Measuring the Information Society Report

2015

Executive summary

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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.

Brahima Sanou
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1 Monitoring global ICT goals and targets

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 that were intended to measure progress towards that vision (ITU, 2005). In December 2015, the United Nations General Assembly will complete its ten-year review of the implementation of WSIS outcomes. This review takes place in the context of the United Nations' 2030 Agenda for Sustainable Development, adopted in September 2015, which includes sustainable development goals (SDGs) aimed at enhancing economic prosperity, social welfare and environmental sustainability over the next fifteen years.

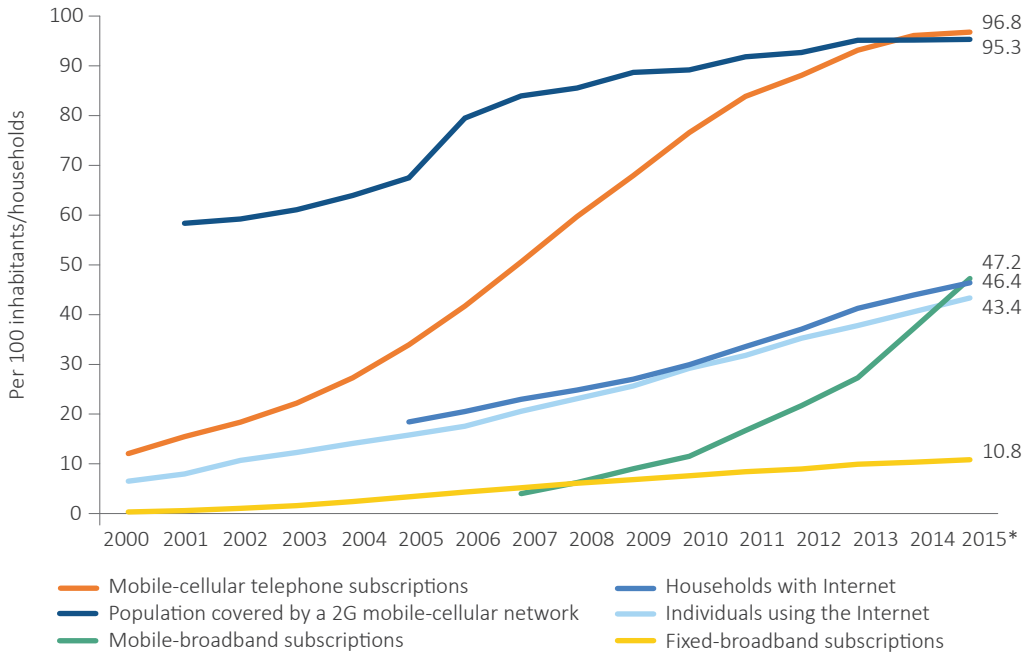
Since WSIS, there has been substantial growth in access to and use of ICTs.

In the ten years since WSIS, ICT access and use have grown substantially, particularly where mobile services and the Internet are concerned.

The proportion of the global population covered by mobile-cellular networks is now over 95 per cent, while the number of mobile-cellular subscriptions has risen from 2.2 billion in 2005 to an estimated 7.1 billion in 2015 (Chart 1.1). Growth in mobile-cellular penetration worldwide has slowed as the number of subscriptions approaches that of global population, though there is still some way to go in achieving universal mobile access and usage in developing countries. There has been a slow but steady decline in the number of fixed-telephone subscriptions worldwide, from 1.25 billion in 2005 to an estimated 1.06 billion in 2015, partly due to fixed-mobile substitution.

The number of mobile-broadband subscriptions worldwide has grown from 0.8 billion in 2010 to an estimated 3.5 billion in 2015, though the number of fixed-broadband subscriptions has risen much more slowly, to an estimated 0.8 billion today. The number of Internet users has also grown rapidly, and is now estimated at over 40 per cent of the world's population (Chart 1.1).

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



Note: *ITU estimates.
Source: ITU.

There are still substantial digital divides, both between and within countries.

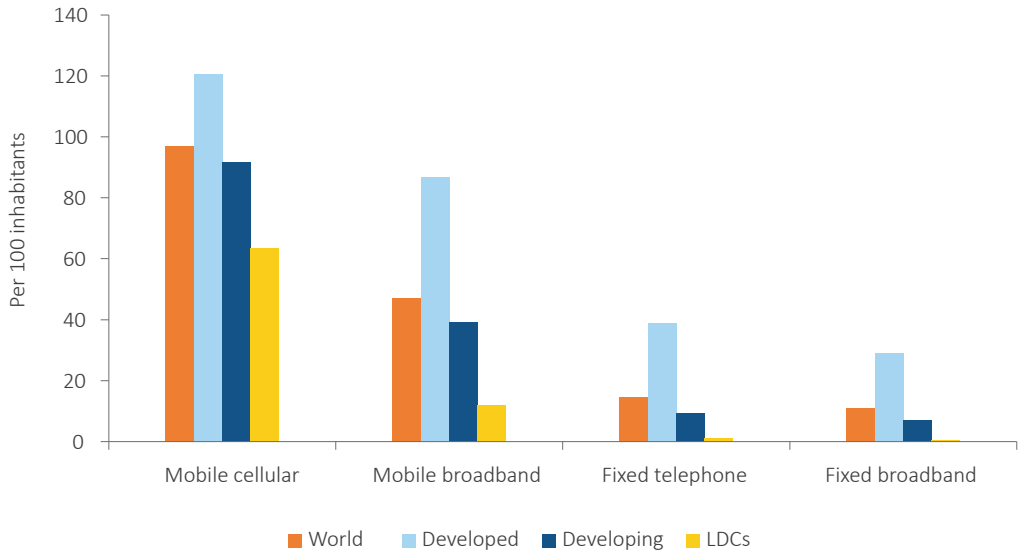
There continue to be substantial differences in fixed and mobile telephone and broadband penetration rates between countries in different development groupings (Chart 1.2). Developing countries still lag behind developed countries in access to ICTs, and least developed countries (LDCs) are particularly disadvantaged. Access to ICTs and the Internet is also much lower in some regions than others, with penetration rates in Africa lagging behind those elsewhere.

Digital divides are found within as well as between countries, particularly between urban and rural areas. A significant digital divide persists between men and women in many countries, and there are widespread divides between those with higher and lower incomes.

The Connect 2020 Agenda sets out a series of goals and targets for improvements in the growth and inclusiveness of ICTs, their sustainability and the contribution of innovation and partnerships.

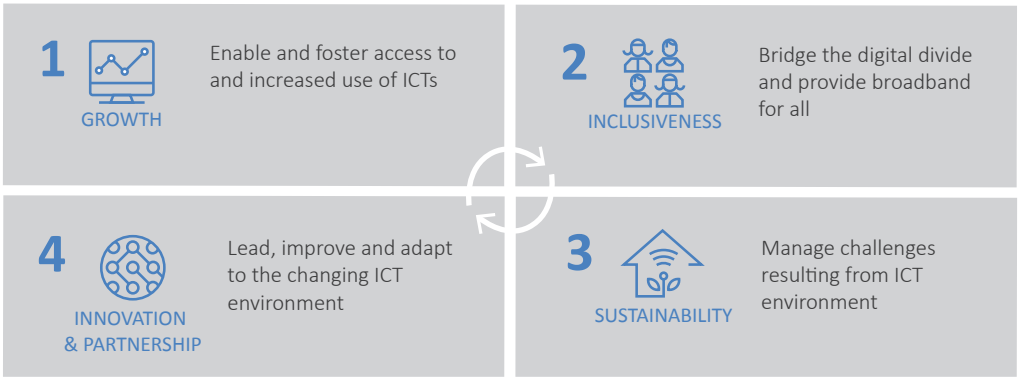
In 2014, recognizing the need to monitor, address and overcome the digital divide, the ITU Plenipotentiary Conference adopted the Connect 2020 Agenda. It includes four goals, with seventeen targets, to monitor and stimulate the development of the ICT sector between 2015 and 2020 (Figure 1.1).

Chart 1.2: ICT access by development status, 2015*



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

Figure 1.1: The Connect 2020 Goals



Source: ITU.

The Connect 2020 Agenda's seventeen targets have been designed to assist the international community in monitoring and measuring progress towards ICT access for all, covering the areas of ICT growth, inclusiveness, sustainability and innovation and partnership (Table 1.1). They provide the basis for enabling ICTs to contribute fully towards the 2030 Agenda for Sustainable Development.

The proportion of households with Internet access is expected to exceed the Connect 2020 target worldwide, but more needs to be done to increase the number of Internet users.

The Connect 2020 Agenda seeks to ensure that at least 55 per cent of households worldwide have Internet access by 2020, compared to an estimated 46.4 per cent in 2015. ITU predicts that 56 per cent of households worldwide will have Internet access by 2020, and that the Connect 2020 target for household access will therefore be met (see Chart 1.3).

The Agenda seeks to ensure that at least 60 per cent of individuals worldwide use the Internet by 2020. It is estimated that in 2015 43.4 per cent of individuals worldwide are online, a rise of 2.8 per cent on 2014. ITU predicts that 53 per cent of individuals worldwide will be using the Internet by 2020, and that further policy initiatives will be required to foster greater take-up in order to achieve the target (see Chart 1.4).

More action is needed to ensure that targets for growth and inclusiveness are not missed in developing countries, in particular LDCs.

It is a priority for the international community to address the digital divides between developed and developing countries. At present, access to the Internet is much more prevalent in developed than in developing countries. In particular, the world's LDCs are lagging behind (Charts 1.5 and 1.6).

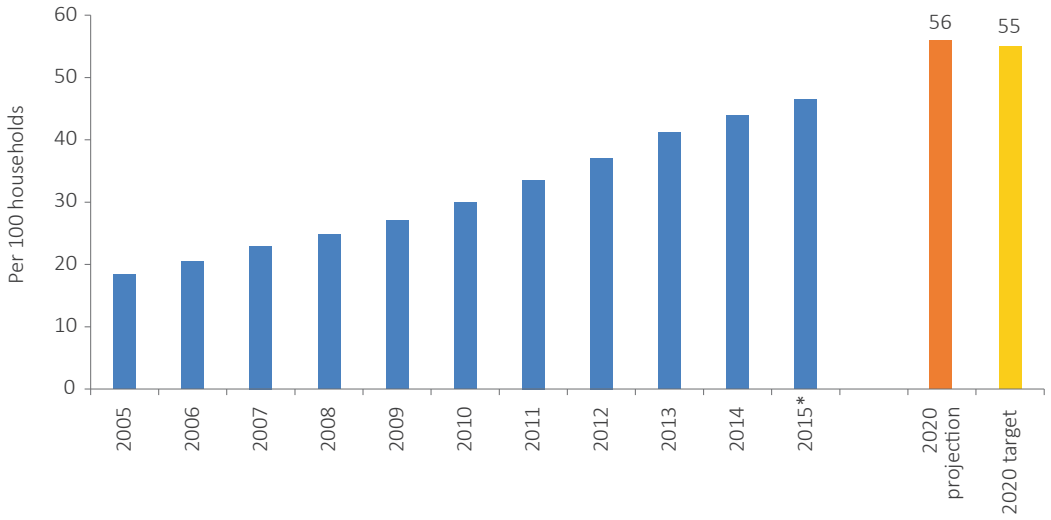
The Connect 2020 Agenda aims to ensure that at least 50 per cent of households in developing countries and at least 15 per cent of households in LDCs have access to the Internet by 2020. ITU estimates that 45 per cent of households in developing countries and 11 per cent of households in LDCs will have Internet access by that date.

Table 1.1: The Connect 2020 Goals and Targets

Goal 1. Growth – Enable and foster access to and increased use of telecommunications/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/ICT environment
4.1 Telecommunication/ICT environment conducive to innovation
4.2 Effective partnerships of stakeholders in telecommunication/ICT environment

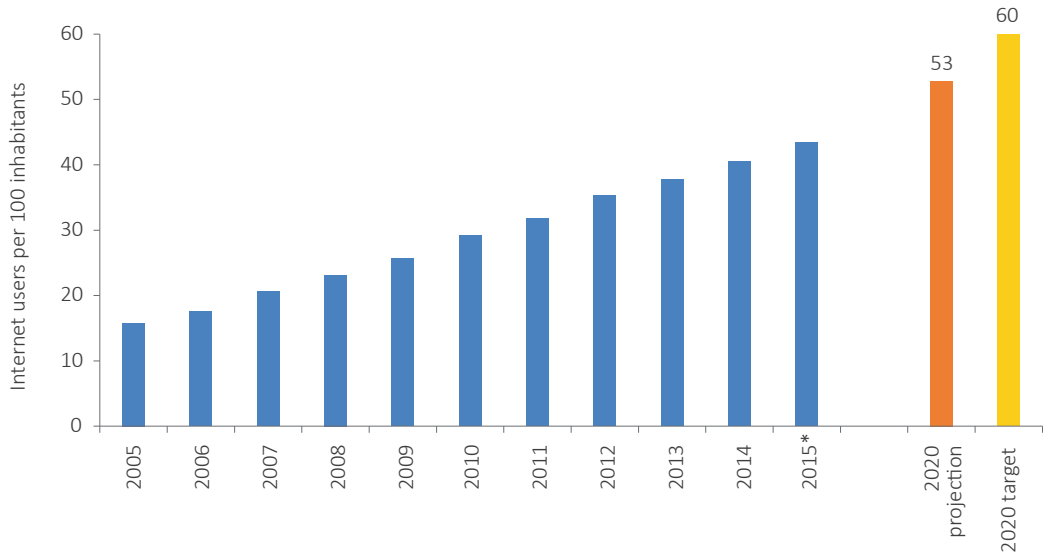
Source: ITU.

Chart 1.3: Households with Internet access worldwide, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU.

Chart 1.4: Percentage of individuals using the Internet worldwide, 2005-2015*, against target and 2020 projection



Note: * Estimate.
Source: ITU

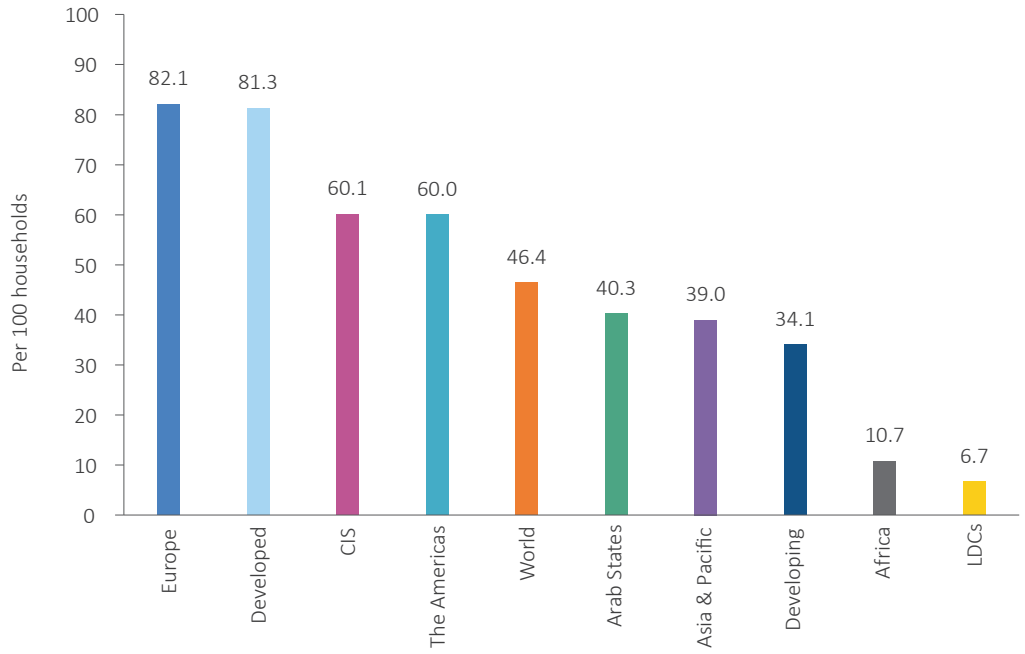
The Agenda also aims to ensure that at least 50 per cent of individuals in developing countries and at least 20 per cent of individuals in LDCs will use the Internet by 2020. Based on current trends, ITU estimates that only 46 per cent of those in developing countries and 16 per cent of those in LDCs will use the Internet by then.

These indicators show that further action is needed to ensure that developing countries, and particularly LDCs, are fully included in the information society. Regulatory changes and further investments, including public-private partnerships, will be required to achieve these targets, together with further improvements in technology and affordability.

There have been substantial improvements in the affordability of broadband services since 2012, but services remain too expensive for many people in developing countries.

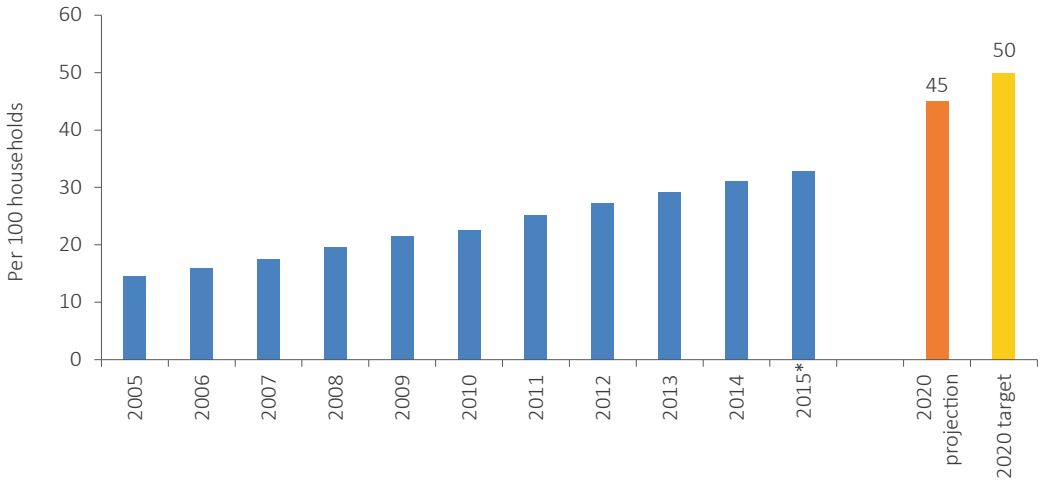
The Connect 2020 Agenda calls for telecommunications/ICTs to be 40 per cent more

Chart 1.5: Households with Internet access, by region and development status, 2015*



Note: * Estimate.
Source: ITU.

Chart 1.6: Households with Internet access, developing countries, 2005-2015*, against target and 2020 projection

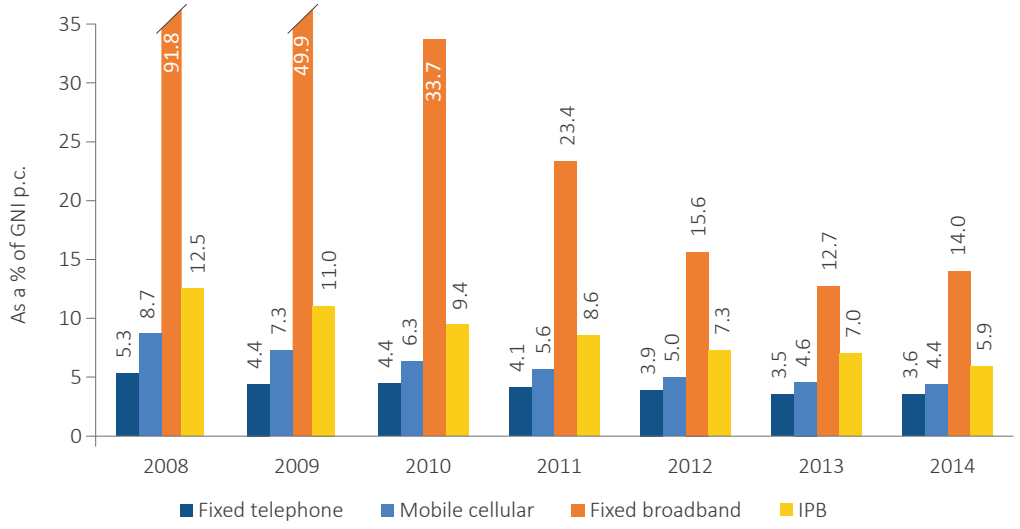


Note: *ITU estimates.
Source: ITU.

affordable worldwide in 2020 than in 2012, for the affordability gap between developed and developing countries to be reduced by 4 per cent, and for the cost of broadband services to be no more than 5 per cent of average monthly income by that date.

ITU measures prices for fixed and mobile telephony and broadband, in relation to average monthly income (GNI p.c.), through the ICT Price Basket (see Chapter 4). Prices for ICT services have become more affordable in recent years, particularly in LDCs (Chart 1.7). In particular, 29 per cent of the reduction in mobile-cellular prices needed to meet the global target was achieved between the baseline date of 2012 and 2014, a period which also saw sharp reductions in mobile-broadband prices.

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.

By early 2015, 111 economies (out of 160 with available data) had achieved the target that the cost of broadband services should be no more than 5 per cent of average monthly income. However, 22 developing countries still had broadband prices which were more than 20 per cent of average monthly income.

These findings indicate that significant progress has been achieved in improving affordability, but that sustained regulatory and policy attention will be required to ensure continued price reductions in order to achieve affordability targets, particularly in developing countries.

In 2015, only 29 per cent of the world's rural population was covered by a 3G network.

The Connect 2020 Agenda seeks to ensure that 90 per cent of the rural population worldwide is covered by broadband services by 2020. In most countries, connectivity has tended to favour urban areas, which have higher aggregated demand and secure earlier returns on investment. ITU estimates that 95 per cent of the world's population is now covered by a mobile-cellular signal. However, while 3G network coverage grew from 45 to 69 per cent of world population between 2011 and 2015, 3G networks remain absent from many rural areas in low-income countries, especially in Africa (Chart 1.8).

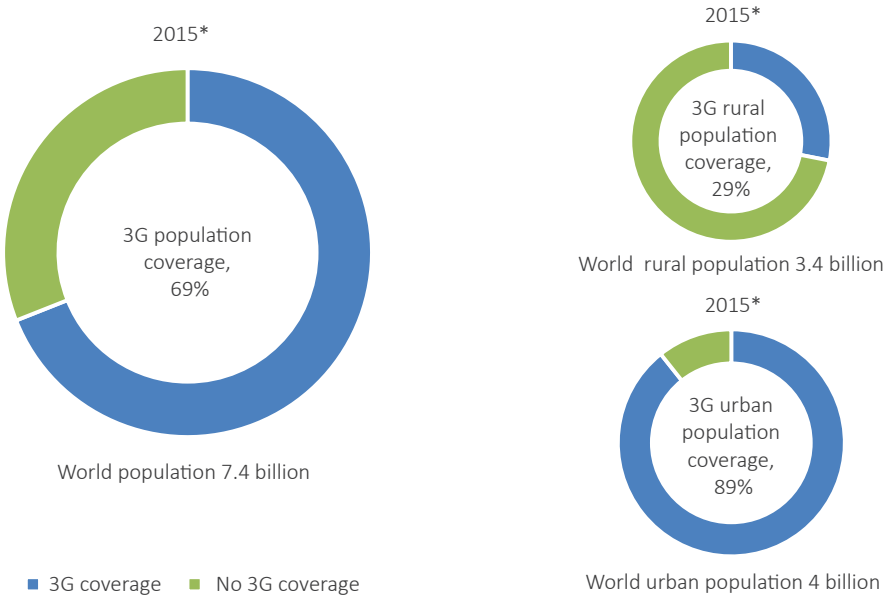
There is a significant divide in ICT access and use between men and women, and the gender gap is higher in developing countries and LDCs.

ICT access is important for gender equality because it enables women to achieve greater independence, improves access to economic and social opportunities, and facilitates empowerment. However, there are significant differences in levels of Internet access between men and women (Chart 1.9), which reflect inequalities in income, education and other structural inequalities between men and women in many economies and societies. The Connect 2020 Agenda aims to secure gender equality among Internet users by 2020.

ITU estimates that there is a gap of some 11 per cent in Internet use between men and women worldwide (Table 1.2). This gap is higher in developing countries (15.4 per cent) than in developed countries (5.4 per cent), and is particularly high in LDCs (28.9 per cent). The gap appears to have narrowed in developed countries between 2013 and 2015, but to have remained stable in developing countries.

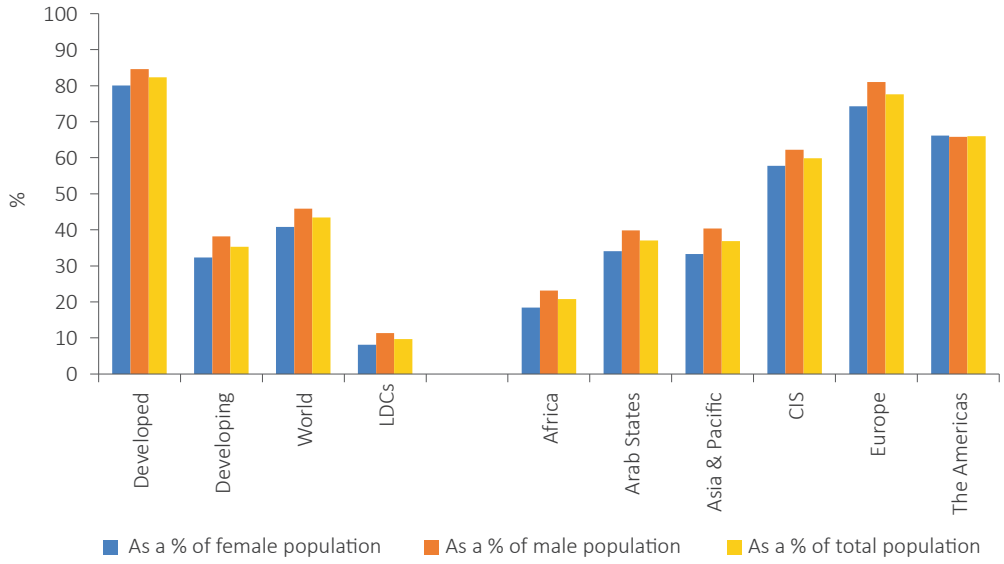
Persons with disabilities, who account for 15 per cent of the world's population, are often disadvantaged in ICT access and use. The Connect 2020 Agenda seeks to ensure that enabling policy and practitioner environments for telecommunications/ICTs are established in all countries by 2020 to ensure greater accessibility

Chart 1.8: Population coverage by 3G networks, urban and rural areas, 2015*



Note: * Estimate.
Source: ITU ICT Facts and Figures: the World in 2015..

Chart 1.9: Percentage of individuals using the Internet, by gender, development status and region, 2015*



Note: * Estimate.
Source: ITU.

for persons with disabilities. Data concerning policy and regulatory frameworks for accessibility are now being gathered through ITU's annual regulatory survey, and will be reported in the 2016 edition of the *Measuring the Information Society Report*.

Threats to cybersecurity and the impact of ICTs on the environment pose important challenges which must be addressed within the 2030 Agenda for Sustainable Development.

Cybersecurity has become an increasingly important issue in the information society. Threats to cybersecurity undermine the ability of governments, businesses and individual users

Table 1.2: Gap in Internet user penetration rate between men and women, 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 gain maximum advantage from ICTs and the Internet.

More attention needs to be paid by policy-makers to ensuring access for persons with disabilities.

The Connect 2020 Agenda aims to ensure that cybersecurity readiness should be improved by 40 per cent by 2020. ITU has worked with ABI Research to establish a Global Cybersecurity Index to measure different countries' commitment and preparedness in respect of cybersecurity. Countries in North America show the highest level of cybersecurity preparedness, and developed countries in general show higher levels of preparedness than developing countries (Figure 1.2).

In 2014, 42 million tonnes of e-waste were generated globally, of which six million tonnes were ICT-related.

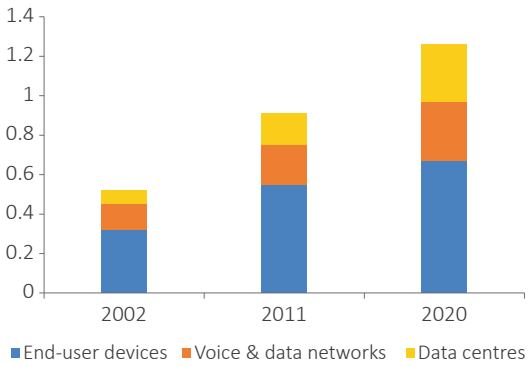
The use of ICTs can help to mitigate environmental challenges through the more efficient use of energy and natural resources. However, the ICT sector also adds to environmental challenges, in particular by generating waste and greenhouse gas emissions (GHGs).

The Connect 2020 Agenda seeks to reduce the volume of redundant e-waste by 50 per cent by 2020. The United Nations University estimates that 42 million tonnes of e-waste were generated globally in 2014, of which six million tonnes were ICT-related. This target can be addressed through a combination of activities concerned with different stages of the ICT product lifecycle, including manufacturing, standards and licensing, trade, recycling and disposal. ITU is working with other agencies to establish a baseline and methodologies for measuring progress towards this target.

The ICT sector is working to reduce GHGs arising from ICT manufacture and use.

The Connect 2020 Agenda aims to reduce GHGs generated by the sector by 30 per cent per device by 2020. GHG emissions from the ICT sector are expected to rise by 3.8 per cent per year between 2011 and 2020, increasing the sector's contribution to 2.3 per cent of total emissions by 2020. These emissions result from the manufacture and use of devices, from data transmission, and from the increasing role of data centres (Chart 1.10). ITU is working with other agencies to reduce the ICT sector's own emissions and to highlight potential positive impacts of ICTs in mitigating GHG emissions from all sectors, within the context of the United Nations Framework Convention on Climate Change.

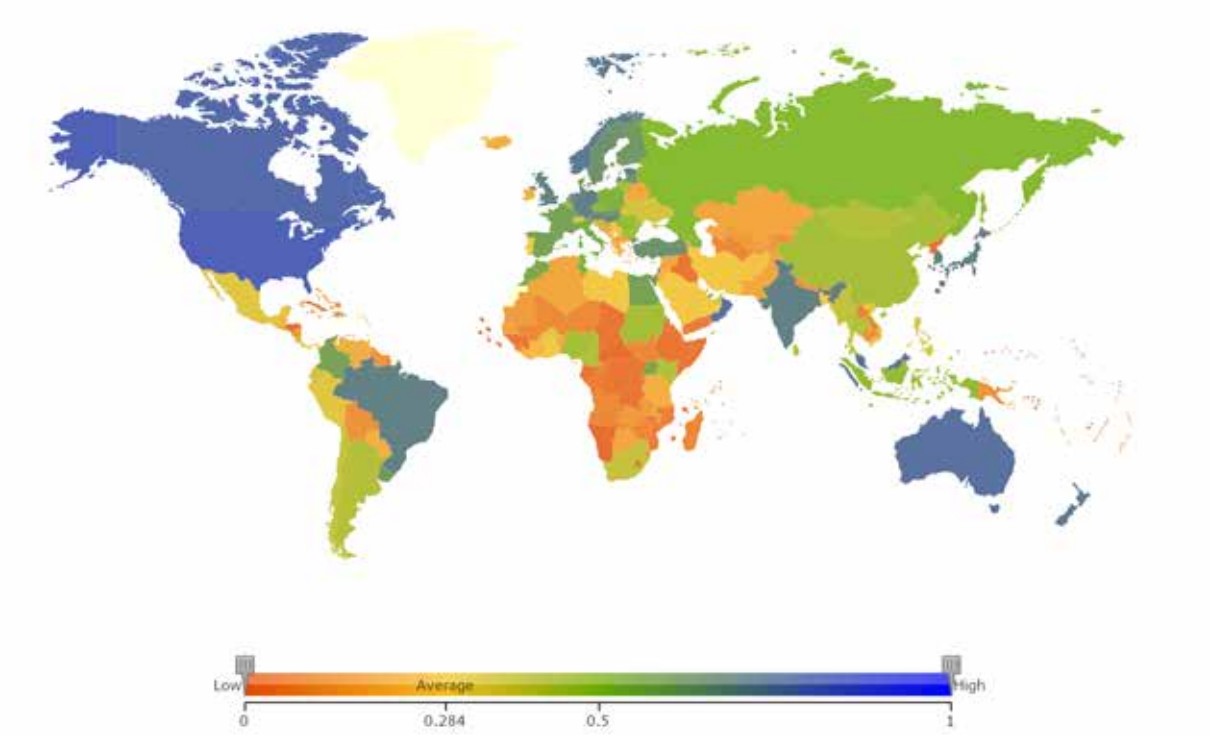
Chart 1.10: Global ICT emissions (gigatonnes of CO_2 equivalent – GeSI estimates and projections)



Source: UNCTAD, *Implementing WSIS Outcomes: a ten-year review 2015*, derived from GeSI, *SMARTer 2020: the role of ICT in driving a sustainable future, 2011*.

The Connect 2020 Agenda seeks to develop a telecommunication/ICT environment which is conducive to innovation and to support effective partnerships between stakeholders. Innovation is widely recognized as a powerful driver of development. The enabling environment for investment and innovation has been critically important to the rapid growth of the ICT sector for many years, and needs to be prioritized by governments. Partnerships, including public-

Figure 1.2: Levels of cybersecurity, 2014 Global Cybersecurity Index



Source: ITU and ABI Research. *Global Cybersecurity Index and Cyberwellness Profiles 2014*.

private and other multistakeholder partnerships, have also proved effective drivers of the dynamism that has been apparent in the sector. ITU is working with other agencies to develop indicators that can measure achievement of these targets.

ICTs are critically important to the development of a people-centred, inclusive and development-oriented information society and to achievement of the SDGs.

The 2030 Agenda for Sustainable Development 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' (UNGA, 2015). ICTs will therefore play a crucial role in supporting the implementation of all the SDGs in that Agenda. In addition, the Agenda call for 'significantly increase[d] access to information and communications technology' and for the international community to 'strive to provide universal and affordable access to the Internet in least developed countries by 2020' (SDG 9.c). The Connect 2020 Agenda provides a firm basis for achieving progress towards this goal. ITU is also working with partners to establish ICT indicators for measuring progress towards the SDGs in general, and a framework for integrating the implementation of WSIS action lines with the 2030 Agenda for Sustainable Development.

2 The ICT Development Index (IDI) – global analysis

The ICT Development Index (IDI) is a composite index combining eleven 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 (Figure 2.1). The main objectives of the IDI are to measure:

- the *level and evolution over time* of ICT developments in countries and the experience of those countries relative to other countries;
- 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.

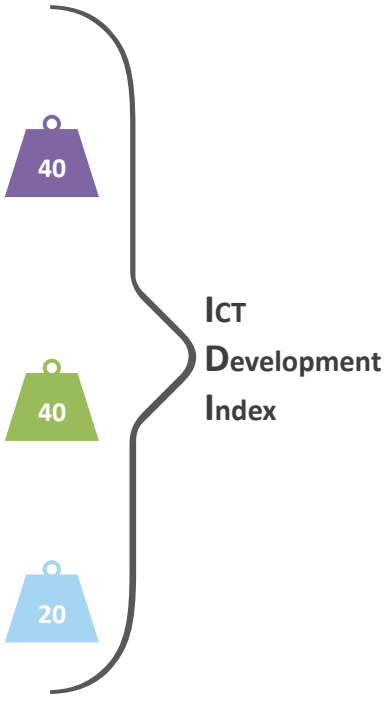
The IDI is divided into three sub-indices: the access sub-index, the use sub-index and the skills sub-index, which capture different aspects of the ICT development process. The report presents IDI values for 167 economies based on data gathered at the end of 2014 (IDI 2015) and compares these with data relating to 2010 (IDI 2010).

All countries improved their IDI values between 2010 and 2015, but the disparity between the highest and lowest remains unchanged.

The IDI results show that all countries increased their IDI values between 2010 and 2015. The average IDI value rose by 0.89 points from 4.14 in 2010 to 5.03 in 2015, with smaller rises at the top and bottom of the distribution. While this illustrates continued growth in ICT access and use, the results also highlight the wide range of ICT development, with IDI values ranging from 1.17 to 8.93 (Table 2.1). The same countries – the Republic

Figure 2.1: 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.

Table 2.1: 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.

of Korea and Chad, respectively – were at the top and bottom of the distribution in 2015 as in 2010, with the same disparity (7.76 points) between them. There has been a widening of the gap in IDI values between middle-ranking countries and the group of least connected countries (LCCs) at the bottom of the distribution.

The Republic of Korea leads the IDI rankings for 2015, as it did in 2010.

The Republic of Korea leads the IDI rankings for both 2010 and 2015, with an IDI value which has risen from 8.64 to 8.93. Eight of the top ten economies in the rankings for 2015 are from Europe (Denmark, Iceland, the United Kingdom, Sweden, Luxembourg, Switzerland, the Netherlands and Norway), alongside one further economy in Asia (Hong Kong (China)). These are all high-income economies, reflecting the strong association between high levels of IDI performance and of national income (GNI p.c.). There has been relatively little change in the highest performers in the Index since 2010. All ten economies which were in the top ten performers in 2010 were in the top twelve in 2015. The average IDI value for the top ten performers during the period rose by 0.62 points to 8.68. This growth was predominantly due to improvements in usage (the sub-index for which rose by 1.82 points) rather than in access (the sub-index for which rose by 0.24 points).

Top IDI performers have high income levels, competitive markets and a skilled population base…

The upper quartile of economies in the Index, all of which have IDI values of 7.00 and above, include 28 countries from Europe together with high-income countries in the Asia/Pacific and Americas regions, and three States from the Arab region (Bahrain, United Arab Emirates and Saudi Arabia). Only four countries – these three Arab States and Belarus – joined the upper quartile between 2010 and 2015, illustrating the consistency of improvements in high-performing economies.

The top quartile of IDI performers generally share a number of common characteristics that help to explain their high levels of ICT access and use. These include liberalized and competitive markets that encourage innovation, and populations with relatively high incomes and the skills to make effective use of ICTs. In addition, all top IDI performers benefit from abundant international Internet bandwidth. High levels of Internet connectivity at home and widespread availability of affordable broadband have enabled high levels of Internet usage in these countries.

… but dynamic improvements in performance are found at all levels within the distribution.

Positive regulatory frameworks have enabled a number of countries, with different levels of performance in 2010, to improve their positions in the rankings between that year and 2015. The most dynamic countries in the IDI between 2010 and 2015, in IDI values and rankings, were Bahrain, Costa Rica and Lebanon, while the Arab States region included six of the twelve most dynamic countries. The experience of these countries is described in Chapter 3.

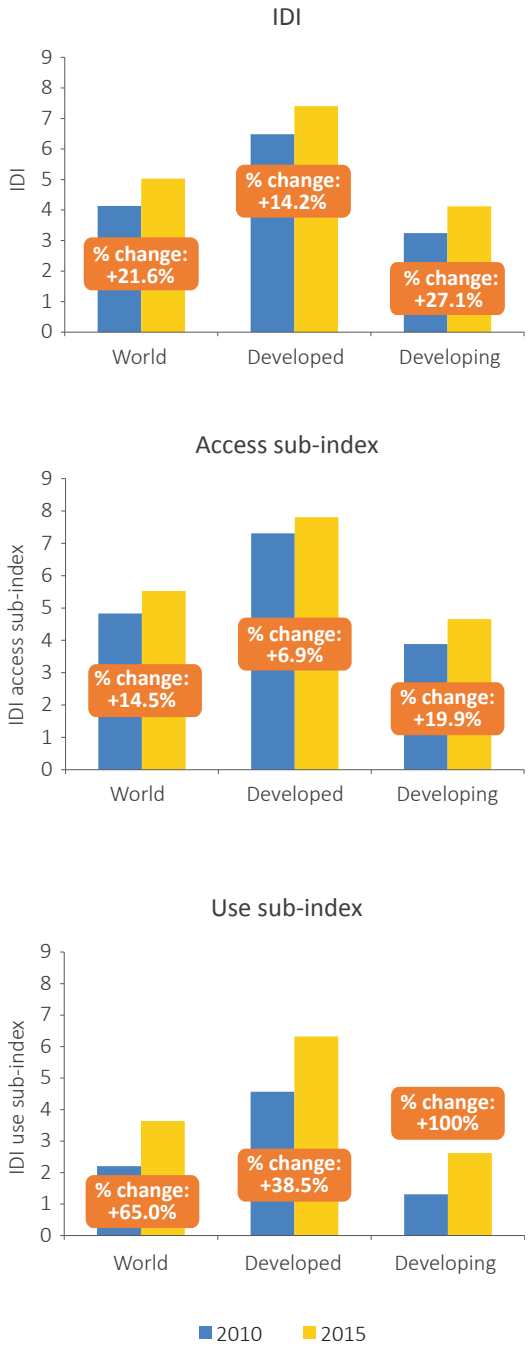
At the lower end of the rankings, all 43 countries in the lowest quartile have values below 3.00, and 13 have IDI values below 2.00. The Africa region accounts for 29 of the countries in the lowest quartile, along with three countries on the African continent which are in the Arab States region, eight countries in Asia, two in the Pacific and one in the Caribbean. Nine of the ten lowest ranking countries in 2010 remained in that group in 2015.

Significant disparities remain in ICT development between developed and developing countries, with LDCs falling behind other developing countries.

The report confirms that, although some developing countries in the Asia/Pacific and Arab States regions are among high performing countries (including the overall top performer, the Republic of Korea), there is a strong correlation between IDI values and development status. Chart 2.1 shows that the gap between developed and developing countries is both substantial and persistent. The average gap between these two groups in the overall Index rose marginally, from 3.24 to 3.29 points, between 2010 and 2015. The disparity between them in the access sub-index fell slightly, from 3.42 points to 3.15, while that in the use sub-index rose from 3.26 to 3.71.

The IDI performance of LDCs was generally poorer between 2010 and 2015 than that of higher- and middle-income developing countries, rising by only 0.56 points overall compared with the average of

Chart 2.1: IDI ratings by development status, 2010 and 2015



Source: ITU.

0.88 points for all developing countries and 0.89 for all countries. The bottom twenty countries in the Index are all LDCs. The comparison of LDCs with other development groupings in Table 2.2 confirms that LDCs are falling behind in overall IDI values. The divergence between LDCs and other countries is most serious in the use sub-index, where the average sub-index for LDCs rose by 0.51 points compared with an average of 1.31 for all developing countries and 1.43 for all countries. This suggests that LDCs may also be falling behind in their ability to derive developmental gains from ICTs.

There is a strong association between LCCs and LDCs.

As well as assessing the gap between developed and developing countries, the report considers the relative performances of countries in four quartiles determined by their overall IDI performance: high, upper, medium and low performance countries. The distribution of countries in these quartiles is illustrated in Figure 2.2. Those in the lowest category are considered LCCs. Of the 42 LCCs, 34 are also LDCs, while only one LDC – Bhutan – does not fall in the lowest quartile.

Chart 2.2 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. While progress was achieved in all four quartiles, the minimum IDI value in the LCC quartile rose only from 0.88 in 2010 to 1.17 in 2015, much less than the minimum values for other quartiles, while the average IDI value for the LCC quartile rose from 1.61 to 2.16 points. This suggests that the performance of countries in the lowest quartile is sluggish relative not only to the IDI as a whole but also relative to other developing countries.

The same countries tend to achieve high performance in both the access and use sub-indices.

There is a strong level of association between rankings in the overall Index and those in the access and use sub-indices. Eight of the ten top economies in the overall Index fall into the top ten in each of these sub-indices, and there is similar consistency among those ranking lowest in the overall Index and these sub-indices.

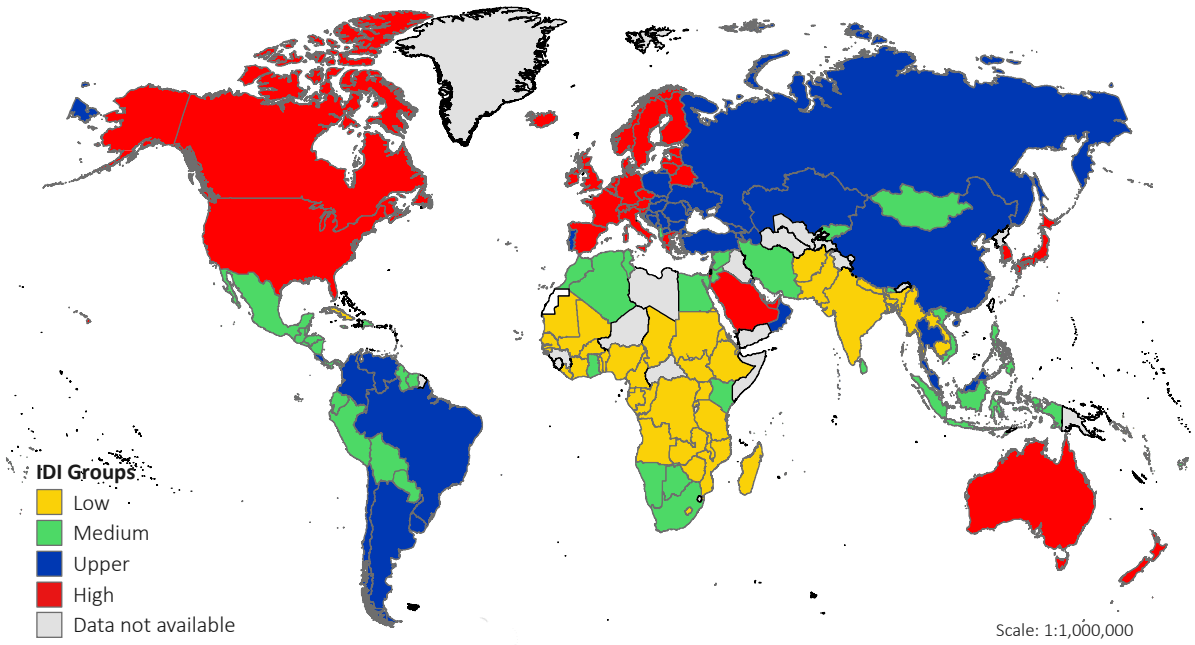
There has been little change among the top performers in these sub-indices between 2010 and 2015. Nine of the top ten countries in the access sub-index in 2010, and eight of those in the use sub-index, remain in the leading group in 2015. At the other end of the rankings, in the 2015 Index the same countries as in 2010 tend to perform poorly in both sub-indices.

Table 2.2: 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.

Figure 2.2: Quartiles by IDI value, 2015



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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.

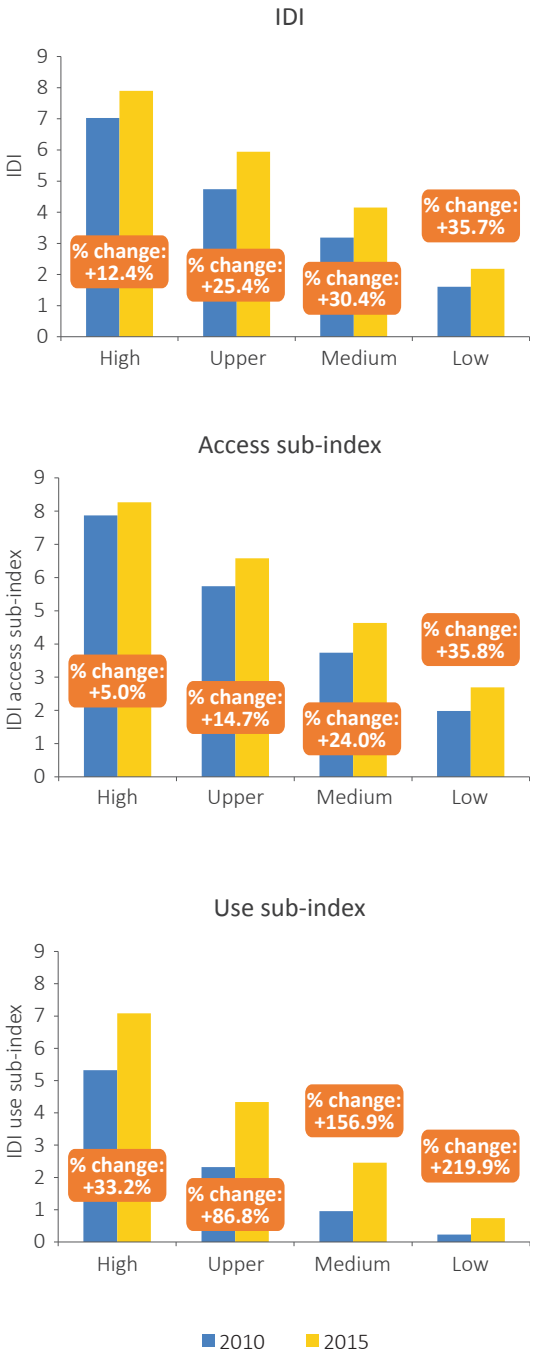
Source: ITU.

Improvements in the access index were strongest in middle-ranking countries.

The average improvement in the access sub-index between 2010 and 2015 was 0.70 points, with most progress being achieved by countries in the middle of the distribution. Countries heading the rankings already had high access values in 2010 and thus had relatively little scope for further improvement. However, countries at the bottom of the rankings also reported only limited improvements in their access levels. This suggests that countries in the middle of the distribution may be closing the digital divide in access with developed countries at the top of the distribution but may also be drawing away from LCCs.

Ghana showed the highest improvement in this sub-index, raising its score by 2.37 points and rising 36 places in the rankings to 104th in the 2015 IDI access sub-index. Five other countries – Oman, Costa Rica, Georgia, Lebanon and Belarus – increased their access values by more than 1.50 points.

Chart 2.2: IDI values by IDI performance quartile, 2010 and 2015



Source: ITU.

Many economies have seen high growth in mobile-cellular subscriptions during the period since 2010, while the penetration rate for fixed-telephone subscriptions has fallen or stagnated. There have also been significant increases in many countries in the proportions of households with a computer and households with an Internet connection. Some countries have achieved significant improvements in international Internet bandwidth per Internet user, illustrating the growing importance of quality of access in determining overall Internet experience.

Over the past five years, the use sub-index has experienced higher growth than the access sub-index.

Changes in the use sub-index between 2010 and 2015 have been more dynamic than in the access sub-index because there has been greater scope for improvements in the former, even in economies which had relatively high rankings in 2010. The average improvement in the use sub-index was 1.43 points, with much more substantial improvements being achieved by countries at the top of the distribution than at the bottom. This suggests that, in this sub-index too, there is a risk that the digital divide between LCCs and other countries may be growing.

The highest growth rates in this sub-index were achieved by countries in the Arab region (Bahrain, the United Arab Emirates, Lebanon and Saudi Arabia), the Americas (Barbados, Costa Rica and Brazil) and Asia (Thailand).

The dynamic growth in the use sub-index is due in particular to the mobile-broadband indicator, which showed the greatest volatility amongst indicators in the Index. Overall, mobile-broadband penetration increased from 11.5 per 100 inhabitants in 2010 to 37.2 in 2015, but there were major differences in the performances of individual countries.

Targeted policy initiatives can improve IDI performance, enabling LDCs and LCCs to reduce digital divides and enhance the contribution of ICTs to social and economic development.

Positions in the IDI rankings have generally been relatively stable between 2010 and 2015, reflecting significant progress in the large majority of countries. Overall trends suggest that middle-income developing countries are improving their access and use indicators 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 are falling behind other developing countries, particularly in the use sub-index.

The experience of high performing and dynamic countries in the IDI points to the importance of policies that establish an environment conducive to investment and innovation in improving access, increasing affordability and extending the use of ICTs, with consequential benefits for sustainable social and economic development.

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

The results of the ICT Development Index (IDI) for 2010 and 2015 provide insights into trends and disparities between the six ITU Telecommunication Development Bureau (BDT) regions – Africa, the Americas, the Arab States, Asia and the Pacific, the Commonwealth of Independent States (CIS) and Europe[1] – in the development of ICTs, including changes over time, and point to challenges which these different regions are facing in achieving progress towards inclusive information societies.

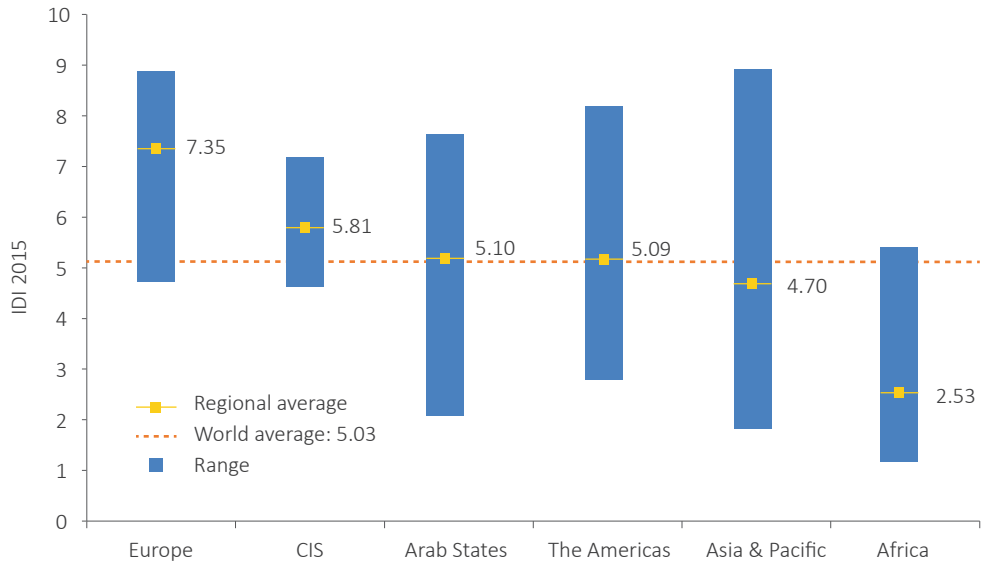
Major differences persist in IDI values, and in ICT development, between and within world regions.

Average IDI values vary considerably between regions (Chart 3.1). Europe has by far the highest average IDI value, at 7.35. 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 value, at 2.53, less than half of that in every other region except Asia and the Pacific.

The distribution of IDI values in Europe reflects high performance in all three sub-indices – access, use and skills. The most significant progress in Europe since 2010 has been in the indicator for mobile broadband subscriptions. IDI values for access and use in the Americas, the Arab States, Asia-Pacific and CIS were significantly lower than those in Europe in 2010, and have seen strongest growth in the indicators for mobile broadband subscriptions, Internet users and households with Internet access. Africa started from much lower IDI values in 2010, and has seen the most dynamic growth since then in the indicators for mobile cellular subscriptions and international Internet bandwidth per Internet user.

Changes in IDI values and measures of variation between different regions are set out in Table 3.1. This shows that there is considerably more variation in some regions than others. The CIS region shows the smallest range in IDI values, reflecting the relative homogeneity of its relatively small number of countries. Europe also has a relatively narrow range of values, reflecting its generally high level of economic development and connectivity. The IDI distribution within Africa is more variable, with 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 gross national income per capita (GNI p.c.) levels, and greatest in the Asia and Pacific region, which

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



Source: ITU.

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.

includes a number of top performers in the Index as well as a number of least connected countries (LCCs).

The range of IDI values has increased in most regions, suggesting that the digital divide within regions is growing.

The difference between highest and lowest IDI values fell sharply in Europe between 2010 and 2015, as the country at the bottom of the regional distribution (Albania) improved its rating more than highly-connected top performers, which were already approaching maximum values. The range of IDI values increased in Africa, where the lowest-ranking country (Chad) improved its value far less than middle-income countries heading the regional distribution.

Measures of disparity – the coefficient of variation and standard deviation – confirm that there was greater homogeneity in the CIS and Europe regions, but both these measures increased in the Arab States, reflecting the rises in IDI values achieved by the region's high-income oil-exporting countries.

Europe continues to lead the way in ICT uptake and use.

All countries in Europe, with the exception of Albania, exceed the global average IDI value of 5.03, and fall within the top half of countries in the IDI ranking, reflecting the region's high levels of economic development and GNI p.c. (see Table 3.2). The region's average IDI value rose between 2010 and 2015 from 6.48 to 7.35, an increase of 0.87 points, just below the global average rise (0.89).

Positions at the top of the regional rankings are mostly held by countries in northern and western Europe, in particular by Nordic countries, while lower rankings are concentrated around the Mediterranean and in eastern Europe. Denmark is the region's top performer, with an IDI value of 8.88, while the greatest improvement in IDI rankings between 2010 and 2015 was achieved by the United Kingdom, which rose from tenth to fourth position globally.

The CIS region is the most homogeneous region in terms of ICT development and has seen significant improvements in IDI performance since 2010.

The CIS region shows the least variation of any region between its highest and lowest performing countries, reflecting the region's relative economic homogeneity (see Table 3.3). While all countries in the region fall below the average developed country value of 7.41, all but one have rankings in the top half of the overall distribution and an IDI value which is above the global average.

The average increase of 1.43 points in IDI values in the region since 2010 is considerably above the global average (0.89). Belarus, the highest-ranking country in the region, improved its performance by 1.88 points and 14 places, while Kyrgyzstan, the region's lowest-ranking country, also showed considerable improvement, rising by 1.60 points and 15 places.

Asia-Pacific is the most heterogeneous region in terms of ICT development.

Asia-Pacific is the most diverse region in terms of ICT development, reflecting stark differences in levels of economic development. Six high-income economies in the region – including the global top performer, the Republic of Korea, Hong Kong (China) and Japan – have IDI rankings in the top twenty of the global distribution. However,

Table 3.2: 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.

the region also includes ten of the Index's least connected countries (LCCs), including India, Pakistan, Bangladesh and Afghanistan (see Table 3.4).

Countries throughout the region have shown considerable improvements in their IDI values between 2010 and 2015, however, particularly middle-income countries. The average growth in value for the region was 0.85 points, just below the

Table 3.3: 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.

global average. The most dynamic improvements in IDI rankings in the region were achieved by Thailand, Mongolia and Bhutan, which rose by 18, 13 and 9 places, respectively, in the global rankings during the period.

IDI values in the Arab States reflect national income disparities, and may represent a growing digital divide within the region.

The top five countries in terms of ICT development in the Arab States region – Bahrain, Qatar, the United Arab Emirates, Saudi Arabia and Kuwait – are oil-rich high-income economies that are members of the Gulf Cooperation Council (GCC) (see Table 3.5). These countries all have IDI values over 6.50 and are among the top fifty countries in the global rankings. Three of them (Bahrain, the United Arab Emirates and Saudi Arabia) are among the ten countries which have seen the most dynamic improvements in IDI rankings and values since 2010, as are two other countries in the region (Lebanon and Oman).

As shown in Table 3.1, however, there is a growing disparity between these high-performing countries and those lower down the distribution. While GCC countries improved their IDI values by 1.78 points between 2010 and 2015, the average improvement for non-GCC countries was 0.89 points, the global average. The strong performance of GCC countries reflects the association between IDI and national income levels described in Chapter 2.

In the Americas region, some countries experienced an impressive improvement in their IDI ranking, while others have fallen significantly.

The United States, Canada and Barbados lead the IDI rankings in the Americas, with IDI values above 7.50 and global rankings in the top thirty economies. These three countries 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. (see Table 3.6).

Countries in the Americas region have experienced some of the most significant movements up and down in global IDI rankings between 2010 and 2015. The most dynamic improvement worldwide was achieved by Costa Rica, which rose 23 places in the global rankings, while other substantial improvements were achieved by Suriname, Brazil, Barbados and Colombia. However, a number of countries, particularly in Central America and the Caribbean, fell significantly, including Belize, Cuba, Grenada, Jamaica and St. Kitts and Nevis.

Table 3.4: 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.

Africa is the region with the lowest IDI levels, and includes the most LCCs.

Africa has by far the lowest IDI levels among world regions, with an average value of 2.53 (see Table 3.7). Only one country in the region, Mauritius, has an IDI value above the global average in 2015, while just three others (Seychelles, South Africa and Cape Verde) exceed the average value for developing countries (4.12). Altogether, 29 out of 37 African countries in the 2015 IDI rank as LCCs in the lowest quartile of the distribution, including the 11 countries with the lowest rankings. These findings illustrate the extent to which Africa continues to lag behind other regions in terms of ICT development, and the importance of addressing the digital divide between Africa and other regions.

The average rise in IDI values in Africa between 2010 and 2015 was 0.64, lower than that in other regions in nominal terms, but from a lower base and therefore higher in proportion to the benchmark set in 2010. The most significant improvement was achieved by Ghana, which increased its IDI value by 1.92 points and rose 21 places in the global rankings. Other substantial

Table 3.5: 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

improvements in the rankings were achieved by Lesotho, Cape Verde and Mali.

The experience of top performers and of economies which have seen dynamic improvements in their IDI performance can point to policy approaches which may be relevant to other countries.

Economies with very high IDI rankings naturally have generally high values across all the indicators in the Index. The indicator for mobile broadband penetration has seen the most significant improvement between 2010 and 2015 for many of these countries.

A number of countries have achieved substantial improvements in their IDI values and rankings since 2010, starting from different levels of performance (Table 3.8). The highest improvements in both values and rankings have been achieved by Bahrain, Costa Rica and Lebanon, while other notable dynamic countries include Saudi Arabia, the United Arab Emirates and Oman among the Arab States, Belarus and Kyrgyzstan in the CIS region, Ghana, Thailand, Brazil and Suriname. These more dynamic countries have typically seen substantial rises in mobile broadband penetration, together with improvements in the proportions of households with computers and Internet access, in international Internet bandwidth per Internet user and, where this was relatively low in 2010, in mobile cellular subscriptions.

The experience of a number of individual dynamically-performing countries is assessed in the report. Their experience confirms the importance of developing enabling environments for ICT investment and innovation – in particular, competitive markets that encourage affordable access – and suggests policy approaches which may be relevant to other countries.

Table 3.6: 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.

Table 3.7: 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.

Table 3.8: Most dynamic countries

Change in IDI ranking				Change in IDI value			
IDI rank 2015	Country	IDI rank change (2010-15)	Region	IDI rank 2015	Country	IDI value change (2010-15)	Region
57	Costa Rica	23	Americas	27	Bahrain	2.22	Arab States
27	Bahrain	21	Arab States	57	Costa Rica	2.14	Americas
56	Lebanon	21	Arab States	56	Lebanon	2.12	Arab States
109	Ghana	21	Africa	41	Saudi Arabia	2.09	Arab States
74	Thailand	18	Asia & Pacific	32	United Arab Emirates	1.94	Arab States
32	United Arab Emirates	17	Arab States	54	Oman	1.92	Arab States
41	Saudi Arabia	15	Arab States	109	Ghana	1.92	Africa
85	Suriname	15	Americas	36	Belarus	1.88	CIS
97	Kyrgyzstan	15	CIS	74	Thailand	1.74	Asia & Pacific
36	Belarus	14	CIS	61	Brazil	1.74	Americas
54	Oman	14	Arab States				

Source: ITU.

4 Monitoring the price and affordability of ICTs

The cost and affordability of ICT services remain a determining factor for ICT uptake.[2] The report shows 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 broadband services.

The price of mobile-cellular services continues to fall as penetration rates and coverage reach all-time highs.

As the number of mobile-cellular subscriptions approaches 7.1 billion and mobile population coverage reaches close to 95 per cent globally, prices continue to fall. Mobile-cellular price data from 2008 to 2014 confirm that, globally, prices have continually decreased in terms of United States dollars (USD) and purchasing power parity dollars (PPP$), as well as relative to the percentage of GNI p.c.

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 corresponded on average to 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.

While fixed-broadband prices fell throughout the world until 2013, they increased between 2013 and 2014.

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 did not become more affordable. These developments, which distinguish fixed-broadband services from the other services for which ITU collects data, are alarming, since higher fixed-broadband prices will remain a major barrier to further uptake.

In 2014, the price of the fixed-broadband basket in developing countries represented an average of 29 per cent of GNI p.c., up from 25 per cent a year earlier. In developed countries, the fixed-broadband basket has been relatively affordable for a number of years, and 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 (Chart 4.1).

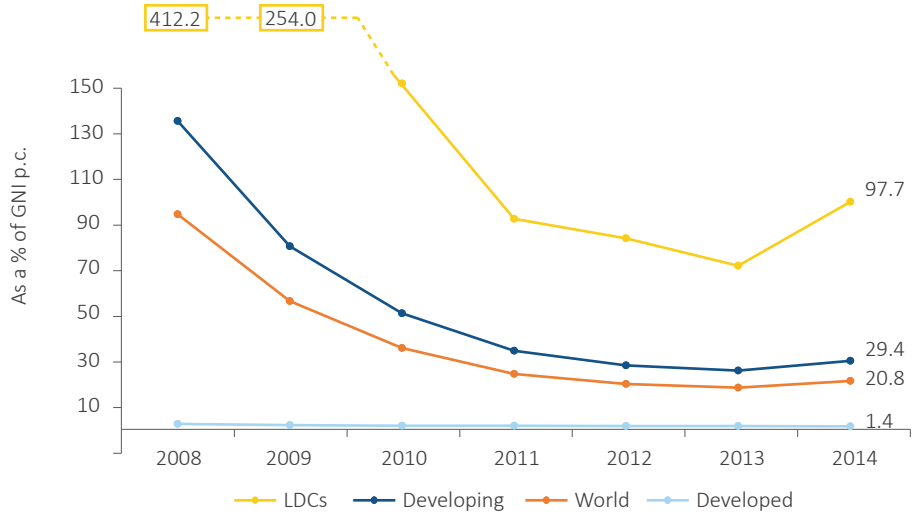
Fixed-broadband prices remain prohibitively expensive in large parts of the developing world, and particularly in the LDCs, SIDS, and LLDCs.

In the LDCs, fixed-broadband services remain unaffordable and most of the countries ranked at the bottom of the fixed-broadband basket are LDCs (see Table 4.1). The 2014 average fixed-broadband basket corresponded to 98 per cent of GNI p.c., up from 70 per cent a year before, a sharp increase that will not improve the already very low uptake of fixed-broadband in the world's poorest countries. Many of the countries with the least affordable fixed-broadband prices are also small island developing States (SIDSs), such as the Solomon Islands, Kiribati, Comoros, Haiti and Cuba, and landlocked developing countries (LLDCs), including Rwanda, Chad, Burundi and Burkina Faso. In these countries, international Internet bandwidth – a key element of Internet access- remains limited and expensive, driving prices up.

While in 2014 fixed-broadband prices increased, entry-level fixed broadband plans in some countries include better quality, i.e. higher speeds or more data for money.

In 2014, fixed-broadband prices increased. At the same time, entry-level fixed-broadband plans in a number of countries offer better (higher) speeds,

Chart 4.1: Fixed-broadband basket as a percentage of GNI p.c., 2008-2014



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

as well as more data for money. This suggests that in some cases higher prices come with higher or better quality connections. In 2014, the most common entry-level fixed-broadband speed offered in developing countries was 1 Mbit/s compared to only 256 kbit/s a year earlier. While the most common entry-level speed offered in developed countries did not change and remained at 5 Mbit/s (Chart 4.2), in more than a quarter of developed countries entry-level speeds increased in 2014. In the LDCs, the most common entry-level speed 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.

In terms of the cap (the monthly data allowance included in the basic fixed-broadband plan), 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.

Fixed-broadband prices remain most affordable in Europe and least affordable in Africa, but prices vary within regions.

Europe remains the region with the most affordable prices in terms of GNI p.c., followed by CIS, the Americas, Arab States, and Asia and the Pacific. In Africa, the fixed-broadband basket represents close to 180 per cent of GNI p.c., few countries offer affordable entry-level fixed-broadband plans, and the region also has the highest USD as well as PPP$-adjusted prices (see Table 4.2).

Asia and the Pacific is one of the most diverse regions in the world by many criteria (income, population, languages), and this diversity is also reflected in the absolute and relative prices 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, and 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. Fixed-broadband speeds and caps in the Asia and Pacific region vary as much as prices. While the most common entry-level fixed-broadband speed in the region is 2 Mbit/s, a number of countries continue to offer the minimum 256kbit/s speed. Less than half the entry-level fixed-broadband plans in Asia and the Pacific offer unlimited data download volumes, and the most restricted caps apply in Papua New Guinea, Viet Nam and India (see Chart 4.3).

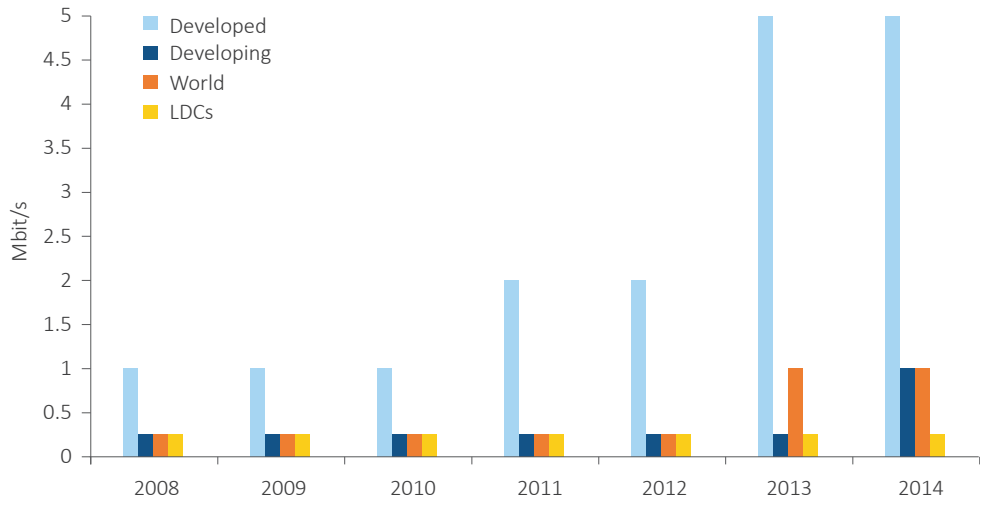
Table 4.1: Fixed-broadband sub-basket, 2014

Fixed-broadband sub-basket							
Rank	Economy	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

Fixed-broadband sub-basket							
Rank	Economy	as % of GNI p.c.	USD	PPP$	Speed in Mbit/s	Cap per month in GB	GNI p.c., USD, 2014*
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.

Chart 4.2: 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.

Table 4.2: 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.

111 countries meet the Broadband Commission's target for broadband price affordability and mobile broadband is cheaper than fixed broadband in most countries.

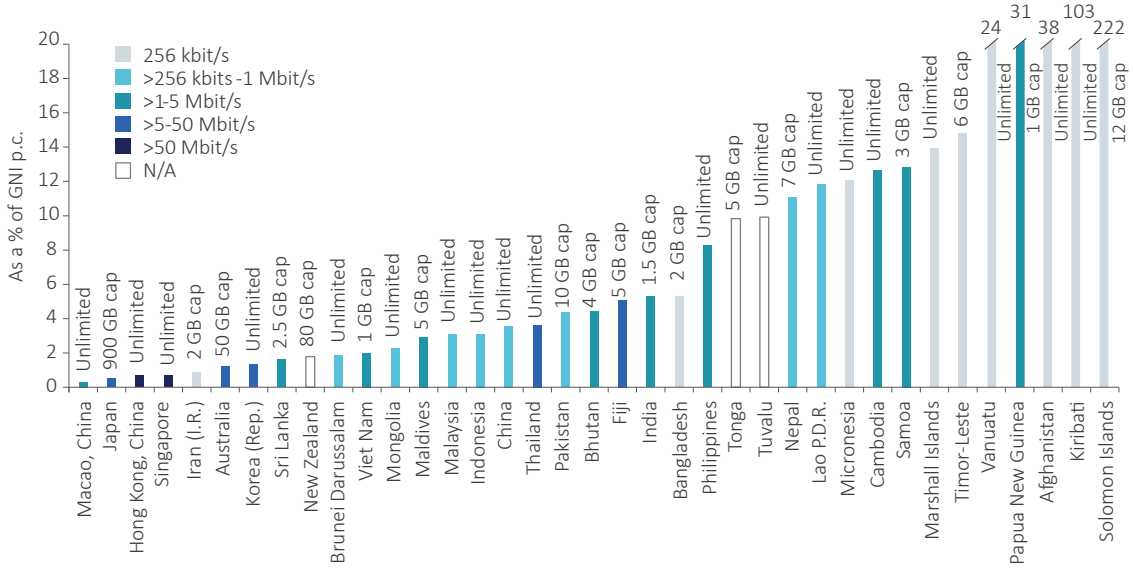
By early 2015, a total of 111 countries, including all of the world's developed countries and 67 developing countries, had achieved the target set by the Broadband Commission for Digital Development[3] in 2010: to make broadband affordable and to ensure that by 2015, entry-level broadband services cost less than 5 per cent of average monthly income.

Based on comparable fixed- and mobile-broadband prices for 160 economies worldwide, the results highlight the fact that mobile-broadband services tend to be cheaper than fixed-broadband. 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. Although currently only a limited number of countries have achieved the broadband target thanks to lower mobile-broadband prices, this is liable to change in the near future. With mobile-broadband service prices continuing to fall, mobile broadband is expected to help more countries achieve the target despite the fact that in many countries fixed-broadband service prices are increasing.

Mobile-broadband: more offers, more subscriptions, wider coverage, intense competition and decreasing prices.

Mobile broadband has become the most dynamic telecommunication market segment, enjoying sustained double-digit growth rates in subscription figures over the past eight years. For most of the population in developing countries it is *de facto* the only option for accessing broadband Internet services, given the limited capacity and

Chart 4.3: Fixed-broadband prices as a percentage of GNI p.c., broadband speeds and caps, in Asia and the Pacific, 2014



Note: GNI p.c. values are based on World Bank data. 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.

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 uptake is very low and growth is stagnating. ITU estimates that 3G coverage reaches 69 per cent of the world population in 2015 and progress has continued as the different types of mobile-broadband services, including more innovative pricing schemes and types of plans and devices, become available in more and more countries (Chart 4.4).

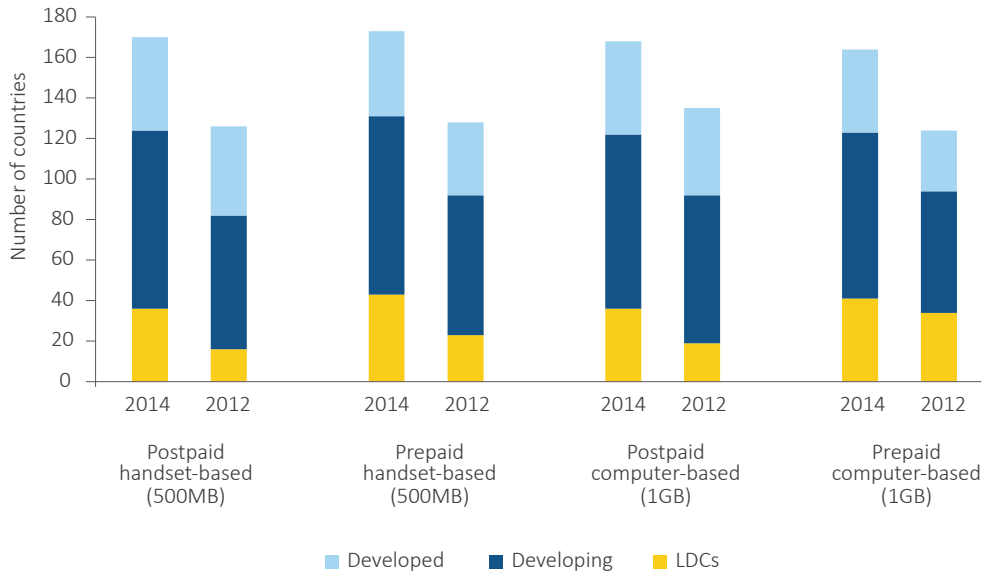
The variety of pricing schemes and the dynamism of the market are reflected in prices, which are far more volatile than for other telecom services. Indeed, mobile broadband prices per MB fluctuated by more than 30 per cent during the period 2012-2014 in half of the countries for which data were available. Driven by a highly competitive market, often characterized by the absence of a clear market leader, and sub-segmentation of the market based on the different types of mobile-broadband services, the price data analysis remains complex but overall points to a drop in mobile-broadband prices.

Over the last year, mobile-broadband has become 20-30 per cent more affordable globally.

A comparison of the average mobile-broadband prices per service in 2013 and 2014 (Chart 4.5) shows that prices for all four types of plan (prepaid, postpaid/computer- and handset-based) decreased, making the services between 20-30 per cent more affordable globally between 2013 and 2014. In terms of USD, developed and developing countries saw a reduction of between 15 and 25 per cent.

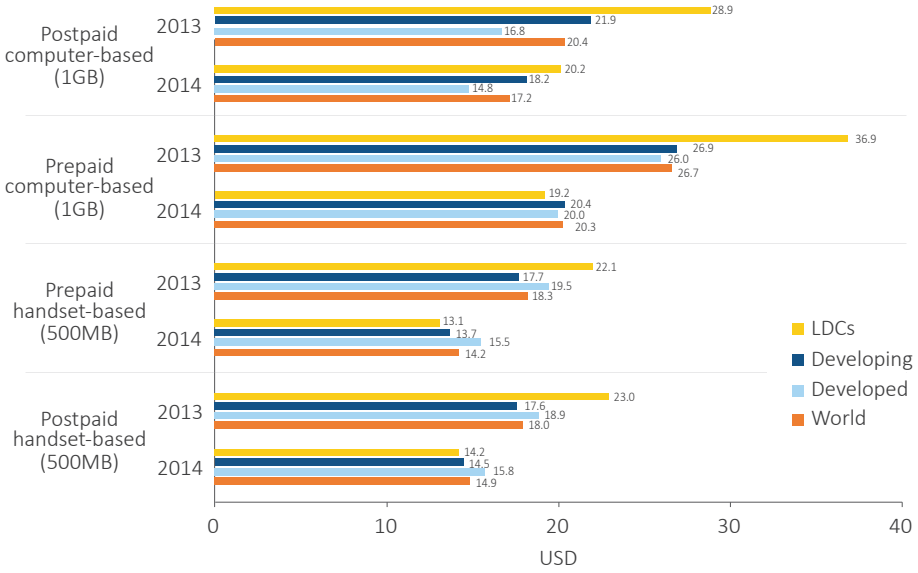
The largest decrease in prices occurred in the LDCs, where average prices for all types of mobile-broadband service were reduced by more than 25 per cent between 2013 and 2014. The strongest drop was seen in prepaid mobile-broadband plans, suggesting that competition and/or demand is stronger in this 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.

Chart 4.4: 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.[4]
Source: ITU.

Chart 4.5: Mobile-broadband prices, in USD, 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.

Major differences in affordability persist, but mobile broadband is becoming as affordable as traditional mobile-cellular.

Despite the reduction in mobile-broadband prices in LDCs, prices relative to GNI p.c. in LDCs are on average still twice as high as the average for all developing countries, and twenty times higher than for developed countries. 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.

A comparison of prices in developing countries shows that prepaid mobile-broadband plans have reached the affordability levels of mobile-cellular plans: mobile-cellular prices as a percentage of GNI p.c. were on average 30 per cent lower than the average for mobile-broadband prices in 2013, but almost the same in 2014.[5] However, caution must be exercised when comparing the low-user mobile-cellular basket and the 500 MB handset-based mobile-broadband basket, since each basket includes different services and provides access to different ICT applications.

Selected countries in Europe and Asia and the Pacific stand out for offering particularly inexpensive mobile-broadband services.

The comparison of PPP prices makes it possible to highlight those countries that stand out for having the lowest mobile-broadband prices in each region considering the purchasing power of local currencies (Table 4.3). The cheapest mobile-broadband prices in PPP$ are found in countries in Europe and Asia and the Pacific, for all types of mobile-broadband services. Specific countries that stand out in these regions and worldwide for having the lowest mobile-broadband prices are Austria and Lithuania (Europe) and Cambodia and Sri Lanka (Asia and the Pacific).

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.

No country from the Americas stands out for having particularly low mobile-broadband prices 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.

Table 4.3: 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.

Regional initiatives to regulate international roaming prices are contributing to bringing them closer to domestic prices.

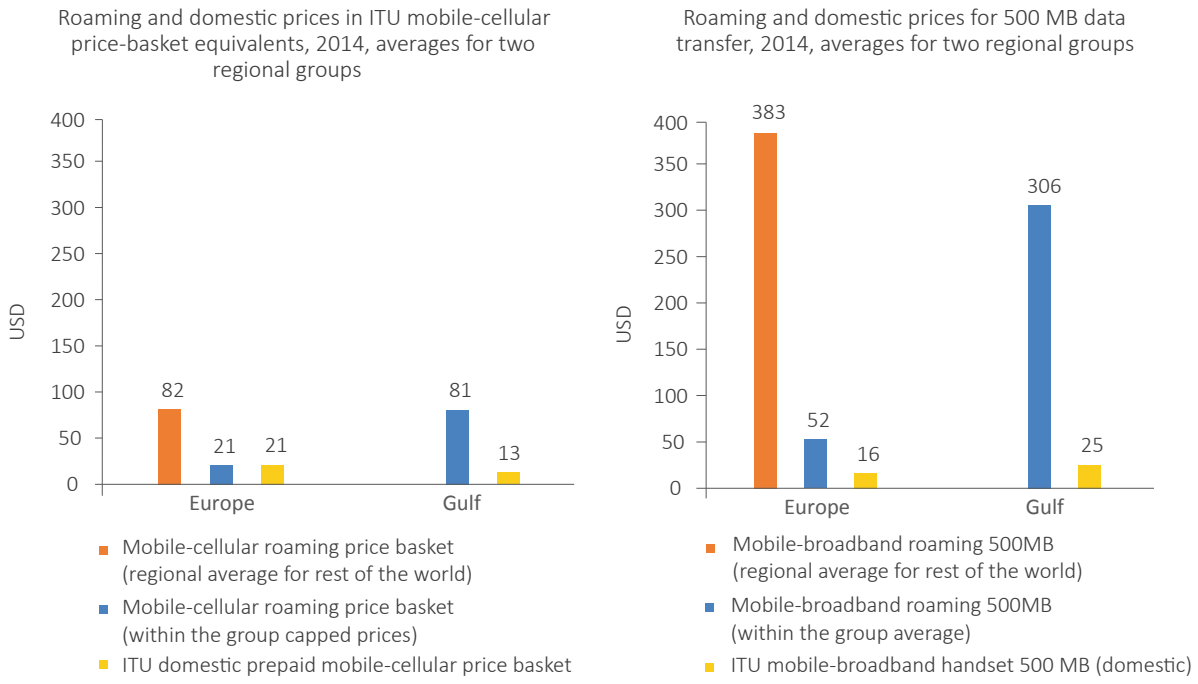
Although global comparable data on international roaming charges do not exist (and would be hard to compile since it would require inputs on numerous dimensions), mobile roaming has been on regulatory radar screens for several years because international roaming charges are often deemed to be excessively high and lacking in transparency. Industry studies confirm that, depending on the home network of the roaming client and the visited country network, applicable international roaming tariffs can vary by as much as a factor of five, if not more. Several regulatory initiatives have emerged in recent years aimed at reducing roaming prices, better informing consumers and preventing "bill shock"[6].

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 over 90 per cent for data roaming[7]. Another region which regulates roaming prices is the Gulf, where the Gulf Cooperation Council's (GCC[8]) regulators introduced caps for intra-group mobile roaming tariffs in 2012. The GCC regulation targets only retail and wholesale voice services.

The ITU ICT Price Basket was used to calculate a comparable roaming price basket for the Gulf countries and the European Union countries (Chart 4.6). The comparison of roaming and domestic prices showed that roaming voice and SMS tariffs were from three to six times higher than the corresponding domestic rates, except for intra-EU roaming calls, where regulation has made roaming and domestic prices very similar. In terms of tariffs for mobile data transfer, the roaming prices within the EU were three times higher than the domestic rates, and the difference was much larger for the unregulated data roaming rates of EU customers roaming outside the region, as well as for data roaming customers in GCC countries.

It is clear that prohibitive pricing can stifle economic and social activity and limit access to ICTs when it prevents people from connecting while abroad. Some regions have succeeded in lowering international roaming prices through

Chart 4.6: 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.

regulation, thus showing that international and regional cooperation on mobile roaming can help ensure that the benefits of lower roaming prices are enjoyed by many.

5 The Internet of Things: data for development

The Internet of Things (IoT) is a global infrastructure for the information society, underpinning the burgeoning network of physical objects or 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.

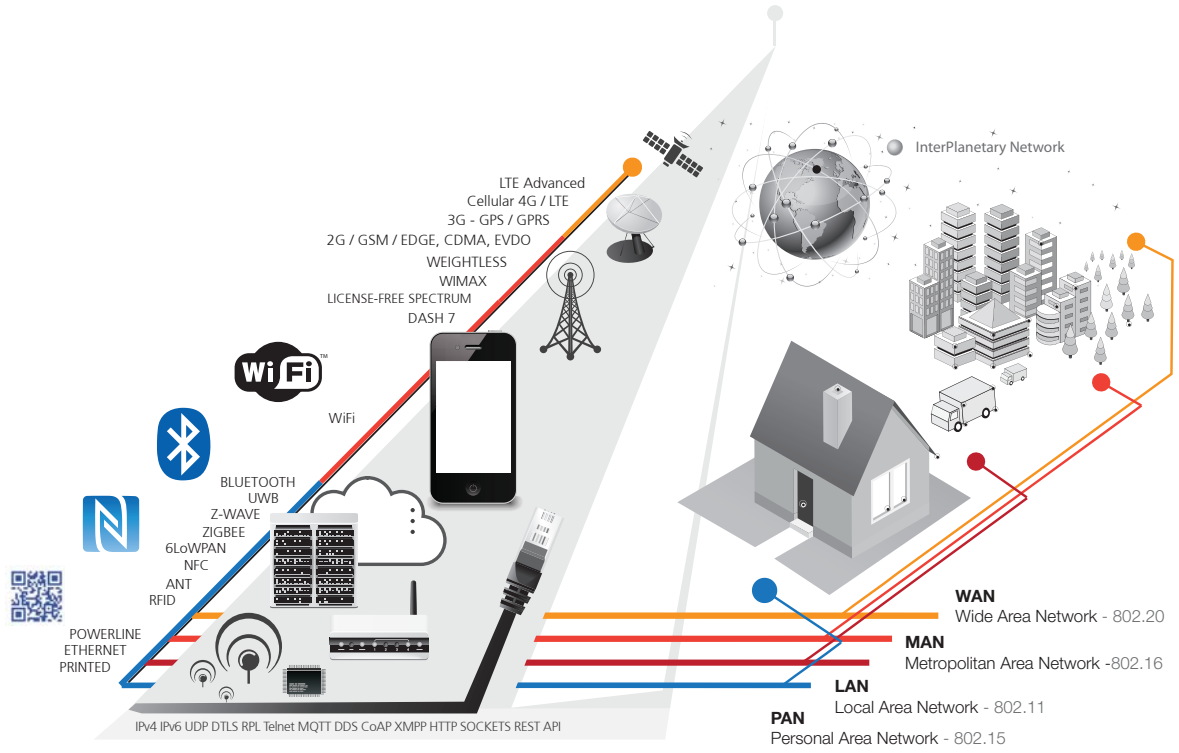
Early Internet-based platforms have been primarily focused on communications between individuals and groups of people, which can be translated into person-to-person communications. IoT adds to these platforms devices enabled to conduct person-to-machine as well as machine-to-machine (M2M) communications without human intervention. As devices are endowed with communication capability, they can make their own contributions to IoT. Just as there is a wide variety of connected device types, these various devices exhibit a range of connectedness (Figure 5.1). 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) being dependent upon a network with connection to the Internet. IoT encompasses both, as well as wireless sensor networks (WSN), which are networks that facilitate peer-to-peer communication within clusters of sensors without connecting to the Internet.

ICT developments are underpinning and accelerating the progress of IoT, which is expected to have a significant impact on nearly every industry of our society.

The IoT world is underpinned by ICT infrastructure, which is needed to gather, transmit and disseminate data as well as facilitate the efficient delivery of services, such as health and education, for society at large.

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

Figure 5.1: Diagram of IoT connectivity



Source: Postscapes and Harbor Research, http://postscapes.com/what-exactly-is-the-internet-of-things-infographic.

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. 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.

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, revealing and making possible new business models and workflow processes as well as new sources of operational efficiencies (Figure 5.2).

Most of the value derived from IoT comes from the generation, processing and analysis of new data.

Big data are being created by billions of devices around the world, and it is estimated that from 26 to 100 billion devices will be connected as part of IoT by 2020 (Table 5.1). 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.

Figure 5.2: Sectors in which IoT can play an enabling role for development

Source: ITU based on Al-Fuqaha, Ala *et al., Internet of Things: A Survey on Enabling Technologies, Protocols and Applications.* Communications Surveys & Tutorials, IEEE. 2015. Volume: PP, Issue: 99.

Table 5.1: The size of the Internet of Things in numbers

Indicator	Statistics	Source
Number of connected devices, milestones reached:	2008-2009: Number of global connected devices surpasses human population	Evans, Dave. "The Internet of Things: How the Next Evolution of the Internet Is Changing Everything," *CISCO white paper* 1 (2011).
	70% annual growth in sensor sales since 2002	Gartner. *Forecast: The Internet of Things, Worldwide.* Stamford, CT: Gartner Research, 2013.
Number of connected devices today:	8 billion devices or 6.58 devices per person online	CISCO, *Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2014–2019.* San Jose, CA: Cisco Systems, 2015.
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. *Forecast: The Internet of Things, Worldwide.* Stamford, CT: Gartner Research, 2013.
	More than 30 billion devices will be connected by 2020	ABI. "More Than 30 Billion Devices Will Wirelessly Connect to the Internet of Everything in 2020." London: ABI Research, 9 May 2013.
	Approximately 50 billion devices will be connected by 2020 (CISCO)	Evans, Dave. "The Internet of Things: How the Next Evolution of the Internet Is Changing Everything," *CISCO white paper* 1 (2011).
	75 billion devices will be connected by 2020 (Morgan Stanley)	Danova, Tony. "Morgan Stanley: 75 Billion Devices Will Be Connected to the Internet of Things by 2020," *Business Insider*, 2 October 2013.
	Anywhere from 50 to 100 billion devices will be connected by 2020 (Bell Labs)	Trappeniers, Lieven, *et al.* "The Internet of Things: The Next Technological Revolution," *Computer* 46, No. 2 (2013).
	The number of devices is already approaching 200 billion (IDC)	Turner, Vernon, *et al.* "The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things." Framingham, MA: *International Data Corporation, White Paper, IDC_1672*, 2014.

Note: data volumes are expressed in multiples of bytes: kilobyte (1 024), megabyte (1 024^2), gigabyte (1 024^3), terabyte (1 024^4), petabyte (1 024^5), exabyte (1 024^6) and zettabyte (1 024^7).

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, such as textual data (e-mails, documents) and social media data (pictures, videos) represent an increasingly diminishing percentage of the total; after all, many IoT devices produce machine-generated data, such as remote-sensing data (volcanic, forestry, atmospheric, seismic), and photographs and video (surveillance, traffic data), and share them directly with other devices, without any human intervention.

The potential overall economic impact of IoT is profound, and while estimates vary, it is expected that IoT will generate several trillions of USD of market value by 2020 (Forbes, 2014; Gartner, 2013; and McKinsey, 2015). Keeping this in mind, while over the next ten years IoT may potentially represent a higher value in developed economies due to a higher value per use, it is anticipated that nearly 40 per cent of the global IoT market value will be generated in developing economies (McKinsey, 2015).

IoT has the potential to become a major driver of development.

IoT offers new opportunities for development by providing new data sources 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 international development goals, including those addressed by the new 2030 Agenda for Sustainable Development.

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 renewable energy value chains.

IoT holds great promise for monitoring the effects of climate change, as it can leverage data from everything ranging from common devices – e.g. smartphones to take pictures, air quality monitors for detecting certain particulates – to large-scale devices – e.g. surveillance systems observing vegetative health, weather- and climate-monitoring devices, energy-managing systems. The use of these data offers numerous opportunities for improving the effectiveness of humanitarian assistance and relief operations following natural disasters.

With the rise of megacities, in particular in developing countries, the use of IoT applications and smart grids can maximize efficiency from energy sources while enhancing the stability of the grid. Likewise, megacities require smarter water use from an ever-diminishing water supply. Electrical utilities, water resource authorities, waste management authorities and transportation authorities are taking advantage of IoT to monitor and manage interconnections and various demands for energy, water and sewage disposal/sanitation, with the aim of converting megacities into smart cities.

Lack of interoperability remains a challenge for IoT.

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.

Fixed-broadband connectivity and large bandwidth are required for the development of IoT.

ICT infrastructure underpins the connectivity and data processing capacity required for IoT. Although wireless coverage is almost universal through satellite and mobile networks, the ICT connectivity required for unlocking the full potential of IoT may be more demanding. Indeed, while some IoT applications may run with low-speed, low-capacity connectivity, 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 storage 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. However, fixed-broadband uptake in the developing world remains very limited, and 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.

National statistical offices, regulators and ministries should work together for the benefit of big data from IoT.

Most of the value derived from IoT is closely linked to the exploitation of big data, and thus the challenges in terms of data management and analysis 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. 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. In this regard, public administrations could also contribute significantly by adopting open data policies for their IoT datasets.

Endnotes

1 See http:/www.itu.int/ITU-D/ict/definitions/regions/index.html. Until 2009, the CIS region included the above countries. Georgia exited the Commonwealth on August 18, 2009, but is included in this report.

2 See, for instance, Section 4.5 in the *ITU Measuring the Information Society 2014* for an analysis of the determining factors in mobile-cellular and fixed-broadband uptake.

3 See http://www.broadbandcommission.org/about/Pages/default.aspx.

4 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.

5 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.

6 "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.

7 European Parliamentary Research Service: http://epthinktank.eu/2013/10/10/a-roaming-free-europe-in-2015/.

8 GCC countries are: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates.

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