.09	13'037	500
96	Philippines	2.47	6.73	15.44	3'267	700
97	India	2.51	3.28	11.41	1'568	600
98	Cambodia	2.53	2.00	5.17	949	600
99	Venezuela	2.61	27.24	35.72	12'537	800
100	Namibia	2.64	12.90	25.12	5'864	500
101	Egypt	2.70	7.06	24.49	3'137	500
102	Grenada	2.73	17.04	22.25	7'483	1'024
103	Timor-Leste	3.02	10.00	14.85	3'976	800
104	Jamaica	3.11	13.52	20.98	5'215	2'048
105	St. Kitts and Nevis	3.14	36.30	44.75	13'876	750
106	Belize	3.33	12.50	21.46	4'505	1'024
107	Bolivia	3.34	7.09	15.79	2'547	500
108	St. Vincent	3.44	18.52	24.55	6'454	1'500
109	Bangladesh	3.49	2.93	8.31	1'009	500
110	Ecuador	3.50	16.79	29.43	5'754	500
111	Dominican Rep.	3.70	17.76	35.53	5'764	1'500
112	Lao P.D.R.	4.12	4.97	12.82	1'449	1'024
113	Angola	4.25	18.31	21.04	5'165	500
114	Brazil	4.32	42.07	55.22	11'678	500
115	Pakistan	4.37	4.95	17.25	1'359	3'072
116	Ghana	4.48	6.60	21.57	1'768	1'000
117	Morocco	4.68	11.78	23.70	3'017	10'000
118	El Salvador	4.84	15.00	28.54	3'716	1'024
119	Nigeria	5.40	12.19	21.39	2'707	750
120	Botswana	5.79	37.43	68.86	7'762	500
121	Samoa	5.84	19.30	23.89	3'966	1'100
122	Kenya	5.89	5.69	12.64	1'159	500
123	Tanzania	5.90	4.22	9.89	859	500
124	Fiji	5.95	21.64	32.67	4'366	4'096
125	Cape Verde	6.35	19.13	33.26	3'616	5'500
126	Guatemala	6.93	19.27	36.79	3'337	600
127	St. Lucia	7.17	42.17	52.14	7'053	1'500
128	Swaziland	7.22	17.97	43.35	2'987	500
129	Nepal	7.45	4.53	15.19	729	500
130	Nicaragua	7.71	11.49	29.36	1'788	1'024
131	Kyrgyzstan	7.96	8.01	23.20	1'209	500
132	Côte d'Ivoire	8.38	10.11	21.14	1'449	800
133	Guinea	9.31	3.56	7.81	460	500
134	Mozambique	9.36	4.75	9.28	609	500
135	Gambia	10.07	4.19	15.19	500	500
136	Afghanistan	10.61	6.10	17.67	689	500
137	Senegal	11.57	10.11	20.60	1'049	1'500
138	Congo (Rep.)	11.73	25.28	39.66	2'587	500
139	Papua New Guinea	11.84	19.91	21.63	2'018	800
140	Zambia	11.89	17.92	39.97	1'808	500
141	Lesotho	13.28	16.59	43.33	1'499	500
142	Uganda	15.40	7.69	18.19	599	500
143	Vanuatu	15.81	41.21	34.78	3'127	1'024
144	Tajikistan	16.44	13.55	33.09	989	1'000
145	Ethiopia	16.92	6.62	18.54	470	500
146	Mali	17.04	9.51	20.94	669	500
147	Benin	18.45	12.14	25.63	789	1'024
148	Honduras	19.01	34.50	67.44	2'178	1'024
149	Comoros	19.28	13.48	22.55	839	500
150	Togo	22.92	10.11	21.35	529	1'000
151	Burkina Faso	24.30	15.17	33.48	749	500
152	South Sudan	25.72	20.34		949	500
153	Malawi	26.18	5.88	21.50	270	512
154	Zimbabwe	26.54	19.00	34.76	859	500
155	S. Tome & Principe	27.10	33.17	52.60	1'469	3'072
156	Madagascar	28.26	10.35	32.63	440	500
157	Uzbekistan	28.75	45.00		1'878	8'000
158	Solomon Islands	30.54	40.68	39.03	1'598	500
159	Haiti	32.80	22.12	44.46	809	7'168
160	Mauritania	37.81	33.36	84.02	1'059	500
161	Congo (Dem. Rep.)	41.17	14.74	23.55	430	500
162	Chad	47.18	40.45	72.19	1'029	2'000
163	Liberia	58.60	20.00	36.87	410	2'048
164	Niger	91.11	30.34	66.08	400	3'072
	Myanmar**		10.16	35.07		1'024
	Argentina**		17.34			500
	San Marino**		38.48	37.17		500
	Liechtenstein**		42.57			1'024
	Monaco**		45.11			1'024
	Syria**		89.09			1'000

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
** Country not ranked because data on GNI p.c. are not available for the last five years.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Table 4.8: Mobile-broadband prices, prepaid handset-based 500MB, 2014

		Mobile-broadband, prepaid handset-based (500 MB)				
Rank	Economy	as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*	Monthly data allowance (MB)
1	Norway	0.09	7.78	4.93	102’597	500
2	Sweden	0.14	7.14	5.31	61’648	1’024
3	Iceland	0.15	5.91	4.76	46’244	500
4	Austria	0.16	6.63	5.76	50’340	1’024
5	Estonia	0.18	2.65	3.16	17’762	1’024
6	Finland	0.22	8.76	6.62	48’771	500
7	Lithuania	0.22	2.69	3.94	14’885	1’024
8	Singapore	0.26	11.84	12.40	53’986	500
9	Poland	0.29	3.17	5.27	13’227	1’024
10	Qatar	0.30	21.98	29.87	86’703	3’000
11	Spain	0.35	8.62	8.58	29’910	500
12	Hong Kong, China	0.36	11.67	15.00	38’382	1’000
13	Switzerland	0.40	30.56	18.17	90’589	500
14	Russian Federation	0.45	5.21	11.96	13’836	2’250
15	Kuwait	0.46	17.57	27.08	46’046	1’024
16	Croatia	0.47	5.22	7.24	13’407	500
17	Netherlands	0.47	19.90	16.66	51’009	500
18	United Kingdom	0.47	16.45	12.68	41’638	500
19	Bahrain	0.48	7.98	13.60	19’881	1’000
20	Australia	0.50	27.04	19.51	65’335	2’048
21	Italy	0.54	15.92	14.35	35’584	2’048
22	Slovenia	0.55	10.61	11.88	23’197	500
23	New Zealand	0.55	16.59	12.77	36’089	500
24	Portugal	0.56	9.94	11.37	21’249	500
25	Brunei Darussalam	0.57	15.78	24.09	32’976	500
26	Kazakhstan	0.57	5.52	11.02	11’538	1’024
27	Belarus	0.58	3.23	9.90	6’723	500
28	Canada	0.59	25.54	21.85	52’158	500
29	Germany	0.67	26.40	24.02	47’203	500
30	Serbia	0.67	3.39	6.07	6’044	500
31	Uruguay	0.68	8.60	10.75	15’165	768
32	Macao, China	0.70	37.56	50.81	64’639	800
33	Slovakia	0.72	10.61	14.22	17’792	700
34	France	0.73	26.53	22.48	43’476	1’000
35	Hungary	0.78	8.60	13.93	13’247	500
36	Azerbaijan	0.83	5.10	12.15	7’343	600
37	Latvia	0.83	10.61	19.77	15’275	6’144
38	UAE	0.84	26.96	37.06	38’713	1’000
39	Saudi Arabia	0.85	18.67	38.13	26’234	500
40	Belgium	0.86	33.17	27.85	46’294	500
41	Bhutan	0.88	1.70	5.35	2’328	500
42	Malta	0.91	15.92	17.95	20’959	1’200
43	Oman	0.92	19.51	37.27	25’381	500
44	Turkey	0.95	8.68	14.30	10’959	500
45	Sri Lanka	0.97	2.57	7.16	3’167	1’024
46	Malaysia	0.99	8.56	17.61	10’420	800
47	Costa Rica	1.03	8.16	12.03	9’540	500
48	Chile	1.04	13.13	19.05	15’215	1’000
49	Greece	1.05	19.90	20.76	22’667	600
50	Romania	1.06	7.96	13.78	9’041	500
51	United States	1.10	48.94	48.94	53’417	500
52	Ireland	1.11	39.80	30.84	43’047	500
53	Bahamas	1.11	20.00	17.58	21’548	1’024
54	Brazil	1.13	11.00	14.43	11’678	500
55	Indonesia	1.13	3.37	9.12	3’576	600
56	Andorra	1.14	39.01		40’974	1’400
57	Bulgaria	1.21	7.44	14.12	7’353	500
58	Albania	1.26	4.74	8.81	4’505	500
59	Pakistan	1.31	1.48	5.17	1’359	1’024
60	Lebanon	1.34	11.00		9’860	500
61	Thailand	1.38	6.13	15.24	5’335	500
62	Moldova	1.39	2.85	6.94	2’468	500
63	Mauritius	1.43	11.40	18.38	9’560	1’000
64	Barbados	1.46	18.50	14.92	15’219	2’048
65	Czech Republic	1.47	23.22	33.31	18’951	500
66	South Africa	1.48	9.12	19.16	7’403	500
67	TFYR Macedonia	1.59	6.44	12.70	4’865	1’024
68	Antigua & Barbuda	1.67	18.15	22.08	13’037	1’024
69	Panama	1.68	14.95	25.44	10’689	2’048
70	Tunisia	1.68	5.89	13.28	4’196	2’048
71	Denmark	1.72	88.20	58.76	61’608	500
72	Trinidad & Tobago	1.77	23.25	29.06	15’744	2’000
73	Iran (I.R.)	1.84	8.87	26.85	5’774	2’048
74	Seychelles	1.85	20.30	30.37	13’197	500
75	Paraguay	1.88	6.27	11.79	4’006	700
76	Georgia	1.91	5.66	12.48	3’556	700
77	Cyprus	1.93	40.48	41.21	25’185	600
78	Cape Verde	2.00	6.02	10.46	3’616	500
79	Peru	2.02	10.57	18.58	6’264	500
80	Bosnia and H.	2.05	8.14	14.15	4’775	1’024
81	Jordan	2.05	8.45	17.61	4’945	500
82	Israel	2.07	58.61	48.32	33’896	600
83	Algeria	2.10	9.31	21.74	5’325	500
84	Mongolia	2.10	6.60	16.86	3’766	1’024
85	Gabon	2.17	19.21	26.55	10’639	500
86	Maldives	2.20	10.27	13.35	5’594	700
87	Philippines	2.47	6.73	15.44	3’267	700
88	India	2.48	3.24	11.29	1’568	600
89	Cambodia	2.53	2.00	5.17	949	600
90	Venezuela	2.61	27.24	35.72	12’537	800
91	Montenegro	2.62	15.79	25.85	7’243	6’144
92	Namibia	2.62	12.81	24.94	5’864	500
93	Sudan	2.70	3.49	7.81	1’548	2’000
94	Egypt	2.70	7.06	24.49	3’137	500
95	Mexico	2.72	22.49	31.96	9’930	1’024
96	St. Vincent	2.75	14.81	19.64	6’454	1’024
97	Timor-Leste	3.02	10.00	14.85	3’976	650
98	Turkmenistan	3.06	17.54		6’873	500
99	St. Lucia	3.15	18.52	22.90	7’053	1’250
100	Colombia	3.24	20.48	33.70	7’582	2’048
101	Bangladesh	3.49	2.93	8.31	1’009	500
102	Libya	3.49	39.30	72.34	13’497	500
103	Suriname	3.50	27.27	46.21	9’361	5’120
104	Grenada	3.50	21.85	28.54	7’483	1’024
105	Jamaica	3.63	15.78	24.47	5’215	2’048
106	Fiji	3.64	13.25	20.00	4’366	2’048
107	Armenia	3.80	12.02	25.97	3’796	500
108	Uzbekistan	3.83	6.00		1’878	500
109	Belize	4.00	15.00	25.76	4’505	1’024
110	Lao P.D.R.	4.12	4.97	12.82	1’449	1’024
111	Angola	4.25	18.31	21.04	5’165	500
112	Ecuador	4.43	21.25	37.24	5’754	500
113	Ghana	4.48	6.60	21.57	1’768	1’024
114	St. Kitts and Nevis	4.48	51.85	63.92	13’876	1’074
115	Guatemala	4.60	12.80	24.44	3’337	1’024
116	Morocco	4.73	11.90	23.93	3’017	3’000
117	El Salvador	4.84	15.00	28.54	3’716	1’024
118	Bolivia	5.11	10.85	24.17	2’547	550
119	Botswana	5.17	33.42	61.48	7’762	500
120	Nigeria	5.40	12.19	21.39	2’707	750
121	Samoa	5.84	19.30	23.89	3’966	500
122	Kenya	5.89	5.69	12.64	1’159	500
123	Mozambique	6.28	3.19	6.23	609	500
124	Dominican Rep.	6.46	31.04	62.10	5’764	2’800
125	Viet Nam	7.31	10.59	26.16	1’738	4’200
126	Nepal	7.45	4.53	15.19	729	500
127	Afghanistan	7.60	4.37	12.66	689	750
128	Kyrgyzstan	7.96	8.01	23.20	1’209	500
129	Côte d'Ivoire	8.38	10.11	21.14	1’449	800
130	Swaziland	8.48	21.10	50.91	2’987	500
131	S. Tome & Principe	8.85	10.83	17.18	1’469	1’000
132	Honduras	8.90	16.15	31.58	2’178	1’024
133	Guinea	9.31	3.56	7.81	460	500
134	Gambia	10.07	4.19	15.19	500	500
135	Nicaragua	10.34	15.41	39.38	1’788	2’000
136	Tanzania	10.54	7.54	17.67	859	500
137	Micronesia	10.99	30.00		3’277	2’048
138	Senegal	11.57	10.11	20.60	1’049	1’500
139	Congo (Rep.)	11.73	25.28	39.66	2’587	500
140	Zambia	11.89	17.92	39.97	1’808	500
141	Yemen	12.19	13.50	30.00	1’329	1’000
142	Benin	12.30	8.09	17.09	789	500
143	Kiribati	12.40	27.04		2’617	500
144	Rwanda	14.02	7.35	18.27	629	500
145	Papua New Guinea	14.50	24.38	26.49	2’018	1’500
146	Uganda	15.40	7.69	18.19	599	500
147	Vanuatu	15.81	41.21	34.78	3’127	750
148	Lesotho	16.23	20.27	52.96	1’499	600
149	Tajikistan	16.44	13.55	33.09	989	1’000
150	Ethiopia	16.92	6.62	18.54	470	500
151	Mali	17.04	9.51	20.94	669	500
152	Comoros	19.28	13.48	22.55	839	500
153	Burkina Faso	24.30	15.17	33.48	749	500
154	Malawi	24.40	5.48	20.04	270	500
155	Sierra Leone	24.74	13.59	28.96	659	500
156	South Sudan	25.72	20.34		949	500
157	Togo	27.50	12.14	25.62	529	1’200
158	Zimbabwe	27.93	20.00	36.59	859	500
159	Solomon Islands	27.99	37.29	35.78	1’598	500
160	Madagascar	28.83	10.56	33.28	440	500
161	Burundi	29.87	6.47	16.68	260	1’000
162	Haiti	32.80	22.12	44.46	809	7’168
163	Mauritania	37.81	33.36	84.02	1’059	500
164	Congo (Dem. Rep.)	41.17	14.74	23.55	430	500
165	Chad	47.18	40.45	72.19	1’029	2’000
166	Liberia	58.60	20.00	36.87	410	2’000
167	Niger	91.11	30.34	66.08	400	3’072
	Myanmar**		10.16	35.07		1’024
	Argentina**		10.53			510
	Somalia**		15.00			600
	San Marino**		26.53	25.64		800
	Djibouti**		28.13	48.03		500
	Syria**		534.52			500

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
** Country not ranked because data on GNI p.c. are not available for the last five years.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Table 4.9: Mobile-broadband prices, postpaid computer-based 1GB, 2014

		Mobile-broadband, postpaid computer-based (1 GB)				
Rank	Economy	as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*	Monthly data allowance (GB)
1	Austria	0.16	6.63	5.76	50'340	1
2	Norway	0.18	15.71	9.96	102'597	1
3	Luxembourg	0.23	13.27	10.17	69'810	1
4	Qatar	0.23	16.48	22.40	86'703	1
5	Sweden	0.28	14.43	10.73	61'648	3
6	Iceland	0.29	11.05	8.90	46'244	1
7	Ireland	0.30	10.60	8.21	43'047	1
8	Italy	0.30	8.80	7.93	35'584	3
9	Denmark	0.34	17.64	11.75	61'608	3
10	Singapore	0.35	15.71	16.45	53'986	2
11	France	0.37	13.25	11.23	43'476	2
12	United States	0.37	16.32	16.32	53'417	1
13	Lithuania	0.37	4.61	6.76	14'885	1
14	Switzerland	0.40	30.56	18.17	90'589	1
15	Australia	0.41	22.54	16.26	65'335	1
16	United Kingdom	0.47	16.45	12.68	41'638	1
17	Finland	0.49	19.77	14.93	48'771	1
18	Germany	0.50	19.83	18.04	47'203	1
19	Andorra	0.53	18.03		40'974	1
20	Saudi Arabia	0.54	11.73	23.97	26'234	1
21	Poland	0.57	6.31	10.48	13'227	3
22	Kazakhstan	0.57	5.52	11.02	11'538	1
23	Romania	0.59	4.48	7.75	9'041	5
24	Oman	0.61	13.00	24.85	25'381	1
25	Netherlands	0.62	26.53	22.22	51'009	1
26	Hong Kong, China	0.64	20.51	26.36	38'382	1
27	Estonia	0.67	9.88	11.77	17'762	15
28	Belgium	0.69	26.52	22.27	46'294	2
29	Macao, China	0.69	37.31	50.47	64'639	1
30	Latvia	0.73	9.35	17.42	15'275	2
31	Uruguay	0.74	9.38	11.71	15'165	1
32	Malta	0.76	13.27	14.96	20'959	5
33	Hungary	0.78	8.60	13.93	13'247	2
34	Russian Federation	0.79	9.12	20.93	13'836	3
35	Belarus	0.80	4.46	13.68	6'723	2
36	Brunei Darussalam	0.80	22.10	33.72	32'976	2
37	Mauritius	0.82	6.53	10.53	9'560	2
38	Slovenia	0.82	15.92	17.82	23'197	3
39	New Zealand	0.83	24.89	19.15	36'089	1
40	UAE	0.84	26.96	37.06	38'713	1
41	Slovakia	0.89	13.25	17.75	17'792	1
42	Kuwait	0.92	35.14	54.15	46'046	15
43	Japan	0.93	35.68	33.72	46'284	2
44	Portugal	0.94	16.57	18.97	21'249	1
45	Canada	0.94	40.86	34.96	52'158	5
46	Cyprus	0.95	19.90	20.26	25'185	1
47	Turkey	1.00	9.09	14.98	10'959	1
48	Libya	1.05	11.79	21.70	13'497	1
49	Czech Republic	1.06	16.81	24.12	18'951	2
50	Bulgaria	1.10	6.72	12.74	7'353	1
51	Bahrain	1.12	18.62	31.74	19'881	8
52	Sri Lanka	1.14	3.01	8.38	3'167	6
53	Korea (Rep.)	1.16	25.07	28.86	25'894	2
54	Croatia	1.17	13.05	18.09	13'407	2
55	Spain	1.17	29.19	29.05	29'910	1
56	South Africa	1.18	7.28	15.29	7'403	1
57	Montenegro	1.31	7.89	12.93	7'243	1
58	Chile	1.37	17.36	25.18	15'215	1
59	Greece	1.40	26.53	27.67	22'667	2
60	Barbados	1.42	18.00	14.52	15'219	2
61	Azerbaijan	1.46	8.92	21.27	7'343	1
62	China	1.49	8.14	13.30	6'553	1
63	Iran (I.R.)	1.50	7.23	21.89	5'774	2
64	Egypt	1.55	4.06	14.08	3'137	1
65	Indonesia	1.56	4.64	12.54	3'576	2
66	Serbia	1.57	7.91	14.14	6'044	5
67	TFYR Macedonia	1.59	6.44	12.70	4'865	1
68	Costa Rica	1.61	12.82	18.90	9'540	1
69	Malaysia	1.69	14.67	30.20	10'420	2
70	Seychelles	1.78	19.53	29.23	13'197	1
71	Mongolia	2.10	6.60	16.86	3'766	1
72	Trinidad & Tobago	2.13	27.94	34.91	15'744	5
73	Colombia	2.21	13.94	22.93	7'582	1
74	Panama	2.24	19.95	33.95	10'689	1
75	Mexico	2.26	18.73	26.61	9'930	1
76	Brazil	2.31	22.48	29.51	11'678	1
77	Suriname	2.33	18.18	30.80	9'361	3
78	Thailand	2.49	11.05	27.50	5'335	1
79	Albania	2.53	9.48	17.62	4'505	4
80	Tunisia	2.53	8.84	19.92	4'196	5
81	Lebanon	2.54	20.90		9'860	2
82	Bhutan	2.66	5.16	16.19	2'328	1
83	Armenia	2.66	8.42	18.18	3'796	2
84	Antigua & Barbuda	2.69	29.26	35.60	13'037	1
85	Grenada	2.73	17.04	22.25	7'483	1
86	Namibia	2.81	13.73	26.73	5'864	1
87	Georgia	2.87	8.50	18.72	3'556	1
88	Peru	3.04	15.85	27.88	6'264	1
89	India	3.13	4.10	14.26	1'568	1
90	Cambodia	3.15	2.49	6.44	949	1
91	Gabon	3.19	28.32	39.13	10'639	1
92	Belize	3.33	12.50	21.46	4'505	1
93	Jordan	3.42	14.08	29.35	4'945	3
94	Moldova	3.46	7.12	17.35	2'468	5
95	Maldives	3.70	17.23	22.41	5'594	3
96	Dominican Rep.	3.70	17.76	35.53	5'764	2
97	Venezuela	3.70	38.67	50.70	12'537	1
98	Timor-Leste	3.77	12.50	18.56	3'976	1
99	Viet Nam	3.92	5.67	14.02	1'738	2
100	Bosnia and H.	3.99	15.87	27.60	4'775	1
101	Ecuador	4.44	21.28	37.30	5'754	1
102	Ghana	4.48	6.60	21.57	1'768	1
103	El Salvador	4.52	13.99	26.62	3'716	2
104	Morocco	4.68	11.78	23.70	3'017	10
105	Paraguay	5.03	16.81	31.59	4'006	2
106	Lao P.D.R.	5.15	6.21	16.02	1'449	5
107	Jamaica	5.19	22.54	34.96	5'215	1
108	Bangladesh	5.28	4.44	12.59	1'009	1
109	St. Vincent	5.46	29.39	38.96	6'454	3
110	Algeria	5.59	24.82	57.98	5'325	2
111	Samoa	5.84	19.30	23.89	3'966	1
112	Fiji	5.95	21.64	32.67	4'366	6
113	Cape Verde	6.35	19.13	33.26	3'616	6
114	Guatemala	6.74	18.75	35.80	3'337	1
115	Bolivia	6.75	14.33	31.91	2'547	2
116	Tanzania	7.59	5.43	12.72	859	1
117	Philippines	8.27	22.50	51.59	3'267	5
118	Sudan	8.78	11.33	25.38	1'548	5
119	Nicaragua	9.26	13.80	35.27	1'788	1
120	Nigeria	9.46	21.34	37.44	2'707	2
121	Kyrgyzstan	9.47	9.54	27.61	1'209	2
122	Turkmenistan	9.80	56.14		6'873	4
123	Pakistan	10.47	11.86	41.36	1'359	20
124	Cameroon	11.30	12.14	25.70	1'289	1
125	Botswana	11.57	74.87	137.72	7'762	1
126	Kenya	11.78	11.37	25.28	1'159	2
127	Nepal	13.05	7.93	26.61	729	1
128	Mozambique	13.13	6.67	13.02	609	1
129	Honduras	13.94	25.30	49.46	2'178	5
130	Zambia	14.16	21.33	47.59	1'808	1
131	Swaziland	14.77	36.77	88.69	2'987	2
132	Vanuatu	15.81	41.21	34.78	3'127	1
133	Burkina Faso	16.20	10.11	22.32	749	1
134	Tajikistan	16.44	13.55	33.09	989	1
135	Lesotho	19.19	23.96	62.59	1'499	1
136	Afghanistan	21.23	12.19	35.35	689	1
137	Benin	21.53	14.16	29.90	789	1
138	Congo (Rep.)	21.58	46.52	72.97	2'587	1
139	Togo	22.92	10.11	21.35	529	1
140	Papua New Guinea	23.92	40.22	43.71	2'018	2
141	Côte d'Ivoire	25.13	30.34	63.43	1'449	4
142	Guinea	26.06	9.98	21.86	460	3
143	S. Tome & Principe	27.10	33.17	52.60	1'469	3
144	Mali	27.20	15.17	33.41	669	1
145	Rwanda	28.03	14.70	36.54	629	2
146	Uzbekistan	28.75	45.00		1'878	8
147	Uganda	28.88	14.42	34.11	599	1
148	Comoros	28.92	20.23	33.83	839	1
149	Haiti	32.80	22.12	44.46	809	7
150	Ethiopia	39.29	15.37	43.05	470	1
151	Sierra Leone	41.23	22.66	48.26	659	1
152	Malawi	41.88	9.41	34.40	270	1
153	South Sudan	47.15	37.29		949	1
154	Chad	47.18	40.45	72.19	1'029	2
155	Madagascar	52.00	19.05	60.04	440	1
156	Congo (Dem. Rep.)	54.89	19.65	31.40	430	1
157	Mauritania	56.71	50.04	126.03	1'059	1
158	Zimbabwe	62.85	45.00	82.33	859	1
159	Solomon Islands	68.80	91.64	87.93	1'598	1
160	Gambia	143.92	59.90	217.02	500	1
161	Burundi	149.35	32.33	83.41	260	1
162	Liberia	172.86	59.00	108.77	410	10
	Myanmar**		10.16	35.07		1
	Argentina**		21.05			1
	San Marino**		38.48	37.17		1
	Liechtenstein**		53.48			20
	Monaco**		58.91			7
	Syria**		89.09			1

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
** Country not ranked because data on GNI p.c. are not available for the last five years.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Table 4.10: Mobile-broadband prices, prepaid computer-based, 1GB, 2014

		Mobile-broadband, prepaid computer-based (1 GB)				
Rank	Economy	as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*	Monthly data allowance (GB)
1	Austria	0.16	6.63	5.76	50'340	1
2	Sweden	0.24	12.12	9.02	61'648	2
3	Iceland	0.29	11.05	8.90	46'244	1
4	Poland	0.29	3.17	5.27	13'227	1
5	Lithuania	0.34	4.23	6.19	14'885	1
6	France	0.37	13.25	11.23	43'476	2
7	Spain	0.37	9.29	9.24	29'910	1
8	Qatar	0.38	27.47	37.34	86'703	6
9	Kuwait	0.46	17.57	27.08	46'046	1
10	United Kingdom	0.47	16.45	12.68	41'638	1
11	Bahrain	0.48	7.98	13.60	19'881	2
12	United States	0.49	21.77	21.77	53'417	1
13	Singapore	0.49	22.10	23.14	53'986	60
14	Australia	0.50	27.04	19.51	65'335	2
15	Switzerland	0.51	38.20	22.71	90'589	1
16	Belgium	0.52	19.90	16.71	46'294	1
17	Saudi Arabia	0.54	11.73	23.97	26'234	1
18	Ireland	0.55	19.90	15.42	43'047	1
19	Brunei Darussalam	0.57	15.78	24.09	32'976	1
20	Kazakhstan	0.57	5.52	11.02	11'538	1
21	Hong Kong, China	0.60	19.09	24.53	38'382	3
22	Oman	0.61	13.00	24.85	25'381	1
23	Netherlands	0.62	26.53	22.22	51'009	1
24	Slovenia	0.69	13.27	14.85	23'197	1
25	Croatia	0.78	8.70	12.06	13'407	1
26	Finland	0.78	31.71	23.95	48'771	1
27	Russian Federation	0.79	9.12	20.93	13'836	3
28	Belarus	0.80	4.46	13.68	6'723	2
29	New Zealand	0.83	24.89	19.15	36'089	1
30	UAE	0.84	26.96	37.06	38'713	1
31	Romania	0.88	6.63	11.49	9'041	1
32	Italy	0.89	26.53	23.92	35'584	7
33	Estonia	0.90	13.27	15.80	17'762	15
34	Malta	0.91	15.92	17.95	20'959	1
35	Canada	0.94	40.86	34.96	52'158	5
36	Sri Lanka	0.97	2.57	7.16	3'167	1
37	Germany	1.01	39.67	36.09	47'203	1
38	Uruguay	1.02	12.91	16.12	15'165	1
39	Macao, China	1.05	56.34	76.21	64'639	1
40	Serbia	1.12	5.66	10.12	6'044	1
41	Portugal	1.12	19.90	22.78	21'249	1
42	Andorra	1.14	39.01		40'974	1
43	Czech Republic	1.25	19.73	28.31	18'951	1
44	Egypt	1.35	3.53	12.25	3'137	1
45	Albania	1.39	5.21	9.69	4'505	1
46	Mauritius	1.43	11.40	18.38	9'560	1
47	Turkey	1.45	13.25	21.82	10'959	1
48	Azerbaijan	1.46	8.92	21.27	7'343	1
49	Israel	1.47	41.64	34.34	33'896	1
50	Barbados	1.54	19.50	15.73	15'219	1
51	Hungary	1.58	17.41	28.20	13'247	3
52	TFYR Macedonia	1.59	6.44	12.70	4'865	1
53	Antigua & Barbuda	1.67	18.15	22.08	13'037	1
54	Bhutan	1.67	3.24	10.18	2'328	1
55	Malaysia	1.69	14.67	30.20	10'420	2
56	Moldova	1.73	3.56	8.68	2'468	1
57	Trinidad & Tobago	1.77	23.25	29.06	15'744	2
58	Slovakia	1.83	27.17	36.40	17'792	1
59	Iran (I.R.)	1.84	8.87	26.85	5'774	2
60	Jordan	2.05	8.45	17.61	4'945	4
61	Mongolia	2.10	6.60	16.86	3'766	1
62	Greece	2.11	39.80	41.51	22'667	5
63	Indonesia	2.12	6.32	17.11	3'576	2
64	South Africa	2.23	13.73	28.84	7'403	1
65	Panama	2.24	19.95	33.95	10'689	1
66	Cape Verde	2.36	7.10	12.34	3'616	1
67	Latvia	2.36	29.98	55.84	15'275	40
68	Colombia	2.36	14.94	24.58	7'582	1
69	Morocco	2.37	5.95	11.97	3'017	4
70	Seychelles	2.45	26.98	40.36	13'197	2
71	Tunisia	2.53	8.84	19.92	4'196	5
72	Lebanon	2.54	20.90		9'860	2
73	Brazil	2.61	25.37	33.30	11'678	1
74	Montenegro	2.62	15.79	25.85	7'243	6
75	Mexico	2.72	22.49	31.96	9'930	1
76	Thailand	2.76	12.28	30.56	5'335	1
77	Cyprus	2.84	59.70	60.79	25'185	1
78	Georgia	2.87	8.50	18.72	3'556	1
79	Maldives	2.96	13.78	17.93	5'594	2
80	India	3.12	4.08	14.20	1'568	1
81	Cambodia	3.16	2.50	6.46	949	1
82	Gabon	3.19	28.32	39.13	10'639	1

		Mobile-broadband, prepaid computer-based (1 GB)				
Rank	Economy	as % of GNI p.c.	USD	PPP$	GNI p.c., USD, 2014*	Monthly data allowance (GB)
83	Bulgaria	3.31	20.28	38.49	7'353	1
84	Grenada	3.50	21.85	28.54	7'483	1
85	Fiji	3.64	13.25	20.00	4'366	8
86	Venezuela	3.70	38.67	50.70	12'537	1
87	Viet Nam	3.92	5.67	14.02	1'738	2
88	Belize	4.00	15.00	25.76	4'505	1
89	Philippines	4.13	11.24	25.77	3'267	2
90	Suriname	4.27	33.33	56.47	9'361	5
91	Ghana	4.48	6.60	21.57	1'768	1
92	Namibia	4.51	22.02	42.88	5'864	1
93	Timor-Leste	4.53	15.00	22.27	3'976	1
94	Sudan	4.57	5.89	13.20	1'548	3
95	Paraguay	4.70	15.69	29.49	4'006	3
96	Chile	4.98	63.08	91.52	15'215	14
97	Lao P.D.R.	5.15	6.21	16.02	1'449	5
98	Bangladesh	5.28	4.44	12.59	1'009	1
99	Armenia	5.32	16.83	36.36	3'796	28
100	St. Vincent	5.46	29.39	38.96	6'454	3
101	Algeria	5.59	24.82	57.98	5'325	2
102	Jamaica	6.22	27.04	41.96	5'215	1
103	Angola	6.38	27.47	31.57	5'165	1
104	Samoa	6.49	21.44	26.54	3'966	1
105	Dominican Rep.	6.59	31.64	63.30	5'764	3
106	Guatemala	6.93	19.27	36.79	3'337	2
107	El Salvador	7.10	22.00	41.86	3'716	3
108	Pakistan	8.74	9.89	34.50	1'359	5
109	S. Tome & Principe	8.85	10.83	17.18	1'469	1
110	Honduras	8.90	16.15	31.58	2'178	1
111	Nigeria	9.46	21.34	37.44	2'707	2
112	Kyrgyzstan	9.47	9.54	27.61	1'209	2
113	Turkmenistan	9.80	56.14		6'873	4
114	Mozambique	10.05	5.10	9.97	609	1
115	Bolivia	10.23	21.71	48.35	2'547	2
116	Ecuador	10.27	49.24	86.30	5'754	1
117	Botswana	10.33	66.84	122.96	7'762	1
118	Cameroon	11.30	12.14	25.70	1'289	1
119	Kenya	11.78	11.37	25.28	1'159	2
120	Nicaragua	11.89	17.72	45.29	1'788	1
121	Yemen	12.19	13.50	30.00	1'329	1
122	Tanzania	12.64	9.05	21.20	859	1
123	Nepal	13.05	7.93	26.61	729	1
124	Zambia	14.16	21.33	47.59	1'808	1
125	Papua New Guinea	14.50	24.38	26.49	2'018	2
126	Swaziland	14.77	36.77	88.69	2'987	2
127	Afghanistan	15.17	8.72	25.27	689	4
128	Burkina Faso	16.20	10.11	22.32	749	1
129	Tajikistan	16.44	13.55	33.09	989	1
130	Bosnia and H.	17.46	69.46	120.76	4'775	1
131	Peru	19.50	101.79	179.03	6'264	2
132	Benin	21.53	14.16	29.90	789	1
133	Congo (Rep.)	21.58	46.52	72.97	2'587	1
134	Rwanda	22.43	11.76	29.23	629	1
135	Togo	22.92	10.11	21.35	529	1
136	Lesotho	24.35	30.41	79.44	1'499	1
137	Côte d'Ivoire	25.13	30.34	63.43	1'449	4
138	Guinea	26.06	9.98	21.86	460	3
139	Ethiopia	26.19	10.25	28.70	470	1
140	Mali	27.20	15.17	33.41	669	1
141	Uganda	28.88	14.42	34.11	599	1
142	Comoros	28.92	20.23	33.83	839	1
143	Vanuatu	29.26	76.23	64.34	3'127	2
144	Burundi	29.87	6.47	16.68	260	1
145	Haiti	32.80	22.12	44.46	809	7
146	Mauritania	37.81	33.36	84.02	1'059	1
147	Sierra Leone	41.23	22.66	48.26	659	1
148	Chad	47.18	40.45	72.19	1'029	2
149	Malawi	48.79	10.97	40.08	270	1
150	Zimbabwe	48.89	35.00	64.03	859	1
151	Madagascar	50.87	18.63	58.74	440	1
152	South Sudan	53.28	42.14		949	1
153	Congo (Dem. Rep.)	54.89	19.65	31.40	430	1
154	Solomon Islands	55.99	74.57	71.56	1'598	1
155	Senegal	57.85	50.56	103.01	1'049	5
156	Niger	91.11	30.34	66.08	400	3
157	Gambia	143.92	59.90	217.02	500	1
158	Liberia	172.86	59.00	108.77	410	10
	Myanmar**		10.16	35.07		1
	Liechtenstein**		21.83			1
	Somalia**		25.00			1
	San Marino**		26.53	25.64		1
	Argentina**		31.21			7
	Nauru**		108.17			1

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
** Country not ranked because data on GNI p.c. are not available for the last five years.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Table 4.11: ICT Price Basket and sub-baskets, 2014

Rank	Economy	IPB 2014	Fixed telephone sub-basket as a % of GNI pc, 2014	Mobile -cellular sub-basket as% of GNI p.c., 2014	Fixed broadband sub-basket as a % of GNI pc, 2014	GNI p.c., USD, 2014*
1	Macao, China	0.2	0.2	0.1	0.3	64'639
2	Kuwait	0.3	0.2	0.4	0.3	46'046
3	Singapore	0.4	0.2	0.2	0.7	53'986
4	Norway	0.4	0.3	0.3	0.6	102'597
5	Qatar	0.4	0.1	0.3	0.9	86'703
6	Hong Kong, China	0.4	0.4	0.2	0.7	38'382
7	Iran (I.R.)	0.5	0.1	0.4	0.9	5'774
8	Switzerland	0.5	0.4	0.5	0.5	90'589
9	Luxembourg	0.5	0.5	0.3	0.7	69'810
10	Russian Federation	0.5	0.3	0.5	0.7	13'836
11	United States	0.5	0.5	0.8	0.4	53'417
12	Austria	0.6	0.8	0.3	0.6	50'340
13	Denmark	0.6	0.7	0.2	0.9	61'608
14	Sweden	0.6	0.6	0.4	0.8	61'648
15	United Kingdom	0.7	1.0	0.5	0.5	41'638
16	Japan	0.7	0.6	0.9	0.5	46'284
17	Andorra	0.7	0.3	1.1	0.6	40'974
18	Finland	0.7	0.8	0.3	0.9	48'771
19	Australia	0.7	0.5	0.3	1.2	65'335
20	Oman	0.7	0.5	0.4	1.2	25'381
21	Bahrain	0.7	0.3	0.7	1.1	19'881
22	Iceland	0.7	0.7	0.6	0.8	46'244
23	Kazakhstan	0.8	0.3	0.9	1.1	11'538
24	United Arab Emirates	0.8	0.3	0.3	1.7	38'713
25	Germany	0.8	0.7	0.5	1.2	47'203
26	Canada	0.8	0.7	0.7	1.0	52'158
27	Saudi Arabia	0.8	0.6	0.6	1.2	26'234
28	Korea (Rep.)	0.8	0.3	0.9	1.3	25'894
29	Cyprus	0.9	1.2	0.4	1.0	25'185
30	Trinidad & Tobago	0.9	0.5	1.2	0.9	15'744
31	France	0.9	0.8	1.1	0.8	43'476
32	Italy	0.9	1.2	0.5	1.0	35'584
33	Belgium	0.9	1.0	0.9	0.9	46'294
34	Netherlands	0.9	0.9	1.0	1.0	51'009
35	Latvia	1.0	0.9	0.9	1.1	15'275
36	Lithuania	1.0	0.9	0.7	1.2	14'885
37	Greece	1.0	1.2	0.5	1.2	22'667
38	Venezuela	1.0	0.1	1.2	1.6	12'537
39	Ireland	1.0	1.2	1.1	0.7	43'047
40	Brunei Darussalam	1.0	0.5	0.7	1.9	32'976
41	Belarus	1.0	0.3	1.2	1.6	6'723
42	Sri Lanka	1.0	1.1	0.4	1.6	3'167
43	Israel	1.0	0.6	1.3	1.2	33'896
44	Ukraine	1.0	0.9	1.1	1.1	3'956
45	Costa Rica	1.1	1.1	0.5	1.8	9'540
46	Uruguay	1.2	0.8	1.6	1.1	15'165
47	Seychelles	1.2	0.8	1.3	1.4	13'197
48	Bahamas	1.2	0.9	1.0	1.7	21'548
49	Slovenia	1.2	1.0	1.2	1.3	23'197
50	New Zealand	1.2	1.3	0.5	1.8	36'089
51	Slovakia	1.2	1.2	1.1	1.3	17'792
52	Czech Republic	1.2	1.6	1.0	1.1	18'951
53	Poland	1.2	1.7	0.8	1.1	13'227
54	Malta	1.2	0.6	1.3	1.8	20'959
55	Estonia	1.3	0.8	1.6	1.4	17'762
56	Portugal	1.3	1.4	0.9	1.6	21'249
57	Spain	1.4	1.3	1.5	1.3	29'910
58	Mauritius	1.4	0.6	0.8	2.9	9'560
59	Tunisia	1.4	1.4	1.2	1.7	4'196
60	Azerbaijan	1.4	0.5	1.7	2.1	7'343
61	Mongolia	1.6	1.5	1.0	2.3	3'766
62	Malaysia	1.6	1.0	0.7	3.1	10'420
63	Turkey	1.6	1.2	2.5	1.1	10'959
64	Maldives	1.6	0.8	1.2	2.9	5'594
65	Panama	1.7	1.8	1.4	1.8	10'689
66	Croatia	1.7	1.3	1.7	2.0	13'407
67	China	1.7	0.9	0.7	3.6	6'553
68	Brazil	1.8	1.9	2.3	1.3	11'678
69	Romania	1.9	1.3	3.1	1.1	9'041
70	Lebanon	1.9	1.1	2.5	2.1	9'860
71	St. Kitts and Nevis	2.0	1.1	1.6	3.2	13'876
72	Indonesia	2.0	1.2	1.7	3.1	3'576
73	Chile	2.0	2.1	1.8	2.2	15'215
74	Hungary	2.1	1.8	2.2	2.2	13'247
75	Viet Nam	2.1	1.2	3.1	2.0	1'738
76	Montenegro	2.1	1.3	1.9	3.1	7'243
77	Armenia	2.2	0.8	2.6	3.2	3'796
78	Mexico	2.2	2.2	1.3	3.2	9'930
79	Thailand	2.2	1.3	1.8	3.6	5'335
80	South Africa	2.3	2.8	1.7	2.5	7'403
81	Egypt	2.3	1.0	2.0	4.1	3'137
82	Barbados	2.4	1.7	2.0	3.4	15'219
83	Bhutan	2.4	1.3	1.5	4.4	2'328
84	Suriname	2.4	0.4	2.1	4.8	9'361
85	Georgia	2.5	0.8	1.9	4.8	3'556
86	Serbia	2.6	1.5	2.9	3.5	6'044
87	Bosnia and Herzegovina	2.7	2.6	3.7	2.0	4'775
88	Sudan	2.8	2.3	2.6	3.5	1'548
89	Antigua & Barbuda	2.8	1.2	2.2	5.1	13'037
90	TFYR Macedonia	2.8	2.1	3.1	3.2	4'865
91	Algeria	2.8	1.3	2.9	4.4	5'325
92	Botswana	2.9	2.1	1.5	5.0	7'762
93	Peru	2.9	2.3	2.4	4.0	6'264
94	Colombia	3.0	3.0	3.1	2.9	7'582
95	Bulgaria	3.0	1.9	5.4	1.9	7'353
96	Ecuador	3.1	1.4	3.6	4.2	5'754
97	India	3.1	1.9	2.1	5.3	1'568
98	Bangladesh	3.3	3.0	1.7	5.3	1'009
99	Moldova	3.4	0.2	4.4	5.5	2'468
100	Jamaica	3.4	2.7	1.9	5.7	5'215
101	Dominican Rep.	3.5	3.1	3.0	4.3	5'764
102	Jordan	3.5	1.9	1.2	7.3	4'945
103	Grenada	3.5	2.2	3.7	4.7	7'483
104	Gabon	3.8	5.7	2.2	3.4	10'639
105	Pakistan	3.8	5.2	1.9	4.4	1'359
106	Albania	3.9	1.8	8.0	1.8	4'505
107	Dominica	3.9	2.1	2.9	6.6	6'923
108	Morocco	4.0	2.6	4.7	4.7	3'017
109	Paraguay	4.1	2.5	3.5	6.1	4'006
110	St. Lucia	4.3	2.3	4.4	6.2	7'053
111	St. Vincent and the G.	4.3	2.0	4.6	6.3	4'775
112	Guyana	4.3	1.0	4.2	7.8	3'746
113	Fiji	4.3	2.4	5.5	5.1	4'366
114	El Salvador	4.5	2.9	4.8	5.8	3'716
115	Namibia	4.6	2.5	1.9	9.4	5'864
116	Equatorial Guinea	4.6	1.6	2.0	10.2	14'306
117	Kyrgyzstan	5.6	1.2	4.9	10.7	1'209
118	Guatemala	5.7	2.2	7.9	6.9	3'337
119	Cape Verde	5.9	3.6	10.4	3.6	3'616
120	Philippines	5.9	5.8	3.8	8.3	3'267
121	Yemen	6.0	0.9	7.6	9.5	1'329
122	Lao P.D.R.	6.3	3.9	3.1	11.8	1'449
123	Nepal	6.4	4.1	4.1	11.1	729
124	Angola	6.6	3.8	4.3	11.6	5'165
125	Ghana	6.8	2.2	2.5	15.7	1'768
126	South Sudan	7.4	2.7	9.9	9.7	949
127	Lesotho	7.5	4.1	11.0	7.3	1'499
128	Samoa	7.6	3.7	6.2	12.8	3'966
129	Nigeria	7.6	3.1	2.7	17.0	2'707
130	Micronesia	7.6	4.4	6.5	12.1	3'277
131	Bolivia	7.8	11.3	5.4	6.7	2'547
132	Honduras	8.1	3.6	8.6	12.1	2'178
133	Timor-Leste	8.3	6.0	4.2	14.8	3'976
134	Cambodia	8.7	4.8	8.6	12.6	949
135	Belize	9.3	6.3	8.3	13.3	4'505
136	Swaziland	10.4	1.8	6.1	23.2	2'987
137	Marshall Islands	11.0	12.8	6.2	13.9	4'306
138	Nicaragua	13.7	4.6	20.5	16.1	1'788
139	Ethiopia	14.4	2.1	8.4	32.7	470
140	S. Tome & Principe	14.7	6.7	10.3	27.1	1'469
141	Vanuatu	15.9	15.1	9.0	23.5	3'127
142	Afghanistan	16.9	2.7	9.9	38.0	689
143	Tanzania	17.3	18.1	8.4	25.3	859
144	Kenya	17.5	13.2	3.9	35.3	1'159
145	Papua New Guinea	17.7	7.7	14.5	30.9	2'018
146	Zambia	18.2	4.1	7.4	43.1	1'808
147	Congo (Rep.)	20.4	9.0	6.9	45.4	2'587
148	Côte d'Ivoire	20.6	16.7	14.0	31.1	1'449
149	Mauritania	20.9	32.3	16.0	14.2	1'059
150	Senegal	25.0	14.3	18.9	41.6	1'049
151	Zimbabwe	25.7	14.2	28.0	34.9	859
152	Haiti	28.3	7.4	14.1	63.5	809
153	Mozambique	29.5	24.7	22.9	40.8	609
154	Gambia	35.0	5.9	12.7	86.3	500
155	Sierra Leone	35.5	6.3	21.9	78.4	659
156	Burkina Faso	37.5	22.7	18.7	71.3	749
157	Kiribati	38.9	5.2	11.5	103.3	2'617
158	Benin	39.1	19.4	20.9	76.9	789
159	Comoros	39.9	28.9	19.4	71.3	839
160	Solomon Islands	40.5	8.2	13.2	221.7	1'598
161	Uganda	43.2	9.7	19.9	600.6	599
162	Mali	43.4	18.0	26.5	85.6	669
163	Burundi	47.0	6.3	34.7	239.0	260
164	Chad	47.0	20.9	20.2	698.6	1'029
165	Eritrea	47.7	11.2	31.9	214.1	490
166	Togo	52.5	19.0	38.5	102.2	529
167	Niger	58.3	35.4	39.6	180.7	400
168	Malawi	65.3	47.0	48.9	111.2	270
169	Madagascar	65.9	47.4	50.5	168.4	440
170	Central African Rep.	81.8	93.8	51.6	2194.2	320

Note: * Data correspond to the GNI per capita (Atlas method) in 2013 or latest available year adjusted with the international inflation rates.
Source: ITU. GNI p.c. and PPP$ values are based on World Bank data.

Endnotes

1 See, for instance, Section 4.5 in ITU (2014b) for an analysis of the determining factors in mobile-cellular and fixed-broadband uptake.

2 http://www.cnmc.es/Portals/0/Ficheros/sala_de_prensa/2014/01_Enero/20140131_Preciosmayoristas_bandancha.pdf.

3 http://www.moc.gov.il/sip_storage/FILES/8/3358.pdf.

4 http://www.itu.int/ITU-D/ict/newslog/Kazakhstan+To+Get+MNP+This+Year.aspx.

5 http://www.artpsenegal.net/images/LIGNES_DIRECTRICES_RELATIVES_A_LA_PORTABILITES_DE_NUMEROS_MOBILES_AU_SENEGAL_VF.pdf.

6 http://www.tra.gov.ae/news/tra-announces-uae-mobile-number-portability-arrangement-to-be-effective-within-two-months-.

7 European Commission: Digital Agenda Scoreboard 2014, Digital Inclusion and Skills.

8 GSMA: The mobile economy, 2015; see: http://www.gsmamobileeconomy.com/GSMA_Global_Mobile_Economy_Report_2015.pdf.

9 For example, if country A and country B have the same price in USD for any given ICT service, but in country A prices of other products are in general cheaper (in USD), then applying PPP exchange rates to the price of the ICT service in country A will make this service more expensive. That is because, compared to country B, in country A the same amount of USD (exchanged into national currency at market exchange rates) can buy more products or services. The ICT service in country A is thus more expensive in terms of what could be purchased with that amount in each country. The International Comparison Program (ICP) is the major global initiative to produce internationally comparable price levels. For more information on the PPP methodology and data, see http://icp.worldbank.org.

10 GNI takes into account all production in the domestic economy (i.e. GDP) plus the net flows of factor income (such as rents, profits and labour income) from abroad. The Atlas method eases exchange-rate fluctuations by using a three-year moving average, price-adjusted conversion factor. See: http://data.worldbank.org/indicator/NY.GNP.PCAP.CD.

11 It should be noted that fixed-telephone and mobile-cellular subscriptions are not strictly comparable, since the former are usually shared per household/organization and the latter are mainly for individual use.

12 By 2014, fixed-telephone networks had ceased to exist in the Democratic Republic of the Congo, Guinea, South Sudan, and Nauru.

13 See, for example ITU (2011a) and ITU (2012).

14 ITU: Trends in Telecommunication Reform, Special Edition: 4th Generation Regulation: Driving Digital Communications Ahead, Geneva, 2014.

15 Only one operator offers mobile-cellular services in Kiribati, the Marshall Islands and Tuvalu. In Cabo Verde, Saint Vincent and the Grenadines, and Vanuatu, two operators compete in the mobile-cellular market, but only in Cabo Verde and Saint Vincent and the Grenadines does the alternative operator hold more than 25 per cent of the market share. Source: GSMA Intelligence.

16 Data on mobile-cellular prices were available for eleven CIS countries in 2014. This compares with mobile-cellular price data available for 44 countries in Africa, 21 in the Arab States, 39 in Asia and the Pacific, 42 in Europe and 34 in the Americas.

17 Bulgaria and Albania stand out, with the most expensive prepaid mobile-cellular prices in PPP terms in Europe, at PPP$ 63 and PPP$ 56 respectively. In the Americas, Nicaragua (PPP$ 78) and Belize (PPP$ 54) have much higher prices than the average for the region. In Africa, prices in Cabo Verde (PPP$ 55) and Madagascar (PPP$ 58) are about double the regional average.

18 Considering the 183 countries included in the mobile-cellular price comparison, the average GNI p.c. in Africa is less than half the average GNI p.c. in the CIS, the region with the second lowest average GNI p.c.

19 See http://www.millicom.com/where-we-operate/#ghana.

20 January 2015 market shares, see: Ghana National Communication Authority market report, at: http://www.nca.org.gh/downloads/Voice_Market_Share_March_2015_Final.pdf.

[21] See Ghana National Communication Authority Press Release, "Mobile number portability in Ghana passes 2 million", at: http://www.nca.org.gh/downloads/NCA_MNP_Passes_2_Million.pdf.

[22] See http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6062.pdf.

[23] Republic of Ghana Ministry of Communications, National Telecommunications Policy, 2005. See: http://www.nca.org.gh/downloads/Ghana_Telecom_Policy_2005.pdf.

[24] See for example Verizon's *MORE Everything Plan* and AT&T's *Mobile Share Value Plans*, which allow sharing of data contracted with up to 10 devices. For more information, see http://www.verizonwireless.com/landingpages/more-everything/ and http://www.att.com/shop/wireless/data-plans.html.

[25] Considering the 183 countries included in the mobile-cellular price comparison, the average GNI p.c. in the European region is twice the average GNI p.c. in the Arab States region, two and a half times more than in the Asia and the Pacific region, three times more than in the Americas region, five and a half times the CIS figure, and more than ten times the average GNI p.c. in the Africa region. The CIS and Europe are the regions with the lowest dispersion in GNI p.c. values, with coefficients of variation (*cv*) of 0.73 and 0.75, respectively. In all other regions, *cv* is above 1 for the GNI p.c. values.

[26] The OECD notes that "…. The throughput of wireless networks continues to improve, but the highest performance over a wireless connection will always lag behind what is possible over the more controlled environment of a wire".

[27] See European Commission Press Release: EUR 57.1 million of regional funds for a major broadband project in Romania, October 2014, at: http://ec.europa.eu/regional_policy/upload/documents/Commissioner/RO-broadband_21102014_final.pdf.

[28] See http://www.broadbandcommission.org/about/Pages/default.aspx.

[29] On a global average, the Herfindahl-Hirschman Index is significantly lower in mobile markets than in fixed-broadband markets, thus proving that competition is stronger in mobile markets (ITU, 2014b). In addition, mobile-broadband services continue to see double-digit growth rates that allow operators to benefit from economies of scale and scope. These cost savings are partially passed on to customers in terms of lower prices because of the competitive pressure in mobile markets. This virtuous circle is not as strong in fixed-broadband markets owing to a number of factors, such as the still limited liberalization of fixed services in several countries, the higher upfront investments required to roll out independent fixed infrastructure and the slow growth rates in fixed-broadband uptake. As a result, price trends in fixed-broadband services are not as dynamic as in mobile-broadband services, and this situation will most probably not change in the short term.

[30] In Cuba, Internet access at home is limited to dial-up subscriptions at narrowband speeds. Fixed-broadband plans are available only for organizations.

[31] In 12 African LDCs (out of a total of 26 African LDCs for which data are available) the price of the fixed-broadband plan exceeds average GNI p.c. levels.

[32] Even if mobile-broadband and fixed-broadband subscriptions are not directly comparable, because the former are in most cases for individual use whereas the latter are usually shared per household/organization, the very low fixed-broadband penetration in most developing countries suggests that the uptake of the service is very limited in the developing world. This is confirmed by the commercial offers available for fixed-broadband services in several developing countries, such as Uganda, where the service is advertised as targeting businesses rather than residential customers, and is priced as a premium service.

[33] For instance, Canada made new spectrum available for further development of mobile-broadband services in March 2015, see: http://www.ic.gc.ca/eic/site/ic-gc.nsf/eng/07389.html. Serbia issued LTE licences in February 2015 (see http://www.ratel.rs/information/news.134.html?article_id=1602), and an LTE licence was issued for the first time in Pakistan in May 2014, see: http://www.pta.gov.pk/index.php?option=com_content&view=article&id=265&Itemid=135, http://www.pta.gov.pk/media/lte_1800_spec_090714.pdf.

[34] For instance, Algeria started offering 3G services at the end of December 2013, see: http://www.arpt.dz/fr/doc/reg/dec/2013/DEC_N90_11_12_2013.pdf. Several Eastern Caribbean countries, such as Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia and Saint Vincent and the Grenadines, started offering 3G services in 2013 or 2014, see: http://www.ectel.int/index.php/regulatory-framework/blockquote/policy-on-the-allocation-assignment-of-frequencies-in-the-700-mhz-ban.

[35] For example, the main mobile operator in Venezuela, Movilnet, offered prepaid computer-based mobile-broadband plans only for businesses until 2013, whereas since 2014 prepaid computer-based plans are also available for residential customers.

36 In almost all of the countries included in the 2014 price data collection, the cheapest option for a prepaid handset-based mobile-broadband plan was a data package. In most cases, the cheapest add-on data package with a validity of one month included 500 MB, but in some countries monthly data packages are offered only for larger data allowances. This is the case, for example, of Pakistan, where the dominant mobile-cellular operator, Mobilink, offered a monthly data package including 1 GB for less than USD 2 per month, the lowest price worldwide in 2014.

37 Data for mobile-broadband prices have been collected since 2012 through the ITU ICT Price Basket Questionnaire, which is sent out annually to all ITU Member States/national statistical contacts.

38 In Brazil, for example, the dominant mobile operator, Vivo, offers the SmartVivo 3G plus package, which includes free local on-net voice traffic and SMS, as well as 60 minutes per month of off-net and to-fixed traffic, for a total cost of USD 42 per month. This is the least expensive postpaid handset-based mobile-broadband plan, with a minimum monthly data allowance of 500 MB offered by Vivo, excluding promotional offers and limited discounts.

39 In Azerbaijan, for example, the mobile-cellular operator with the largest market share is Azercell, whereas the operator with the largest number of active mobile-broadband subscriptions is Bakcell. In Gabon, the incumbent operator, Gabon Telecom, retains the largest market share in the mobile-cellular market, whereas Airtel, the first operator to launch 3G services in the country, has taken the lead in the mobile-broadband market (source: GSMA Intelligence).

40 In Venezuela, for example, the dominant operator in the handset-based mobile-broadband segment is Movilnet, whereas in the computer-based mobile-broadband segment the market leader is Digitel.

41 The size of an e-mail, photo, website or Facebook profile varies according to its content and quality. For instance, the size of a photo can vary from less than 100 kB (low quality) to over 4 MB (high quality). An e-mail containing only text may require no more than some 0.03 MB, whereas one with a 40-page Word document attached may easily amount to between 0.5 MB and 2 MB, depending on the images included in the document. Likewise, a webpage with a low graphical content may consume 0.5 MB, whereas webpages with rich graphical content may take more than 2 MB. Some webpages, moreover, have optimized versions for mobile use so that they consume less data when accessed from a mobile phone (e.g. m.facebook.com and m.youtube.com), so data consumption may also depend on the device. For the examples shown in the box, average values are taken for each Internet application based on estimates from the following mobile operators: AT&T, Bell, Entel, Everything Everywhere and Vodafone.

42 Monthly data consumption for school courses calculated on the basis of the online courses from the Khan Academy and their mapping to the curriculum in South Africa (http://numeric.org/grade6-9) and the United States (khanacademy.org/r/curricularmap).

43 See Coursera's course on child nutrition: https://www.coursera.org/learn/childnutrition.

44 Data consumption for the transfer of medical images retrieved from the Mission de préfiguration de la délégation à la stratégie des systèmes d'information de santé (MPDSSIS, 2010). The report calculates the average size of a medical image by weighting the different sizes of each medical image (radiography, echography, scanner and MRI) by the frequency with which they are required. A compression factor of two has been considered.

45 For more information on the recommended speeds for specific applications, see Ookla's article available at: https://support.speedtest.net/hc/en-us/articles/203845210-What-speeds-do-I-need-for-Skype-Netflix-video-games-etc-.

46 Averages based on 108 developing countries for which 2013 and 2014 data on mobile-broadband prices, mobile-cellular prices and GNI p.c. were available.

47 Despite having a relative small population of less than 4 million inhabitants, Moldova has three mobile-network operators offering mobile-broadband services, plus a regional operator also offering the service in a part of the country. The two main mobile-broadband operators with national coverage are part of strong transnational groups (Orange and TeliaSonera) and launched LTE networks in 2012, while the third operator is owned by the incumbent fixed-broadband provider and offers services based on the UMTS technology. The growth in the mobile-broadband market has been spurred by an increase in competition: the dominant operator Orange saw its market share in the mobile-broadband market (measured by number of mobile-broadband enabled SIM cards) decrease from 60 per cent at end 2011 to 56 per cent by end 2014 (source: GSMA Intelligence).

48 Mozambique has three mobile network operators, MCEL, Vodacom and Movitel, all of them currently offering mobile-broadband services. The launch of Movitel's operations in 2012, when Mozambique had a mobile-cellular penetration level of below 35 per cent, greatly contributed to stirring the market, see: http://viettel.com.vn/menu-60-64-94-Mozambique.html. The increase in competition has not been to the detriment of investment, and this has also been reflected in the mobile-broadband market, where the incumbent MCEL's market share (measured by number of mobile-broadband enabled SIM cards) shrank from 71 per cent at end 2011 to 42 per cent by end 2014 (source: GSMA

Intelligence). At the same time, new 3G networks have been deployed in the country, including Movitel's HSPA network, see: http://www.incm.gov.mz/incm-outorga-licencas-para-prestacao-de-servico-de-terceira-geracao.

49 For the 149 countries included in the comparison, the average GNI p.c. in the European region is one and a half times that of the Arab States region, twice that of the Asia-Pacific and Americas regions, five times that of the CIS region, and over ten times that of the Africa region.

50 The number of mobile-broadband enabled SIM cards, as reported by GSMA Intelligence, is used as a proxy to calculate each operator's share in the mobile-broadband market.

51 For more information, see the press release from Metfone, available at: http://www.metfone.com.kh/en/News/News/VIETTEL-%28CAMBODIA%29-PTE-LTD-%28-METFONE-%29-AND-SOTELCO-LTD-%28-BEELINE-CAMBODIA-%29-AGRREMENT-TO-LICENCES-ASSETS-TRANSFER-TRANSACTION-e2-80-8b.248.aspx.

52 Source: B2B Cambodia. Full article available at: http://www.b2b-cambodia.com/news/metfones-3g-internet-boasts-the-largest-coverage-in-cambodia.

53 For more information on Smart's LTE coverage, see the company's press release available at: http://www.smart.com.kh/news/press-release/4g-lte-smart-now-available-all-25-provinces, as well as their coverage map at: http://www.smart.com.kh/coverage-checker.

54 From 18 to 30 June 2015, SEATEL offered to replace for free the SIM card and mobile phone of their subscribers with new ones adapted to the new LTE network. Source: SEATEL Group. For more information, see: http://www.seatelgroup.com/en/gedxd.html.

55 Median income is used as a reference because the "The mean value gets inflated by a few households with large incomes. Most Cambodian households have an income well below the mean value" (National Institute of Statistics of Cambodia, 2014), and the median value is deemed to reflect better the income level of typical Cambodian households. In the example, for handset-based plans, the median disposable income per capita is considered, assuming that mobile handsets are for personal use, while the income per household is considered for computer-based plans, assuming that computer plans are shared per household.

56 "Bill shock" refers to a bill which the consumer finds unexpectedly excessive; see for example Recommendation ITU-T D.98, *Charging in international mobile roaming service*, September 2012, available online at: https://www.itu.int/rec/T-REC-D.98.

57 International mobile roaming services are not available automatically for all operators and all destinations. They depend on agreements negotiated bilaterally between operators.

58 European Parliamentary Research Service: http://epthinktank.eu/2013/10/10/a-roaming-free-europe-in-2015/.

59 European Commission press release, 17 February 2014, http://europa.eu/rapid/press-release_IP-14-152_en.htm.

60 International Roaming BEREC Benchmark Data Report April – September 2014, BoR (15) 29, BREC 2015, http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/4922-international-roaming-berec-benchmark-data-report-april-8211-september-2014.

61 Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates.

62 Data retrieved from the GCC Roaming Working Group (2014) consultation document concerning International Mobile Roaming (IMR) across the Gulf Cooperation Council (GCC) Region, 4 September 2014, available online at: http://www.tra.gov.ae/files/consulation/consultation-International_Mobile_Roaming_IMR_Consultation_Document.pdf.

63 Kenya, Burkina Faso, Chad, Congo (Rep. of), Democratic Republic of the Congo, Gabon, Ghana, Madagascar, Malawi, Niger, Nigeria, Rwanda, Seychelles, Sierra Leone, Tanzania, Uganda, Zambia. See: http://www.airtel.in/about-bharti/media-centre/bharti-airtel-news/mobile/airtel-connects-with-africa-to-become-the-first-indian-brand-to-go-truly-global.

64 See http://www.china-mobile-phones.com/china-mobile-roaming.html and http://www.shanghaidaily.com/Business/finance/China-Mobile-to-cut-international-roaming-fees-from-Saturday/shdaily.shtml.

65 See for example http://www.t-mobile.com/optional-services/international.html.

66 See for example http://www.orange.com/en/press/Press-releases/press-releases-2014/Orange-First-to-Remove-Roaming-Charges-in-Select-Plans-Across-Europe.

67 http://www.cubictelecom.com/What-We-Do/Our-Technologies.aspx.

68 http://www.telecomnorthamerica.com/multiimsiroamingub/index.php/information/technology.

5 The Internet of Things: data for development

5.1 Overview

Historically, the field of information and communication technology (ICT) has consisted of a wide variety of infrastructural systems, devices and capabilities that were developed and operated independently from one another. In 2005, ITU published one of the first reports on the Internet of Things (IoT) and pointed to the possibility of connecting many new elements to telecommunication networks (ITU, 2005a) Ten years after, the emergent trend and advent of IoT are unifying the various disparate elements of the ICT landscape into a vast yet coherent network of technologies that are capable of communicating and interacting with each other in both anticipated and unanticipated ways.

IoT has the potential to create massive disruptions within the ICT sector — even how the Internet is construed, defined and measured. IoT brings substantial changes to the data/information, computing and ICT domains. Collectively, these changes are having a tremendous societal, technological and scientific impact, and are incorporating many new elements into the information society.

This chapter presents and analyses the various dynamics underlying the rise of IoT. The first section describes IoT, how it is developing, and its relation with ICTs. It then analyses how telecommunication infrastructure is unlocking the potential of IoT and creating opportunities for development, in forms such as new IoT applications and big data generated by the myriad of connected devices. The following section analyses, in more detail, the opportunities that IoT brings to development, paying particular attention to areas of high impact for developing countries, such as health, climate change, disaster management, precision agriculture and the growth of megacities. The chapter concludes by identifying some of the main challenges for the development of IoT and by providing some recommendations on how national statistical offices, telecommunication regulators and ministries can address them.

5.2 Introduction to IoT

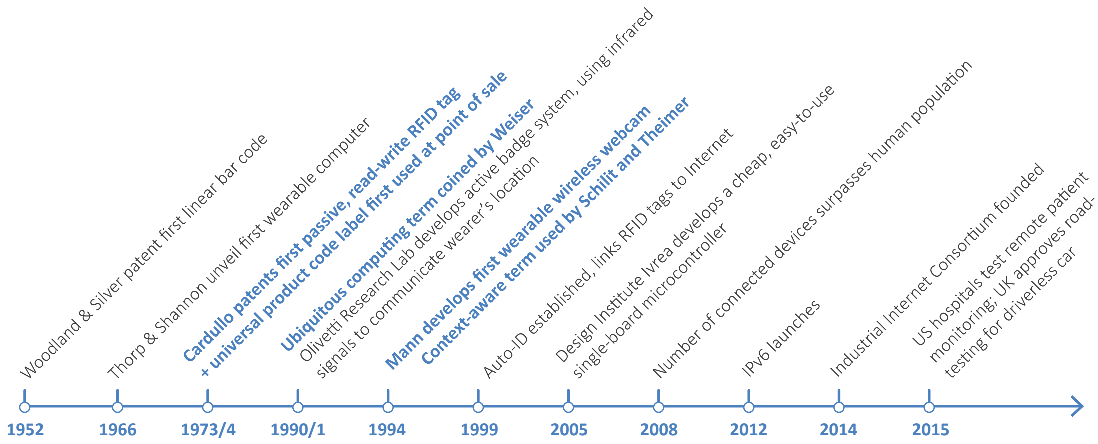
What is IoT?

The ITU Telecommunication Standardization Sector (ITU-T) has defined IoT as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies".[1] IoT refers to the burgeoning network of physical objects (e.g. devices) which have an Internet protocol (IP) address for Internet connectivity, as well as the communication that occurs between these objects and other devices and systems that thus become Internet-enabled. The widespread connectivity of devices allows them to share data and exercise control through the Internet, whether directly through their own IP address and ensuing Internet connection or indirectly through other telecommunication protocols, such as WiFi or Bluetooth.

IoT represents a convergence of several factors that have facilitated its growth: growth of the Internet and development of Internet-linked radio frequency identification (RFID), context-aware computing, wearables, and ubiquitous computing, which each developed throughout the second half of the twentieth century, as depicted in Figure 5.1. The sampling of the IoT timeline provides an indication of how extensive the legacy of IoT actually is. The various IoT-related phenomena can also be mapped against an historical backdrop, particularly with respect to the evolution from person-to-person to machine-to-machine communications (Figure 5.2).

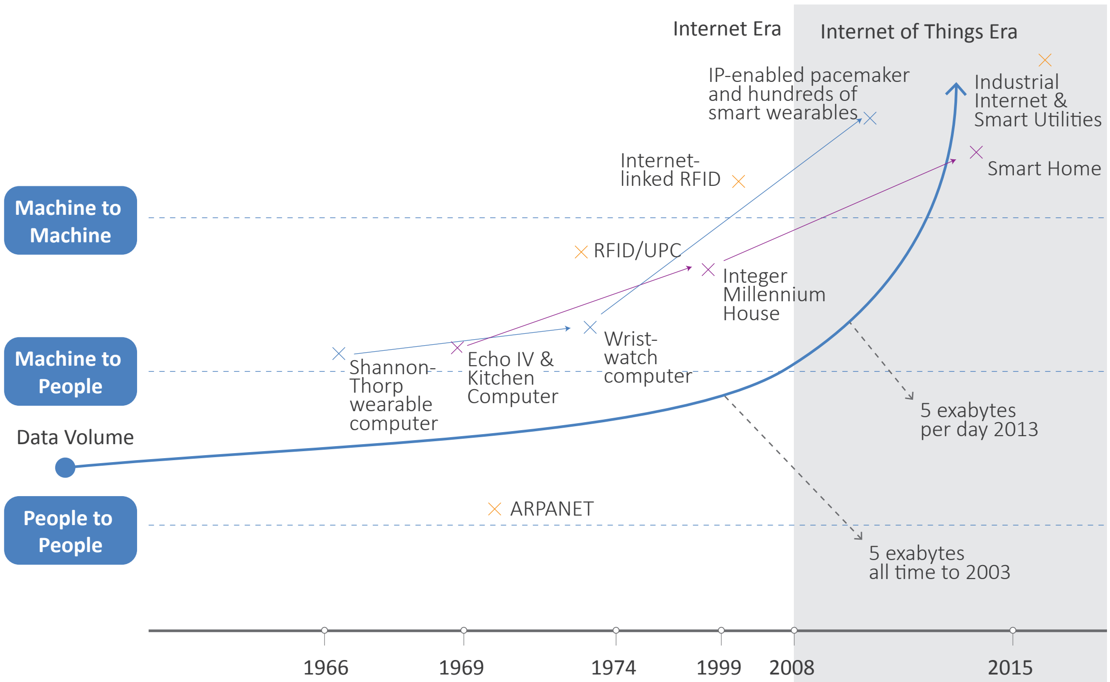
Early Internet-based platforms such as the world wide web (WWW) have been primarily focused on communications between individuals and groups of people, which can be translated into

Figure 5.1: Timeline of developments that led to IoT



Source: ITU.

Figure 5.2: Path to IoT: from people-to-people to machine-to-machine communications



Source: ITU.

person-to-person communications. IoT enables devices to conduct person-to-machine as well as machine-to-machine (M2M) communications without human intervention (Chen, 2012). A subtle but distinguishable characteristic of the M2M subdomain within IoT is worth noting: whereas M2M refers specifically to "things" (i.e. devices, machines, or anything that can send data) connecting to other "things" (e.g. remote computer) so as to form isolated systems of sensors and islands of telemetry data, IoT also encompasses "things" connecting with people and systems.

IoT represents a step forward in the connectivity provided by M2M connections, because it offers the potential for integrating disparate systems and enabling new applications. Indeed, M2M communication capabilities are seen as an essential enabler of IoT, but represent only a subset of its whole set of capabilities. From this point of view, IoT can be construed as the arch connecting M2M vertical pillars[2] (i.e. technology stacks), and for IoT to provide value that extends beyond M2M it must fulfill a function not already addressed by an individual M2M stack.

More specifically, M2M communications, particularly in the context of ICT infrastructure, are often referred to as "plumbing", while IoT is deemed to be a universal enabler, as it extends beyond M2M communications to include information exchanges between people, and between people and devices. Devices within the M2M paradigm typically rely upon point-to-point communications (i.e. communication between a "thing" and a remote "thing") and use embedded hardware modules (e.g. subscriber identity module or SIM card).

In many cases, devices within the IoT paradigm rely upon standards-based IP communication networks; however, it is important to note that devices within M2M do not rely solely upon the prototypical TCP/IP over Ethernet for connectivity (Kim, 2011). Whereas emerging wireless broadband platforms are contributing to the growth of IoT connectivity, technologies such as Bluetooth (Miller, 2000), ZigBee (Baronti, 2007), and other protocols/standards enable devices to communicate and are increasingly used in IoT implementations. For example, the ZigBee protocol works with the IEEE 802.15.4 standard, which specifies the physical layer and media access control for low-rate wireless personal area networks. As another example, while Z-Wave[3] implementations are in accordance with the Recommendation ITU-T G.9959, each individual vendor's implementation can vary for the protocols used in the transport layer.

IoT uses various protocols/standards to accommodate low-power and passive sensors as well as other inexpensive devices that might not be able to justify a dedicated M2M hardware module. In addition, IoT-based delivery of data is, typically, to a cloud-based architecture, thereby allowing IoT to be inherently more scalable. In essence, devices that are not directly IP-addressable are leveraging wireless radio protocols/standards so as to indirectly connect to the Internet, and thus the rising volume of M2M communications is contributing to the growth of IoT (Goodwin, 2013). However, IoT shares some of the regulatory challenges of M2M, such as the lock-in of M2M subscriptions with a single operator, particularly when considering cross-border communications (Box 5.1).

As devices are endowed with communication capability, they can make their own contributions to IoT (Gantz, 2008). IoT is by no means a singular class, or standardized set of devices. Just as there is a wide variety of connected device types, these various devices exhibit a range of connectedness (Figure 5.3). By way of example, even though personal wearable devices, such as for calculating

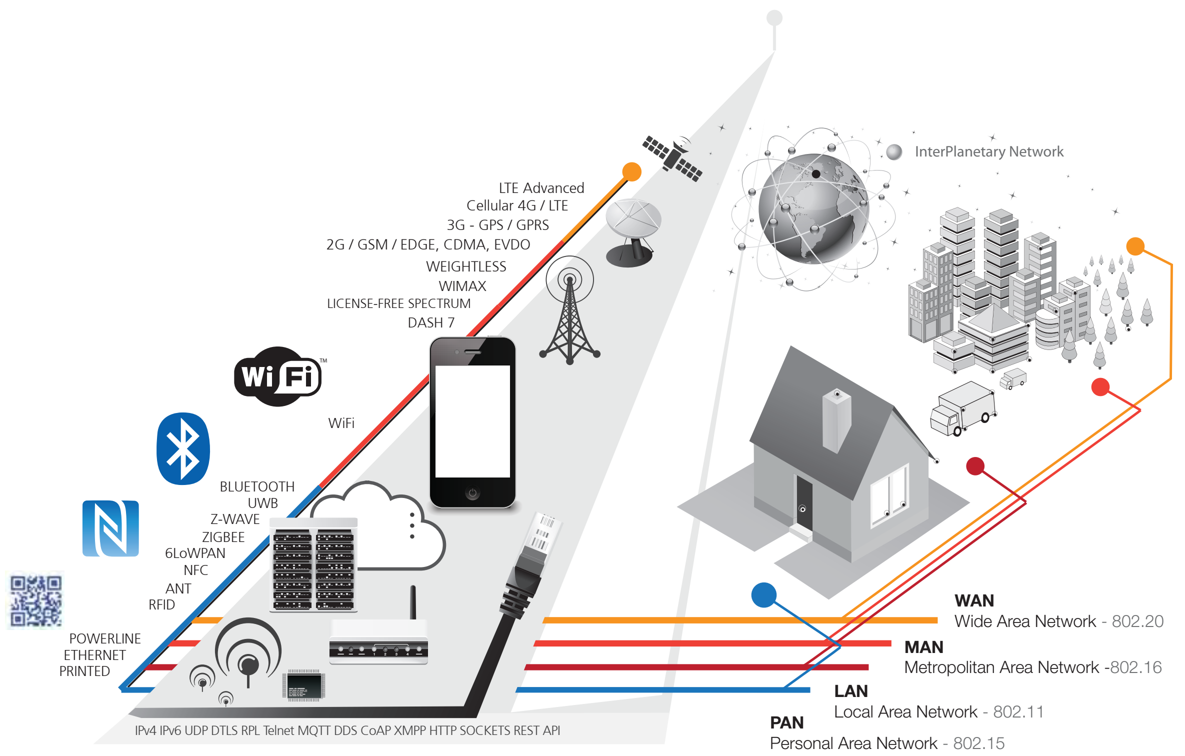
Box 5.1: IoT communications across borders

The manufacturing of devices with IoT capabilities — in industries with large volumes — is usually managed at the global level, in order to take advantage of the economies of scale and scope that the outsourcing of production allows. For example, in the automotive industry, cars that are manufactured in a given country with embedded M2M capabilities are sold and used in several foreign markets, and the same occurs in most sectors in which IoT can make an impact.

Although the production of devices with embedded IoT capabilities has become global, pricing of the actual IoT communications remains local. For instance, if a truck with an embedded sensor travels from one country to another – which is, for instance, often the case in the European Union – the information sent by the sensor to the Internet will be subject to roaming charges. Considering that roaming rates are significantly higher than regular mobile prices (see Section 4.5), this may limit the use of the IoT capabilities embedded in the truck. A similar situation will arise if a person with an e-reader travels to a foreign country and wants to download a travel guide from the Internet using the SIM card embedded in the e-reader.

The limitations that roaming charges place on the development of M2M have been extensively discussed, as have the possible regulatory actions that could mitigate them (OECD, 2012). As the industry advances from M2M to IoT and the need for affordable cross-border connectivity grows, this issue will require more regulatory and policy attention.

Figure 5.3: Diagram of IoT connectivity



Source: Postscapes and Harbor Research, http://postscapes.com/what-exactly-is-the-internet-of-things-infographic.

the number of steps taken, etc., are capable of collecting data, they rely upon additional communication gateways (e.g. smartphone, laptop) to transmit these data to a cloud-based application (Desai, 2014). Indeed, many wearables do not have their own Internet connection and must wait until they are in range of Bluetooth connectivity or similar connective networks. In essence, devices can be classified as either: (1) having their own Internet connection with capability of accessing the Internet at any time; or (2) dependent upon a network with connection to the Internet. IoT encompasses both (Want, 2015).

The development of IoT fosters the creation of wireless sensor networks (WSNs, Box 5.2), and this may lead to the development of alternative network architectures. Today, in the usual network configuration, mobile data pass through the carrier's gateway to connect to the Internet (Pitoura, 2012), and most mobile devices are thus connected to the Internet (Dinh, 2013). Researchers have been exploring communication approaches that could potentially bypass the Internet entirely by facilitating peer-to-peer communication between WSN clusters so as to form a new "Internet" comprised of WSNs (Xu, 2005). As people opt in to allow their wireless personal area networks to communicate with WSNs, communication can occur directly between WSNs rather than through the traditional Internet.

Apart from WSNs, there is another potential technological disruption on the horizon. Semiconductor companies are advancing system on chip (SOC) (Wolf, 2008) paradigms tailored for IoT. Intel, Broadcom and ARM have all developed SOC for the IoT market. In essence, connected devices are becoming smarter with higher-performance embedded processors as well as increased memory and random access memory (RAM) as the per unit cost of SOC and storage continue to drop and components become more miniaturized (Itoh, 2013). While SOC is not something that has just been developed, the advent of programmable SOC (PSoC) marks a new era of longevity and extensibility. This has particular potential to change the IoT paradigm.

To articulate this point, during the fourth quarter of 2014 a new PSoC for IoT was unveiled at the Electronica international trade show in Munich, Germany (Bahou, 2014a). This unveiling was particularly interesting, as it moved beyond the

Box 5.2: Wireless sensor networks

In essence, a WSN is a network formed by a large number of sensor nodes, wherein each node is equipped with a sensor to detect physical phenomena (e.g. light, vibration, heat, pressure, etc.) (International Electrotechnical Commission, 2014). WSNs exist in various domains ranging from electric grids and other critical infrastructure to building management and transportation. The power industry has been upgrading various parts of the electric grid, and WSN technologies are playing an important role for a smarter grid, including online monitoring of transmission lines, intelligent monitoring and early warning systems for distribution networks, and smart electricity consumption services (Eris, 2014). As these WSNs, which are deemed to be a revolutionary information-gathering method, are increasingly becoming a critical part of the ICT infrastructure that underpins the reliability and efficiency of infrastructure systems, they are becoming the key technology for IoT[4](Khalil, 2014). In managing energy consumption in green buildings, WSNs can be implemented to control the illumination of homes and offices, thereby minimizing the power wasted by unnecessary lighting in vacant rooms and office spaces (Magno, 2015). In the context of smart cities, WSNs are being used to design traffic monitoring and control systems that go beyond the conventional round-robin scheme of reducing congestion at busy intersections, by dynamically prioritizing higher volume lanes of traffic (Desai, 2014). With regard to critical infrastructure protection and public safety, WSNs are also being widely employed in the detection of hazardous gas leaks (Somov, 2014). Although these areas represent only a glimpse of the many ways WSNs are being employed, such a diversity of applications demonstrates how transformative this technology is likely to be. As an example, urban consolidation centres (UCCs) can reduce the traffic load caused by delivery vehicles. By having the UCC warehouses geographically situated just outside the city, goods destined for retailers in the city are first consolidated and then shipped with an optimized routing, thereby making the best possible use of truck capacity and reducing the total number of trucks needed. For this paradigm, tracking at the pallet (or other packaging unit) level is required. The pallet becomes the “sensor” for measuring the flow of goods, and a combination of various wireless technologies (e.g. GPS, RFID, WLAN, cellular) in combination with big data analysis techniques are utilized to optimize scheduling and routing.

typical trending of decreasing size, cost and energy consumption and presented a PSoC that was not only scalable, but also extensible. In other words, the PSoC was “future-proofed,” enabling firmware-based changes at any point in the design cycle, including after deployment. It also showcased the possibilities of single-chip Bluetooth® low energy (BLE) PSoC for IoT: home automation, healthcare equipment, sports and fitness monitors and other, wearable smart devices.

Similarly, a BLE programmable radio-on-chip presents a viable method for wireless human interface devices, remote controls and other applications requiring wireless connectivity (Bahou, 2014b). As research progresses into developing increasingly compact PSoC designs that can harvest energy as well as sense and communicate a variety of data wirelessly, the limits of IoT capabilities will continue to extend (Klinefelter, 2015).

The importance of IoT and its potential to become a disruptive technology has been recognized by several administrations and organizations. For instance, in 2008, the United States National Intelligence Council identified IoT as one of the six primary “disruptive civil technologies” that will most significantly impact national power through 2025 (NIC, 2008). This particular assessment of IoT is well captured in a 2009 speech by the Chinese Premier, who presented the equation: *Internet + Internet of Things = Wisdom of the Earth.*[4] Similarly, Cisco asserts that IoT is the next evolution of the Internet, and this transformation occurred during the 2008-2009 time period when the number of objects connected to the Internet surpassed the number of people online worldwide (Evans, 2011). The United Kingdom Government, in its 2015 budget, made quite the statement by allocating GBP 40 million to IoT research (Gibbs, 2015).

Today, it is estimated that over 50 per cent of IoT activity is centred on manufacturing, transportation, smart city and consumer applications, but that within five years all industries will have rolled out IoT initiatives (Turner, 2014). Indeed, IoT will have a significant impact on nearly every industry of our society, revealing and making possible new business models and workflow processes as well as new sources of operational efficiencies. A key element in reaching the efficiency gains that IoT can deliver will be interoperability within vertical industries (i.e. across different manufacturers in the same industry) as well as across industries. Indeed, it is estimated that the interoperability of IoT systems is the key to unlocking 40-60 per cent of potential value across IoT applications (McKinsey, 2015).

IoT will very likely revolutionize how individuals, corporations, government and international organizations interact with the world. Whereas IoT centres upon connected devices that enable the range of capabilities shown in Figure 5.4, it is by no means the end of the line for technological evolution. Researchers, industry experts and technologists foresee an evolutionary path beyond IoT to an Internet of Everything (IoE), in which communications among people, devices, data and processes will be fully unified (Bradley, 2013).

What is the role of ICTs in IoT?

ICTs comprise a broad and unconsolidated domain (Lampathaki, 2010) of products, infrastructure and processes (Antonelli, 2003)

Figure 5.4: Sectors in which IoT can play an enabling role for development

Source: ITU based on Al-Fuqaha, Ala *et al.* (2015).

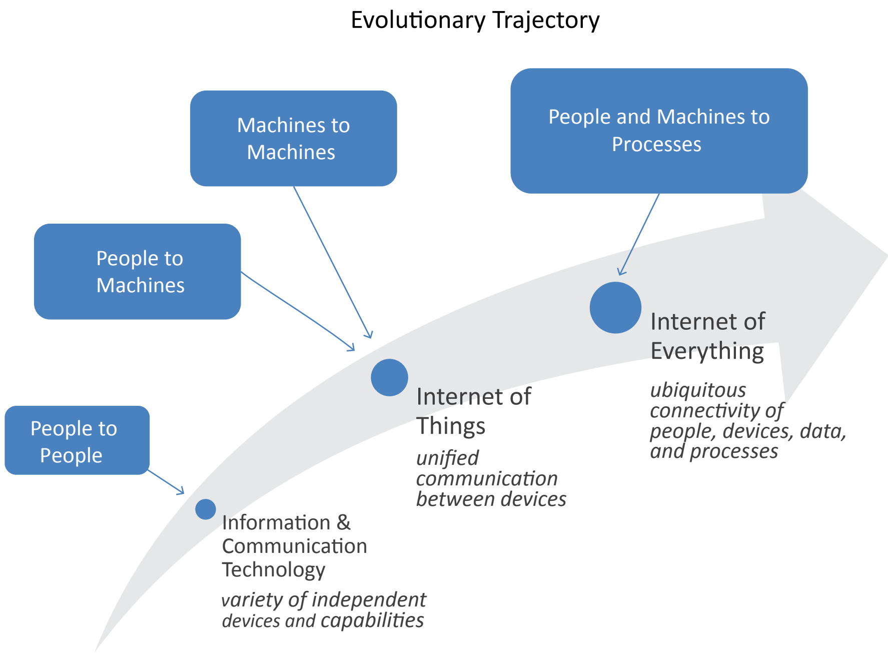
that include telecommunications and information technologies, from radios and telephone lines to satellites, computers and the Internet (Riemer, 2009). In turn, IoT is composed of objects that communicate, via the Internet or other networks, which might not be identified as ICTs in the conventional sense (Nambi, 2014). On one hand, the advent of IoT represents an evolution of ICTs (Roselli, 2015); on the other, ICTs are key enabling technologies, without which IoT could not exist (Gubbi, 2013). The IoT world is indeed underpinned by ICT infrastructure, which is needed to gather, transmit and disseminate data as well as facilitate the efficient delivery of services for society at large (e.g. health, education) and assist in the management of organizations, whether it be for individuals, companies, governments or international organizations. ICTs serve as an enabler for individual social development and societal transformation by improving access to critical services (including by way of IoT pathways), enhancing connectivity and creating new opportunities.

Robust ICT infrastructure can most definitely facilitate — at the very least — the transmission of a greater volume, variety and velocity of data; these three "V"s in particular collectively serve to better allow for in-stream processing and analytics so as to help "remove hay from the haystack" (Lindquist, 2011) and better illuminate the "needles in the haystack" (Grover, 1997). With this foundational basis, the veracity of data can be better scrutinized, and, playing a role similar to that of traditional "small data" (Martens, 1998) in verification, relevant long-tail data from the entire corpus of devices may prove extremely illuminating in providing maximum context in terms of validating information (i.e. to mitigate against misinformation or disinformation) and providing an additional value-added proposition for the community at large.

A higher level of confidence in ICT infrastructure and its capacity to ensure data privacy and protection will lead to an ever-increasing reliance on IoT. Likewise, this reliance on IoT will serve as a self-reinforcing societal trend for an even more ubiquitous IoT, thereby eventually leading to the IoE phenomenon that will extend connectivity beyond the boundaries of IoT and connect people, processes, data and things (Evans, 2012), as depicted in Figure 5.5.

Although aspirational, IoE could result in networks of networks with trillions of connections, facilitating automated connectivity, embedded intelligence and event correlation (Yesner, 2013). Whereas IoT connects objects to the Internet so as to increase available data in a query-response paradigm, the envisioned IoE will enable greater automated insight generation in a real-time sense-

Figure 5.5: Evolution from the Internet of Things to the Internet of Everything



Source: ITU.

and-respond paradigm (Etzion, 2014) through computational capacity in the cloud and within objects themselves (Kiat Seng, 2014). At the very least, the notion of IoE helps to position and establish an envisioned approach for architecting next-generation systems and devising viable policies to contend with the massive torrent of big data.

The IoT and big data

More big data have been generated, especially via IoT, during the last 2 years than in all of previously recorded history (Sagiroglu, 2013). Table 5.1 presents a range of estimates from a variety of sources regarding data generated and stored in electronic format, and Table 5.2 compiles estimates on the size of IoT and its potential value.

Table 5.1: Summary of statistics on global data generated and stored in electronic format

Data generated		
Indicator	**Statistics**	**Source**
Total data generated:	From the dawn of civilization to 2003, humanity has generated 5 exabytes (EB) of data	Intel (2013)
Data structure:	85% of big data is unstructured	Berry (2012)
Genomic data per person:	4 terabytes (TB)	Miller (2012)
Data generated by Boeing jet engine per 30 minutes of flight:	10 TB	Higginbotham (2010)
Data generated by automobile per hour of driving:	25 gigabyte (GB)	Taveira (2014)
Data increase in electrical utilities due to IoT-enabled smart grid:	680 million smart meters will be installed globally by 2017. This will lead to 280 petabytes (PB) of data per year.	Bloomberg (2015)

Data in electronic format		
Statistics		**Source**
The volume of data stored in electronic format has been doubling almost every 18 months.		Gantz (2011)
2013	3.1 zettabytes (ZB) data centre traffic	Cisco (2014)
	4.4 ZB (trillion gigagbytes) total	Gantz (2011)
	5 GB per capita	Bahrami (2015)
2014	2.5 billion GB per day; 1.7 megabytes (MB) per minute per capita	Gantz (2011)
2015	14.5 billion indexed webpages	Woollaston (2013)
2016	1 ZB global annual IP traffic	Cisco (2015)
2018	403 ZB total IoE traffic	Cisco (2014)
	14 GB per capita	Bahrami (2015)
2019	2 ZB global annual IP traffic	Cisco (2015a)
2020	44 ZB (44 trillion GB)	Gantz (2011)
	10% from embedded IoT devices	Gantz (2011)
	27% from mobile connected things	Gantz (2011)

Note: data volumes are expressed in multiples of bytes: kilobyte (1024), megabyte (1024^2), gigabyte (1024^3), terabyte (1024^4), petabyte (1024^5), exabyte (1024^6) and zettabyte (1024^7).

Table 5.2: The size and value of the Internet of Things in numbers

Size of IoT		
Indicator	**Statistics**	**Source**
Number of connected devices, milestones reached:	70% annual growth in sensor sales since 2002	Evans (2011)
	2008-2009: Number of global connected devices surpasses human population	Gartner (2013)
Number of connected devices today:	8 billion devices or 6.58 devices per person online	Cisco (2015b)
Number of connected devices by 2020:	Nearly 26 billion devices will be connected as part of IoT by 2020 (and this figure excludes smart phones, tablets and PCs, which would account for another separate 7.3 billion devices)	Gartner (2013)
	More than 30 billion devices will be connected by 2020	ABI (2013)
	Approximately 50 billion devices will be connected by 2020 (CISCO)	Evans (2011)
	75 billion devices will be connected by 2020 (Morgan Stanley)	Danova (2013)
	Anywhere from 50 to 100 billion devices will be connected by 2020 (Bell Labs)	Trappeniers (2013)
	The number of devices is already approaching 200 billion (IDC)	Turner (2014)

Potential value of IoT		
Indicator	**Statistics**	**Source**
IoT incremental revenue by 2020:	USD 300 billion, mostly from services	Gartner (2013)
IoT market worth by 2020:	USD 7.1 trillion	Press (2014)
IoT annual growth of market worth by 2025:	USD 3.9-11.1 trillion, 40% generated in developing countries	McKinsey (2015)
IoT contribution to GDP over the next 20 years:	USD 15 trillion	Press (2014)
IoT by sector:	50% of IoT activity is centred around manufacturing, transportation, smart city and consumer applications	IDC (2011)

Note: data volumes are expressed in multiples of bytes: kilobyte (1024), megabyte (1024^2), gigabyte (1024^3), terabyte (1024^4), petabyte (1024^5), exabyte (1024^6) and zettabyte (1024^7).

The number of connected devices

Big data are being created by billions of devices around the world, as shown in Table 5.1. It is estimated that from 26 to 100 billion devices (Gartner, 2013) (Trappeniers, 2013) (ABI, 2013) will be connected as part of IoT by 2020. These devices will include the traditional "dumb" devices (e.g. toaster, light bulb, refrigerator, faucet), which will be made "smart" with real-time sensors equipped with communication capabilities.

In addition to these devices, many additional, hitherto unconnected consumer devices and industrial machines could be connected to the Internet, and this number (particularly in the realm of sensors) is burgeoning. There are multiple factors "accelerating the data surge" (Press, 2014), including:

(1) Increased affordability: technological progress, such as high-volume manufacturing techniques, and the increase of the size of the market of devices with embedded communication technology allow for economies of scale; the 70 per cent annual growth in sensor sales since 2002 (Gartner, 2013) is leading to a situation in which ever-more capable sensors are becoming more affordable.

(2) Increased connectivity, access to cloud computing (Zhang, 2010) and more affordable high-speed wireless data networks extend the

reach of IoT applications to uses not yet even imagined.

(3) Rapid innovation: technological advances make it possible to include multiple sensors within one device to perform a variety of distinct and disparate tasks (e.g. detecting geolocation, temperature, motion, etc.); furthermore, power management is allowing devices to run unattended for longer periods of time (Abras, 2008).

(4) Regulatory mandates and policy initiatives are accelerating the adoption rate of IoT solutions, especially within industries (e.g. healthcare, automotive and energy). As just one example, the European Union has mandated that 80 per cent of European homes must have a smart meter installed by 2020 (Faruqui, 2010).

(5) The adoption of communication protocols, such as Internet Protocol 6 (IPv6), allows more devices to connect to the Internet; IPv6 has 2^{128} addresses as compared with 2^{32} for IPv4 (Wu, 2013).

(6) The high expectations that IoT is generating in industrial markets are encouraging more stakeholders to enter the IoT market, thus contributing to increasing the number of devices and expanding the sector. Indeed, industrial titans such as General Electric are forecasting that the industrial Internet has the potential to contribute approximately USD 15 trillion to global GDP over the next 20 years (Press, 2014), and connected cars, smart homes, wearables, *et al.*, are expected to comprise trillion dollar markets (MacGillivray, 2013).

In this context, it is possible to imagine several scenarios that may be close to becoming reality. For example, a home camera device detecting movement of a pet can notify the homeowner, via an e-mail or text message; it can capture the associated video and transmit the video stream to a private cloud. Should the homeowner elect to share the video – let us say that the movement by the homeowner's pet and the associated video has the potential of being propelled to the ranks of YouTube's funniest videos – then that video will be transmitted, disseminated, propagated, replicated and preserved in archives and repositories all over the world. Screen captures and textual transcriptions of the video — and related data — can be shared, via social networking platforms, microblogging platforms and other social media platforms.

The torrent of big data from connected devices

As connected devices create new opportunities for the scientific exploration of large datasets, there is an increasing volume of and value given to observational, experimental and computer-generated or machine-spawned data. In the context of big data, human-generated data (e.g. textual data – e-mails, documents, etc.; social media data – pictures, videos, etc., and other data) represent an increasingly diminishing percentage of the total; after all, IoT devices are producing machine-generated data (e.g. remote-sensing data – volcanic, forestry, atmospheric, seismic, etc.; photographs and video – surveillance, traffic, etc.) and sharing them directly with other devices without any human intervention.

Given the sheer volume of human-generated as well as machine-generated data, there have been several attempts to quantify these data and project future trends. The 2014 report of the *EMC Digital Universe Study* asserts that, as a result of IoT, the amount of data generated in digital format is doubling every two years and will increase by about a factor of ten between 2013 and 2020 – from 4.4 trillion gigabytes to 44 trillion gigabytes (IDC, 2011).

The 2013 4.4 ZB estimate of the data generated in digital format breaks down into 2.9 ZB generated by consumers and 1.5 ZB generated by enterprises.[5] In fact, only 0.6ZB (about 15 per cent) of the consumer portion is not touched by enterprises in some way, leaving enterprises responsible for the vast majority of the world's data (about 3.8 ZB in 2013),[6] with mobile connected things contributing another 27 per cent[7]. In terms of geography, EMC and IDC predict that the balance will swing from mature markets, which accounted for 60 per cent of the data generated in digital format in 2013 (Turner, 2014), to emerging markets within developing countries, with the inflection point occurring around 2016-2017 (Turner, 2014). This nevertheless presumes that the infrastructure in the emerging markets of developing countries will be able to cope with this increase in enterprise data, which would require major investments in ICTs.

In this world of big data, several latent data sources are starting to be tapped. For instance, each person equates to about 4 TB of raw genomics data (Miller, 2012), a Boeing jet generates 10 TB of information per engine for every 30 minutes of flight (Higginbotham, 2010), and the array of sensors in a modern hybrid car generates 25 GB of data per hour of driving (Taveira, 2014). Given the aforementioned genomic, jet engine and automotive examples, the descriptor "torrent of data" (Vermesan, 2011) — to represent the phenomenon of big data being generated and shared among connected devices — is difficult to dispute. To accompany this "torrent of data", there are data given off as a byproduct (Singh, 2014). This "digital exhaust" is both actively contributed (e.g. the writing of a blog post) and passively contributed (e.g. the background generation by the device — mobile phone or other — of geolocation, time, date and other metadata).

It is important to note that, currently, most of the world's data are transient (e.g. the streaming video of Netflix Instant, Hulu Plus or Amazon Instant Video, etc.) and require no storage. The significance of this resides in the fact that the global amount of available storage capacity (i.e. unused bytes) across all media types is growing at a much slower rate than the data generated in digital format (Hilbert, 2011). In 2013, the available storage capacity could accommodate just 33 per cent of the data generated in digital format (Turner, 2014). By 2020, it is forecast that it will be able to store less than 15 per cent of such data (Turner, 2014). In essence, the amount of data being generated is far outpacing the ability to store those data, let alone analyse them (Kumar, 2011).

The volume of data produced by connected IoT devices is a problem not only of storage, but also of sustainable access and preservation. The diversity of data formats, metadata (all of which might not necessarily adhere to metadata standards, such as the Dublin Core Metadata Standard), semantics, access rights, associated computing hardware, and the myriad of software tools for modeling, visualizing and analysing the data too, collectively, all add to the complexity and scale of the big data challenge.

In addition, the vast amounts of data that will be generated by IoT devices will put enormous pressure on networks and data centre infrastructures. IoT data flows will be primarily from sensors to applications and will range between continuous data flows (e.g. real-time stock ticker system) and bursty data flows (e.g. non-real-time video) depending upon the type of application. The anticipated magnitude of IoT-related network connections and data volumes is likely to favour a distributed approach for data centre architectures, with several "mini-data centres" performing initial processing and forwarding relevant data over wide area network (WAN) links to a central data centre for further analysis.[8] Cisco has coined the term "fog computing" (Bonomi, 2012) to describe this methodology of data processing at the network edge or "edge computing" so as to mitigate against location-based and/or network latency issues. The efforts to back up this massive volume of data will accentuate issues of remote storage bandwidth and potentially insufficient storage capacity.

The examples given in this section show how IoT is shaping the observational space for what is considered "useful data." In 2013, according to Turner (2014), only 22 per cent of the data were considered useful, and less than 5 per cent of that "useful data" were actually analysed. By 2020, more than 35 per cent of all data could be considered "useful data" due to the strategic and tailored growth of data from IoT, but it will be up to the community at large to determine what are "useful data" and come up with methodologies to actually put these big data to use.

Regardless of whether data are deemed to be "useful data" or "not useful data" (incidentally, some type of analysis would be required to make this initial determination), there is most definitely a great deal of data traffic. Commercial traffic through large data centres for business applications represents a significant portion of the data generated in digital form (Benson, 2010) Yet despite the potential invaluable commercial value of the data, less than 1 per cent of that data has actually been analysed (Box 5.3) (Burn-Murdoch, 2013).

To explain this situation, it is worthwhile to note that many early instances of connected devices have occurred in the context of private internal networks, or "intranets of things", which were developed and operated in isolation from industrial-scale commercial applications (Zorzi, 2010). Although such internal networks

Box 5.3: Surface web and deep web

The surface web is that part of the world wide web (WWW) that is readily available to the general public and searchable by traditional search engines. From a quantitative point of view, it maintains a current steady contribution of approximately 571 websites per minute per day toward the already existing corpus of about 14.5 billion indexed webpages.[9] Apart from this indexed set of webpages, Google estimates that WWW is growing at a speed of about a billion pages per day.[10] Moreover, according to YouTube, more than 300 years' worth of video are uploaded to digital video repositories daily, and the substantive portion of the corpus of YouTube videos on the surface web has not yet been analysed.

The deep web is that part of WWW that is not readily available to the general public and cannot be indexed by traditional search engines. By way of background information, web crawlers collect and index metadata (e.g. page title, URL, keywords, etc.) from every site on the surface web, which constitute far less content than that of the actual site. Pages on the deep web function in the same way as any surface website, but are built in such a way that their presence is not readily discoverable by a web crawler for any of several reasons. First, search engines typically ignore pages whose URLs consist of lengthy sequences of parameters, equal signs and question marks in order to avoid duplication of indexed sites. Second, web crawlers cannot access sites with form-controlled entry (i.e. page content only gets displayed when an actual person applies a set of actions and databases generate pages on demand, such as flight information, hotel availability, job listings, etc.) or sites with password-protected access, including virtual private networks (VPNs). In addition, sites with timed access (i.e. free content becomes inaccessible after a certain number of page views, and is moved to a new URL requiring a password) and robots exclusion (i.e. a file in the main directory of a site tells search robots which files and directories should not be indexed) are inaccessible to web crawlers. Finally, there are hidden pages that no sequence of hyperlink clicks could navigate to, and therefore are only accessible to individuals who know of their existence.[11]

Initial research on the size of the deep web found that it was approximately 500 times greater than the surface web (i.e. the deep web contained nearly 550 billion individual documents compared with about one billion on the surface web (Bergman, 2001)), and sixty of the largest deep web sites collectively contained about 750 TB of information — sufficient by themselves to exceed the size of the surface web forty times over (Bergman, 2001). Subsequent research on the deep web has been carried out applying surveying techniques, such as random sampling of IP addresses or hosts, to estimate the size of the deep web. The results have revealed additional deep web data sources suggesting that the deep web might be larger than initially thought (B. He et al., 2007; Madhavan et al., 2007; Shestakov, 2011). Although research on the quantification of the deep web is ongoing, it has been established that the deep web has as much as an order of magnitude more content than that of the surface web (He, Yeye, et al., 2013) and that the deep web is the largest-growing category of new information on the Internet (B. He et al., 2007).

or intranets have generated vast amounts of data, these repositories are not accessible on the public Internet. In light of the vast amount of personal data that can be collected by wearables as well as home networking devices, maintaining isolated intranets of things separate from the public Internet is a vital consideration in terms of understanding how much data are being segregated due to desired privacy and securing the privacy of sensitive data (Roman, 2011).

5.3 The opportunities of IoT for development

IoT offers new opportunities for development by providing a new data source that can contribute to the understanding, analysis and tackling of existing development issues. As a consequence, the debate on IoT has become part of the larger debate on the data revolution and the possibilities that new ICT developments (including the growth of IoT) have opened up to achieve larger development goals, including those addressed by the new Sustainable Development Agenda.

The potential overall economic impact of IoT is profound, and while estimates vary, McKinsey expects the IoT market to generate from USD 3.9 trillion to 11.1 trillion a year by 2025 (McKinsey, 2015). The latter figure is roughly equivalent to 11 per cent of the global economy. Keeping this in mind, while over the next ten years IoT may indeed potentially represent a higher value within advanced economies based on higher value per use, it is anticipated that nearly 40 per cent of its value will be generated in developing economies (McKinsey, 2015). Hence, the future of leveraging IoT for developing countries is quite promising. While many discussions on the opportunities offered by IoT have focused on the consumer side and benefits for the individual, IoT offers great potential for broader development issues. Existing examples of the use of IoT for development are mainly to be found in the areas of health, climate change and disaster management, water and sanitation, and agriculture and infrastructure. IoT has been recognized as providing a particular opportunity to address challenges faced by the growing number of megacities, and to help turn cities into smart cities.

The following section will look into some of the uses of IoT to address certain key challenges facing developed and developing countries. It will highlight the fact that there are significant global development challenges that IoT can potentially help to address. In fact, IoT can well serve as a launching pad for developing countries in contending with epidemics and natural hazards and managing resource scarcity. IoT-centric endeavours also include precision agriculture for the production of food, tests for water quality, and systems that relate to the provision of public services to residents, such as transportation. The rise of IoT offers developing nations the potential to leapfrog and accrue especially large benefits from strategic technological adoption (Nolan, 1985). Emphasis will be placed on the discussion of megacities, for megacities concentrate and exacerbate several challenges found on a lesser scale elsewhere. Indeed, megacities can serve as testbeds for IoT applications aimed at alleviating key issues, particularly those centred around basic infrastructure services such as energy, water, sewage disposal and sanitation.

IoT for health

An important role for IoT has been established in the area of healthcare delivery, research and response. From the advent of wearable health devices and other sensor-based capabilities to the monitoring of pandemics and endemic disease control, the opportunities within the IoT paradigm are growing. A macro-level approach to combining anonymized user data allows a more comprehensive view of the observational space, and layering additional datasets, such as geographic or economic, can provide additional insight. For example, today's amalgam of mobile-cellular data and other sensory data from IoT might shed more insight into the cyber-physical supply chain at hand and provide a test of reasonableness regarding data validity — for tracking, anticipating and mitigating the spread of infectious disease.

This notion of IoT syndromic surveillance (i.e. the collection and analysis of health data pertaining to a clinical syndrome that has a significant impact on public health), especially for the purposes of potentially modeling the spread of infectious diseases, has already been used to great effect (Wesolowski *et al.*, 2012). For example, in Kenya, passive mobile positioning data was combined with epidemiological data to identify the prevalence, spread and source of malarial infections (Wesolowski *et al.*, 2012, 2015). Similar experience in Haiti also illuminated how mobile positioning data could be used to study both population displacement and the spread of cholera after the 2010 earthquake (Rinaldo, 2012).

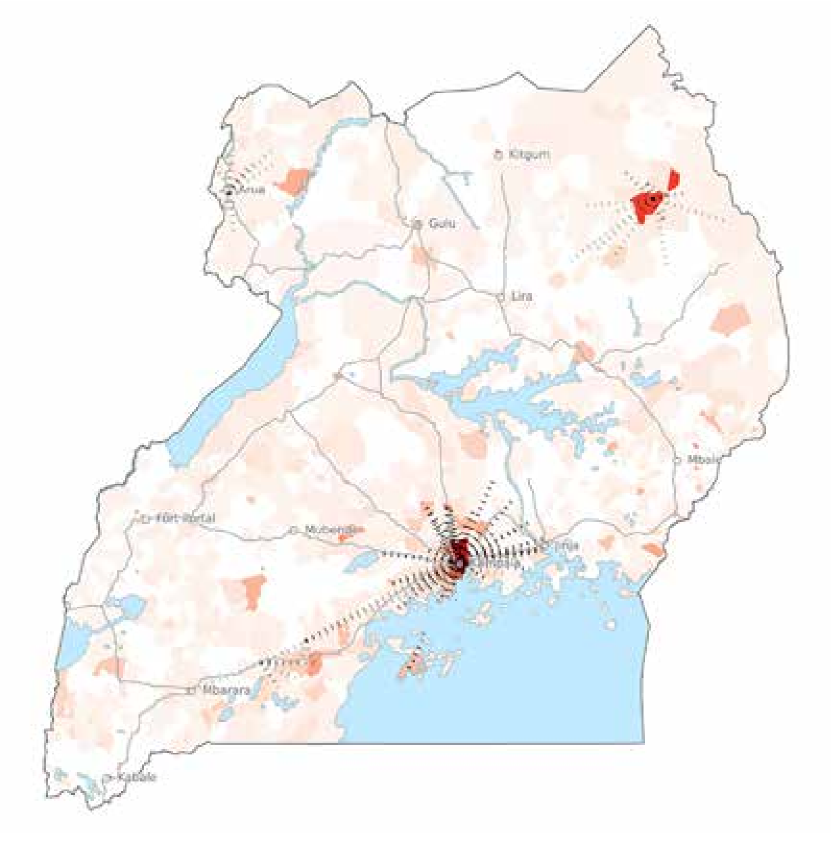
Most recently, mobility data were used during the Ebola outbreak in several West African countries (Fink, 2015), and highlighted the need for more extensive and timely data for pandemic disease tracking and prevention. Population flow data between areas is a key ingredient in Ebola containment strategies, and analysis of travel routes is the best resource (Wesolowski *et al.*, 2014). As a mobile phone subscriber moves from one area to another, the phone will ping towers along the way. It is often difficult to obtain such granular data, thus policies for sharing aggregated and anonymized datasets are encouraged. Companies like OrangeTelecom made such data available during the Ebola crisis.

ITU, in cooperation with the Government of Sierra Leone and the operators in the country, is carrying out a project to analyze anonymized call detail records to understand geographic mobility patterns of communities affected by the Ebola outbreak. In a similar approach, the UN Global Pulse Lab, along with the Ministry of Health in Uganda and WHO, is carrying out infectious disease and risk factor mapping in Uganda through advanced data visualization techniques (UN Global Pulse, 2015). The conjoining of mobility data with remote sensing and geographic information systems (GIS) data offers great potential for tracking the spread of infectious diseases and the deployment of resources (Figure 5.6).

IoT has the inherent potential to improve upon scientific concepts related to epidemic studies. In 2015, for example, Microsoft began testing semi-autonomous drones whose purpose is to carry a trap to collect mosquitoes in remote areas. These mosquitoes will be utilized in the lab to identify the prevalence of diseases such as avian flu and dengue fever. The method circumvents what is currently a painstaking and lengthy process to obtain samples, ultimately reducing the latency of deployment of pesticides or other control methods (Linn, 2015). In the future, rural communities will be able to have test results in minutes from a sample collected and transmitted through a handheld device, preventing delays in diagnosis (Jezierski, 2014).

As chronic diseases and other long-term health issues become more prevalent in society, IoT enables an extension of mobile health (m-health) known as mIoT. In fact, Frost and Sullivan identified "health informatics" as one of the top ten medical device and information trends in 2015 (Frost 2015). Through mIoT, the healthcare industry is poised to offer assistance to those with chronic health conditions through wearable devices. A best case use of mIoT may be to monitor conditions such as diabetes, where constant streaming data on blood glucose levels are necessary for medical intervention (Istepanian, 2011). Accelerometers and other motion-based sensors can be used to capture the movement and vital signs of patients who have a condition – for example Parkinson's - that puts them at risk of injury. As just one

Figure 5.6: Typhoid incidence and human mobility from highly infected areas in Uganda during the January-May 2015 typhoid outbreak



Source: UN Global Pulse (2015).

example, the MyLively device allows family members to monitor the well-being of a relative in their home through strategically placed and wearable sensors that transmit motion data from within the home (MyLively.com, 2015). Wearable devices and non-invasive sensors will allow patients to lead more regular lives while providing ongoing data to doctors and hospitals.

IoT for climate change and disaster management

Today's array of sensors offered by the IoT paradigm also hold great promise for monitoring the effects of climate change, as IoT can leverage data from everything ranging from common devices – e.g. smartphones to take pictures, air quality monitors for detecting certain particulates, etc. – to large-scale devices – e.g. surveillance systems observing vegetative health, weather- and climate-monitoring devices, energy-managing systems (Box 5.4). These approaches and the successful use of their associated methodologies offer numerous opportunities for improving the effectiveness of humanitarian assistance and disaster relief (HADR) operations following natural hazards. Given the high value-added proposition of IoT in syndromic surveillance, many post-disaster response plans now include and emphasize the proviso that any damaged infrastructure (e.g. mobile cellular network) is to be repaired as quickly as possible so as not to impair IoT-based HADR efforts.

Small island developing States (SIDS) are particularly vulnerable to the effects of climate change, often owing to their remote locations and limited resources. This requires increasing self-reliance to anticipate the drastic effects to local economies, trade and tourism, food production and the health of the population, all due to rising sea levels, dramatic changes in weather patterns and global warming. It is important to

Box 5.4: IoT-enabled management of photovoltaic (PV) systems

Nest Labs is a ZigBee-based IoT company featuring three consumer home products: a thermostat, a smoke/carbon monoxide detector and a video camera. The main product, the Nest Learning Thermostat, is designed to learn and adapt to the user's schedule. After an initial 12-day acclimatization period, the thermostat adjusts the temperature in the home to more efficient heating and cooling based on patterns of life. The company was acquired by Google in 2014 for USD 3.2 billion dollars, and it has since made strategic partnerships in the renewable energy sector and the insurance industry (Higganbotham, 2015).

In early 2015, Nest partnered with SolarCity, a United States-based photovoltaic (PV) system company, to provide a limited number of free thermostats to customers. Unlike a smart meter, the thermostat will have more finely-tuned user data as more IoT-powered devices are connected to it, thereby allowing it to heat or cool each room individually, or having a trigger to initiate the change, for example starting a car at work. With many smart devices attached, it will be possible to establish precise energy-usage profiles and respond to peak demand by limiting the activities of other smart home devices (Baraniuk, 2015; Tilley, 2015).

With regard to inclement weather, sudden cloud cover would interrupt PV energy production and create a surge in demand for power from the grid. To prevent this potential generation rejection and circumvent a potential brownout or blackout, Nest could potentially communicate with household smart devices to reduce, pause or stop heavy power-consuming activities.

Previously, SolarCity, which also uses Zigbee in their PV array installations, created the MySolarCity App that captured generation and usage data in order to mitigate the issues that prevent solar energy from being more freely integrated into the grid. Where previously an audit conducted in the home as part of the installation process would have to manually add and account for energy usage of home electronics and heating, ventilating, and air conditioning, the Nest acts as an extensible hub within the IoT realm (Korosec 2015).

note that more than 50 per cent of Caribbean and Pacific island populations live within 1.5 km of the shore (UNESCO, 2014). In addition, special attention is being given to unsustainable practices and geological incidences, which can worsen or accelerate the effects of climate change.

The negative effect of climate change, as manifested in the increasing incidence of extreme weather events, poses a significant threat to the stable operation of a host of critical infrastructure systems, including transportation, energy delivery and telecommunications (Power, 2015). In particular, extreme weather events have the potential to compromise major communication backbones, such as the Internet, which rely largely on fixed data connections and power supplies (Hauke, 2014). In turn, a variety of IoT sensors and communication devices that use small amounts of battery power and transmit data through wireless communication protocols — independent of the Internet — can help to facilitate the operation of essential services and emergency management despite the loss of backbone communication infrastructure during large-scale natural disasters (Hauke, 2014).

In another example, sea-level rise, extreme storm intensification and other alarming trends increasingly threaten modern civilization along shorelines, which, historically, have represented the areas of high population growth. A wealth of sensors offered by the IoT paradigm can provide critical monitoring. As the cost and size of sensor devices decrease, their widespread deployment becomes an increasingly practical method for improving the ability to observe effects of climate change through crowd-sourced meteorological observation. By way of example, the Japanese firm Weathernews is distributing thousands of palm-sized atmospheric sensors to citizens, enabling them to measure and communicate temperature, humidity and pressure readings in real time, thereby increasing the granularity of weather forecasting and awareness of climatological phenomena (Hornyak, 2015). More granular atmospheric data can help to manage the impact of extreme weather events, as well as provide a richer body of evidence to inform computational models and drive more accurate analysis of patterns in global climate change (Faghmous, 2014). In the context of disaster scenarios, the prevalence of crowd-sourced radiation mapping efforts following the 2011 tsunami and Fukushima nuclear incident further demonstrates the speed with which impromptu sensing networks can be established (Plantin, 2015).

Aside from disaster scenarios, sensor networks can also be used for the research and monitoring of the environment, and to provide data about those parts of the planet still relatively unknown (Box 5.5). On a much smaller scale, the use of IoT in experiments, such as the Birmingham Urban Climate Laboratory's enhancements to the Road Weather Information System (RWIS), demonstrates that acquiring robust data on real-time road conditions can improve the maintenance of transportation infrastructure by precisely identifying which sections of roadway are most in need of repair or maintenance at a specific time (Chapman, 2014). Similarly, the "Padova Smart City" proof-of-concept project demonstrates a viable IoT architecture for fielding sensors to monitor the status of public infrastructure, such as streetlamps.

IoT for precision agriculture

The growing number of people in the world and the encroachment of megacities upon limited land resources, as well as increasing demand for food, beget a need for precision agriculture, which is ''that kind of agriculture that increases the number of (correct) decisions per unit area of land per unit time with associated net benefits.'' (McBratney, 2005). Although precision agriculture has been practised for several decades with the help of remote sensing by satellites (Mulla, 2013), the ability to integrate diverse data from an array of affordable sensing devices is a recent development that will enable a larger segment of the agribusiness community to leverage the advantages of technology.

Precision agriculture requires a large amount of connectivity, bandwidth and capable sensors in order to deliver timely and accurate data, which are the foundation for any precision agriculturalist's decision-making. IoT sensors and communication devices could be central to a number of precision agriculture processes, such as preparing soil, planting and harvesting at precisely the optimal time, thus ultimately helping to meet the challenge of increasing food production by 70 per cent by 2050 (Beecham, 2014).

Box 5.5: Monitoring the world's deep oceans

The negative effects of climate change are compounded by a relative paucity of sea-state data, and sparse ocean data acquisition endeavours. The tragic 2014 loss of Malaysia Airlines Flight 370 (MH370) reveals how little is actually known about the world's deep oceans, as an over-a-year-long search of more than 4 million square kilometres has turned up almost no trace of the aircraft or its 239 passengers (only a flaperon of the plane was found in Réunion in July 2015).[12] The global response has led international governing bodies to revise standards and practices for the civil aviation industry. ITU, having the mandate to coordinate global orbital resources and radio spectrum, was asked by the International Civil Aviation Organization (ICAO) to expand satellite capabilities for global flight tracking. As an outcome of ITU plenipotentiary conference Resolution 185, global flight tracking was added to the agenda of the World Radiocommunication Conference 2015 (WRC-15) (ITU, 2014c). In addition, ITU established the Focus Group on Aviation Applications of Cloud Computing for Flight Data Monitoring to determine the telecommunication standards needed for real-time monitoring of flight data.[13]

The case of MH370 lends credibility to the argument that we have greater knowledge of the surface of Mars and the Earth's Moon than we do of the topography of our own planet's deep oceans (Smith, 2014). Although ocean data acquisition systems (e.g. data buoys) have been in use for decades and have played a critical role in facilitating our knowledge of complex climatic phenomena, such as El Niño and El Niño Southern Oscillation (ENSO) (McPhaden, 1998), the advent of IoT represents an opportunity to significantly increase the value of data buoys and scientific understanding of the ocean. This potential is illustrated by the deployment, by the National Oceanic and Atmospheric Administration (NOAA), of the Chesapeake Bay Interpretive Buoy System, which collects and relays a variety of sea-state data in real-time for a host of applications, ranging from public education and weather monitoring to fisheries management and environmental protection (Wilson, 2011).

With the development of self-sustaining power sources such as microbial fuel cells (Tender, 2008) (a bio-electrochemical device that harnesses the power of respiring microbes to convert organic substrates directly into electrical energy) and wave energy harvesting (Hangil, 2014), it will be increasing affordable to deploy large fleets of drifting and moored buoys that improve our ability to monitor the ocean, understand its role in climate change, and prepare for potential disaster events emanating from the ocean. Another initiative to collect data from the oceans is the ITU/WMO/UNESCO-IOC Joint Task Force that investigates the use of submarine telecommunication cables for ocean and climate monitoring and disaster warning.[14]

By way of example, the successful implementation of a precision agriculture management system (PAMS) in Huaihua, Hunan, China, demonstrates that such IoT-enabled processes can maximize workforce productivity, while increasing and improving crop yields (Ye, 2013).

On the African continent, African farmers could indeed rise to this challenge if they had access to the requisite infrastructure and associated analytics. Raising productivity in agriculture is vital to transformative growth, and Africa's USD 35 billion food market (Munang, 2015) could well be served directly by its own farmers, if the aforementioned enhanced productivity paradigm existed.

As climate change shifts ecosystems and precipitation patterns, it will be necessary for farmers to adapt. The 2014 Big Data Climate Challenge winner from the International Center for Tropical Agriculture, Colombia, created an app-based tool for site-specific agriculture. The app combines multiple datasets to create recommendations for rice farmers who provide their individual data (UN Global Pulse, 2014)

The criticality of precision agriculture becomes particularly evident when analysing the trends of developing countries, for as developing countries mature, most economic activities (e.g. agriculture, energy, industry, etc.) affect not only the quantity but also the quality of water resources, thereby further limiting acceptable potable water availability. Allocation of limited potable water resources among competing economic sectors will be an increasing challenge for many developing countries (Tilman, 2002), and failure to establish appropriate allocation mechanisms might impede further development, economic viability and latent stability (Gleick, 1993); if not properly addressed, exacerbated environmental pressures and social instability (e.g. increased income inequality) may result.

Precision agriculture techniques can be used to increase crop yield to keep up with demand. To ensure maximum crop yields, water supplies need to be predictable and timely. Predicting water supplies at a given time require "hyper-local" weather forecasting.[15] (Wakefield, 2013). One such example is IBM's Deep Thunder project, which focuses on generating hyper-local weather forecasts to gain more specific knowledge about weather, and translate this knowledge into insights for improved agricultural practices (Sonka, 2014). Capabilities, such as those offered by Deep Thunder, can help to inform a variety of farming decisions — from which seeds to plant and when to plant them, to when the use of fertilizers and pesticides should be avoided to prevent run-off and pollution (Jacob, 2014).

Certain technologies and other complementary offerings, comprising a highly effective architectural stack, are needed for the type of weather forecasting required by a precision agriculture paradigm. Sensors that allow for monitoring of crop growth rates, potential blight, water consumption, etc., will be required. These sensors will need to be connected to data collection systems. New platforms have emerged, such as unmanned aerial vehicles (UAVs), which can be used to collect the requisite information in rural areas and in the agricultural fields.

The use of drones accounts for as much as 90 per cent of seeding and pesticide spraying in Japan's agricultural sector (National Research Council, 2014) and provides an informative use case for how IoT-enabled devices can improve agricultural productivity. Whereas conventional aerial seeding and pesticide spraying by manned aircraft is both costly and imprecise due to the altitude from which such aircraft must deliver their payloads, unmanned aircraft are capable of delivering precise amounts of seed, fertilizer or pesticide to the exact locations in which they are needed (Huang, 2013). This allows farmers to maximize productivity by conserving seed and pesticide resources, while minimizing fuel and other aircraft operational costs. Unmanned aircraft are also capable of monitoring crop growth with greater efficiency than could be achieved with manned aircraft, satellite or other means, thus enabling farmers to accurately plan harvest schedules and identify particular areas in need of remedial pest control (Huang, 2013). By way of example, Field Touch is a service being piloted on 100 farms around Hokkaido, Japan, whereby data collected by unmanned aircraft are synthesized with other remote sensing data captured by satellite and weather monitoring devices in order to generate recommended courses of action for individual farmers (Kiyoshi, 2014).

IoT to address key challenges faced by megacities

Many people are moving to urban areas and cities, leading to the development of a growing number of megacities. According to United Nations statistics, currently 54 per cent of the world's population live in urban areas, and by 2050 that figure is expected to grow to 66 per cent (United Nations, 2014). Indeed, urban areas and city centres of the world are exploding, and the number of megacities, usually referring to an urban area with over 10 million inhabitants, is increasing rapidly. As at 2015, there are 34 megacities in existence compared with only ten in 1990 (United Nations, 2014). The urban sprawl - the predominantly unplanned, uncontrolled spreading of urban development into adjacent areas at the edge of the city- often means that existing critical infrastructure is not designed to accommodate the high capacities required by such rapidly burgeoning resident populations. The rise of megacities has led to overstressed infrastructures and unreliable delivery mechanisms, and presents a host of development challenges. These include the provision of adequate basic public infrastructure services, including sustainable, reliable and efficient energy, potable water and adequate sewage disposal and sanitation.

Growing cities are creating massive use of IoT applications and demand for smarter grids to maximize efficiency from energy sources while enhancing the stability of the grid, smarter water use from an ever-diminishing water supply, and more connectivity for better situational awareness and a better sense-and-respond paradigm. To best illuminate the interconnections and various demands for energy, water, sewage disposal/ sanitation and transportation, it is useful look at electrical utilities, water resource authorities, waste management authorities and transportation authorities and how they are taking advantage of IoT for converting megacities into smart cities (Box 5.6).

One example is the city of Sao Paulo, Brazil, which is home to the world's most complex public bus transportation system, transporting over 10 million passengers per day on over 26 000 buses (Guizzo, 2007). IoT helps such a large bus rapid transit (BRT) system operate effectively, by tracking the movement of buses via GPS, synchronizing traffic signals, enabling electronic payment to streamline boarding processes, and disseminating real-time route progress to assist travelers in their trip planning (Hidalgo, 2014). The city of Rio de Janeiro's Centro De Operacoes Prefeitura Do Rio is a nerve centre for the city, combining data feeds from 30 agencies, including transportation, utilities, emergency services, weather and other information submitted by city employees and the public via phone, Internet and radio, all in order to synchronize the delivery of essential public services (Kitchin, 2014). Integrating diverse data from across various systems operating in a single municipality in order to achieve more complete situational awareness and efficient operations is a primary tenet of the smart city paradigm (Gaur, 2015). The city of Songdo, Republic of Korea, embodies such a concept, as it is built to be smart from the ground up, with each residence and office networked through a centralized monitoring infrastructure, including an automated refuse collection system that sucks garbage through chutes from all around the city into treatment centres that will ultimately transform the waste into a sustainable power supply (Marr, 2015).

Box 5.6: IoT as an enabler of smart cities

Although there is no universally accepted definition or set of standards for what constitutes a smart city, all smart city initiatives are characterized by the pervasive employment of technology intended to make better use of a city's resources (Neirotti, 2014). In particular, IoT plays an important role in a city becoming smart, as evidenced by the case of Singapore. Singapore is unique in that it is a city-State. As a nation, it has recently unveiled a bold Smart Singapore strategy, which aims to convert the city-State into the first true smart nation through a range of initiatives leveraging intelligence, integration and innovation to become a major player on the world stage. Part of this strategy involves the implementation of heterogeneous networks that will allow mobile users to transition smoothly between wireless networks, as well as a roll-out of smart aggregation gateway boxes containing sensors, connected via fibre optic cables, which will collect and deliver real-time information to government agencies and citizens.[16] (Hidalgo, 2014).

In contrast, Shanghai's development as a smart city is conceptualized around the five "I"s of: (1) Information Infrastructure focusing on broadband access and wireless connectivity;(2, 3) Information Perception and Intelligent Applications focusing on governance and livelihood issues; (4) New Generation of Information Technology Industry focusing on urban self-sensing, self-adaptation and self-optimization; and (5) Information Security Assurance (Lin, 2015).

The rise of IoT offers developing nations the potential to segue from stressed megacities to smarter cities by converging various IoT-centric lines of effort towards the overarching strategic goal of a "smart city" paradigm. These IoT-centric efforts might relate to precision agriculture for the production of food, monitoring for water quantity as well as water quality, and observing for indicators that might impact the normal operations of the electric grid and other elements of critical infrastructure.

Electric grids, water and sanitation management

The Institute of Electrical and Electronics Engineers (IEEE) defines a smart grid as “an electric system that uses information, two-way, cyber-secure communication technologies, and computational intelligence in an integrated fashion across the entire spectrum of the energy system from the generation to the end points of consumption of the electricity” (Ghafurian, 2011).

Electrical utilities employ networks of sensors that can monitor the flow of electricity to better ascertain fault location and other related failures more quickly. In particular, the use of phasor measurement units (PMUs) has given rise to wide-area monitoring systems, in which the generation, transmission and distribution of electricity can be measured in near-real time (Ghosh, 2014). Although electric grid systems operate at a rate of many cycles per second (60 cycles per second in the United States, 50 cycles per second in the United Kingdom), conventional monitoring systems such as supervisory control and data acquisition (SCADA) are only capable of recording one measurement every two to four seconds (Sharma, 2014). In contrast, PMUs can record multiple measurements in a single cycle and communicate these data to centralized data concentrators, enabling system operators to gain a much clearer picture of the complex dynamics at play throughout electric grids (Aminifar, 2014).

By way of example, on 30 and 31 July 2012, the Indian electric grid suffered a series of cascading failures due to oscillations and load imbalances among three of its five interconnected grids that resulted in the largest blackout in world history, with over 620 million citizens left without power (Lai, 2012). A more robust monitoring capability, including PMUs, could have prevented the 2012 blackout (Pal, 2014), and the power grids of the Indian operators have begun deploying PMU or synchrophasor capabilities in order to enhance the system’s reliability and move towards a smarter grid (Saha, 2015). Indeed, synchrophasors, smart meters and other IoT-enabled capabilities are central to the achievement of smart grids that can quickly assimilate diverse data and take corrective action in order to maintain stable power supplies (Moslehi, 2010). In India, the deployment of IoT-enabled synchrophasors has facilitated the consolidation of five previously interlinked grids into a single national grid, as well as the continually increasing incorporation of renewable energy sources (Mukhopadhyay, 2014).

Likewise, water resource authorities utilize networks of sensors for continually monitoring water quality and water supply security. In parallel, waste management authorities utilize sewage sensors to assist in the various efforts to monitor public health. Sewage sensors have even been used to monitor for other elements, including drugs, bombs, etc., that represent a danger to the community at large (Heil, 2012).

Just as the ability to acquire precise measurements regarding electricity is central to a smart grid, the ability to acquire precise measurements regarding water quality is central to smart water management. By way of example, the use of quick deployment sensor networks (QDSNs) in Valencia, Spain, is enabling system operators to monitor various aspects of water quality throughout the city’s network of sanitary sewers in order to quickly identify malfunctioning components in the water management cycle (Bielsa, 2012). Such an IoT capability is especially valuable during periods of heavy rain or other extreme weather, when water management systems are under heightened stress.

Infrastructure and traffic control

Rapidly distending cities are accompanied by a rising number of cars and other forms of transportation, forcing policy-makers to look into better ways of monitoring and managing traffic. Next-generation sensor networks can assist in realizing more effective traffic flows for all modes of transport, identify shortcomings in infrastructure and help reduce CO_2 emissions. Indeed, WSNs are also being used for smarter transportation. For example, traffic lights are equipped with countdown timers and electronic signs that display various speed limits depending upon the information they collect from optical and/or radar-based sensors that provide information regarding the occupancy of individual lanes and/or the speed of vehicles. Upgrading the infrastructure of an existing intersection with state-of-the-art technology requires also providing the necessary communication links between all these components. Wireless technology can help reduce the cost by eliminating the need to route communication cables (e.g. Ethernet) to all devices in an intersection. As WSNs, which are deemed to be a revolutionary information-gathering method, are increasingly becoming a critical part of the ICT infrastructure that underpins the reliability and efficiency of infrastructure systems, they are becoming the key technology for IoT.

IoT projects to monitor and improve transportation systems include:

- The New York City's Transportation Alternative's "CrashStat" (Lovasi, 2013), which uses reports of "near miss" accidents to identify high-risk traffic trouble-spots;
- the City of Boston's Office of New Urban Mechanic's mobile application "Street Bump" (Harford, 2014), which uses a phone's accelerometer to detect potholes while the application user is driving around the city; and
- the "Crowdsourcing Urban Simulation Platform" (Shin, 2011), which uses the phone's accelerometer and location data to deduce the mode of transportation. Further, the platform uses location and time stamp data (i.e. correlated against pattern of life data) and attempts to recognize the current activity (e.g., whether one is at work, home, etc.). By using the vehicle type and location activity, the framework endeavours to compute urban sustainability values, such as what amounts of CO2 emissions are generated, and examines how well the city was, is and can be for the commuting requirements of its residents.

At the same time, an increasing amount of research is focusing on the safety and needs of cyclists and pedestrian access, particularly as more cities around the world promote citizen health and a "green community" (Bichard, 2015). For example, IoT is being used to help cyclists identify better routes to choose, as illustrated by the MIT Media Laboratory's Mindrider project (Box 5.7).

Natural hazards

Megacities, particularly those along shorelines, are burgeoning, and these population centres tend to be particularly susceptible to the effects of land erosion, hurricanes, flooding, salinization issues, major land subsidence, etc.

Robust sensor networks are highly capable of providing some semblance of early warning for punctuating events and can continuously monitor changing conditions, which may be indicators of risk. The hitherto acceptable paradigm of static data and batch processing may no longer be viable in this data environment, wherein streaming data and in-stream processing of continuous data streams become vital for these densely populated areas. This migration from static to streaming data is exemplified by the implementation of smart grids. Whereas conventional equipment used for monitoring fault or disturbance events in an electric grid have been event-driven (i.e. they only began recording once a disturbance event had occurred), synchrophasors and other wide-area-measurement capabilities constantly record

Box 5.7: Mindrider

Mindrider is a project born and spun out of the MIT Media Laboratory. The project features a helmet with: (1) a forehead-based sensor that uses electroencephalography (EEG) to measure electrical activity (i.e. brainwaves) in a bicycle rider's brain (Davies, 2015), and (2) an ear-based sensor that helps to remove noise from the EEG signal (Walmink & Wilde, 2014). The MindRider helmet also features a light-emitting diode (LED) that glows green to indicate a "calm state of mind" or red for a "more stressed state of mind" during a cyclist's journey. The MindRider helmet is Bluetooth compatible, and the information from the EEG sensor can be fed into an application on the user's smartphone, which uses the onboard GPS to map the relaxing "sweetspots" in green and the stressful "hotspots" in red (Walmink & Chatham, 2014). In this way, other cyclists can note where the hotspots are and pay particular attention to the reasons behind them — whether they are high-traffic areas requiring extra caution or dangerous areas that should simply be avoided. For commuters, this could help in the evaluation of alternative routes and identification of better routes.

and transmit data regarding the system's state (Kezunovic, 2012).

Lack of adequate infrastructure and cyber vulnerabilities remain a challenge for IoT

As highlighted in the previous section, there is great potential for IoT to help address some of the world's most pressing development challenges. At the same time, the deployment of IoT applications and their effectiveness depend on the availability, quality and safety of the underlying network. Although some of the IoT applications can be used over low-bandwidth networks (see Box 5.8), many monitoring efforts require significant amounts of bandwidth. Moreover, even IoT applications requiring low bandwidth may demand a high-capacity infrastructure if they are to be deployed in dense areas where other IoT/ICT applications are running concurrently. There is therefore a risk that countries and communities that do not have access to high-capacity ICT infrastructure are left behind IoT.

At the same time, the quantity and quality of networks differ markedly between countries, cities and regions and in particular between urban and rural areas. Internet connectivity is not yet available to all parts of the world and there are increasing efforts to bring Internet connectivity to currently unconnected and remote areas. Although urban centres are home to 54 per cent of the global population and are, appropriately, a major focus of infrastructure improvement and protection, the importance of Internet connectivity for rural and physically isolated areas should not be overlooked.

In expanding access to the Internet, there needs to be a careful counterpoising between reach, performance and cost. As Internet connectivity increases and a variety of actors endeavour to expand global Internet accessibility, the underlying ICT infrastructure remains somewhat brittle in key technological areas.[17] The cost of expanding fixed infrastructure to remote and isolated areas is often prohibitively expensive. Mobile broadband can contribute to covering the gap, and satellite broadband (Boxes 5.9 and 5.10) is the technology most commonly employed in making broadband access universal. Taking account of the progress made in satellite technology, some of the past restrictions on the use of satellite connectivity for IoT deployments have disappeared, although cost and performance requirements still need to be carefully considered in each specific IoT implementation. Mobile infrastructure provides an intermediate solution between the cost and capacity of fixed broadband and those of satellite-broadband networks. However, mobile networks ultimately depend on good fixed connectivity in the backhaul and backbone of the network if the capacity requirements increase. In an IoT scenario, more capacity will be required either because there are more IoT applications running concurrently on the network or because the IoT applications are upgraded and become more bandwidth-hungry.

Box 5.8: Second generation (2G) networks and IoT

The number of M2M subscriptions in developing countries overtook those in developed countries by the end of 2013 according to GSMA Intelligence (GSMA, 2014c). Mobile wireless communication platforms can support data collection and transmission through a variety of applications, such as EpiCollect, Magpi and ODKCollect, which can in turn be implemented for many process-automation and remote-sensing functions (Baumüller, 2013). Indeed, even technology as basic as second-generation (2G) wireless networks may be able to serve as gateways into IoT functionality (Zhu, 2010). In rural communities with limited access to either fixed or wireless broadband, finding inventive ways to leverage the advantages of networked sensors is especially valuable (Sivabalan, 2013). By way of example, GPS-equipped mobile devices affixed to livestock are assisting with tracking stolen cattle in Kenya, while data from weather stations trigger micro-insurance pay-outs by mobile phone in the event of extreme weather and herd loss (Baumüller, 2013). In addition, organizations like the Syngenta Foundation have been working to develop applications that leverage mobile wireless M2M to increase efficiency in agricultural processes and track the supply of agricultural products (Brugger, 2011).

Box 5.9: Geosynchronous satellites

Communication satellites and weather satellites often utilize geostationary orbits (GEOs). In this scenario, a satellite orbits the Earth along a circular path 36 000 km above the Earth's equator at 0° latitude, following the direction of the Earth's rotation and proceeding at the same speed as the planet is turning, thereby enabling the satellite to stay in place over a single location. Owing to the constant 0° latitude and the nature of geostationary orbits, the location of satellites in GEO differs by longitude only. Compared to ground-based communications, all GEO satellite communications experience higher latency due to the signal having to actually travel the 36 000 km to the GEO satellite and back to Earth again. This delay can be significant (about 250 milliseconds to travel to the satellite and back to the ground) even though the signal is traveling at the speed of light (about 300 000 km per second). This latency may be somewhat mitigated for Internet communications with TCP features that shorten the round trip time (RTT) per packet by splitting the feedback loop between the sender and the receiver.

Box 5.10:Low Earth orbit (LEO) and medium Earth orbit (MEO) satellites

A low Earth orbit (LEO) is an orbit around the Earth at an altitude of between 150 and 2 000 km A medium Earth orbit (MEO), also known as an intermediate circular orbit (ICO), is an orbit around the Earth at an altitude of between 2 000 and 36 000 km. These lower orbits (as compared to geostationary orbits) may cause LEO satellites to be visible from Earth for only an hour or less before they go over the horizon and out of range. Unlike GEO satellites, LEO satellites do not appear at a fixed position in the sky. In order for the ground-based antennas that communicate with these satellites to be as simple as possible, a constellation of LEO satellites is required, with relaying and passing-off of information from one satellite to another so as to hand over the fixed-position terrestrial signal.

Apart from the underlying infrastructure, the success of IoT also depends on the resilience and safety of the network, services and applications. Despite the positive benefits and attributes, it is necessary to be aware both of the technological efforts needed to mitigate against cyber vulnerabilities plaguing the aforementioned sensor networks, and of malicious acts by people, including acts of vandalism, sabotage or even terrorism. These can have significant negative impacts on the development and reliability of IoT applications. Something as simple as a vandalized traffic signal can cause very serious hazards to traffic flow as well as to pedestrians. Other simple acts of vandalism (e.g. destroying a fire hydrant), while not directly life-threatening, can be significantly wasteful of all the efforts that went into sourcing, treating and managing the water supply to improve the availability of potable water. It is easy to see that some elements of the current infrastructure that might have been considered non-critical are in fact critical nodes in a highly connected world.

5.4 Conclusions and recommendations

Several ICT developments are accelerating the progress of IoT: low-cost and low-power sensor technology, growth in high-speed and high-quality infrastructure, near ubiquitous wireless connectivity, an increase in the number of devices with embedded communication capabilities, large amounts of available and affordable (predominantly cloud-based) storage space and computing power, and a plethora of Internet addresses from the advent of the IPv6 protocol.[18] The high expectations that IoT is generating in many sectors – e.g. education, healthcare, agriculture, transportation, utilities and manufacturing – are encouraging more stakeholders to enter the market, thus contributing to its expansion.

Because it is cross-cutting, IoT can significantly contribute to the achievement of development goals that go beyond the ICT sector, including those addressed by the new Sustainable Development Agenda. For instance, IoT is poised to become a building block of tomorrow's sustainable cities and communities, as well as a key element in future climate action, clean water sanitation systems and the renewable energy value chains. This chapter has presented a number of concrete examples of how innovative IoT services and applications are already being used to deliver better healthcare services, address key challenges of climate change and disaster management, and contribute to precision agriculture. IoT is also a key driver in the approach to make cities smarter and help governments deliver better basic services.

However, IoT opportunities are not equally distributed between and within countries, and in order to unlock the potential of IoT as a development enabler, several challenges remain to be addressed, both within and outside the ICT sector.

IoT brings together and requires the cooperation of various stakeholders in the ICT sector: from consumer electronics manufacturers to telecommunication service providers and application developers. In addition, for IoT to fulfil the high expectations created, other stakeholders outside the ICT sector need to be engaged, including car manufacturers, utilities, home-appliance manufacturers, public administrations and many others. Bringing together all these stakeholders adds considerable complexity to the development of IoT, but it is a requirement to ensure interoperability, which is regarded as the key to unlocking as much as 40 to 60 per cent of IoT's potential value (McKinsey, 2015). This is a paramount challenge to be addressed in ITU and other forums.[19]

Most of the value derived from IoT comes from the generation, processing and analysis of new data and use of the insights extracted therefrom for specific decisions in each domain in which IoT can be applied. The value of IoT is therefore closely linked to the exploitation of big data, and thus the challenges in terms of data management are similar to those of other big data applications. In this regard, national statistical offices have an important role to play given their legal mandate to set the statistical standards, and they could for instance become standards bodies and big data clearing houses that promote analytical best practices and facilitate data sharing (ITU, 2014b). National telecommunication regulatory authorities have a complementary role to play, considering that most IoT data are transferred through telecommunication networks. Indeed, regulators could facilitate the establishment of mechanisms to protect privacy and foster competition and openness in data markets (ITU, 2014a). In this regard, public administrations could also contribute significantly by adopting open data policies for their IoT datasets.

Lastly, ICT infrastructure underpins the connectivity and data processing capacity required for IoT. Although wireless coverage is almost universal through satellite and mobile networks, the actual ICT connectivity required for unlocking the full potential of IoT may be more demanding. Indeed, some IoT applications may run with low-speed, low-capacity connectivity, but others will require high-capacity broadband connections. Even in a scenario with IoT applications requiring low capacity, the simultaneous use of numerous devices may make a high-capacity backhaul or backbone connection necessary. In addition, the processing of big data generated by IoT will require bandwidth. This applies even more in areas with limited IT infrastructure, where the storing and analytical capabilities will be in the cloud and rely on high-capacity transmissions. Fixed-broadband connectivity is the most suited to meet these requirements, along with sufficient international Internet bandwidth and backbone capacity. Data presented in Chapter 2 show that fixed-broadband uptake in the developing world remains very limited and that there is a scarcity of international connectivity in many developing countries. This holds particularly true for the least connected countries (LCCs) and suggests that LCCs do not have the necessary ICT infrastructure for IoT, despite being those countries that could benefit the most from its potential for development. This calls for additional policy and regulatory action to close the fixed ICT infrastructure gap in the developing world and avoid many developing countries being left behind in the IoT race.

Endnotes

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Annex 1. ICT Development Index (IDI) methodology

This annex outlines the methodology used to compute the IDI, and provides more details on various steps involved, such as the indicators included in the index and their definition, the imputation of missing data, the normalization procedure, the weights applied to the indicators and sub-indices, and the results of the sensitivity analysis.

1. Indicators included in the IDI

The selection of indicators was based on certain criteria, including relevance for the index objectives, data availability and the results of various statistical analyses such as the principal component analysis (PCA).[1] The following 11 indicators are included in the IDI (grouped by the three sub-indices: access, use and skills).

a) ICT infrastructure and access indicators

Indicators included in this group provide an indication of the available ICT infrastructure and individuals' access to basic ICTs. Data for all these indicators are collected by ITU.[2]

1. Fixed-telephone subscriptions per 100 inhabitants

Fixed-telephone subscriptions refers to the sum of active analogue fixed-telephone lines, voice-over-IP (VoIP) subscriptions, fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents and fixed public payphones. It includes all accesses over fixed infrastructure supporting voice telephony using copper wire, voice services using Internet Protocol (IP) delivered over fixed (wired)-broadband infrastructure (e.g. DSL, fibre optic), and voice services provided over coaxial-cable television networks (cable modem). It also includes fixed wireless local loop (WLL) connections, defined as services provided by licensed fixed-line telephone operators that provide last-mile access to the subscriber using radio technology, where the call is then routed over a fixed-line telephone network (not a mobile-cellular network). In the case of VoIP, it refers to subscriptions that offer the ability to place and receive calls at any time and do not require a computer. VoIP is also known as voice-over-broadband (VoB), and includes subscriptions through fixed-wireless, DSL, cable, fibre-optic and other fixed-broadband platforms that provide fixed telephony using IP.

2. Mobile-cellular telephone subscriptions per 100 inhabitants

Mobile-cellular telephone subscriptions refers to the number of subscriptions to a public mobile-telephone service providing access to the public switched telephone network (PSTN) using cellular technology. It includes both the number of postpaid subscriptions and the number of active prepaid accounts (i.e. that have been active during the past three months). It includes all mobile-cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services.

3. International Internet bandwidth (bit/s) per Internet user

International Internet bandwidth refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbit/s). Used international Internet bandwidth refers to the average traffic load of international fibre-optic cables and radio links for carrying Internet traffic. The average is calculated over the 12-month period of the reference year, and takes into consideration the traffic of all international Internet links. If the traffic is asymmetric, i.e. if there is more incoming (downlink) than outgoing (uplink) traffic, the average incoming (downlink) traffic load is used. The combined average traffic load of different international Internet links can be reported as the sum of the average traffic loads of the individual links. *International Internet bandwidth (bit/s) per Internet user* is calculated by converting to bits per second and dividing by the total number of Internet users.

4. Percentage of households with a computer

Computer refers to a desktop computer, laptop (portable) computer, tablet or similar handheld computer. It does not include equipment with some embedded computing abilities, such as smart TV sets, or devices with telephony as a main function, such as mobile phones or smartphones.

Household with a computer means that the computer is available for use by all members of the household at any time. The computer may or may not be owned by the household, but should be considered a household asset.[3]

Data are obtained by countries through national household surveys and are either provided directly to ITU by national statistical offices (NSO) or obtained by ITU through its own research, for example from NSO websites. There are certain data limits to this indicator, insofar as estimates have to be calculated for many developing countries which do not yet collect ICT household statistics. Over time, as more data become available, the quality of the indicator will improve.

5. Percentage of households with Internet access

The *Internet* is a worldwide public computer network. It provides access to a number of communication services, including the World Wide Web, and carries e-mail, news, entertainment and data files, irrespective of the device used (not assumed to be only a computer; it may also be a mobile telephone, tablet, PDA, games machine, digital TV, and so on). Access can be via a fixed or mobile network. *Household with Internet access* means that the Internet is available for use by all members of the household at any time.[4]

Data are obtained by countries through national household surveys and are either provided directly to ITU by national statistical offices (NSOs) or obtained by ITU through its own research, for example from NSO websites. There are certain data limits to this indicator, insofar as estimates have to be calculated for many developing countries which do not yet collect ICT household statistics. Over time, as more data become available, the quality of the indicator will improve.

b) ICT use indicators

The indicators included in this group capture ICT intensity and usage. Data for all these indicators are collected by ITU.[5]

1. Percentage of individuals using the Internet

Individuals using the Internet refers to people who used the Internet from any location and for any purpose, irrespective of the device and network used in the last three months. It can be via a computer (i.e. desktop computer, laptop computer, tablet or similar handheld computer), mobile phone, games machine, digital TV, etc. Access can be via a fixed or mobile network.

Data are obtained by countries through national household surveys and are either provided directly to ITU by national statistical offices (NSOs), or obtained by ITU through its own research, for example from NSO websites. There are certain data limits to this indicator, insofar as estimates have to be calculated for many developing countries which do not yet collect ICT household statistics. Over time, as more data become available, the quality of the indicator will improve.

2. Fixed-broadband subscriptions per 100 inhabitants

Fixed-broadband subscriptions refers to fixed subscriptions for high-speed access to the public Internet (a TCP/IP connection), at downstream speeds equal to or greater than 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. This total is measured irrespective of the method of payment. It excludes subscriptions that have access to data communications (including the Internet) via mobile-cellular networks. It includes fixed WiMAX and any other fixed wireless technologies, and both residential subscriptions and subscriptions for organizations.

3. Active mobile-broadband subscriptions per 100 inhabitants

Active mobile-broadband subscriptions refers to the sum of standard mobile-broadband subscriptions and dedicated mobile-broadband subscriptions. The subscriptions can be used through handset-based or computer-based (USB/dongles) devices. It covers actual subscribers, not potential subscribers, even though the latter may have broadband-enabled handsets.

- *Standard mobile-broadband subscriptions* refers to active mobile-cellular subscriptions with advertised data speeds of 256 kbit/s or greater that allow access to the greater Internet via HTTP and which have been used to set up an Internet data connection using Internet Protocol (IP) in the past three months. Standard SMS and MMS messaging do not count as active Internet data connection, even if messages are delivered via IP.

- *Dedicated mobile-broadband data subscriptions* refers to subscriptions to dedicated data services (over a mobile network) that allow access to the greater Internet and are purchased separately from voice services, either as a stand-alone service (e.g. using a data card such as a USB modem/dongle) or as an add-on data package to voice services which requires an additional subscription. All dedicated mobile-broadband subscriptions with recurring subscription fees are included regardless of actual use. Prepaid mobile-broadband plans require use of the monthly data allowance where there is no monthly subscription. This indicator could also include mobile WiMAX subscriptions.

c) ICT skills indicators

Data on adult literacy rates and gross secondary and tertiary enrolment ratios are collected by the UNESCO Institute for Statistics (UIS).

1. Adult literacy rate

According to UIS, the *Adult literacy rate* is defined as “the percentage of population aged 15 years and over who can both read and write with understanding a short simple statement on his/her everyday life. Generally, ‘literacy’ also encompasses ‘numeracy’, the ability to make simple arithmetic calculations.” The main purpose of this indicator is “to show the accumulated achievement of primary education and literacy programmes in imparting basic literacy skills to the population, thereby enabling them to apply such skills in daily life and to continue learning and communicating using the written word. Literacy represents a potential for further intellectual growth and contribution to economic-socio-cultural development of society.”[6]

2. Gross enrolment ratio (secondary and tertiary level)

According to UIS, the *gross enrolment ratio* is “the total enrolment in a specific level of education, regardless of age, expressed as a percentage of the eligible official school-age population corresponding to the same level of education in a given school-year.”

2. Imputation of missing data

A critical step in the construction of the index is to create a complete data set, without missing values. A number of imputation techniques can be applied to estimate missing data. Each of the imputation techniques, like any other method employed in the process, has its own strengths and weaknesses. The most important consideration is to ensure that the imputed data will reflect a country’s actual level of ICT access, usage and skills.

Given that ICT access and usage are both correlated with national income, hot-deck imputation was chosen as the method for imputing the missing data where previous year data are not available to calculate growth rates. Hot-deck imputation uses data from countries with “similar” characteristics, such as GNI per capita and geographic location. For example, missing data for country A were estimated for a certain indicator by first identifying countries in the same region with similar levels of GNI per capita, and an indicator that has a known relationship to the indicator to be estimated. For instance, Internet use data for country A was estimated by using Internet use data for country B from the same region and with a similar GNI per capita and similar level of fixed Internet and wireless-broadband subscriptions. The same logic was applied to estimate missing data for all indicators included in the index.

3. Normalization of data

Normalization of data is necessary before any aggregation can be made in order to ensure that the data set uses the same unit of measurement.

As regards the indicators selected for the construction of the IDI, it is important to convert the values into the same unit of measurement, since some values are expressed as a percentage of the population/total households, whereby the maximum value is 100, while other indicators can have values exceeding 100, such as mobile-cellular and active mobile-broadband penetration or international Internet bandwidth (expressed as bit/s per user).

Certain particularities need to be taken into consideration in selecting the normalization method for the IDI. For example, in order to identify the digital divide, it is important to measure the *relative* performance of countries (i.e. the divide among countries). Secondly, the normalization procedure should produce index results that allow countries to track progress in their evolution towards an information society over time.

A further important criterion for selecting the normalization method was replicability by countries, as some countries have shown a strong interest in applying the index methodology at the national or regional level. Certain methods therefore cannot be applied, for example those that rely on the values of other countries, which might not be available to users.

For the IDI, the *distance to a reference measure* was used as the normalization method. The reference measure is the *ideal value* that could be reached for each variable (similar to a "goalpost"). For all the indicators chosen, this will be 100 except for the following four indicators:

- International Internet bandwidth per Internet user, which in 2014 ranged from 27 (bits/s/user) to almost 6 887 708. Values for this indicator vary significantly between countries. To diminish the effect of the huge dispersion of values, the data were first converted to a logarithmic (log) scale. Outliers were then identified using a cut-off value calculated by adding two standard deviations to the mean of the rescaled values, resulting in a log value of 5.98.

- Mobile-cellular subscriptions, which in 2014 ranged from 6.4 to 322.6 per 100 inhabitants. The reference value for mobile-cellular subscriptions was reviewed in the last edition of the index and was lowered to 120, a value derived by examining the distribution of countries based on their value for mobile-cellular subscriptions per 100 inhabitants in 2013. For countries where postpaid is the predominant mode of subscription, 120 is the maximum value attained, while in countries where prepaid is dominant (57 per cent of all countries included in the IDI have more than 80 per cent prepaid subscriptions) 120 is also the maximum value attained by a majority of countries. It was therefore concluded that 120 is the ideal value that a country could attain, irrespective of the predominant type of mobile subscription. Although the distribution of 2014 values may differ slightly from that of 2013 values, the ideal value of 120 was used to calculate this year's IDI, in the interests of consistency with the value used last year.

- Fixed-telephone subscriptions per 100 inhabitants, which ranged from zero to 133 in 2014. The reference value was calculated by adding two standard deviations to the mean, resulting in a rounded value of 60 per 100 inhabitants.

- Fixed-broadband subscriptions per 100 inhabitants. Values ranged from zero to 46.7 per 100 inhabitants in 2014. In line with fixed-telephone subscriptions, the ideal value was defined as 60 per 100 inhabitants.

After normalizing the data, the individual series were all rescaled to identical ranges, from 1 to 10. This was necessary in order to compare the values of the indicators and the sub-indices.

4. Weighting and aggregation

The indicators and sub-indices included in the IDI were weighted on the basis of the PCA results obtained when the index was first computed.[7] Annex Box 1.1 presents the weights for the indicators and sub-indices.

Annex Box 1.1: Weights used for indicators and sub-indices included in the IDI

	Weights (indicators)	Weights (sub-indices)
ICT access		0.40
Fixed-telephone subscriptions per 100 inhabitants	0.20	
Mobile-cellular telephone subscriptions per 100 inhabitants	0.20	
International Internet bandwidth per Internet user	0.20	
Percentage of households with a computer	0.20	
Percentage of households with Internet access	0.20	
ICT use		0.40
Percentage of individuals using the Internet	0.33	
Fixed-broadband Internet subscriptions per 100 inhabitants	0.33	
Active mobile-broadband subscriptions per 100 inhabitants	0.33	
ICT skills		0.20
Adult literacy rate	0.33	
Secondary gross enrolment ratio	0.33	
Tertiary gross enrolment ratio	0.33	

Source: ITU.

5. Calculating the IDI

Sub-indices were computed by summing the weighted values of the indicators included in the respective subgroup.

- *ICT access* is measured by fixed-telephone subscriptions per 100 inhabitants, mobile-cellular subscriptions per 100 inhabitants, international Internet bandwidth per Internet user, percentage of households with a computer and percentage of households with Internet access.
- *ICT use* is measured by percentage of individuals using the Internet, fixed-broadband Internet subscriptions per 100 inhabitants and active mobile-broadband subscriptions per 100 inhabitants.
- *ICT skills* are approximated by adult literacy rate, secondary gross enrolment ratio and tertiary gross enrolment ratio.

The values of the sub-indices were calculated first by normalizing the indicators included in each sub-index in order to obtain the same unit of measurement. The *reference values* applied in the normalization were discussed above. The sub-index value was calculated by taking the simple average (using equal weighting) of the normalized indicator values.

For computation of the final index, the ICT access and ICT use sub-indices were each given a 40 per cent weighting, and the skills sub-index (because it is based on proxy indicators) a 20 per cent weighting. The final index value was then computed by summing the weighted sub-indices. Annex Box 1.2 illustrates the process of computing the IDI for the Republic of Korea (which tops the IDI 2015).

6. Sensitivity analysis

Sensitivity analysis was carried out to investigate the robustness of the index results, in terms of the relative position in the overall ranking, using different combinations of methods and techniques to compute the index.

Potential sources of variation or uncertainty can be attributed to different processes employed in the computation of the index, including the selection of individual indicators, the imputation of missing values and the normalization, weighting and aggregation of the data.

Annex Box 1.2: Example of how to calculate the IDI value

	KOREA (REP.) Indicators			2014
	ICT access	**Ideal value***		
a	Fixed-telephone subscriptions per 100 inhabitants	60		59.5
b	Mobile-cellular telephone subscriptions per 100 inhabitants	120		115.5
c	International Internet bandwidth per Internet user**	962’216		43’358
d	Percentage of households with a computer	100		78.3
e	Percentage of households with Internet access	100		98.5
	ICT use			
f	Percentage of individuals using the Internet	100		87.9
g	Fixed-broadband Internet subscriptions per 100 inhabitants	60		38.8
h	Active mobile-broadband subscriptions per 100 inhabitants	100		108.6
	ICT skills			
i	Adult literary rate	100		99.0
j	Secondary gross enrolment ratio	100		97.2
k	Tertiary gross enrolment ratio	100		98.4
	Normalized values	**Formula**	**Weight**	
	ICT access			
z1	Fixed-telephone subscriptions per 100 inhabitants	a/60	0.20	0.99
z2	Mobile-cellular telephone subscriptions per 100 inhabitants	b/120	0.20	0.96
z3	International Internet bandwidth per Internet user	log(c)/5.98	0.20	0.79
z4	Percentage of households with a computer	d/100	0.20	0.78
z5	Percentage of households with Internet access	e/100	0.20	0.98
	ICT use			
z6	Percentage of individuals using the Internet	f/100	0.33	0.88
z7	Fixed-broadband Internet subscriptions per 100 inhabitants	g/60	0.33	0.65
z8	Active mobile-broadband subscriptions per 100 inhabitants	h/100	0.33	1.00
	ICT skills			
z9	Adult literary rate	i/100	0.33	0.99
z10	Secondary gross enrolment ratio	j/100	0.33	0.97
z11	Tertiary gross enrolment ratio	k/100	0.33	0.98
	Sub-indices	**Formula**	**Weight**	
	ICT access sub-index (L)	**y1+y2+y3+y4+y5**	**0.40**	**0.90**
y1	Fixed-telephone subsriptions per 100 inhabitants	z1*.20		0.20
y2	Mobile-cellular telephone subscriptions per 100 inhabitants	z2*.20		0.19
y3	International Internet bandwidth per Internet user	z3*.20		0.16
y4	Percentage of households with a computer	z4*.20		0.16
y5	Percentage of households with Internet access	z5*.20		0.20
	ICT use sub-index (M)	**y6+y7+y8**	**0.40**	**0.84**
y6	Percentage of individuals using the Internet	z6*.33		0.29
y7	Fixed-broadband Internet subscriptions per 100 inhabitants	z7*.33		0.22
y8	Active mobile-broadband subscriptions per 100 inhabitants	z8*.33		0.33
	ICT skills sub-index (N)	**y9+y10+y11**	**0.20**	**0.98**
y9	Adult literary rate	z9*.33		0.33
y10	Secondary gross enrolment ratio	z10*.33		0.32
y11	Tertiary gross enrolment ratio	z11*.33		0.33
IDI	**ICT Development Index**	**((L*.40)+(M*.40)+(N*.20))*10**		**8.93**

Note: *The ideal value for indicators a, b, c and g was computed by adding two standard deviations to the mean value of the indicator.
**To diminish the effect of the large number of outliers at the high end of the value scale, the data were first transformed to a logarithmic (log) scale. The ideal value of 962’216 bit/s per Internet user is equivalent to 5.98 if transformed to a log scale.
Source: ITU.

Each of the processes or combination of processes affects the IDI value. A number of tests were carried out to examine the robustness of the IDI results (rather than the actual values). The tests computed the possible index values and country rankings for different combinations of the processes mentioned above. Results show that, while the computed index values change, the message remains the same. The IDI was found to be extremely robust with regard to different methodologies, with the exception of certain countries including in particular those in the "high" group.

The relative position of countries included in the "high" group (see Chapter 2) can change depending on the methodology used. Caution should therefore be exercised in drawing conclusions based on these countries' rankings. However, the relative position of countries included in the "low" group is in no way affected by the methods or techniques used, and the countries in this group ranked low in all index computations using different methodologies. This confirms the results conveyed by the IDI.

Endnotes

[1] PCA was used to examine the underlying nature of the data. A more detailed description of the analysis is available in Annex 1 to ITU (2009).

[2] More information about the indicators is available in ITU (2011b) and the ITU (2014e).

[3] This definition reflects the revisions agreed by the ITU Expert Group on ICT Household Indicators (EGH) at its meeting in Sao Paulo, Brazil, 4-6 June 2013. See http://www.itu.int/en/ITU-D/Statistics/Documents/events/brazil2013/Final_report_EGH.pdf).

[4] See footnote 3.

[5] See footnote 2.

[6] UIS "Education Indicators: Technical Guidelines". See http://www.uis.unesco.org/ev.php?ID=5202_201&ID2=DO_TOPIC.

[7] For more details, see Annex 1 to ITU (2009).

Annex 2. JRC Statistical Assessment of the 2015 ICT Development Index[1]

Summary

Since 2009, the International Telecommunication Union (ITU) has been publishing its annual ICT Development Index (IDI), which benchmarks countries' performance with regard to ICT infrastructure, use and skills. The JRC analysis, conducted at ITU's invitation, suggests that the conceptualized three-level structure of the 2015 IDI is statistically sound in terms of coherence and balance, with the overall index as well as the three sub-indices – on ICT access, use and skills – being driven by all the underlying components. The IDI has a very high statistical reliability of 0.96 and captures the single latent phenomenon underlying the three main dimensions of the IDI conceptual framework.

Country rankings are also robust with respect to methodological changes in the data normalization method, weighting and aggregation rule (a shift of less than ± 3 positions with respect to the simulated median in 96 per cent of the 167 countries).

The added value of the IDI lies in its ability to summarize different aspects of ICT development in a more efficient and parsimonious manner than is possible with a selection of 11 indicators taken separately. In fact, for between 26 and 52 per cent of the 167 countries included this year, the IDI ranking and any of the three sub-index rankings (access, use and skills) differ by ten positions or more. This is a desired outcome because it evidences the added value of the IDI as a benchmarking tool, inasmuch as it helps to highlight aspects of ICT development that do not emerge directly by looking into ICT access, ICT use and ICT skills separately. At the same time, this result also points to the value of taking due account of the individual ICT dimensions and indicators on their own merit. In so doing, country-specific strengths and bottlenecks in ICT development can be identified and used as an input for evidence-based policy-making.

The IDI is intended for a broad audience of governments, UN agencies, financial institutions and private-sector analysts worldwide. Its aim is to identify strengths and weaknesses in each of the countries under review and encourage policy choices that will advance ICT development. In this respect, assessment of the conceptual and statistical coherence of the IDI and of the impact of modelling choices on a country's performance are fundamental. It adds to the transparency and reliability of the IDI and the building of confidence in the narratives supported by the measure. For this reason, the Econometrics and Applied Statistics Unit of the European Commission's Joint Research Centre (JRC) in Ispra, Italy, was invited by ITU to conduct a thorough statistical assessment of the IDI.[2]

Conceptual and statistical coherence in the IDI

In the seventh (2015) release of its IDI, ITU, a specialized agency of the United Nations, seeks, by means of a selected set of 11 indicators, to summarize complex and versatile concepts underlying ICT development across 167 countries worldwide. This raises practical challenges when it comes to combining these concepts into a single number per country. Indeed, extending what is argued for models in general, stringent transparency criteria must be adopted when composite indicators are used as a basis for policy assessment[3].

The analysis of the conceptual and statistical coherence of the IDI can be synthesized into five main steps:

1. Consideration of the IDI conceptual framework with respect to existing literature.

2. Data-quality checks, including possible reporting errors, missing data, outliers.

3. Assessment of statistical coherence through correlation-based analyses.

4. Assessment of the impact of the weighting scheme and aggregation method.

5. Qualitative confrontation with experts in order to get feedback on the choices made during development of the IDI.

The ITU team has already undertaken the first and last steps, relating for the most part to conceptual issues. The JRC assessment presented below focuses on the second, third and fourth steps, relating to the statistical soundness of the IDI framework and impact of key modelling assumptions on the country rankings. Statistical coherence is pursued by means of three statistical approaches: principal component analysis, reliability item analysis and variance-based analysis. The key modelling assumptions tested include alternative random weights and alternative aggregation formulas (arithmetic and geometric). The JRC analysis complements the IDI country rankings with confidence intervals, in order to better appreciate the robustness of these rankings to the index computation methodology. In addition, the analysis includes an assessment of potential redundancy of information in the IDI framework.

Data checks

The IDI framework builds on three dimensions, or sub-indices, which are aggregated over 11 selected indicators. A complete matrix of 11 indicators, referring to 2014 data for 167 countries, are included in the IDI. These data have been collected annually by ITU through a questionnaire sent to its Member States. Where country data are not available, ITU estimates the missing data using appropriate statistical techniques. The JRC analysis based on the values for skewness and kurtosis[4] suggests that only two indicators – international Internet bandwidth and fixed-broadband subscriptions – have outlier values that could bias the calculation of the aggregate scores and interpretation of the correlation structure. ITU has opted to take the logarithm of international Internet bandwidth and to cap fixed-broadband subscriptions at 60, which is considered to be an ideal value and equal to the maximum value achieved in many developed countries.

The main justification for capping indicators, regardless of whether they are affected by outliers, is the developers' objective to have an ideal value that could be achieved by most countries. For this reason, the ITU team decided to set this ideal value at two standard deviations away from the mean for most indicators.

Instead, the use of logarithmic transformation for international Internet bandwidth goes beyond the need to treat outlier values: it is also aimed at strongly favouring improvements at the lower end of the indicator and at allowing improvements at the higher end to add only a minimal benefit to a country's IDI ranking. The JRC analysis suggests that a further justification for the use of logarithmic transformation is that it increases the correlation of the international Internet bandwidth indicator with the remaining indicators in the ICT access sub-index, whereby the average bivariate correlation of this indicator increases from 0.56 to 0.67 (see Annex Table 2.1).

Principal component analysis and reliability analysis

Principal component analysis (PCA) was used to assess whether the IDI conceptual framework is confirmed by statistical approaches, and to identify possible pitfalls. The expectation is that every aggregate in the IDI framework, whether sub-index or the overall IDI, captures most of the variance in the underlying components. This expectation is confirmed in the IDI framework. In fact, the first principal component captures between 78 per cent (ICT access) and 86 per cent (ICT use) of the total variance in the underlying indicators (Annex Table 2.2). The statistical reliability for each of the IDI sub-indices, measured by the Cronbach-alpha (or c-alpha) coefficient, is very high, at 0.86 (up to 0.91). These values are well above the 0.7 threshold for a reliable aggregate[5]. Particularly important to the reliability of the ICT skills sub-index is the secondary gross enrolment ratio: had this indicator been excluded, the reliability of the ICT skills sub-index would have fallen from 0.86 to 0.71 (see Annex Table 2.2).

Furthermore, the three ICT sub-indices share a single latent dimension that captures 92 per cent of the total variance, and their aggregate, the IDI, has a very high statistical reliability of 0.95. Finally, results confirm the expectation that the indicators

Annex Table 2.1: Impact of log transform of the international Internet bandwidth indicator

	Without log	With log
Fixed-telephone subscriptions per 100 inhabitants	0.68	0.65
Mobile-cellular telephone subscriptions per 100 inhabitants	0.29	0.54
Percentage of households with a computer	0.63	0.76
Percentage of households with Internet access at home	0.63	0.74
Average bivariate correlation	*0.56*	*0.67*

Note: Numbers represent the Pearson correlation coefficient (excluding outliers) between the *international Internet bandwidth per Internet user* indicator (with/without log transformation) and any of the four indicators in the ICT access dimension.
Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

Annex Table 2.2: Statistical coherence in the 2015 IDI – Principal components analysis and reliability analysis

ICT Development Index (& sub-indices)	Variance explained	c-alpha	c-alpha when excluding one component				
			#1	#2	#3	#4	#5
ICT Development Index (3 sub-indices)	91.7	0.95	0.89	0.92	0.97		
ICT access sub-index (5 indicators)	78.2	0.91	0.89	0.92	0.91	0.86	0.86
ICT use sub-index (3 indicators)	85.9	0.90	0.79	0.88	0.91		
ICT skills sub-index (3 indicators)	81.0	0.86	0.71	0.85	0.83		

Note: "Variance explained" shows the amount of total variance explained by the first principal component across the three ICT sub-indices, or the indicators in the case of the ICT sub-indices. c-alpha (or Cronbach-alpha) is a measure of statistical reliability (values greater than 0.7 are recommended for good reliability).
Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

are more correlated to their own ICT dimension than to any other and that all coefficients are greater than 0.75 (see Annex Table 2.3). This outcome suggests that the indicators have been allocated to the most relevant ICT dimension.

Thus far, the results show that the grouping of the eleven indicators into three ICT sub-indices and to an overall index is statistically coherent at each aggregation level.

Weights and importance

The statistical analysis in the previous sections was based on classical correlation coefficients. In this audit, the assessment is extended to a non-linear context, to anticipate potentially legitimate criticism about the nonlinearity of the associations between the IDI components. To this end, global sensitivity analysis has been employed in order to evaluate an indicator's contribution to the variance of the IDI dimensions and overall index scores.

The overarching consideration on the part of the ITU team was that the ICT sub-indices on access and use should have equal importance in the IDI and twice as much importance as the sub-index on ICT skills. The lower weight assigned to ICT skills is justified by the developers on the grounds that it is based on proxy variables. Hence, ICT access and ICT use are given weights of 0.4 each, and ICT skills a weight of 0.2. At the same time, within each ICT sub-index, all underlying indicators are given equal weights and considered to be of similar importance.

The tests reported on in this assessment focused on identifying whether the IDI 2015 is statistically well-balanced in its sub-indices, and in its indicators within each sub-index. There are several approaches for such testing, such as eliminating one indicator at a time and comparing the resulting ranking with the original ranking, or using a simple (e.g. Pearson or Spearman rank) correlation coefficient. A more appropriate measure, aptly named 'main effect' (henceforth S_i), also known as correlation ratio or first order sensitivity measure[6], has been applied here. The suitability of Pearson's correlation ratio as a measure of the importance of variables in an index is argued to be fourfold, inasmuch as (a) it offers

Annex Table 2.3: Statistical coherence in the 2015 IDI – Cross-correlations

Indicators	ICT access	ICT use	ICT skills
Fixed-telephone subscriptions per 100 inhabitants	0.877	0.819	0.765
Mobile-cellular telephone subscriptions per 100 inhabitants	0.722	0.607	0.608
International Internet bandwidth per Internet user (log)	0.865	0.789	0.758
Percentage of households with a computer	0.964	0.935	0.828
Percentage of households with Internet access at home	0.962	0.946	0.814
Percentage of individuals using the Internet	0.940	0.955	0.843
Fixed-broadband subscriptions per 100 inhabitants	0.885	0.904	0.775
Mobile-broadband subscriptions per 100 inhabitants	0.802	0.917	0.696
Secondary gross enrolment ratio	0.828	0.766	0.928
Tertiary gross enrolment ratio	0.771	0.778	0.899
Adult literacy rate	0.694	0.663	0.862

Note: Numbers are the classical Pearson correlation coefficients (n=167).
Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

a precise definition of importance that is 'the expected reduction in variance of the composite indicator that would be obtained if a variable could be fixed'; (b) it can be used regardless of the degree of correlation between variables; (c) it is model free, in that it can be applied also in non-linear aggregations; and (d) it is not invasive, in that no changes are made to the composite indicator or to the correlation structure of the indicators (as is the case when eliminating one indicator at a time).[7]

The results of this analysis appear in Annex Table 2.4. Examining the S_i's for the three ICT dimensions, we see that the IDI is perfectly balanced with respect to ICT access and ICT use (S_i = 0.96), while ICT skills is slightly less important (0.83). This suggests that the weighting scheme chosen by the development team has indeed led to the desired outcome whereby the two key ICT sub-indices – access and use – are of equal importance, and are more important than ICT skills.

At the sub-index level, the results are similarly reassuring: all indicators are important in classifying countries within each dimension, although some indicators are slightly more important than others. Within the ICT access sub-index, all five indicators are important, with S_i values greater than 0.5. However, the S_i for mobile-cellular telephone subscriptions is significantly smaller than that of the other indicators (0.54 as against 0.75-0.93), despite their equal weights within the ICT access.

The S_i values for households with a computer and households with Internet access at home are very high (0.93), suggesting a relative dominance of those two indicators in the variation of the ICT access scores. This can be explained by the undesirably high correlation (0.98) between these two indicators, which has persisted over the last five years, with a similar correlation having been found in 2010, 2012 and 2013. On statistical grounds, these indicators would need to be assigned half the weight of the other indicators in order to reduce their undue impact on the variation of ICT access scores and on the overall IDI. However, owing to the changing pattern of ICT household access (use of smartphones to access the Internet) and increase in the number of countries collecting the data from official surveys, it is possible that such a correlation may cease to exist over the coming years. The JRC recommendation for next year's release of the IDI is to reassess/revisit the weights assigned to these two indicators.

Within the ICT use sub-index, all three indicators are important, as reflected in their equal weights, although the indicator on individuals using the Internet is slightly more important than the other two, on fixed-broadband subscriptions and mobile-broadband subscriptions (0.91 as against 0.82-0.84). Similarly, within the ICT skills sub-index, all three indicators are important, with the

Annex Table 2.4: Importance measures (variance-based) for the IDI components

IDI sub-index	Importance (S_i) within the IDI	Weights
ICT access	0.96	0.40
ICT use	0.96	0.40
ICT skills	0.83	0.20
IDI indicators	**Importance (*Si*) within an IDI sub-index**	**Weights**
Fixed-telephone subscriptions per 100 inhabitants	0.78	0.20
Mobile-cellular telephone subscriptions per 100 inhabitants	0.54 (*)	0.20
International Internet bandwidth per Internet user (log)	0.76	0.20
Percentage of households with a computer	0.93 (*)	0.20
Percentage of households with Internet access at home	0.93 (*)	0.20
Percentage of individuals using the Internet	0.91	0.33
Fixed-broadband subscriptions per 100 inhabitants	0.82	0.33
Active mobile-broadband subscriptions per 100 inhabitants	0.84	0.33
Secondary gross enrolment ratio	0.86	0.33
Tertiary gross enrolment ratio	0.81	0.33
Adult literacy rate	0.75	0.33

Note: Numbers represent the kernel estimates of the Pearson correlation ratio, as in Paruolo et al., 2013. (*) Sub-factors that make a much lower/higher contribution to the variance of the relevant dimension scores than the equal weighting expectation are marked with an asterisk.
Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

adult literacy rate being slightly less important than the other two indicators, relating to the secondary and tertiary gross enrolment ratio (0.75 as against 0.81-0.86).

In short, the weights assigned by the developers to the IDI components coincide, in most cases, with the importance of the IDI components.

Added value of the IDI vis-à-vis the three ICT dimensions

A very high statistical reliability may be the result of redundancy of information in an index. The analysis discussed below reveals that this is not the case in the 2015 IDI. Instead, the high statistical reliability (c-alpha = 0.95) of the IDI is a sign of a statistically sound composite indicator that brings in additional information on the monitoring of ICT development in countries around the world. This is shown in Annex Table 2.5, which presents, for all pairwise comparisons between the IDI and the three sub-indices, the Spearman rank correlation coefficients (above the diagonal) and the percentage of countries that shift ten positions or more (below the diagonal). In fact, for between 26 and 52 per cent of the 167 countries included this year, the IDI ranking and any of the three sub-index rankings – on access, use and skills – differ by ten positions or more. This is a desired outcome because it evidences the added value of the IDI as a benchmarking tool, inasmuch as it helps to highlight aspects of ICT development that do not emerge directly by looking into ICT access, ICT use and ICT skills separately. At the same time, this result also points to the value of taking due account of the individual ICT dimensions and indicators on their own merit. In so doing, country-specific strengths and bottlenecks in ICT development can be identified and used as an input for evidence-based policy-making.

Impact of modelling assumptions on the IDI ranking

The IDI and its underlying sub-indices are the outcome of choices with respect to, among other things: the framework (driven by theoretical models and expert opinion), the indicators included, the normalization of the indicators, the weights assigned to the indicators and to the sub-indices, and the aggregation method. Some of these choices are based on expert opinion or on common practice, driven by statistical

Annex Table 2.5: Added value of the IDI vis-à-vis its main components

	IDI	ICT access	ICT use	ICT skills
IDI	-	0.984	0.984	0.903
ICT access	26%	-	0.953	0.857
ICT use	26%	50%	-	0.860
ICT skills	52%	62%	69%	-

Note: Numbers above the diagonal: Spearman rank correlation coefficients; numbers below the diagonal: percentage of countries (out of 167) that shift +10 positions or more between the rankings.
Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

analysis or the need for ease of communication. The aim of the uncertainty analysis is to assess the extent to which – and for which countries in particular – these choices might affect country classification. We have dealt with these uncertainties simultaneously in order to assess their joint influence and fully acknowledge their implications[8]. The data are considered to be error-free since the ITU team already undertook a double-check control of possible errors and corrected them during this phase.

The robustness assessment of the IDI was based on a combination of a Monte Carlo experiment and a multi-modelling approach. This type of assessment aims to respond to any criticism that the country scores associated with aggregate measures are generally not calculated under conditions of certainty, even though they are frequently presented as such[9]. The Monte Carlo simulation was played on the weights for the three sub-indices and comprised 1 000 runs, each corresponding to a different set of weights, randomly sampled from uniform continuous distributions in the range 15-25 per cent for the ICT skills sub-index, and 30-50 per cent for the ICT access and ICT use sub-indices. The sampled weights were then rescaled to unity sum (Annex Table 2.6). This choice of the range for the weights variation ensures a wide enough interval to have meaningful robustness checks (±25 per cent of the reference value and a roughly three-to-one ratio of the highest to the lowest weight). At the same time, it reflects the ITU team's rationale that the ICT skills sub-index should be given less weight than the ICT access and ICT use sub-indices.

The next type of uncertainty considered relates to use of the arithmetic average in the calculation of the index from the three ICT dimensions, a formula that received statistical support from principal component analysis and reliability item analysis. However, decision-theory practitioners have challenged the use of simple arithmetic averages because of their fully compensatory nature, in which a comparative high advantage on a few indicators can compensate a comparative disadvantage on many indicators[10]. In order to account for this criticism, the geometric average was considered as an alternative. The geometric average is a partially compensatory approach that rewards countries with similar performance in the three ICT dimensions or motivates countries to improve in those ICT dimensions in which they perform poorly, and not just in *any* ICT dimension[11].

Combined with the 1 000 simulations per model to account for the uncertainty in the weights across

Annex Table 2.6: Uncertainty parameters (weights and aggregation function)

	Reference	Alternative
I. Uncertainty in the aggregation function at the sub-index level	Arithmetic average	Geometric average
II. Uncertainty intervals for the three sub-index weights	Reference value for the weight	Distribution for uncertainty analysis
ICT access	0.4	U[0.30, 0.50]
ICT use	0.4	U[0.30, 0.50]
ICT skills	0.2	U[0.15, 0.25]

Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

the sub-indices, we conducted a total of 2 000 simulations.

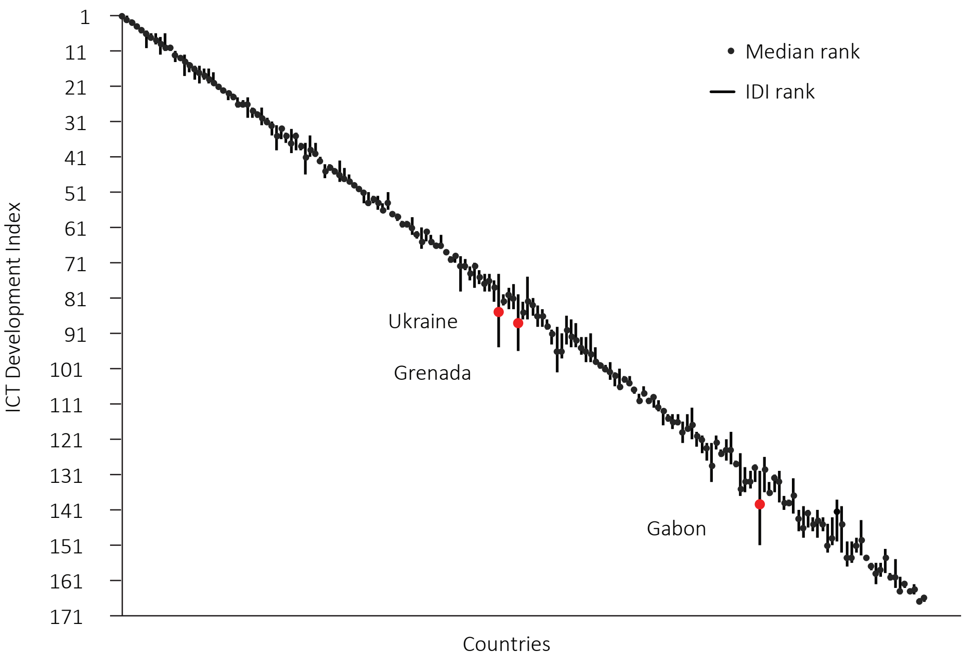
The results of the uncertainty analysis for the IDI are provided in Annex Figure 2.1, which shows median ranks and 90 per cent intervals computed across the 2 000 Monte Carlo simulations. Countries are ordered from the highest to the lowest levels of ICT development according to their reference rank in the IDI (black line), the dot being the simulated median rank. Error bars represent, for each country, the 90 per cent interval across all simulations.

Taking the simulated median rank as being representative of the simulations, then the fact that the IDI ranks are close to the median ranks suggests that the IDI ranking is a suitable summary measure of ICT development. Country ranks in the IDI are very close to the median rank: 90 per cent of the countries shift by less than ± 3 positions with respect to the simulated median. For the vast majority of countries, these modest shifts can be taken as an indication that country classification based on IDI depends mainly on the indicators used and not on the methodological judgments made during the weighting and aggregation phases.

Simulated intervals for most countries are narrow enough, hence robust to changes in the weights and aggregation formula – less than six positions in 75 per cent of the cases for the overall IDI. These results suggest that for the vast majority of the countries, the IDI ranks allow for meaningful inferences to be drawn.

Nevertheless, three countries have relatively wide intervals (more than 15 positions): Ukraine and Gabon (21 positions) and Grenada (16 positions). These relatively wide intervals are due to the compensation effect among the ICT sub-indices, which is evidenced by the use of the geometric average. These cases have been flagged herein as part of the uncertainty analysis, in order to bring more transparency to the entire process and to help appreciate the IDI results with respect to the choices made during the development phase. To this end, Annex Table 2.7 reports the index ranks together with the simulated intervals (90 per cent of the 2 000 scenarios simulating uncertainties in the weights and the aggregation formula for the three ICT dimensions).

Annex Figure 2.1: Uncertainty analysis of the IDI (ranks vs median rank, 90 per cent intervals)



Note: Countries are ordered from high to low levels of ICT development. Median ranks and intervals are calculated over 2 000 simulated scenarios combining random weights for the three ICT dimensions (25 per cent above/below the reference value), and geometric versus arithmetic average at the dimension level. Countries with wide intervals (more than 15 positions) are flagged.
Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

Annex Table 2.7: IDI country ranks and 90 per cent intervals

Countries	IDI rank	90% interval
Afghanistan	156	[156, 158]
Albania	94	[87, 95]
Algeria	113	[113, 117]
Andorra	28	[27, 30]
Angola	140	[132, 142]
Antigua & Barbuda	62	[62, 64]
Argentina	52	[51, 55]
Armenia	76	[74, 79]
Australia	13	[13, 13]
Austria	25	[24, 27]
Azerbaijan	67	[63, 67]
Bahrain	27	[24, 30]
Bangladesh	144	[143, 147]
Barbados	29	[28, 30]
Belarus	36	[33, 40]
Belgium	21	[21, 21]
Belize	116	[114, 117]
Benin	151	[150, 157]
Bhutan	119	[112, 121]
Bolivia	107	[107, 108]
Bosnia and Herzegovina	77	[74, 79]
Botswana	111	[109, 112]
Brazil	61	[58, 63]
Brunei Darussalam	71	[69, 79]
Bulgaria	50	[50, 50]
Burkina Faso	159	[152, 159]
Cambodia	130	[129, 136]
Cameroon	147	[145, 153]
Canada	23	[23, 25]
Cape Verde	96	[92, 97]
Chad	167	[166, 167]
Chile	55	[54, 56]
China	82	[77, 84]
Colombia	75	[73, 77]
Congo (Dem. Rep.)	160	[159, 161]
Congo (Rep.)	141	[141, 147]
Costa Rica	57	[57, 58]
Côte d'Ivoire	137	[130, 139]
Croatia	42	[41, 42]
Cuba	129	[125, 137]
Cyprus	53	[52, 54]
Czech Republic	34	[33, 36]
Denmark	2	[1, 3]
Djibouti	148	[143, 151]
Dominica	80	[80, 83]
Dominican Rep.	103	[102, 106]
Ecuador	90	[90, 94]
Egypt	100	[99, 101]
El Salvador	106	[103, 106]
Equatorial Guinea	146	[143, 147]
Eritrea	166	[166, 167]
Estonia	20	[17, 20]
Ethiopia	165	[162, 165]
Fiji	101	[100, 101]
Finland	12	[11, 14]
France	17	[15, 20]
Gabon	133	[130, 151]
Gambia	135	[133, 137]
Georgia	78	[76, 82]
Germany	14	[12, 18]
Ghana	109	[106, 109]
Greece	39	[37, 46]
Grenada	83	[80, 96]
Guatemala	121	[120, 125]
Guinea-Bissau	162	[160, 165]
Guyana	114	[114, 116]
Honduras	120	[119, 123]
Hong Kong, China	9	[7, 12]
Hungary	48	[46, 48]
Iceland	3	[2, 3]
India	131	[130, 135]
Indonesia	108	[108, 111]
Iran (I.R.)	91	[89, 102]
Ireland	22	[22, 22]
Israel	35	[34, 37]
Italy	38	[37, 39]
Jamaica	105	[103, 105]
Japan	11	[10, 11]
Jordan	92	[91, 98]
Kazakhstan	58	[57, 59]
Kenya	124	[120, 124]
Korea (Rep.)	1	[1, 2]
Kuwait	46	[42, 48]
Kyrgyzstan	97	[92, 99]
Lao P.D.R.	138	[137, 141]
Latvia	37	[34, 39]
Lebanon	56	[51, 56]
Lesotho	128	[127, 129]
Liberia	155	[154, 155]
Lithuania	40	[35, 41]
Luxembourg	6	[5, 10]
Macao, China	24	[23, 25]
Madagascar	164	[164, 164]
Malawi	163	[162, 163]
Malaysia	64	[62, 65]
Maldives	81	[78, 84]
Mali	145	[141, 149]
Malta	30	[27, 32]
Mauritania	150	[140, 153]
Mauritius	73	[72, 76]
Mexico	95	[88, 95]
Moldova	66	[66, 67]
Monaco	18	[16, 19]
Mongolia	84	[82, 87]
Montenegro	65	[63, 66]
Morocco	99	[95, 99]
Mozambique	158	[156, 160]
Myanmar	142	[140, 149]
Namibia	118	[114, 118]
Nepal	136	[131, 136]
Netherlands	8	[6, 9]
New Zealand	16	[15, 19]
Nicaragua	123	[122, 133]
Nigeria	134	[126, 136]
Norway	10	[6, 11]
Oman	54	[52, 56]
Pakistan	143	[141, 146]
Panama	89	[87, 90]
Paraguay	112	[110, 113]
Peru	104	[101, 107]
Philippines	98	[91, 99]
Poland	44	[43, 45]
Portugal	43	[43, 47]
Qatar	31	[30, 31]
Romania	59	[59, 61]
Russian Federation	45	[44, 46]
Rwanda	154	[144, 154]
Samoa	122	[122, 127]
Saudi Arabia	41	[37, 41]
Senegal	132	[128, 133]
Serbia	51	[51, 54]
Seychelles	87	[83, 89]
Singapore	19	[16, 20]
Slovakia	47	[44, 48]
Slovenia	33	[32, 39]
Solomon Islands	139	[138, 140]
South Africa	88	[84, 89]
South Sudan	161	[155, 163]
Spain	26	[25, 27]
Sri Lanka	115	[114, 118]
St. Kitts and Nevis	63	[61, 67]
St. Lucia	86	[81, 86]
St. Vincent and the Grenadines	68	[68, 68]
Sudan	126	[121, 127]
Suriname	85	[75, 87]
Sweden	5	[5, 6]
Switzerland	7	[6, 8]
Syria	117	[116, 122]
Tanzania	157	[156, 162]
TFYR Macedonia	60	[59, 61]
Thailand	74	[71, 78]
Togo	152	[150, 156]
Tonga	110	[110, 111]
Trinidad & Tobago	70	[69, 71]
Tunisia	93	[86, 94]
Turkey	69	[69, 71]
Uganda	149	[138, 150]
Ukraine	79	[74, 95]
United Arab Emirates	32	[31, 35]
United Kingdom	4	[4, 4]
United States	15	[14, 17]
Uruguay	49	[49, 49]
Vanuatu	125	[124, 126]
Venezuela	72	[70, 73]
Viet Nam	102	[99, 104]
Zambia	153	[149, 153]
Zimbabwe	127	[119, 128]

Note: Countries are presented in alphabetical order. 90 per cent intervals are calculated over 2 000 simulated scenarios combining random weights for the three ICT dimensions (25 per cent above/below the reference value), and geometric versus arithmetic average at the dimension level.
Source: Saisana and Domínguez-Torreiro, European Commission, Joint Research Centre; IDI 2015.

The choice of aggregation function at the sub-index level is the main driver of the variation in country ranks. Following best practices in the relevant literature and choosing the average absolute shift in rank as our robustness metric[12], we found that the aggregation function choice accounts for 95 per cent of the sample variance, while the dimensions' weights choice accounts for only 5 per cent. This result suggests that, should the methodological choices behind IDI 2015 stimulate further discussion, then this should focus more on the aggregation formula for the three ICT dimensions and much less on their weights.

As a general remark, the robustness of an index should not be interpreted as an indication of the index quality. It is instead a consequence of the index dimensionality. In other words, robustness is to some extent the flip side of redundancy: a very high correlation between variables will lead to an index ranking that is practically unaffected by the methodological choices, so the index will be both robust and redundant. Similarly, a low correlation among variables would imply that the methodological choices are very important in determining country rankings, and thus the index is unlikely to be robust to those choices.

The results herein have revealed that country classification based on the IDI depends mainly on the indicators used and not on the methodological judgments made, thus allowing for meaningful inferences to be drawn. In fact, 90 per cent of the countries shift by less than ± 3 positions with respect to the simulated median. At the same time, the IDI ranking has been found to have an added value as a benchmarking tool, highlighting aspects of ICT development that do not emerge directly by looking at the three underlying sub-indices. For between 26 and 52 per cent of the 167 countries included this year, the IDI ranking and any of the three sub-index rankings (access, use and skills) differ by ten positions or more. Consequently, the IDI 2015 is robust without being redundant.

Conclusions

ITU invited JRC to delve into the statistical properties of the 2015 IDI in order to assess the transparency and reliability of the results and enable academics and policy-makers to derive more accurate and meaningful conclusions. ITU's objective was to ensure that the IDI conforms to stringent transparency and replicability criteria and that the statistical priorities used in the IDI make it a credible and legitimate tool for improved policy-making.

The JRC analysis suggests that the conceptualized three-level structure of ITU's *2015 IDI* – calculated through 11 indicators related to ICT access, use and skills for 167 countries – is statistically sound, coherent and balanced. Indeed, within each ICT dimension a single latent factor is identified and all indicators are important in determining the variation of the respective dimension scores.

Country rankings in the overall IDI are also fairly robust to methodological changes in the data normalization method, weighting and aggregation rule (a shift of less than ± 3 positions in 96 per cent of the cases). Consequently, benchmarking inferences can be drawn for most countries in the IDI, while some caution may be needed for three countries. It is to be noted that perfect robustness would have been undesirable as this would have implied that the IDI components are perfectly correlated and hence redundant, which is not the case. In fact, one way in which the IDI 2015 helps to highlight other aspects of ICT development is by pinpointing the differences in rankings that emerge from a comparison between the IDI and each of the three dimensions, namely ICT access, ICT use and ICT skills. For between 26 and 52 per cent of the countries, the IDI ranking and any of the three sub-index rankings differ by ten positions or more.

The main refinement suggested by the present analysis relates to the highly correlated indicators within the ICT access sub-index – percentage of households with a computer and percentage of households with Internet access at home. On statistical grounds, these indicators would need to be assigned half the weight of the other indicators in order to reduce their undue impact on the variation of ICT access scores and on the overall IDI. However, owing to the changing pattern of ICT household access (use of smartphones to access the Internet) and the increase in the number of countries collecting the data from official surveys, it is possible that such correlation will cease to exist over the coming years. Accordingly, the methodology used for these indicators should be revisited/reassessed in future releases of the IDI.

The added value of IDI 2015 – developed using international quality standards and tested using state-of-the-art statistical analyses – lies in its ability to summarize different aspects of ICT development in a more efficient and parsimonious manner than is possible with a selection of 11 indicators taken separately. In fact, the IDI has a very high reliability of 0.95 and indeed captures the single latent phenomenon underlying the ICT access, ICT use and ICT skills sub-indices. In past reports, ITU did not include a detailed discussion of the statistical properties of the IDI. It is to be hoped that this year's initiative to provide a detailed statistical assessment of the IDI will reinforce media uptake of the IDI and ITU's engagement with civil society.

Endnotes

[1] This was prepared by Michaela Saisana and Marcos Dominguez-Torreiro, from European Commission, Joint Research Centre (JRC), Econometrics and Applied Statistics Unit, based in Italy.

[2] The JRC analysis was based on the recommendations of the OECD/EC JRC (2008) Handbook on Composite Indicators, and on more recent academic research from JRC. The JRC auditing studies of composite indicators are available at https://ec.europa.eu/jrc/en/coin.

[3] Saltelli and Funtowisz (2014).

[4] Skewness greater than 2 and kurtosis greater than 3.5; Groeneveld and Meeden (1984) set the criteria for absolute skewness above 1 and kurtosis above 3.5. The skewness criterion was relaxed to 'above 2' to account for the small sample (167 countries).

[5] Nunnally (1978).

[6] Saltelli *et al.* (2008).

[7] Paruolo *et al.* (2013).

[8] Saisana *et al.* (2005).

[9] Saisana *et al.* (2011).

[10] Munda (2008).

[11] In the geometric average, indicators are multiplied as opposed to summed in the arithmetic average. Indicator weights appear as exponents in the multiplication.

[12] Saisana *et al.* (2005).

Annex 3. ICT price data methodology

Price data collection and sources

The price data presented in this report were collected in the fourth quarter of 2014. The data were collected through the ITU *ICT Price Basket questionnaire*, which was sent to the administrations and statistical contacts of all 193 ITU Member States in October 2014. Through the questionnaire, contacts were requested to provide 2014 data for fixed-telephone, mobile-cellular, fixed-broadband and mobile-broadband prices; the 2012 and 2013 prices were included for reference, where available. For those countries that did not reply, prices were collected directly from operators' websites and/or through direct correspondence. Prices were collected from the operator with the largest market share, as measured by the number of subscriptions. Insofar as, for many countries, it is not clear which Internet service provider (ISP) has the dominant market share, preference was given to prices offered by the (former) incumbent telecommunication operator. In some cases, especially when prices were not clearly advertised or were described only in the local language, and when operators did not respond to queries, alternative operators were chosen. All prices were converted into USD using the IMF's average annual rate of exchange for 2014, and into PPP$ using World Bank conversion factors for 2013. Prices are also presented as a percentage of countries' monthly GNI per capita (p.c) using GNI p.c. values from the World Bank (Atlas method) for 2013 or the latest available year adjusted with the international inflation rates. Prices for 2008, 2009, 2010, 2011, 2012 and 2013, which are also shown and used in this chapter, were collected in previous years (always during the second half of the respective year), in national currencies, and converted using the average annual rates of exchange.

The ICT Price Basket

The ICT Price Basket (IPB) is a composite basket that includes three price sets, referred to as sub-baskets: the fixed-telephone, mobile-cellular and fixed-broadband sub-baskets. The IPB is the value calculated from the sum of the price of each sub-basket (in USD) as a percentage of a country's monthly GNI p.c., divided by three. The collection of price data from ITU Member States and the methodology applied for the IPB was agreed upon by the ITU Expert Group on Telecommunication/ICT Indicators (EGTI)[1] and endorsed by the eighth World Telecommunication/ICT Indicators meeting held in November 2010 in Geneva, Switzerland.

The fixed-telephone sub-basket

The fixed-telephone sub-basket refers to the monthly price charged for subscribing to the public switched telephone network (PSTN), plus the cost of 30 three-minute local calls to the same (fixed) network (15 peak and 15 off-peak calls). It is calculated as a percentage of a country's average monthly GNI p.c., and is also presented in USD and PPP$.

The fixed-telephone sub-basket does not take into consideration the one-time connection charge. This choice has been made in order to improve comparability with the other sub-baskets, which include only recurring monthly charges. If the monthly subscription includes free calls/minutes, then these are taken into consideration and deducted from the total cost of the fixed-telephone sub-basket.

The cost of a three-minute local call refers to the cost of a three-minute call within the same exchange area (local call) using the subscriber's equipment (i.e. not from a public telephone). It thus refers to the amount the subscriber must pay for a three-minute call and not the average price for each three-minute interval. For example, some operators charge a one-time connection fee for every call or a different price for the first minute of a call. In such cases, the actual amount for the first three minutes of a call is calculated. Many operators indicate whether advertised prices include taxes or not. If they are not included, taxes are added to the prices, so as to improve the comparability between countries.[2] The sub-basket does not take into consideration the price of a telephone set (see Annex Box 3.1).

The IPB includes a sub-basket for fixed telephony because fixed-telephone access remains an important access technology in its own right in a large number of countries. Additionally, the conventional fixed-telephone line is used not only for dial-up Internet access, but also as a basis for upgrading to DSL broadband technology, which in 2014 still accounted for the majority of all fixed-broadband subscriptions (although fibre connections are increasing rapidly in many markets). While more and more countries are moving away from narrowband/dial-up Internet

Annex Box 3.1: Rules applied in collecting fixed-telephone prices

1. The prices of the operator with the largest market share (measured by the number of fixed-telephone subscriptions) are used.
2. Prices are collected in the currency in which they are advertised, including taxes.
3. Only residential, single-user prices are collected. Where prices vary between different regions of the country, those applying to the largest city (in terms of population) are used. If that information is not available, prices applying to the capital city are reported.
4. From all fixed-telephone plans meeting the above criteria, the cheapest postpaid plan on the basis of 30 local calls (15 peak and 15 off-peak) of three minutes each is selected. If there is a price distinction between residential and business tariffs, the residential tariff is used.
5. In cases where operators propose different commitment periods, the 12-month plan (or the one closest to this commitment period) is used.
6. The same price plan is used for collecting all the data specified. For example, if Plan A is selected for the fixed-telephone service, according to the above criteria, the elements in Plan A apply to the monthly subscription and to the price per minute (peak and off-peak).
7. Prices are collected for a regular (non-promotional) plan and do not include promotional offers, limited or restricted discounts (for example, only to students, or to pre-existing customers, etc.), or plans where calls can only be made during a limited number of (or on specific) days during the month.
8. Local calls refer to those made on the same fixed network (on-net) within the same exchange area.
9. Peak is the busiest time of the day, normally corresponding to weekday working hours. If there are different peak prices, the most expensive one during the daytime will be selected.
10. Where there are different off-peak prices, the one that is cheapest before midnight is used. Where the cheapest daytime price is applied during the weekend, then this is used. If the only off-peak period is after midnight (valid during the night), then this is not used. Instead, the peak rate is used.
11. Where no distinction is made between peak and off-peak prices, then the same price is used for the peak and off-peak indicators.
12. For plans that include a certain number of minutes, the price advertised per additional minute is used to calculate the price of a three-minute local call (i.e. the price per minute is not calculated based on the number of minutes included in the monthly subscription).

Annex Box 3.1: Rules applied in collecting fixed-telephone prices (continued)

13. Where the price per minute is not available and charging is effected "per unit" of a certain number of minutes, the price per three minutes is calculated and a note indicating the unit price and number of minutes included in the unit is added. For example, if the price is given per unit of two minutes, then the price for three minutes will be two times the price per unit.

14. With convergence, operators are increasingly providing multiple (bundled) services, such as voice telephony, Internet access and television reception, over their networks. They often bundle these offers into a single subscription. This can present a challenge for data collection, since it may not be possible to isolate the prices for a given service. It is preferable to use prices for a specific service; but if this is not possible, then the additional services that are included in the price are specified in a note.

Source: ITU.

access to broadband, dial-up Internet access still remains the only Internet access available to some people in developing countries. Since the IPB does not include dial-up (but only broadband) Internet prices, and since dial-up Internet access requires users to subscribe to a fixed-telephone line, the fixed-telephone sub-basket can be considered as an indication for the price of dial-up Internet access.

The mobile-cellular sub-basket

The mobile-cellular sub-basket refers to the price of a standard basket of mobile monthly usage for 30 outgoing calls per month (on-net/off-net to a fixed line and for peak and off-peak times) in predetermined ratios, plus 100 SMS messages[3]. It is calculated as a percentage of a country's average monthly GNI p.c. and is also presented in USD and PPP$. The mobile-cellular sub-basket is based on prepaid prices, although postpaid prices are used for countries where prepaid subscriptions make up less than two per cent of all mobile-cellular subscriptions.

The mobile-cellular sub-basket is largely based on, but does not entirely follow, the 2009 methodology of the OECD low-user basket, which is the entry-level basket with the smallest number of calls included (OECD, 2010b). Unlike the 2009 OECD methodology, which is based on the prices of the two largest mobile operators, the ITU mobile sub-basket uses only the largest mobile operator's prices. Nor does the ITU mobile-cellular sub-basket take account of calls to voicemail (which in the OECD basket represent four per cent of all calls) or non-recurring charges, such as the one-time charge for a SIM card. The basket gives the price of a standard basket of mobile monthly usage in USD determined by OECD for 30 outgoing calls per month in predetermined ratios, plus 100 SMS messages.[4] The cost of national SMS is the charge to the consumer for sending a single SMS text message. Both on-net and off-net SMS prices are taken into account. The basket considers on-net and off-net calls as well as calls to a fixed telephone[5] and, since the price of a call often depends on the time of day or week it is made, peak, off-peak and weekend periods are also taken into consideration. The call distribution is outlined in Annex Table 3.1.

Prepaid prices were chosen because they are often the only payment method available to low-income users, who might not have a regular income and will thus not qualify for a postpaid subscription. Rather than reflecting the cheapest option available, the mobile-cellular sub-basket therefore corresponds to a basic, representative (low-usage) package available to all customers. In countries where no prepaid offers are available, the monthly fixed cost (minus the free minutes of calls included, if applicable) of a postpaid subscription is added to the basket. To make prices comparable, a number of rules are applied (see Annex Box 3.2).

Annex Table 3.1: OECD mobile-cellular low-user call distribution (2009 methodology):

	To fixed	On-net	Off-net	TOTAL	Call distribution by time of day (%)
Call distribution (%)	17.0	56.0	26.0	100.0	100.0
Calls	5.2	16.9	7.9	30.0	
Peak	2.4	7.8	3.6	13.8	46.0
Off-peak	1.5	4.9	2.3	8.7	29.0
Weekend	1.3	4.2	2.0	7.5	25.0
Duration (minutes per call)	2.0	1.6	1.7		
Duration (total minutes of calls)	10.4	27.0	13.4	50.9	N/A
Peak	4.8	12.4	6.2	23.4	46.0
Off-peak	3.0	7.8	3.9	14.8	29.0
Weekend	2.6	6.8	3.4	12.7	25.0
Calls	30 calls per month				
SMS	100 SMS per month (50 on-net, 50 off-net)				

Source: ITU, based on OECD (2010).

The fixed-broadband sub-basket

The fixed-broadband sub-basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. It is calculated as a percentage of a country's average monthly GNI p.c., and is also presented in USD and PPP$. For comparability reasons, the fixed-broadband sub-basket is based on a monthly data usage of (a minimum of) 1 GB. For plans that limit the monthly amount of data transferred by including data volume caps below 1 GB, the cost for the additional bytes is added to the sub-basket. The minimum speed of a broadband connection is 256 kbit/s.

Where several offers are available, preference is given to the cheapest available connection that offers a speed of at least 256 kbit/s and 1 GB of data volume. Where providers set a limit of less than 1 GB on the amount of data that can be transferred within a month, then the price per additional byte is added to the monthly price in order to calculate the cost of 1 GB of data per month. Preference is given to the most widely used fixed (wired)-broadband technology (DSL, fibre, cable, etc.). The sub-basket does not include the installation charges, modem prices or telephone-line rentals that are often required for a DSL service. The price represents the broadband entry plan in terms of the minimum speed of 256 kbit/s, but does not take into account special offers that are limited in time or to specific geographic areas. The plan does not necessarily represent the fastest or most cost-effective connection since the price for a higher-speed plan is often cheaper in relative terms (i.e. in terms of the price per Mbit/s) (see Annex Box3.3).

Mobile-broadband prices

In 2012, for the first time, ITU collected mobile-broadband prices through its annual ICT Price Basket Questionnaire.[6] The collection of mobile-broadband price data from ITU Member States was agreed upon by EGTI[7] in 2012, and revised by it in 2013 in light of the lessons learned from the first data collection exercise. The revised methodology was endorsed by the eleventh World Telecommunication/ICT Indicators Symposium held in December 2013 in Mexico City, and was applied in the 2014 data collection.

To capture the price of different data packages, covering prepaid and postpaid services, and supported by different devices (handset and computer), mobile-broadband prices were collected for two different data thresholds, based on a set of rules (see Annex Box 3.4).

For plans that were limited in terms of validity (less than 30 days), the price of the additional days was calculated and added to the base package in order to obtain the final price. Two possibilities exist, depending on the operator, for extending a plan that is limited in terms of data allowance (or validity). The customer either (i) continues to use the service and pays an excess usage charge for additional data,[8] or (ii) purchases an additional (add-on) package. Thus, for some countries,

Annex Box 3.2: Rules applied in collecting mobile-cellular prices

1. The prices of the operator with the largest market share (measured by the number of subscriptions) are used. Where prices vary between different regions of the country, prices refer to those applied in the largest city (in terms of population) or in the capital city.

2. Prices are collected in the currency in which they are advertised, including taxes.

3. Prices refer to prepaid plans. Where the operator offers different packages with a certain number of calls and/or SMS messages included, the cheapest one on the basis of 30 calls and 100 SMS is selected. In countries where prepaid subscriptions account for less than two per cent of the total subscription base, postpaid prices can be used. In this case, the monthly subscription fee, plus any free minutes, will be taken into consideration for the calculation of the mobile-cellular sub-basket.

4. Where per-minute prices are advertised only in internal units rather than in national currency, the price of the top-up/refill charge is used to convert internal units into national currency. Where there are different refill prices, then the “cheapest/smallest” refill card is used. Where different refill charges exist depending on the validity period, the validity period for 30 days (or closest to 30 days) is used.

5. Prices refer to a regular (non-promotional) plan and exclude special or promotional offers, limited discounts or options such as special prices to certain numbers, or plans where calls can be made only during a limited number of (or on specific) days during the month.

6. Where subscribers can choose “favourite” numbers (for family, friends, etc.) with a special price, this special price will not be taken into consideration, irrespective of the quantity of numbers involved.

7. Prices refer to outgoing local calls. Where different rates apply for local and national calls, the local rate is used. Where charges apply to incoming calls, these are not taken into consideration.

8. Where prices vary between minutes (first minute = price A, second minute = price B, third minute = price C), the sum of the different prices is divided by the number of different prices (for example: price per minute = (A+B+C)/3).

9. Where prices vary beyond three minutes, the average price per minute is calculated based on the first three minutes.

10. Where there is a connection cost per call, this is taken into consideration in the formula for the mobile-cellular sub-basket, based on 30 calls.

11. Where there are different off-peak prices, the one that is the cheapest before midnight is used. If the only off-peak period is after midnight, then this is not used. Instead, the peak price is used.

12. Where there are different peak prices, the most expensive one during the daytime is used.

Annex Box 3.2: Rules applied in collecting mobile-cellular prices (continued)

13. Where there are different weekend prices, the price that applies on Sundays during the daytime is used (or the equivalent day in countries where weekends are not on Sundays). Where peak and off-peak SMS prices exist, the average of both is used for on-net and off-net SMS.

14. Where there is no weekend price, the average peak and off-peak price that is valid during the week is used.

15. Where calls are charged for by call or by the hour (and not by the minute), the mobile-cellular sub-basket formula is calculated on the basis of 30 calls or 50.9 minutes. Similarly, where calls are charged by call or by number of minutes for a specific network/time of the day, this is taken into account for that particular network/time of the day.

16. Where monthly, recurring charges exist, they are added to the sub-basket.

Source: ITU.

Annex Box 3.3: Rules applied in collecting fixed-broadband Internet prices

1. The prices of the operator with the largest market share (measured by the number of fixed-broadband subscriptions) are used.

2. Prices are collected in the currency in which they are advertised, including taxes.

3. Only residential, single-user prices are collected. Where prices vary between different regions of the country, those applying to the largest city (in terms of population) are used. If that information is not available, prices applying to the capital city are reported.

4. From all fixed-broadband plans meeting the above criteria, the cheapest one on the basis of a 1 GB monthly usage and an advertised download speed of at least 256 kbit/s is selected. Where there is a price distinction between residential and business tariffs, the residential tariff is used.

5. Where the plan selected has no limit for the monthly data usage, the cap is "unlimited".

6. In cases where operators propose different commitment periods, the 12-month plan (or the one closest to this commitment period) is used. Where the plan selected requires a longer commitment (i.e. over 12 months), it is indicated in a note relating to the monthly subscription. Furthermore, where there are different prices (for example, a discounted price for the first year, and a higher price as from the 13th month), the price after the discount period is selected (e.g. the price as from the 13th month). The discounted price charged during the initial period is indicated in a note relating to the monthly subscription charge. The reason for this is that the initial price paid is considered a limited/discounted price, while the other one is the regular price.

7. Prices are collected for the fixed-broadband technology with the greatest number of subscriptions in the country (DSL, fibre, cable, etc.).

Annex Box 3.3: Rules applied in collecting fixed-broadband Internet prices (continued)

8. The same price plans are used for collecting all the data specified. For example, if Plan A is selected for the fixed-broadband service, according to the above criteria, the elements in Plan A apply to the monthly subscription, price of the excess charge, volume of data that can be downloaded, etc.

9. Prices are collected for regular (non-promotional) plans and do not include promotional offers or limited or restricted discounts (for example, only to students, or to pre-existing customers, etc.).

10. With convergence, operators are increasingly providing multiple (bundled) services such as voice telephony, Internet access and television reception over their networks. They often bundle these offers into a single subscription. This can present a challenge for price-data collection, since it may not be possible to isolate the prices for a given service. Prices for a specific service (i.e. unbundled) are used; if this is not possible, then the additional services that are included in the price plan are specified in a note.

11. The cost of a fixed-telephone line is excluded if it can also be used for other services.

Source: ITU.

Annex Box 3.4: Rules applied in collecting mobile-broadband prices[9]

1. Prices are collected based on mobile-broadband technologies, including UMTS, HSDPA+/HSDPA, LTE, CDMA2000 and IEEE 802.16e, excluding plans that provide access only to GPRS and EDGE networks. Prices applying to WiFi or hotspots are excluded.

2. Prices are collected in the currency in which they are advertised, including taxes.

3. Only residential, single-user prices are collected. Where prices vary between different regions of the country, those applying to the largest city (in terms of population) or to the capital city are used.

4. Prices are collected for both a) handset-based mobile-broadband subscriptions, and b) computer-based mobile-broadband subscriptions.

5. Mobile-broadband prices are collected from the operator with the largest market share, measured by the number of mobile-broadband subscriptions. Where this information is not available, mobile-broadband prices are collected from the mobile-cellular operator with the largest market share (measured by the number of mobile-cellular subscriptions) in the country.

6. Different operators may be chosen for different mobile-broadband services where: a) there are differing market leaders for specific segments (postpaid, prepaid, computer-based, handset-based); b) there is no offer available for a specific sub-basket .

7. Prices are collected for prepaid and postpaid services, for both handset and computer-based plans.

Annex Box 3.4: Rules applied in collecting mobile-broadband prices (continued)

8. Where operators propose different commitment periods for postpaid mobile-broadband plans, the 12-month plan (or the closest to this commitment period) is used.

9. Price data are collected for the cheapest plan, with a data volume allowance of at least:

10. 1 GB for the USB/dongle (computer-based) subscription

11. 500 MB for the handset-based subscription

12. The selected plan is not necessarily the one with the cap closest to 500 MB or 1 GB, but the one that is cheapest while including a minimum of 500 MB/1 GB. This means, for example, that if an operator offers a 300 MB and an 800 MB plan, the 800 MB plan or twice the 300 MB plan (if the package can be purchased twice for a monthly capacity of 600 MB) is selected for the 500 MB sub-sub-basket. The cheapest option is selected.

13. Data volumes refer to both upload and download data volumes. Plans with prices linked to "hours of use" and not to data volumes are not considered.

14. The validity period considered for the basket is 30 days or four weeks. If a plan with a validity of 15 days is selected, it will be taken twice to cover the whole period. Likewise, if a plan with a validity of one day or one week is selected, it will be taken as many times as necessary to cover a period of four weeks. The cheapest plan on the basis of a validity period of 30 days (or four weeks) is selected.

15. Preference is given to packages (including a certain data volume). Pay-as-you-go offers are used when they are the cheapest option for a given basket or the only option available. Where operators charge different pay-as-you-go rates depending on the time of the day (peak/off-peak), then the average of both is recorded. Where the off-peak rate is after midnight, it is not taken into account.

16. Even if the plan is advertised as "unlimited", the fine print often specifies that there are limits in the data volumes, applied either by throttling (limiting the speed) or by cutting the service.

17. Non-recurrent fees, such as installation/set-up fees are not included.

18. Preference is given to the cheapest available package even if it is bundled with other services (e.g. voice services). If the plan chosen includes other services besides mobile-broadband access, these are specified in a note.

19. Prices refer to a regular (non-promotional) plan and exclude promotional offers and limited discounts or special user groups (for example, pre-existing clients). Special prices that apply to a certain type of device (iPhone/Blackberry, iPad) are excluded. Allowances during the night are not included.

Source: ITU.

prices presented in this chapter reflect calculated prices of the base package plus an excess usage charge (e.g. a base package including 400 MB plus the price for 100 MB of excess usage for a monthly usage of 500 MB), or a multiplication of the base package price (e.g. twice the price of a 250 MB plan for a monthly usage of 500 MB).

The plans selected represent the least expensive offers that include the minimum amount of data for each respective mobile-broadband plan. The guiding idea is to base each plan on what customers would and could purchase given the data allowance and validity of each respective plan.

Endnotes

1 EGTI was created in May 2009 with the mandate to revise the list of ITU supply-side indicators (i.e. data collected from operators), as well as to discuss outstanding methodological issues and new indicators. It is open to all ITU members and experts in the field of ICT statistics and data collection. EGTI works through an online discussion forum (http://www.itu.int/ITU-D/ict/ExpertGroup/default.asp) and face-to-face meetings, and reports to the World Telecommunication/ICT Indicators Symposium (WTIS).

2 In some cases, it is not clear whether taxes are included or not and it was not possible to obtain this information from country contacts or operators; in such cases, the advertised price is used.

3 On-net refers to a call made to the same mobile network, while off-net and fixed-line refer to calls made to other (competing) mobile networks and to a fixed-telephone line, respectively.

4 See OECD (2010).

5 On-net refers to a call made to the same mobile network, while off-net and fixed-line refer to calls made to other (competing) mobile networks and to a fixed-telephone line, respectively.

6 Data for fixed-telephone, mobile-cellular and fixed-broadband have been collected since 2008 through the ITU ICT Price Basket Questionnaire, which is sent out annually to all ITU Member States/national statistical contacts.

7 EGTI was created in May 2009 with the mandate to revise the list of ITU supply-side indicators (i.e. data collected from operators), as well as to discuss outstanding methodological issues and new indicators. EGTI is open to all ITU members and experts in the field of ICT statistics and data collection. It works through an online discussion forum (http://www.itu.int/ITU-D/ict/ExpertGroup/default.asp) and face-to-face meetings. EGTI reports to the World Telecommunication/ICT Indicators Symposium (WTIS).

8 Some operators throttle speeds after the data allowance included in the base package has been reached. Customers can then pay an excess usage charge in order to continue to have full-speed connections. In some cases, even throttled speeds are still considered broadband (i.e. equal to or greater than 256 kbit/s, according to ITU's definition).

9 These rules were presented to EGTI in September 2012. In the 2013 revision, EGTI agreed that ITU should collect prepaid and postpaid prices, for both handset- and computer-based services, with the following volume allowances: 1 GB for computer-based and 500 MB for handset-based usage. The EGTI proposals to measure mobile-broadband prices were endorsed by the eleventh World Telecommunication/ICT Indicators Symposium held in December 2013 in Mexico City.

Annex 4. Statistical tables of indicators used to compute the IDI

Access indicators

	Economy	Fixed-telephone subscriptions per 100 inhabitants		Mobile-cellular subscriptions per 100 inhabitants		International Internet bandwidth Bit/s per Internet user		Percentage of households with computer		Percentage of households with Internet	
		2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
1	Afghanistan	0.1	0.3	*45.8*	74.9 [1]	*1’761*	6’942	*1.9*	*2.7*	*1.5*	*2.3*
2	Albania	10.6	7.8	*85.5*	105.5	11’992	*26’117*	15.6	*23.5*	*13.7*	*26.6*
3	Algeria	7.9	7.7 [1]	88.4	93.3 [2]	7’771	*12’460*	20.0	*28.2*	*10.0*	*25.9*
4	Andorra	49.0	47.7	84.1	82.6	36’447	78’057	83.2	*82.6*	67.2	*81.6*
5	Angola	*1.4*	1.3	*48.1*	63.5	*614*	*4’250*	*7.1*	*9.9*	*5.7*	*8.6*
6	Antigua & Barbuda	41.6	*35.6*	192.6	*120.0*	29’269	*120’321*	*48.9*	*56.1*	*40.0*	*52.0*
7	Argentina	24.6	22.6 [2]	141.4	158.7 [3]	*31’373*	*48’065*	47.0 [1]	*62.1*	*34.0*	*52.0*
8	Armenia	20.0	18.9	130.4	115.9	14’236	44’534	20.0	*51.5*	13.6	*46.6*
9	Australia	47.4 [1]	38.9 [3]	100.4	131.2	*41’110*	*75’069*	*81.1*	*85.6*	*74.1*	*86.9*
10	Austria	40.4 [2]	38.3 [4]	145.7	151.9	*39’584*	*79’636*	76.2	*83.7*	72.9	81.0
11	Azerbaijan	16.6 [3]	18.9	100.1	110.9	*9’083*	32’219	30.3	*51.7*	*37.4*	*54.6*
12	Bahrain	18.2	21.2	125.2	173.3	*14’528*	49’054	87.0 [2]	94.6	74.0 [1]	81.0
13	Bangladesh	0.8	0.7 [5]	44.9	75.9 [1]	1’431	5’925	3.0 [3]	*6.9*	1.4	*6.5*
14	Barbados	49.0	52.9	124.8	106.8	21’694	*113’985*	*61.4*	*70.0*	*55.3*	*70.5*
15	Belarus	43.6	48.5	108.9	122.5	22’199	142’536	40.8	59.9	31.2 [2]	57.1
16	Belgium	42.4	42.1	111.1 [1]	114.3	*109’676*	*263’915*	76.7	*83.8*	72.7	82.8
17	Belize	9.8 [4]	*6.7*	62.9 [2]	*50.7*	9’193	*41’829*	27.1 [1]	*31.0*	13.6 [3]	*21.0*
18	Benin	1.4	1.8	74.4	101.7	2’090	2’839	2.0	*4.8*	*1.2*	*3.5*
19	Bhutan	3.7	3.1	55.0 [3]	82.1	*1’590*	*2’546*	8.9	*21.9*	*6.0*	*26.3*
20	Bolivia	8.4	8.1	70.7	96.3	*3’728*	15’502	*22.8*	*34.9*	*6.0*	*17.0*
21	Bosnia and Herzegovina	26.0	22.2	80.9	91.3	18’612	*43’003*	*33.7*	*45.0*	*23.0*	*50.0*
22	Botswana	7.0 [5]	8.3	120.0	167.3	6’559	16’437	9.2	*14.8*	*6.1*	*12.1*
23	Brazil	21.6	21.8	100.9 [4]	139.0	*12’602*	*42’966*	34.9	*52.0*	27.1	*48.0*
24	Brunei Darussalam	19.9	11.4	108.6	110.1	*23’551*	*68’720*	*79.6*	*92.0*	*65.0*	*79.2*
25	Bulgaria	29.3	25.3 [2]	138.0	137.7 [4]	68’091	*138’277*	35.1	*57.9*	33.1	56.7
26	Burkina Faso	0.9	0.7	36.7	71.7	2’148	2’860	*2.1*	*4.6*	*2.0*	*8.3*
27	Cambodia	2.5 [6]	*2.8*	56.7	*155.1*	*27’625*	*9’374*	4.3	*10.6*	*1.6*	*7.0*
28	Cameroon	2.6	4.6	41.9	75.7	363	*1’796*	7.2	*9.6*	1.9	*6.5*
29	Canada	53.9 [7]	*46.6*	75.7	*83.0*	*54’738*	*129’244*	82.7	*87.6*	78.4 [4]	*86.6*
30	Cape Verde	14.8	11.6	76.3	121.8	3’179	*12’330*	20.4	*32.2*	7.1	*24.8*
31	Chad	0.4	0.2	24.5	39.8	96	733	*1.1*	*2.9*	*0.9*	*2.7*
32	Chile	20.2	19.2	115.8	133.3	19’099	73’102	*46.8*	*60.3*	*35.0*	*53.9*
33	China	21.6	17.9	63.2	92.3	2’356	4’995	35.4	*46.7*	*23.7*	*47.4*
34	Colombia	15.5	14.7 [6]	95.8	113.1 [5]	10’212	*34’989*	26.1	44.5	19.3	38.0
35	Congo (Dem. Rep.)	0.1	0.0	19.0	53.5	246	*384*	0.7	*1.9*	*0.6*	*2.0*
36	Congo (Rep.)	0.3	*0.4*	90.4	*108.1*	*117*	*185*	*3.5*	*4.9*	*0.7*	*1.9*
37	Costa Rica	22.7	17.8 [2]	67.0	143.8 [3]	12’657	45’329	41.3 [4]	52.3	24.1 [5]	55.1
38	Côte d’Ivoire	1.5	1.2	82.2	106.2	7’807	5’163	*1.8*	*7.2*	*1.1*	*12.2*
39	Croatia	43.0	36.7 [7]	*113.6* [5]	104.4	*22’420*	*58’034*	60.0	*70.1*	56.5	68.4
40	Cuba	10.3	11.2	8.9	22.5	219	462	3.4	12.9	*1.9*	4.1
41	Cyprus	37.4	28.4	93.7	96.3	51’638	*75’055*	60.5	*74.0*	53.7	68.6
42	Czech Republic	22.4	17.6 [2]	122.6	130.0 [3]	*68’842*	*116’806*	64.1	*78.5*	60.5	78.0
43	Denmark	47.1 [8]	33.3	115.7 [6]	126.0	*142’137*	*341’706*	88.0	*95.0*	86.1	93.1
44	Djibouti	2.2	2.5	19.9	32.4	15’439	*8’955*	*13.0*	*18.0*	*3.5*	*7.1*
45	Dominica	21.8	*24.3*	148.3 [7]	*127.5*	63’816	*109’954*	30.0	*38.9*	*28.0*	*37.0*
46	Dominican Rep.	10.1 [9]	11.6 [8]	88.8	78.9 [6]	*4’451*	*24’903*	*16.4*	*26.2*	*10.2*	*21.1*
47	Ecuador	13.9	15.3 [9]	98.5	103.9 [7]	7’950	48’329	27.0	*38.0*	11.5	*32.0*
48	Egypt	12.3	7.6	90.5	114.3	5’370	9’302	31.3	45.1	25.3	36.8

	Economy	Fixed-telephone subscriptions per 100 inhabitants		Mobile-cellular subscriptions per 100 inhabitants		International Internet bandwidth Bit/s per Internet user		Percentage of households with computer		Percentage of households with Internet	
		2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
49	El Salvador	16.1 [10]	14.9	123.8 [8]	144.0 [8]	*2'889*	50'309	13.3	*25.2*	8.0	*23.3*
50	Equatorial Guinea	1.9	1.9	57.4	66.4	4'094	*1'452*	13.0	*18.0*	*7.0*	*8.5*
51	Eritrea	0.9	*1.0*	3.2	*6.4*	857	*1'391*	*0.8*	*2.3*	*0.7*	*1.5*
52	Estonia	37.1	31.7	127.3 [9]	160.7	23'903	*28'665*	69.2	*82.5*	67.8	82.9
53	Ethiopia	1.0	0.8	7.9	31.6	5'102	*5'002*	*1.4*	*2.8*	*1.1*	*2.9*
54	Fiji	15.1 [11]	8.4	81.1 [10]	98.8 [9]	*7'553*	13'946	*26.8*	*36.7*	*18.8*	*29.0*
55	Finland	23.3	11.7	156.3 [11]	139.7	*107'204*	*218'744*	82.0	*91.9*	80.5	89.8
56	France	64.2	60.0	91.4	100.4	*71'626*	*221'660*	76.4	*82.8*	73.6	83.0
57	Gabon	2.0	*1.0*	103.5	*210.4*	6'888	*19'657*	*7.6*	*12.5*	*6.0*	*9.7*
58	Gambia	2.9	2.9	88.0	119.6	1'093	10'928	5.7	*8.3*	*3.8*	*8.5*
59	Georgia	25.3 [12]	25.4	90.6 [12]	124.9	*21'177*	70'966	18.2	45.8	16.6	41.0
60	Germany	63.7	56.9 [10]	106.5 [13]	120.4	*73'449*	*145'990*	85.7	*90.6*	82.5	89.5
61	Ghana	1.1	1.0	71.9	114.8	90	*3'602*	7.9 [1]	*39.9*	*5.0*	*29.0*
62	Greece	53.1	46.9	110.6	115.0 [10]	31'694	*99'513*	53.4	*62.7*	46.4	65.6
63	Grenada	27.1	*26.9*	116.5	*126.5*	*123'838*	*251'661*	*35.0*	*39.4*	*28.0*	*32.6*
64	Guatemala	10.4	10.8 [11]	126.0	106.6 [11]	*3'984*	8'073	*14.2*	*20.9*	*4.7*	*15.0*
65	Guinea-Bissau	*0.3*	*0.3*	42.7	63.5	2'573	2'674	*1.9*	*2.5*	*1.3*	*1.9*
66	Guyana	19.1	19.9	71.3	70.5	*6'126*	9'994	17.5	*26.9*	*15.7*	*24.2*
67	Honduras	8.8	6.4	124.7	93.5	*5'916*	21'765	12.9	*21.6*	*6.8*	*19.6*
68	Hong Kong, China	61.9	61.1	195.7	239.3	777'030	3'345'122	77.9	*83.7*	76.4	*82.4*
69	Hungary	29.7	30.3	119.9	118.1	*9'985*	*37'027*	66.4	*76.8*	60.5	75.1
70	Iceland	60.9	51.5	107.2	111.1	297'960	*519'869*	93.0	*98.1*	92.0	96.5
71	India	2.9	2.1 [12]	62.4 [14]	74.5 [13]	5'917	5'677	*6.1*	*13.0*	*4.2*	*15.3*
72	Indonesia	17.0	11.7	87.8	*126.2*	*2'473*	6'225	10.8	17.8	4.6	29.1
73	Iran (I.R.)	34.7	39.0	72.6	87.8	2'264	6'056	35.2	52.5 [1]	21.4	44.7 [1]
74	Ireland	46.5 [13]	43.2 [13]	105.2	104.3	*64'090*	*160'971*	76.5	*84.0*	71.7	82.2
75	Israel	*45.9*	37.1	*122.8*	121.5 [14]	*7'986*	*98'409*	76.6	*82.4*	68.1	*71.5*
76	Italy	37.2 [14]	*33.7* [5]	154.8 [15]	*154.2* [1]	61'574	*92'497*	64.8	*74.0*	59.0	*72.6*
77	Jamaica	9.6	9.1	116.1	102.9	*10'546*	14'210	22.7	*32.5*	14.0	*25.7*
78	Japan	51.5	50.1 [14]	96.8 [16]	120.2 [15]	15'730 [1]	*48'637*	83.4 [5]	*83.3*	81.3 [6]	*97.5*
79	Jordan	7.5	5.0	102.6	147.8	*7'405*	*7'874*	46.7	*51.1*	21.6	*60.0*
80	Kazakhstan	25.5	26.1	121.9	168.6	9'306	51'489	46.0	*64.7*	*44.0*	*58.8*
81	Kenya	0.9	0.4	61.0	73.8	3'529	25'200	6.5	*12.3*	*6.3*	*16.9*
82	Korea (Rep.)	58.9	59.5	104.8	115.5	11'812	43'358	81.8	78.3	96.8	98.5
83	Kuwait	17.4	14.2	133.0	218.4	*43'553*	50'096	*59.5*	*87.8*	*49.9*	*75.4*
84	Kyrgyzstan	9.2	7.9	98.9	134.5	1'426	*8'166*	*6.1*	*17.6*	*3.6*	*12.0*
85	Lao P.D.R.	1.6	13.4 [15]	62.6	67.0 [16]	*1'117*	2'848	6.9	*10.5*	*3.4*	*5.2*
86	Latvia	*25.5*	19.0	*110.3*	124.2	33'559	*93'683*	62.8	*73.5*	59.8	73.4
87	Lebanon	19.3 [15]	19.4	66.0 [17]	88.3	1'318	23'992	*61.5*	*81.0*	*50.7*	*68.4*
88	Lesotho	1.9	2.4	49.2	101.9	335	2'410	*5.0*	*6.9*	*2.5*	*6.5*
89	Liberia	0.1 [16]	0.2	39.7	73.4	604	*6'306*	1.1	*2.2*	*0.9*	*2.5*
90	Lithuania	24.6	19.5	159.4	147.0	49'203	125'454	59.2	*68.1*	60.6	66.0
91	Luxembourg	53.6 [17]	*49.6*	143.1	*148.4*	2'521'959	*6'887'708*	90.2	*96.3*	90.3	95.6
92	Macao, China	31.5 [18]	26.7 [16]	209.9	322.6	32'196 [2]	88'921	83.0	81.1	75.5	84.3
93	Madagascar	0.7	1.1	36.6	38.2	728	*267*	1.4	*4.5*	*1.3*	*4.7*
94	Malawi	1.0	0.4 [17]	20.8	30.5 [3]	2'034	*4'237*	2.8	*5.2*	*5.0*	*6.2*
95	Malaysia	16.3	14.6	119.7	148.8	11'495	27'173	61.8	*66.5*	55.6 [7]	*65.5*
96	Maldives	8.7	6.1	151.8	189.4	33'447	69'077	55.5	*65.9*	23.5	*44.5*
97	Mali	0.8	1.0	53.2	149.0	2'771	*1'879*	4.7	*8.2*	*1.2*	6.7
98	Malta	58.3	53.6	107.3	127.0	464'099	*1'178'759*	73.1	*82.2*	70.4	80.7
99	Mauritania	2.0 [19]	1.3 [18]	76.9 [18]	94.2 [17]	*1'939*	*1'454*	*3.0*	*4.4*	*1.6*	*6.2*
100	Mauritius	31.5	29.8	96.8	132.2	9'723	32'990	37.7	*51.3*	29.0	*47.5*

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		2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
101	Mexico	16.9	17.0	77.5	82.5 [18]	7'039	*20'926*	29.8	38.3	22.2	34.4
102	Moldova	32.5	35.2	*71.4* [19]	108.0	81'450	152'362	37.0	*52.4*	*34.7* [8]	*47.5*
103	Monaco	116.5	133.0	63.5	88.5	47'044	227'447	69.6	*73.5*	*67.1*	*74.7*
104	Mongolia	7.1	7.9	92.5	105.1 [19]	62'121	*89'976*	22.3	*35.8*	*7.7*	*29.0*
105	Montenegro	*27.5*	26.5	*188.7*	163.0	*30'104*	77'016	*38.0*	*54.7*	*35.9*	*56.6*
106	Morocco	11.8	7.4 [5]	101.1	131.7 [1]	4'558	10'768	34.2 [6]	52.5	25.5 [9]	50.4
107	Mozambique	0.4	0.3	30.1	69.7	1'281	7'755	4.9	*7.3*	*2.4*	*6.2*
108	Myanmar	0.9	1.0	*1.1*	49.5	*7'702*	28'668	1.3	*3.4*	*1.0*	*3.0*
109	Namibia	7.2	7.8	89.5	113.8	1'701	8'162	11.5	*16.5*	*7.0*	*17.3*
110	Nepal	3.1 [20]	3.0 [19]	34.3	82.5 [20]	*1'879*	3'109	4.2	*8.2*	*2.1*	5.6
111	Netherlands	43.5	*42.4*	115.4 [20]	*116.4* [21]	*154'312*	*281'063*	92.0	*97.6*	90.9	95.8
112	New Zealand	43.0	40.6	107.8 [21]	112.1 [22]	*34'143*	*95'081*	*79.5*	*79.8*	*76.8*	*79.8*
113	Nicaragua	4.4	5.5 [20]	68.1 [22]	114.6 [23]	*8'588*	*23'025*	*8.2*	*11.1*	*3.8*	*11.6*
114	Nigeria	0.7 [21]	0.1	54.7	77.8	*2'348*	*3'150*	7.6	*9.1*	6.1	*8.5*
115	Norway	33.7	22.7 [21]	114.5	116.5 [24]	*109'459*	*203'935*	90.9	*95.4*	89.8	93.1
116	Oman	10.1	9.6	164.3	157.8	5'582	33'724	54.3 [1]	*84.0*	35.5 [3]	*86.2*
117	Pakistan	3.5 [22]	2.6 [22]	57.3	73.3 [25]	*4'332*	5'684	*9.7*	*15.9*	5.7	*13.2*
118	Panama	14.7	15.0 [2]	180.7	158.1 [3]	*16'950*	72'678	27.9 [1]	38.2 [2]	20.3 [3]	41.6 [2]
119	Paraguay	5.6	5.4	91.7	105.6	8'295	12'624	19.3	31.9 [3]	13.8	24.6 [3]
120	Peru	10.8	9.9	99.5	102.9 [26]	*8'319*	*36'381*	22.6	32.3	13.0	23.5
121	Philippines	3.6	3.1	89.0	111.2	*10'702*	*27'688*	13.6	*20.5*	9.5	*26.9*
122	Poland	20.1 [23]	*13.2*	122.9	*156.4*	*37'806*	*90'356*	69.0	*77.7*	63.4	74.8
123	Portugal	42.4	43.2	115.3 [23]	111.8 [27]	*141'734*	*218'876*	59.5	*69.4*	53.7	64.9
124	Qatar	15.4 [24]	18.4	125.0 [24]	145.8	20'295 [3]	67'473	87.0	*97.2*	81.8	*98.0*
125	Romania	20.6	21.3 [2]	111.4 [25]	105.9 [28]	50'405	*153'807*	47.9	*63.8*	42.2	60.5
126	Russian Federation	31.3	27.7 [23]	165.5 [26]	155.1	*17'812*	*29'860*	55.0	71.0	41.3	69.9
127	Rwanda	0.4	0.4	32.7	64.0	1'895	8'517	1.3	*3.4*	*1.3*	*3.8*
128	Samoa	*4.3*	6.1	*48.4*	55.5	*3'840*	6'676	*13.0*	*21.1*	*10.0*	*21.9*
129	Saudi Arabia	15.3	13.4 [24]	189.2	179.6	*11'095*	30'548	57.3	80.0 [4]	*54.4*	94.0 [4]
130	Senegal	2.6	2.1	64.4	98.8	5'212	*8'349*	*5.7*	*11.6*	*4.2*	*12.6*
131	Serbia	39.3	37.3	125.3 [27]	122.1	*45'597*	112'372	50.9	*65.6*	*40.2*	*51.8*
132	Seychelles	24.2 [25]	22.7	128.9 [28]	162.2	4'961 [4]	28'945	37.8 [1]	*61.8*	26.1 [3]	*55.0*
133	Singapore	39.3	*35.5*	145.4 [29]	*158.1*	172'404	616'531	84.0 [7]	88.0 [1]	82.0 [10]	88.0 [1]
134	Slovakia	20.2	16.8	109.0	116.9	12'155	*11'462*	72.2	*80.5*	67.5	78.4
135	Slovenia	44.3	37.1	103.3	112.1	*55'634*	*121'137*	70.5	*79.8*	68.1	76.8
136	Solomon Islands	1.6	1.3	21.9	65.8	*3'799*	4'277	*3.8*	*6.1*	*2.9*	*5.6*
137	South Africa	*9.4*	8.1	97.9	149.7	*202'453*	149'542	*18.3*	*28.1*	10.1	*37.3*
138	South Sudan	0.0	0.0 [25]	14.4 [30]	24.5 [29]	4	27	*4.0*	*10.0*	*3.0*	*9.6*
139	Spain	43.7	40.6 [26]	111.3	107.8 [30]	*55'944*	*111'545*	68.7	*74.0*	59.1	74.4
140	Sri Lanka	17.2	12.5	83.6	103.2	3'332	*12'651*	12.3	*17.8*	*5.9*	*15.3*
141	St. Kitts and Nevis	37.8	*34.9*	152.8	*139.8*	*81'863*	*139'540*	64.0	*66.5*	56.5	*62.8*
142	St. Lucia	21.1	17.9 [27]	111.7	102.6 [31]	*52'075*	*128'157*	38.6 [8]	*38.0*	26.5 [3]	*38.9*
143	St. Vincent and the Grenadines	19.9	21.9	120.6	105.2	*71'281*	148'285	*55.1*	*68.9*	*40.3*	*58.5*
144	Sudan	1.3	1.1	41.5	72.2	1'829	2'499	*9.0*	*16.6*	*15.0*	*32.2*
145	Suriname	16.2	*15.6*	99.3	*170.6*	*3'099*	*50'458*	29.0 [9]	*35.8*	14.4 [11]	*20.5*
146	Sweden	50.5	39.7 [2]	117.2	127.8 [3]	*236'853*	*527'447*	89.5	*93.4*	88.3	89.6
147	Switzerland	62.7	53.6 [28]	123.2	140.5 [14]	*152'211*	*352'243*	83.7	*87.6*	80.7 [12]	90.6
148	Syria	18.9	18.1	54.3	70.9	1'287	*4'048*	40.4	*47.6*	*35.2*	*40.9*
149	Tanzania	0.4	0.3	46.7	62.8	2'652	*6'081*	*2.6*	*3.8*	*2.1*	*4.1*

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		2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
150	TFYR Macedonia	19.7 [26]	*18.6*	102.4	109.1 [32]	*16'498*	*41'812*	53.6	*70.1*	46.1	68.3
151	Thailand	10.3	8.5	108.0	144.4	12'791	46'826	22.8 [10]	33.9 [5]	11.4	33.8
152	Togo	1.0 [27]	*0.9*	41.3 [31]	*69.0*	*7'337*	*6'523*	*2.1*	*3.2*	1.0	*3.3*
153	Tonga	*29.8*	11.3 [2]	*52.2*	64.3 [3]	*3'002*	11'817	*23.3*	*34.0*	*10.0*	*35.7*
154	Trinidad & Tobago	22.1	21.4	142.6	147.3	*29'808*	48'903	53.1	*64.0*	*29.0*	*50.0*
155	Tunisia	12.1	8.5	104.5	128.5	13'086	25'972	19.1	33.1 [6]	11.4	28.8 [5]
156	Turkey	22.5	16.5	85.6	94.8	*13'577*	42'911	44.2	56.0	41.6	60.2
157	Uganda	1.0 [28]	0.8 [5]	37.7 [32]	52.4 [1]	849	4'002	2.2	*5.8*	*1.9*	*6.2*
158	Ukraine	28.1	24.6	117.1	144.1	*14'912*	*40'704*	25.2 [11]	52.4	22.2	*43.0*
159	United Arab Emirates	17.5	22.3 [29]	129.4	178.1	18'309	*44'503*	76.0	87.9	65.0	90.1 [6]
160	United Kingdom	53.8	52.4	123.6	123.6	*132'685*	*429'830*	82.6	*90.8*	79.6	89.9
161	United States	47.9	*40.1*	91.3	*98.4*	*40'206*	*70'970*	75.5	*81.5*	71.1	*79.6*
162	Uruguay	28.5	31.7	131.6 [33]	160.8 [33]	24'115 [5]	60'807	53.4	67.4	33.5	57.4
163	Vanuatu	3.0	2.2	71.9	60.4	*2'804*	*2'471*	8.7	*22.0*	*5.4*	*28.8*
164	Venezuela	24.4	25.3 [2]	96.0	99.0 [3]	*6'450*	14'398	19.4	*43.7*	14.3	*34.2*
165	Viet Nam	16.1	*6.0*	125.3	147.1	4'925	20'749	14.2	*20.5*	12.5 [13]	*18.6*
166	Zambia	0.9	0.8	41.2	67.3	*378*	*4'223*	3.7 [1]	*6.6*	*3.1*	*6.9*
167	Zimbabwe	2.9	2.3	58.9	80.8	289	3'939	5.3	*7.6*	4.0	*5.8*

Note: Data in italics are ITU estimates.
Source: ITU World Telecommunication/ICT Indicators database.

Use indicators

	Economy	Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile broadband subscriptions per 100 inhabitants	
		2010	2014	2010	2014	2010	2014
1	Afghanistan	*4.0*	*6.4*	*0.0*	*0.0*	*0.0*	*3.2*
2	Albania	45.0	*60.1*	3.4	*6.6*	0.0	*30.9*
3	Algeria	12.5	*18.1*	2.4	4.0 [1]	*0.0*	20.8 [1]
4	Andorra	81.0	*95.9*	31.5	35.9	0.0	36.6
5	Angola	*10.0*	*21.3*	*0.1*	0.4	*1.4*	16.4
6	Antigua & Barbuda	*47.0*	*64.0*	8.2	*15.1*	0.0	*33.0*
7	Argentina	*45.0*	*64.7*	10.0	14.7 [2]	*5.0*	*53.6*
8	Armenia	*25.0*	*46.3*	3.2	9.1	11.9	34.2
9	Australia	*76.0*	*84.6*	24.6 [1]	25.8 [3]	55.5 [1]	112.2
10	Austria	75.2 [1]	81.0 [1]	24.4	27.5	*32.9* [2]	*67.2*
11	Azerbaijan	46.0 [2]	*61.0*	5.2	19.8	5.0	46.8
12	Bahrain	55.0	91.0 [2]	12.4	21.4	*3.6*	126.2
13	Bangladesh	*3.7*	*9.6*	0.3	1.2 [4]	0.0 [3]	6.4 [2]
14	Barbados	*65.1*	*76.7*	20.0	27.0	0.0	*106.8*
15	Belarus	31.8 [3]	59.0 [3]	17.6 [2]	28.8	*12.6*	55.0
16	Belgium	75.0	85.0 [1]	30.8 [3]	36.0	*9.5*	*57.8*
17	Belize	28.2 [4]	*38.7*	2.9	*2.9*	*0.0*	*10.2*
18	Benin	3.1	*5.3*	0.3	0.4	0.0	2.8
19	Bhutan	13.6 [5]	*34.4*	1.2	3.3	0.3 [4]	28.2
20	Bolivia	*22.4*	*39.0*	0.9 [4]	1.6	*1.0*	28.1
21	Bosnia and Herzegovina	*42.8*	*60.8*	10.2	14.1	5.3	27.8
22	Botswana	6.0	*18.5*	0.6	1.6	1.5	49.7
23	Brazil	40.7 [6]	*57.6*	7.2 [5]	11.5 [5]	10.6 [5]	78.1 [3]
24	Brunei Darussalam	*53.0*	*68.8*	5.4	7.1	*5.5*	*6.3*
25	Bulgaria	46.2 [7]	55.5 [1]	15.2 [6]	20.7 [6]	34.9 [6]	66.4 [4]
26	Burkina Faso	*2.4*	*9.4*	0.1	0.0	0.0	9.6
27	Cambodia	1.3	*9.0*	0.2	*0.2*	*1.0*	*14.0*
28	Cameroon	*4.3*	*11.0*	0.0	0.1	0.0	*0.0*
29	Canada	80.3 [8]	*87.1*	31.7	*35.0*	29.4	*59.8*
30	Cape Verde	*30.0*	*40.3*	3.3	3.8	0.0	*51.3*
31	Chad	*1.7*	*2.5*	0.0	0.1	*0.0*	0.0 [5]
32	Chile	*45.0* [9]	*72.4*	10.4	14.1	8.4	50.5 [6]
33	China	34.3	*49.3*	9.3	14.4	3.5	41.8
34	Colombia	36.5 [4]	52.6 [4]	5.7	10.3 [7]	2.4 [7]	*45.1* [7]
35	Congo (Dem. Rep.)	0.7 [5]	*3.0*	*0.0*	*0.0*	0.0	7.9
36	Congo (Rep.)	*5.0*	*7.1*	0.0	*0.0*	*0.0*	*10.8*
37	Costa Rica	36.5 [10]	*49.4*	8.5	10.4	7.2 [8]	86.9
38	Côte d'Ivoire	*2.7*	*14.6*	0.0	0.3	0.0	24.6
39	Croatia	56.6 [7]	68.6 [1]	19.3	23.0	7.6 [9]	68.5
40	Cuba	15.9 [11]	*30.0*	0.0	0.1	0.0	0.0
41	Cyprus	53.0 [7]	69.3 [1]	17.6	21.1	29.5	42.1
42	Czech Republic	68.8 [7]	79.7 [1]	21.4	27.6 [8]	*33.9*	*62.8* [4]
43	Denmark	88.7 [7]	96.0 [1]	38.1	41.4 [9]	63.9	115.8
44	Djibouti	*6.5*	*10.7*	1.0 [7]	2.3	0.0	*3.2*
45	Dominica	47.5	*62.9*	11.7	*15.8*	*0.0*	*4.1*
46	Dominican Rep.	*31.4*	*49.6*	3.9	5.7	*2.4*	*30.1*
47	Ecuador	29.0 [4]	*43.0*	1.5 [8]	7.8 [6]	8.8	30.9
48	Egypt	21.6 [12]	31.7 [3]	1.9	3.7	17.0	43.5
49	El Salvador	15.9 [13]	*29.7*	2.8 [9]	5.0	*2.3*	34.4
50	Equatorial Guinea	6.0	*18.9*	0.2	0.5	0.0	*0.0*
51	Eritrea	*0.6*	*1.0*	0.0	*0.0*	*0.0*	*0.0*

	Economy	Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile broadband subscriptions per 100 inhabitants	
		2010	2014	2010	2014	2010	2014
52	Estonia	74.1 [14]	84.2 [1]	26.8	27.4	24.8	*117.0*
53	Ethiopia	*0.8*	*2.9*	0.0	0.5	*0.1*	7.5
54	Fiji	*20.0*	*41.8*	2.7	1.4	*0.8*	42.3
55	Finland	86.9 [7]	92.4 [1]	29.1 [10]	32.3	84.3	138.5
56	France	77.3 [7]	83.8 [1]	33.7	40.2	*36.2* [10]	*66.2*
57	Gabon	*7.2*	*9.8*	0.3	*0.6*	*0.0*	*0.0*
58	Gambia	9.2	*15.6*	0.0	0.1	0.5	8.0
59	Georgia	26.9	48.9 [3]	4.2	12.2	5.6 [11]	21.8
60	Germany	82.0 [7]	86.2 [1]	31.5	35.8	*25.5*	*63.6*
61	Ghana	7.8 [15]	*18.9*	0.2	0.3	6.9	59.8
62	Greece	44.4 [7]	63.2 [1]	20.3	28.4	25.1	*41.0*
63	Grenada	*27.0*	*37.4*	13.8	*17.9*	*0.0*	*1.2*
64	Guatemala	*10.5*	*23.4*	*1.8*	2.4 [10]	*3.7*	9.4 [8]
65	Guinea-Bissau	*2.5*	*3.3*	*0.1*	0.1 [11]	*0.0*	*0.0*
66	Guyana	29.9	*37.4*	1.4	5.6	*0.0*	0.2
67	Honduras	11.1	*19.1*	*0.0*	1.4 [12]	*1.3*	16.3 [9]
68	Hong Kong, China	72.0 [13]	*74.6*	30.7	31.2	38.9	104.5
69	Hungary	65.0 [7]	76.1 [1]	21.6	27.3	7.8	34.0
70	Iceland	93.4 [14]	98.2 [1]	34.3	35.9	45.6	*85.3*
71	India	*7.5*	*18.0*	0.9 [11]	1.2 [13]	*0.0*	5.5 [10]
72	Indonesia	10.9 [16]	17.1 [4]	0.9	1.2	*18.6*	34.7
73	Iran (I.R.)	15.9 [12]	39.4 [5]	*1.3*	9.5	*0.0*	10.7 [11]
74	Ireland	69.9 [7]	79.7 [1]	22.8	26.9	*49.2*	*81.0* [12]
75	Israel	67.5 [17]	*71.5*	*23.7*	26.2 [14]	*32.3*	52.2 [13]
76	Italy	53.7 [7]	62.0 [1]	21.6	23.5 [4]	37.8	*70.9* [2]
77	Jamaica	27.7 [18]	*40.5*	4.3	5.4	*1.5*	33.1
78	Japan	78.2 [12]	*90.6*	26.8	29.3 [4]	87.6 [12]	*121.4* [14]
79	Jordan	27.2 [4]	*44.0*	4.5	4.7	0.1	19.1
80	Kazakhstan	31.6 [19]	*54.9*	5.5	12.9	23.2	59.8
81	Kenya	14.0	*43.4*	0.0 [12]	0.2	0.2	9.1
82	Korea (Rep.)	83.7 [20]	87.9 [1]	35.5	38.8	97.7	108.6
83	Kuwait	*61.4*	*78.7*	*1.5*	1.4	58.1	139.8
84	Kyrgyzstan	*16.3*	*28.3*	0.4	4.2	0.5	*68.5*
85	Lao P.D.R.	7.0	*14.3*	0.1 [13]	0.2 [15]	0.1 [13]	4.6 [15]
86	Latvia	68.4 [7]	75.8 [1]	20.8	24.7	29.7	*71.7*
87	Lebanon	*43.7* [21]	*74.7*	7.6	22.8	*0.0* [14]	53.5
88	Lesotho	*3.9*	*11.0*	*0.0*	0.1	1.9	32.8
89	Liberia	2.3	*5.4*	0.0	*0.1*	0.0	7.6
90	Lithuania	62.1 [22]	72.1 [1]	22.1	31.5	9.1	58.6
91	Luxembourg	90.6 [7]	94.7 [1]	33.2	*33.3*	50.0	*111.3*
92	Macao, China	55.2 [20]	69.8 [6]	24.7	28.0	155.2 [15]	322.2 [16]
93	Madagascar	*1.7*	*3.7*	*0.0*	0.1	0.0	6.1
94	Malawi	2.3	*5.8*	0.0	0.1	0.6	*4.1*
95	Malaysia	56.3 [16]	*67.5*	7.4	10.1	9.1	58.3
96	Maldives	26.5 [23]	*49.3*	4.8	5.6	6.4 [16]	48.9 [17]
97	Mali	*2.0*	*7.0*	0.1	0.0	*0.5*	11.3
98	Malta	63.0 [7]	73.2 [1]	29.6	35.2	19.4	*49.7*
99	Mauritania	*4.0*	*10.7*	0.2	*0.2*	*0.5* [17]	14.4
100	Mauritius	28.3 [4]	*41.4*	7.6	14.6	14.4	31.8
101	Mexico	31.1 [24]	44.4 [7]	*9.0*	11.6 [16]	4.1 [18]	37.5 [4]
102	Moldova	*32.3*	*46.6*	7.6	14.7	3.3 [19]	49.4
103	Monaco	75.0	*92.4*	37.5	*46.8*	*40.7*	63.2 [18]
104	Mongolia	10.2 [16]	*27.0*	2.8	6.8	7.4	*57.6*

	Economy	Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile broadband subscriptions per 100 inhabitants	
		2010	2014	2010	2014	2010	2014
105	Montenegro	*37.5*	*61.0*	*10.4*	15.2	*8.9*	31.0
106	Morocco	52.0 [25]	56.8 [8]	1.6 [14]	3.0	5.0	26.8
107	Mozambique	4.2	*5.9*	0.1	0.0	*0.6*	3.0
108	Myanmar	0.3	*2.1*	0.0	0.3	*0.0*	14.9
109	Namibia	11.6	*14.8*	0.4	1.8	14.3	35.5
110	Nepal	7.9 [26]	*15.4*	*0.2* [11]	0.8 [17]	*0.1* [20]	17.4 [19]
111	Netherlands	90.7 [27]	93.2 [1]	38.1	41.0 [18]	38.0	*69.1* [20]
112	New Zealand	*80.5*	*85.5*	25.0	30.5	*38.6* [21]	*92.7*
113	Nicaragua	*10.0*	*17.6*	1.3	2.5 [6]	0.7	1.4 [21]
114	Nigeria	*24.0*	*42.7*	*0.1*	0.0	*0.6*	*11.7*
115	Norway	93.4 [7]	96.3 [1]	35.2	38.1 [19]	74.3	93.0 [22]
116	Oman	35.8 [28]	*70.2*	2.1	4.5	26.2	73.7
117	Pakistan	*8.0*	*13.8*	0.5	1.1 [20]	0.1 [22]	5.1 [23]
118	Panama	40.1 [29]	44.9	7.0	7.9 [2]	*3.2*	29.5 [4]
119	Paraguay	19.8 [30]	43.0 [9]	1.4	2.5 [21]	2.7 [23]	4.2 [24]
120	Peru	34.8 [12]	40.2 [7]	3.2	5.7	*0.9* [24]	*13.7*
121	Philippines	25.0	*39.7*	*1.8*	23.2	*2.3*	28.0
122	Poland	62.3 [7]	66.6 [1]	15.3 [15]	*23.8*	*50.2*	*62.3*
123	Portugal	53.3 [7]	64.6 [1]	20.1	26.7	24.2	45.3
124	Qatar	69.0 [16]	*91.5*	8.3 [16]	9.9	51.6 [25]	106.3
125	Romania	39.9 [7]	54.1 [1]	13.7 [17]	18.5 [22]	9.3	49.4 [25]
126	Russian Federation	43.0 [7]	70.5 [10]	10.9	17.5	*34.5*	*65.9*
127	Rwanda	*8.0*	*10.6*	0.0	0.1	*0.0*	11.1
128	Samoa	*7.0*	*21.2*	*0.1*	1.1	*0.0*	16.4
129	Saudi Arabia	41.0	63.7 [12]	6.3	10.4	*25.7*	99.0
130	Senegal	*8.0* [31]	*17.7*	0.6	0.7	0.2	*23.7*
131	Serbia	40.9	*53.5*	10.9	15.6	18.0 [26]	61.1
132	Seychelles	*41.0*	*54.3*	7.4 [18]	12.7	1.6 [27]	12.7
133	Singapore	71.0 [32]	82.0 [13]	26.4	*27.8*	98.4	*156.1*
134	Slovakia	75.7 [33]	80.0 [1]	16.1	21.8	20.8	*59.5*
135	Slovenia	70.0 [7]	71.6 [1]	22.9	26.6	24.1	46.7
136	Solomon Islands	*5.0*	*9.0*	0.5	0.2	*1.6*	13.0
137	South Africa	*24.0*	*49.0*	1.4	3.2	*16.9*	46.7
138	South Sudan	*7.0*	*15.9*	0.0 [19]	0.0	0.0	1.3
139	Spain	65.8 [34]	76.2 [1]	23.1	27.3 [23]	23.8 [28]	77.1 [26]
140	Sri Lanka	12.0	*25.8*	1.1	2.6	1.4	*13.0*
141	St. Kitts and Nevis	63.0	*65.4*	27.9	*23.7*	*0.0*	*6.4*
142	St. Lucia	43.3 [35]	*51.0*	11.6	15.4	*0.0*	*29.8* [27]
143	St. Vincent and the Grenadines	*38.5*	*56.5*	11.4	14.9	*0.0*	34.4
144	Sudan	*16.7*	*24.6*	0.0	0.1	3.1	27.2
145	Suriname	31.6	*40.1*	2.9	*8.5*	*0.0*	*71.6*
146	Sweden	90.0 [36]	92.5 [1]	32.0	34.2 [2]	*83.8*	*116.3* [4]
147	Switzerland	83.9 [37]	87.0 [14]	37.2	46.0 [6]	30.1	76.6 [21]
148	Syria	20.7	*28.1*	0.3	1.7	0.5	*5.7*
149	Tanzania	*2.9*	*4.9*	0.0	*0.2*	1.0	*3.0*
150	TFYR Macedonia	51.9 [7]	68.1 [1]	12.3	16.2 [24]	*18.4*	*47.7* [28]
151	Thailand	22.4	34.9 [15]	4.9	8.2	*0.0*	79.9
152	Togo	*3.0*	*5.7*	0.4 [20]	*0.1*	0.0 [29]	*4.1*
153	Tonga	*16.0*	*40.0*	*1.1*	*1.7*	*0.0*	19.3 [4]
154	Trinidad & Tobago	48.5 [5]	*65.1*	12.3	17.5	*0.5*	28.3
155	Tunisia	36.8	*46.2*	4.5	4.4	0.9	47.6
156	Turkey	39.8 [27]	51.0 [16]	9.8	11.7	*10.0*	42.7

	Economy	Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile broadband subscriptions per 100 inhabitants	
		2010	2014	2010	2014	2010	2014
157	Uganda	12.5	*17.7*	0.0 [11]	0.3 [4]	1.6	14.7 [2]
158	Ukraine	23.3	*43.4*	6.4	8.4	*4.1*	*7.5*
159	United Arab Emirates	68.0 [16]	90.4 [17]	9.3 [21]	11.5 [25]	13.4 [30]	*114.0*
160	United Kingdom	85.0 [7]	91.6 [1]	30.9 [22]	37.4	*43.2*	*98.7* [29]
161	United States	71.7 [38]	*87.4*	27.1 [23]	30.4 [26]	60.1	97.9 [30]
162	Uruguay	46.4 [12]	*61.5*	11.4	24.6 [27]	13.4 [31]	59.8 [31]
163	Vanuatu	8.0	*18.8*	0.2	1.8 [28]	*0.0*	26.2
164	Venezuela	37.4 [5]	*57.0*	5.8	7.8 [2]	*21.4*	43.9 [4]
165	Viet Nam	30.7	*48.3*	4.1	6.5	*7.9*	31.0
166	Zambia	10.0	*17.3*	0.1	0.1 [29]	*0.3*	*1.0* [32]
167	Zimbabwe	11.5	*19.9*	0.3	1.0	4.7	39.2

Note: Data in italics are ITU estimates.
Source: ITU World Telecommunication/ICT Indicators database.

Skills indicators

	Economy	Gross enrolment ratio				Adult literacy rate	
		Secondary		Tertiary			
		2010	2014	2010	2014	2010	2014
1	Afghanistan	50.2	54.3	3.9	3.7	28.0	38.2
2	Albania	82.4	82.4	43.6	55.5	96.8	97.6
3	Algeria	95.4	97.6	28.8	31.5	72.6	80.2
4	Andorra	87.0	130.8	84.6	84.6	97.9	97.9
5	Angola	31.3	31.5	7.5	7.5	67.4	71.1
6	Antigua & Barbuda	106.2	105.4	16.2	23.5	99.0	99.0
7	Argentina	90.2	107.3	74.8	80.3	97.9	98.1
8	Armenia	96.6	95.9	50.6	46.1	99.6	99.7
9	Australia	130.8	135.5	79.8	86.3	99.0	99.0
10	Austria	98.6	97.7	68.7	72.4	99.0	99.0
11	Azerbaijan	98.8	100.3	19.3	20.4	99.5	99.8
12	Bahrain	96.4	95.5	29.8	33.5	94.6	95.7
13	Bangladesh	49.9	53.7	10.5	13.2	57.7	61.6
14	Barbados	101.5	104.7	64.8	60.8	99.0	99.0
15	Belarus	107.0	105.1	79.0	92.9	99.6	99.7
16	Belgium	105.1	107.3	67.5	70.8	99.0	99.0
17	Belize	80.5	86.1	22.6	25.9	95.5	95.5
18	Benin	47.7	54.2	13.3	12.4	28.7	38.5
19	Bhutan	66.3	77.7	7.0	9.4	52.8	64.9
20	Bolivia	77.5	80.0	37.7	37.7	91.2	95.7
21	Bosnia and Herzegovina	89.3	89.3	38.1	37.7	98.0	98.5
22	Botswana	81.7	81.7	17.0	7.4	85.1	88.5
23	Brazil	105.5	105.8	25.5	25.6	91.4	92.6
24	Brunei Darussalam	100.7	105.9	17.6	24.3	95.4	96.0
25	Bulgaria	90.4	93.1	58.0	62.7	98.4	98.4
26	Burkina Faso	21.9	28.4	3.6	4.8	28.7	36.0
27	Cambodia	45.0	45.0	14.1	15.8	73.9	77.2
28	Cameroon	39.6	50.4	11.0	11.9	71.3	75.0
29	Canada	102.4	103.4	58.9	66.6	99.0	99.0
30	Cape Verde	87.8	92.7	18.0	22.9	84.9	87.6
31	Chad	22.9	22.8	2.1	2.3	35.4	40.2
32	Chile	89.1	89.0	65.9	74.4	98.6	97.5
33	China	83.1	89.0	23.3	26.7	95.1	96.4
34	Colombia	96.0	93.0	39.0	48.3	93.6	94.7
35	Congo (Dem. Rep.)	40.9	43.3	6.8	8.2	66.8	63.8
36	Congo (Rep.)	53.7	53.7	6.5	9.6	66.8	79.3
37	Costa Rica	99.4	108.9	25.6	47.6	96.3	97.8
38	Côte d'Ivoire	39.1	39.1	8.4	9.1	41.0	43.1
39	Croatia	98.4	98.4	55.8	61.6	98.9	99.3
40	Cuba	89.2	92.1	95.0	47.8	99.8	99.9
41	Cyprus	91.4	95.3	48.3	45.9	98.7	99.1
42	Czech Republic	94.5	96.6	63.2	64.2	99.0	99.0
43	Denmark	119.5	124.7	73.6	79.6	99.0	99.0
44	Djibouti	33.3	47.7	3.4	4.9	73.0	94.2
45	Dominica	96.9	96.7	34.2	34.2	89.1	89.1
46	Dominican Rep.	75.5	75.9	46.4	46.4	90.1	91.8
47	Ecuador	85.2	103.3	38.9	40.5	91.6	94.5
48	Egypt	75.9	86.3	33.5	30.1	72.0	73.8
49	El Salvador	64.7	70.2	23.4	25.5	84.5	88.0
50	Equatorial Guinea	28.2	28.2	2.0	3.3	94.2	95.3
51	Eritrea	32.6	29.8	2.0	2.0	68.9	73.8
52	Estonia	109.1	107.1	71.7	76.7	99.8	99.8

	Economy	Gross enrolment ratio				Adult literacy rate	
		Secondary		Tertiary			
		2010	2014	2010	2014	2010	2014
53	Ethiopia	28.9	28.9	2.8	2.8	39.0	49.1
54	Fiji	86.5	88.3	16.2	16.1	95.1	95.1
55	Finland	107.2	107.7	94.1	93.7	99.0	99.0
56	France	110.0	109.7	56.1	58.3	99.0	99.0
57	Gabon	53.9	53.9	8.5	8.5	82.3	83.2
58	Gambia	57.5	57.5	4.1	3.4	51.1	55.6
59	Georgia	86.8	100.6	28.3	33.1	99.7	99.8
60	Germany	101.6	101.3	46.2	61.7	99.0	99.0
61	Ghana	58.3	67.1	8.8	12.2	71.5	76.6
62	Greece	110.8	108.6	108.1	116.6	97.3	97.7
63	Grenada	107.8	107.8	52.8	52.8	99.0	99.0
64	Guatemala	64.6	65.3	17.9	18.7	75.9	81.6
65	Guinea-Bissau	34.5	34.5	2.6	2.6	41.4	59.9
66	Guyana	99.4	101.0	11.5	12.9	85.0	88.5
67	Honduras	73.2	71.0	20.6	21.1	85.1	88.5
68	Hong Kong, China	87.2	99.3	57.8	66.8	99.0	99.0
69	Hungary	100.0	101.6	60.4	59.6	99.0	99.1
70	Iceland	109.5	112.0	78.5	81.4	99.0	99.0
71	India	65.1	68.5	18.2	24.8	62.8	71.2
72	Indonesia	78.4	82.5	24.9	31.5	92.8	93.9
73	Iran (I.R.)	81.1	86.3	43.1	55.2	85.0	86.9
74	Ireland	121.2	119.1	70.6	71.2	99.0	96.7
75	Israel	102.0	101.4	62.4	67.9	99.0	97.8
76	Italy	100.3	99.2	64.3	62.5	99.0	99.2
77	Jamaica	91.0	77.8	28.9	28.7	87.0	88.7
78	Japan	101.6	101.8	58.1	61.5	99.0	99.0
79	Jordan	89.9	87.8	40.4	46.6	95.9	95.4
80	Kazakhstan	96.1	97.7	39.5	44.5	99.7	99.8
81	Kenya	60.1	67.0	4.1	4.0	72.2	78.0
82	Korea (Rep.)	97.1	97.2	101.0	98.4	99.0	99.0
83	Kuwait	100.3	100.3	28.5	28.5	93.9	96.3
84	Kyrgyzstan	84.0	88.2	42.1	47.6	99.2	99.5
85	Lao P.D.R.	44.8	50.5	16.1	17.7	72.7	79.9
86	Latvia	98.5	97.7	70.6	65.1	99.9	99.9
87	Lebanon	74.4	75.1	47.8	47.9	89.6	93.9
88	Lesotho	50.4	53.3	10.8	10.8	75.8	79.4
89	Liberia	31.7	37.9	9.3	11.6	42.9	47.6
90	Lithuania	106.7	105.9	80.8	74.0	99.8	99.8
91	Luxembourg	101.0	100.1	18.2	19.7	99.0	99.0
92	Macao, China	93.8	96.0	61.8	62.6	95.6	96.2
93	Madagascar	30.4	38.4	3.6	4.1	64.5	64.7
94	Malawi	32.7	36.6	0.7	0.8	61.3	65.8
95	Malaysia	66.9	70.8	37.1	37.2	93.1	94.6
96	Maldives	72.3	72.3	13.2	13.2	98.4	99.3
97	Mali	42.4	45.0	6.5	7.5	33.4	38.7
98	Malta	99.1	86.3	36.5	41.2	92.4	94.4
99	Mauritania	20.3	29.5	4.4	5.4	58.6	52.1
100	Mauritius	93.2	95.9	34.2	41.2	88.8	90.6
101	Mexico	83.7	85.7	26.7	29.0	93.5	95.1
102	Moldova	88.0	88.3	38.2	41.3	99.0	99.4
103	Monaco	119.7	109.7	54.9	54.9	99.0	99.0
104	Mongolia	91.6	103.5	53.8	62.3	98.3	98.4
105	Montenegro	98.6	90.9	55.5	55.5	98.5	98.7
106	Morocco	62.5	68.9	14.3	16.2	67.1	68.5

	Economy	Gross enrolment ratio				Adult literacy rate	
		Secondary		Tertiary			
		2010	2014	2010	2014	2010	2014
107	Mozambique	25.3	26.1	4.6	5.2	50.6	58.8
108	Myanmar	50.2	50.2	10.1	13.4	92.7	93.1
109	Namibia	64.9	64.8	9.3	9.3	76.5	81.9
110	Nepal	60.4	67.0	14.4	14.5	57.4	64.0
111	Netherlands	122.0	129.9	64.3	77.3	99.0	99.0
112	New Zealand	119.1	119.5	82.6	79.8	99.0	99.0
113	Nicaragua	68.9	68.9	17.0	17.9	78.0	82.8
114	Nigeria	43.8	43.8	10.4	10.4	51.1	59.6
115	Norway	113.1	111.1	72.8	74.1	99.0	99.0
116	Oman	96.2	93.5	24.8	28.1	86.9	91.1
117	Pakistan	34.1	38.3	6.6	9.8	54.9	57.9
118	Panama	70.3	73.0	43.9	43.5	94.1	95.1
119	Paraguay	67.8	69.6	34.5	34.5	93.9	95.6
120	Peru	91.7	94.0	40.7	42.6	89.6	94.5
121	Philippines	84.6	84.6	28.2	28.2	95.4	96.3
122	Poland	97.2	97.7	73.5	73.2	99.7	99.8
123	Portugal	109.7	112.9	66.0	68.9	95.4	95.7
124	Qatar	104.3	111.6	10.0	14.3	96.3	97.3
125	Romania	94.9	95.0	56.8	51.6	97.7	98.8
126	Russian Federation	84.9	95.3	75.5	76.1	99.7	99.7
127	Rwanda	30.1	32.6	5.8	6.9	65.9	70.5
128	Samoa	87.7	85.7	7.6	7.5	98.8	99.0
129	Saudi Arabia	110.2	116.2	37.3	57.5	87.2	94.7
130	Senegal	36.4	41.0	7.6	7.6	52.1	57.7
131	Serbia	91.4	94.4	49.1	56.4	98.0	98.1
132	Seychelles	74.8	79.5	1.8	1.3	91.8	91.8
133	Singapore	74.1	97.2	43.8	43.8	95.9	96.8
134	Slovakia	92.8	93.9	56.0	55.1	99.0	99.5
135	Slovenia	97.8	97.6	88.5	86.0	99.7	99.7
136	Solomon Islands	48.6	48.4	16.2	16.2	82.0	98.7
137	South Africa	95.4	110.8	15.8	19.7	93.0	94.3
138	South Sudan	40.7	40.7	17.2	17.2	73.4	75.9
139	Spain	124.6	130.8	78.1	84.6	97.7	98.1
140	Sri Lanka	97.2	99.3	16.0	17.0	91.2	92.6
141	St. Kitts and Nevis	97.5	101.2	18.2	18.2	96.0	98.4
142	St. Lucia	95.2	88.4	12.5	13.9	99.0	99.0
143	St. Vincent and the Grenadines	107.5	102.9	18.2	18.2	99.0	99.0
144	Sudan	41.7	40.7	15.2	17.2	71.9	75.9
145	Suriname	74.9	76.0	12.1	12.1	94.7	95.6
146	Sweden	98.1	98.4	74.6	70.0	99.0	99.0
147	Switzerland	95.8	96.3	52.8	55.6	99.0	98.7
148	Syria	72.5	47.7	25.7	28.4	84.1	86.4
149	Tanzania	31.7	33.0	2.1	3.9	67.8	70.6
150	TFYR Macedonia	81.9	82.8	37.1	38.5	97.4	97.8
151	Thailand	83.5	87.0	50.0	51.2	96.4	96.7
152	Togo	44.0	54.9	9.1	10.0	60.4	66.6
153	Tonga	104.0	90.9	6.4	6.3	99.0	99.4
154	Trinidad & Tobago	85.5	85.5	12.0	12.0	98.8	99.0
155	Tunisia	89.0	90.6	36.1	35.2	79.1	81.8
156	Turkey	84.4	86.1	55.9	69.4	94.1	95.0
157	Uganda	26.4	26.9	3.9	9.1	73.2	78.4
158	Ukraine	95.4	98.9	76.7	79.0	99.7	99.8
159	United Arab Emirates	83.6	83.6	30.4	30.4	90.0	93.8
160	United Kingdom	106.2	95.4	60.5	61.9	99.0	95.2

	Economy	Gross enrolment ratio				Adult literacy rate	
		Secondary		Tertiary			
		2010	2014	2010	2014	2010	2014
161	United States	93.2	*93.7*	93.3	*94.3*	99.0	*99.0*
162	Uruguay	90.3	*90.3*	63.2	*63.2*	98.1	*98.5*
163	Vanuatu	59.5	*59.5*	4.6	*4.7*	83.2	*85.2*
164	Venezuela	82.3	*93.0*	77.9	*78.1*	95.5	*96.3*
165	Viet Nam	77.2	*77.2*	22.4	*24.6*	93.4	*94.5*
166	Zambia	45.5	*45.5*	2.4	*2.4*	61.4	*63.4*
167	Zimbabwe	47.2	*47.2*	6.2	*5.8*	83.6	*86.5*

Note: Data in italics refer to ITU estimates.
Source: UIS. Latest available data.

Notes

Access indicators

Fixed-telephone subscriptions per 100 inhabitants, 2010

1) Includes payphone, excludes VOIP. 2) Incl. ISDN channels measured in ISDN B channels equivalents. 3) Incl. VoIP. 4) Incl. PSTN, CDMA, and AMPS fixed base. 5) This is an estimate as there was no verifiable statistics at beginning of April 2010. 6) WLL lines included. 7) Total access lines. 8) Incl. PSTN+ISDN channels and VoIP subscriptions. 9) Incl. IP lines. 10) Estimate based on June 2010 data. 11) 30th June 2011. 12) From this year, data incl. WLL subscriptions. 13) Incl. PSTN lines, ISDN paths, FWA subscriptions, public payphones and VOIP subscriptions. 14) Source: AGCOM Quarterly Observatory- including Telecom Italia access lines, ULL, Virtual ULL, Naked DSL, Wholesale line Rental, Fiber, Public Telephony. 15) Source: MOT. 16) Fixed Wireless Local Loop. 17) Including digital lines. Without ISDN channels. 18) Revised figure, excl. ISDN channels and fixed wireless subscriptions. 19) Includes inactive subscriptions. 20) December. 21) Refers to active Fixed Wired/Wireless lines. 22) Revised. 23) POTS, ISDN BRA & ISDN PRA. 24) Operators data/ictQATAR estimate. 25) January 2011 data. 26) Excl. internal lines and WLR of incumbent. 27) Break in comparability: only includes fixed subscriptions (BLR and RNIS) but excludes CDMA subscriptions. 28) Dec.

Fixed-telephone subscriptions per 100 inhabitants, 2014

1) Includes 277 162 WLL. 2) Preliminary data. 3) Includes PSTN and other fixed-line telephone services. Due to a methodology change in 2014, data reported for 2014 differs from data reported in previous communications reports. In 2014, the total resale (retail services directly connected via another network) and retail services in operation are reported. In previous communications reports, wholesale and retail totals were reported. 4) Incl. ISDN channels measured in ISDN B channels equivalents. 5) December. 6) Source: Colombia TIC. 7) Counting voice channel equivalents, 1'500'250 is the number of subscriptions. 8) Incl. IP lines (110,033). 9) Incl. public payphones. 10) Including ISDN voice-channel equivalents. Data based on estimates. 11) New tax on numbering resources, which has prompted operators to return several numbers, either inactive ones or with low consumption. 12) December 2014. Excluding fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents. 13) Incl. PSTN lines, ISDN paths, FWA subscriptions, public payphones and VOIP subscriptions. 14) December, 2014. The number of fixed public payphones is as of March 2014. (This data is reported by carrier every March). 15) There are Ref.no from 4 main operators, LTC, BEELINE, UNITEL, and ETL. 16) Excl. ISDN channels and fixed wireless subscriptions. 17) From ICT Indicators Survey by PPPC. 18) Active subscribers. 19) Source: January 2015 Management Information System Report. 20) Estimate. 21) End June. 22) Figures are as off 31st December, 2014 based on data received from Fixed Line Operators. 23) Forecast. 24) It is no longer necessary to have a fixed-telephone subscription to be able to have a fixed broadband service. 25) Sudatel terminate its fixed landline, CDMA and GSM services in South Sudan in Oct 2012. 26) Q4 (consolidated end-2014 data not yet available). 27) Refers to March 2014. 28) Estimates. 29) Telecommunications Regulatory Authority (TRA).

Mobile-cellular subscriptions per 100 inhabitants, 2010

1) Number of active clients (yearly reports mobile network operators, MVNO included). 2) Incl. mobile GSM and AMPS post- and pre- mobile base. 3) Both Bhutan Telecom and Tashi Cell provide mobile-cellular services. 4) This value is updated compared to previous releases. Previous data reported was including mobile data services, which is not part of the definition. 5) Incl. mobile-broadband subscriptions via USB keys/datacards from two MNOs. 6) Break in comparability, from this year excluding telemetry subscriptions. 7) Country estimate. 8) Estimate based on June 2010 data. 9) Excl. 1'890'000 prepaid cards that are used to provide travel SIM service. 10) 30th June 2011. 11) Includes data-only subscriptions. 12) Break in methodology: active subscriptions in the last quarter. Previously active subscriptions in the last month. 13) Break in comparability: includes only active mobile-cellular subscriptions. Excl. data-only SIM cards and M2M cards. 14) December. 15) Source: Agcom Annual Report 2011. 16) Including PHS and data cards, undividable. 17) Source: OSB/MOT. 18) Includes inactive subscriptions. 19) Active subscriptions (80.59% total). 20) July 2010. Decrease due to the removal of inactive SIM-cards out of the administrative system of operators. 21) Measured using subscriptions active in the last 90 days. 22) Incl. inactive. 23) M2M included. 24) Active subscriptions. 25) includes active (in the last 6 months) prepaid accounts. 26) Issued SIM cards, incl. inactive. 27) Incl. inactive prepaid subscriptions. 28) Jan 2011. 29) No differentiation between active and non-active subscriptions. 30) Total of five operators. 31) Abonnés GSM + Abonnés CDMA. 32) December. 33) Incl. data dedicated subscriptions.

Mobile-cellular subscriptions per 100 inhabitants, 2014

Note: 1) December. 2) Source: ARPT. 3) Preliminary. 4) Preliminary. Incl. all mobile-cellular subscriptions that offer voice communications, but excludes mobile data subscriptions (via data cards, USB modems and M2M cards). 5) Source: Colombia TIC. 6) Validation process of mobile accounts carried out in 2014, resulting in unverified accounts being disactivated. 7) Suscriptores de voz y voz+datos. 8) Incl. data-only subscriptions. 9) Reduction in multiple sim usage per subscriber (of different network operators). 10) Data from one operator refer to end of Q3. 11) New tax on numbering resources, which has prompted operators to return several numbers, either inactive ones or with low consumption. 13) December 2014. Including fixed wireless local loop (WLL) subscriptions. 14) Estimate. 15) Dec.2014 including PHS and data cards, undividable. 16) There are Ref.no from 4 main operators, LTC, BEELINE, UNITEL, and ETL. 17) Active subscribers. 18) September. Preliminary. 19) End of 2013 year mobile active subscriptions 2’877’584. 20) Source: January 2015 Management Information System Report. 21) Q3 data. Excl. M2M and dedicated mobile broadband. 22) Estimate of subscriptions active in last 90 days. 23) Estimate. Incl. inactive. 24) End June. 25) Figures are as off 31st December, 2014 based on data received from Cellular Mobile Operators. 26) From this year excl. data-only subscriptions. 27) Excl. 495 811 M2M subscriptions. 28) Includes active (in the last 6 months) prepaid accounts. 29) This is the total number of subscriptions from four operators. 30) Q4 (consolidated end-2014 data not yet available). 31) Reduction due to change in accounting method for prepaid subs by major provider. 32) Q3. 33) Incl. data dedicated subscriptions.

International Internet bandwidth Bit/s per Internet user, 2010

1) Mid-year, freely accessible country profile. 2) Incoming capacity. 3) Operators data/ictQATAR estimate. 4) Jan 2011. 5) Potential (installed) capacity.

Percentage of households with computer, 2010

1) Census. 2) Country estimate. 3) HIES Survey report 2010. 4) Data correspond to dwellings (not households). 5) Decrease in values confirmed by Ministry. 6) In electrified areas (98% of households are in electrified areas (with 86.4% in rural areas)). 7) Base is households with at least 1 Singapore citizen or Permanent Resident (PR). 8) Census. Refers to ownership by the household. 9) Refers to two urban districts (Paramaribo and Wanica) where nearly 80% of population live. 10) Including PDAs. 11) Inc. only desktop pc.

Percentage of households with computer, 2014

1) Country estimate. 2) Preliminary. 3) A household is considered to have access only when it is available to all household members at any time. 4) ICT market survey. 5) Computer includes personal computer, notebook and PDA. 6) Preliminary results based on a representative sample of the census.

Percentage of households with Internet, 2010

1) Preliminary results based on 2010 census. 2) Households with Internet access from a home computer. 3) Census. 4) Survey was redesigned in 2010, therefore comparison with previous years should not be done. 5) Data correspond to dwellings (not households). 6) Decrease in values confirmed by Ministry. 7) Does not include dial-up. 8) Based on Ministry survey 2009. 9) In electrified areas (98% of households are in electrified areas (with 86.4% in rural areas)). 10) Base is households with at least 1 Singapore citizen or Permanent Resident (PR). 11) Refers to two urban districts (Paramaribo and Wanica) where nearly 80% of population live. 12) As a % of households with at least one person aged 16 to 74. 13) ITU estimate based on Information and Data on Information and Communication Technology Report, 2010.

Percentage of households with Internet, 2014

1) Country estimate. 2) Incl. access via mobile phones. 3) A household is considered to have access only when it is available to all household members at any time. 4) ICT market survey. 5) Preliminary results based on a representative sample of the census. 6) Incl. access to Internet via mobile phone.

Use indicators

Percentage of individuals using the Internet, 2010

1) Population age 16-74. 2) Population age 7+. 3) Population age 16+. 4) Population age 5+. 5) Country estimate. 6) In the last 3 months. Population 10+. 7) Population age 16-74. 8) Population age 16+. Survey was redesigned, therefore comparison with previous years should not be done. 9) Estimated based on surveys’ results. Population age 5+. 10) Population age 5+ using Internet in the last 3 months. 11) Incl. users of the international network and also those having access only to the Cuban network. 12) Population age 6+. 13) Population age 10+. 14) Population age 16-74, in the last 3 months. 15) Break in comparability: persons 12 years and older. Based on Census 2010 results. 16) Refers to total population. 17) Population age 20+. 18) Population age 14+. 19) According to annual sample surveys. Population age 16-74. 20) Population age 3+. 21) Estimate based on population aged 15+. 22) Population age 16-74 using Internet in the last 12 months. 23) Population age 15+. Census. 24) Estimate to December based on ENDUTIH survey. Refers to total population. 25) Estimate for population age 6-74 in electrified areas (98% of households are in electrified areas (with 86.4% in rural areas)). 26) December. 27) Population age 16-74 using Internet in the last 12 months. 28) Population age 5+. Census. 29) Multipliers were applied to residential and

commercial subscriptions, taking into account the average size of households and employees per business. 30) Population age 10+ using internet in the last 3 months. 31) Refers to total population. Survey result: 16% for population age 12+. 32) Estimated based on proportion of resident Internet users (aged 7 & above) from IDA's annual survey on infocomm usage in household and by individuals. 33) Population age 16-74 in the last 3 months (source: Eurostat). 34) CMT's survey. Population age 10+. 35) Census. 36) Population age 16-75. 37) In the last 6 months. Population age 14+. 38) NTIA/CPS survey.

Percentage of individuals using the Internet, 2014

1) Population age 16-74. 2) Population age 15+. 3) Population age 6+. 4) Population age 5+. 5) Country estimate. 6) Population age 3+. 7) Population age 6+. 8) Population aged 5 to 75 using Internet in the last 3 months. 9) Population age 10+ using internet in the last 3 months. 10) Individuals aged 15 to 72 years. 12) Refers to total population. 13) Country estimate. 14) In the last 6 months. Population age 14+. 15) Population age 6+. Break in comparability since total population estimates were revised and lower than in 2013. 16) Population age 16-74 in the last 12 months. 17) Population age 15-74 in the last 3 months.

Fixed-broadband subscriptions per 100 inhabitants, 2010

1) Internet Activity Survey, December. 2) Incl. fixed wireless broadband. 3) From this year excl. FWA. 4) Incl. narrowband subscriptions (i.e. below 256kbit/s). 5) Refers to speed greater than, or equal to 64kbit/s in one or both directions. 6) Speeds equal to or greater than 144 kbit/s. 7) Includes ADSL connections at 128kbps. 8) Break in comparability: as of 2010 >=256 kbits/s. 9) Estimate based on June 2010 data. Incl. a small part of ISDN (i.e. narrowband). 10) September 2012. 11) December. 12) Decline was due to subscribers switching to wireless technologies. 13) Only ETL and LTC. 14) 1Mbit/s and more (ADSL). 15) Speeds equal to or greater than 144 kbit/s. 16) Operators data/ictQATAR estimate. 17) Incl. subscriptions at downstream speeds equal to, or greater than, 144 kbit/s (the number of subscriptions that are included in the 144-256 range is very low). 18) Jan 2011. 19) Mainly government offices. Preliminary. 20) ADLS and leased line subscriptions. 21) Excl. 3264 WiMax subscriptions. 22) Excl. corporate connections. 23) Data reflect subscriptions with associated transfer rates exceeding 200 kbps in at least one direction, consistent with the reporting threshold the FCC adopted in 2000.

Fixed-broadband subscriptions per 100 inhabitants, 2014

1) Source: ARPT. 2) Preliminary. 3) Internet Activity Survey, June 2014. 4) December. 5) Estimated. There is no specific data collected for ≥ 256 kbit/s. 6) Estimate. 7) Source: Colombia TIC. 8) Preliminary data. Incl. WiFi subscriptions (not WiFi hotspots). 9) Incl. 144 kbit/s to less than 256 kbit/s. 10) Does not incl. data from cable operators. 11) Fixed WiMAX. 12) Speeds greater than, or equal to, 1 Mbit/s. 13) December 2014. These are the subscriptions with the minimum download speed of 512 kbps. This is as per the revised definition of Broadband (>= 512kbps) in India. 14) Incl. DSL and cable subscriptions. 15) There are Ref.no from 4 main operators, LTC, BEELINE, UNITEL, and ETL. 16) September. Preliminary. 17) Source: January 2015 Management Information System Report. 18) Q3. 19) End June. 20) Figures are as off 31st December, 2014 based on data received from Broadband Operators. 21) June. 22) Incl. subscriptions at downstream speeds equal to, or greater than, 144 kbit/s (the number of subscriptions that are included in the 144-256 range is insignificant). 23) Q4 (consolidated end-2014 data not yet available). 24) Q3. 25) Excl. 2,878 WiMAX subscriptions. 26) 2014 data is an estimate as of June 30, 2014. Data reflect subscriptions with associated transfer rates exceeding 200 kbps in at least one direction, consistent with the reporting threshold the FCC adopted in 2000. 27) Incl. ADSL and FTTH + LMDS. 28) This is the correct figure for 2014- includes xDSL, fixed wireless data subscription and fixed broadband internet subscribers. The figure excludes prepaid wireless internet subscriptions. Increase from 2013 has been due to operators investing in fiber optic cable and landing of the submarine cable in Vanuatu in Jan 2014 has increased capacity and reduced price thus increasing the number of subscribers. 29) ISP subscribers with internet speed of at least 256 kbps.

Active mobile broadband subscriptions per 100 inhabitants, 2010

1) Internet Activity Survey, December. 2) Incl. subscriptions with a download volume of at least 250MB incl. in the monthly fee and prepaid products with at least 750MB being downloaded per quarter. 3) Includes dedicated mobile-broadband subscriptions. 4) 3G services only available in Thimphu. 5) Incl. GPRS, WCDMA and CDMA2000. 6) Speeds equal to or greater than 144 kbit/s. 7) Incl. only subscriptions that pay a recurrent monthly fee to access the Internet. 8) Excl. prepaid mobile-broadband subscriptions. 9) Incl. data-only subscriptions. 10) Parc actif 3G utilisateurs actifs (clés 3G inclus). 11) Methodology changed from ability to have mobile broadband to actual mobile broadband usage. 12) WCDMA, EVDO, LTE subscriptions. 13) ETL and LTC. 14) OSB/MOT. 15) 3G subscriptions (prepaid+postpaid). 16) Equal to dedicated mobile-broadband subs as CAM does not report on standard mobile-broadband pay-as-you-go subscriptions due to inaccuracy of available data. 17) ARE reported 17'971 mobile Internet subscriptions in 2010 but this includes EDGE/GPRS/CDMA 1X. 18) Break in comparability: from this year, incl. all active mobile-broadband subscriptions. 19) Only dedicated mobile-broadband subscriptions. 20) EVDO+3G. 21) December 2010. 22) EVDO. November 2010. 23) Only USB/dongles/datacards. 24) Refers to dongle/USB-based access only. 25) Operators data/ictQATAR estimate. 26) Excl. add-on data packages. 27) Jan 2011. 28) Break in comparability: from this year incl. standard mobile-broadband subscriptions. 29) 3G and EvDo. 30) January 2011. 31) Incl. subscriptions with potential access.

Active mobile broadband subscriptions per 100 inhabitants, 2014

1) Source: ARPT. 2) December. 3) Preliminary. Counting plans that allow mobile-broadband access and are using LTE, WCDMA and CDMA2000 enabled devices. 4) Preliminary. 5) Il est difficile de distinguer les utilisateurs de la 2G de 3G et 4G. 6) 3G and other more advanced mobile connections of at least 256 Kbit/s. 7) Source: Colombia TIC. 8) Does not incl. prepaid smartphones. 9) Speeds equal or greater than 1 Mbit/s. 10) December 2014. These are the subscriptions with the minimum download speed of 512 kbps. This is as per the revised definition of Broadband (>= 512 kbps) in India. 11) In 2014, 3G and 4G licenses were awarded to the two largest mobile operators (Hamrahe Avval and IranCell). 12) Users who have made a transaction in the last 90 days via a handset, dongle/USB modem or other mobile Internet device, whereby they accessed advanced data services such as web/Internet content, online multiplayer gaming content, VoD or other equivalent data services (excluding SMS and MMS). 13) Estimate. 14) Dec.2014. Including standard and dedicated mobile broadband Wimax. 15) There are Ref.no from 4 main operators, LTC, BEELINE, UNITEL, and ETL. 16) 3G subscriptions (prepaid+postpaid) provided instead, as all 3G subscriptions provide download speeds of at least 256 kbits/s when enabled. Users may disable/enable their mobile-broadband functionality via USSD code, via service hotline or in person. The number of 3G subscribers who have disabled their mobile-broadband functionality is not collected. Internet usage statistics of individual users are not collected either. 17) Equal to dedicated mobile-broadband subs as CAM does not report on standard mobile-broadband pay-as-you-go subsriptions.18) Lignes ayant réalisé des connections data sur les 3 derniers mois. 19) Source: January 2015 Management Information System Report. 20) Q3. 21) Estimate. 22) June. Subscriptions generating >0.5MB/month + data-only subscriptions + add-on data packages. 23) Figures are as off 31st December, 2014 based on data received from Broadband and cellular mobile operators. 24) June. Only USB/dongles/datacards. 25) Includes active subs (in the last 6 months), by 3G and higher technologies. 26) Q4 (consolidated end-2014 data not yet available). 27) Value for last year was 59701. 28) Q3. 29) Estimate. Incl. M2M subscriptions. 30) 2014 data is an estimate as of June 30, 2014. 31) Incl. subscriptions with potential access. 32) Blackberry and other mobile broadband subscriptions.

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