

# Measuring the Information Society Report 2017

Executive summary



# Chapter 1. The current state of ICTs

**The latest data on ICT development from ITU show continued progress in connectivity and use of ICTs.** There has been sustained growth in the availability of communications in the past decade, led by growth in mobile cellular telephony and, more recently, in mobile broadband. Growth in fixed and mobile-broadband infrastructure has stimulated Internet access and use.

**Mobile-cellular networks are increasingly pervasive and now dominate the provision of basic telecommunication services.** The number of mobile-cellular subscriptions worldwide now exceeds the global population, although many individuals, especially in developing countries, still do not use a mobile phone. The number of fixed-telephone subscriptions has continued to fall, dropping below 1 billion worldwide, and is particularly low in the least developed countries (LDCs).

**There has been rapid growth in mobile-broadband services.** The number of mobile-broadband subscriptions worldwide now exceeds 50 per 100 inhabitants, enabling improved access to the Internet and online services. The introduction of new mobile technologies is accelerating this trend, with LTE or higher capabilities now available to most mobile users. There has been slower growth in the number of fixed-broadband subscriptions worldwide, although this now marginally exceeds that for fixed telephone lines.

**There are substantial digital divides between countries and regions, and between developed and developing countries, particularly LDCs.** There are twice as many mobile-broadband subscriptions per 100 inhabitants in developed countries compared to developing countries, while the gap between more-connected developing countries and LDCs has grown in recent years. Mobile-broadband subscription rates are much higher in Europe and the Americas than in other regions, and more than three times those in Africa. Subscribers in developed countries also tend to benefit from higher bandwidth than those in developing countries.

**These divides are evident in Internet use as well as connectivity.** More than half of all households worldwide now have access to the Internet, although the rate of growth appears to have fallen below 5 per cent a year. Households in developed countries are almost twice as likely to be online as those in developing countries and more than five times as likely as those in LDCs. There are similar differences between rates of access for individual users. People in Europe are more than three times more likely to access the Internet regularly than those in Africa, and are likely to benefit from higher access speeds when doing so.

**There is a significant gender digital divide.** Data compiled by ITU suggest that this digital gender gap is relatively small in developed countries, more pronounced in developing countries and substantial in LDCs, where only one in seven women is using the Internet compared with one in five men. The gender digital divide in Africa appears to have grown significantly over the past five years.

**Young people are more likely to be online than their elders.** The proportion of people aged between 15 and 24 who are online is estimated to be over 70 per cent worldwide, compared with just 48 per cent of the population overall. Elderly people are less likely to be connected.

## Chapter 2. The ICT Development Index – global analysis

**The ITU ICT Development Index (IDI) is a unique benchmark of the level of ICT development in countries across the world.** The IDI combines eleven indicators on ICT access, use and skills, capturing key aspects of ICT development in one measure that allows for comparisons to be made between countries and over time. IDI 2017 covers 176 economies worldwide. Comparison with IDI 2016 shows that progress has continued to be made in ICT access and use in almost all countries. However, it also demonstrates that there are still great disparities in ICT development between more and less connected countries which need to be addressed if inclusive information societies are to contribute to the achievement of sustainable development and other international goals.

**Iceland tops the IDI rankings in 2017, with an IDI value of 8.98.** It is followed by six other countries in Europe and three economies in the Asia-Pacific region which have competitive ICT markets that have experienced high levels of ICT investment and innovation over many years. Countries at the top of the IDI distribution also have high levels of economic prosperity, literacy and other skills that enable citizens to take full advantage of access to communications.

**The average value for all economies in the Index rose by 0.18 points between IDI 2016 and IDI 2017,** reaching 5.11 points, the first time that it has exceeded the halfway point along its scale. As in IDI 2016, improvements were particularly significant among countries in the middle of the distribution, many of which are middle-income developing countries, although there were only limited changes in positions in the rankings. The most substantial improvements in IDI value were recorded by Namibia, the Islamic Republic of Iran and Gabon, all of whose values rose by 0.50 points or more. All but eight countries improved their overall IDI values.

**As in previous years, the ICT use sub-index grew more rapidly, by 0.31 points, than did the access and skills sub-indices,** both of which rose by an average 0.10 points. The most significant contribution to improvements in IDI values was made by the indicator for mobile-broadband subscriptions, the average value for which rose by 12.9 per cent during the year. The indicator for fixed-telephone subscriptions, by contrast, continued to show a gradual decline in the majority of countries.

**The reduction of the digital divide between more and less connected countries continues to be challenging.** The gap between the highest and lowest performing countries in the Index rose to 8.02 points (out of 10.0) in IDI 2017. As in previous years, there is a strong association between economic and ICT development, with least developed countries (LDCs) filling 37 of the 44 places in the lowest (least connected) quartile of the distribution. LDCs improved their average IDI value by 0.15 points during the year, compared with 0.22 points for other developing countries, suggesting that they may be falling further behind in ICT development.

**Recent developments in ICT markets have led to the adoption of proposals for change in the composition of the Index.** A revised set of indicators will be introduced from IDI 2018 which should add further insights into the performance of individual countries and the relative performance of countries at different development levels.

## Chapter 3. The ICT Development Index – regional and country analysis

**There are considerable differences between geographical regions in the levels of ICT development as demonstrated by the IDI.** There is also significant variation in the experience of individual countries within each region. The differences in the IDI between regions and individual countries are associated mainly with levels of economic development.

**Europe continues to lead the way in ICT development.** It has the highest average IDI value among world regions (7.50 points). This reflects the region's high levels of economic development, competitive communication markets, and high levels of ICT skills. Every country in the Europe region has an IDI value above the global average. As many as 28 of its 40 countries rank within the highest quartile, while only one, Albania, falls outside the top half of the distribution. The most substantial improvements in value were recorded by Cyprus and Turkey.

**The United States and Canada top the IDI ranking in the Americas region.** The majority of countries in the region fall within the two middle quartiles, with only two least connected countries (LCCs) in the bottom quartile (Cuba and Haiti). The most significant improvements in the Americas region were recorded by middle-ranking countries in South and Central America and the Caribbean.

**The Commonwealth of Independent States (CIS) is the most homogeneous region in ICT development,** reflecting its relative economic homogeneity. Only one country in the region, Belarus, is in the top quartile of the Index, but the region includes no LCCs. The most dynamic countries in terms of IDI value were those at the bottom of the regional rankings – Ukraine, Uzbekistan and Kyrgyzstan.

**Asia and the Pacific is, by contrast, the most heterogeneous region in terms of ICT development.** Seven economies in this region have IDI values above 7.50 points and rank within the highest quartile in the global IDI 2017, including the Republic of Korea, which is ranked second overall. However, ten countries in the region, including several with very large populations, are LCCs. Six countries improved their IDI values by more than 0.40 points, led by the second most dynamic country in IDI 2017, the Islamic Republic of Iran.

**The Arab States region is also very diverse in terms of IDI performance.** This region includes a number of oil-rich high-income economies, three of which are in the top quartile of the IDI, as well as a number of low-income countries, four of which are LCCs. The strongest improvements in this region were seen in middle-income countries, whose average value rose by more than twice that of countries at the top and bottom of the regional distribution.

**Africa continues to be the region with the lowest IDI performance.** The average value for this region in IDI 2017 is 2.64 points, little more than half the global average of 5.11. Only one country in the region, Mauritius, ranks in the upper half of the global IDI distribution, while 28 of the 38 African countries included in IDI 2017 fall into the lowest (LCC) quartile. This reflects the generally low level of economic development in the region. The region does, however, include two of the three countries which achieved the most dynamic improvements in their IDI value over the year – Namibia and Gabon.

## Chapter 4. Emerging ICT trends

**Concurrent advances in the Internet of Things (IoT), big data analytics, cloud computing and artificial intelligence (AI) will fundamentally transform business, government, and society over the coming decades.** To harness their benefits, countries will need to create conditions supportive to the deployment of next-generation network and service infrastructures. They will also have to adopt policies that are conducive to experimentation and innovation while mitigating potential risks to information security, privacy, and employment.

**The Internet of Things will greatly expand the digital footprint.** In addition to people, organizations and information resources, it will connect objects equipped with digital information sensing, processing, and communication capabilities. This ubiquitous infrastructure will generate abundant data that can be used to achieve efficiency gains in the production and distribution of goods and services, and improve human life in innovative ways.

**Big data analytics will extract useful knowledge from digital information flows.** It will enable us to better describe, understand and predict developments and to improve management and policy decisions. Making sense of proliferating information requires a workforce with appropriate analytical, computational and methodological skills, as well as a high-capacity ICT infrastructure.

**Cloud and other architectures will lower the entry barriers to scalable computing resources.** They are starting to deliver flexible and on-demand computational services over the Internet, lowering the fixed costs of ICT infrastructure, to the benefit of small and medium-sized organizations. Realizing their full potential will depend on the availability of reliable fixed and mobile broadband connectivity.

**Artificial intelligence will help human beings to make better decisions.** In order to achieve this objective, every algorithm needs to be tailored carefully to existing data and the objectives pursued. This requires considerable human expertise in machine learning and large datasets to train algorithms.

**Advanced ICTs, such as IoT, big data analytics, cloud computing and AI, contribute to realizing the Sustainable Development Goals (SDGs).** Promising applications exist in areas such as manufacturing, precision agriculture, government, education, health care, smart cities, and smart transportation. As part of broader initiatives, ICTs can contribute to achieving each of the 17 SDGs.

**Harnessing the benefits of advanced ICTs requires appropriate infrastructures, services, and skills.** Networks will have to support diverse quality-of-service demands from applications and users while delivering robust and ubiquitous connectivity. This will require roll-out of wireless IoT platforms, reliance on network virtualization and improved fibre connectivity. Moreover, it will require the development of advanced ICT skills among users.

**Advanced ICTs raise concerns over next-generation digital divides.** Network operators and users will have to adapt their business models to take advantage of the opportunities of the digital transformation. Policy-makers and regulators are called upon to create conditions facilitating entrepreneurial experiments and innovation. Policy will also have to mitigate challenges in the areas of information security, privacy, employment and income inequality.

**Reliable and meaningful measurements of the deployment and use of advanced ICTs are critical.** Fully harnessing the potential benefits of advanced ICTs requires reliable and meaningful metrics that go beyond existing data. This will require collaboration among various stakeholders and novel approaches to harvesting information from digital infrastructures and applications directly.

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It is my pleasure to present to you the latest edition of the *Measuring the Information Society Report*. This annual report presents a global and regional overview of the latest developments regarding information and communication technologies (ICTs), based on internationally comparable data and agreed methodologies. It aims to provide ITU Member States with an objective assessment of countries' ICT performance by highlighting areas of success stories and areas that need further improvement.

The release of this report comes after the successful conclusion of the World Telecommunication Development Conference (WTDC), held in Buenos Aires, Argentina, where we adopted a Strategic Plan and Action Plan that will provide future direction and guidance to the ITU Telecommunication Development Sector (ITU-D), including its work on statistics.



Based on ITU data collections, the report gives an overview of the long-term telecommunication/ICT trends. Analysis shows an overall upward trend in the availability of communication services, driven by rapid growth in broadband, with a growing predominance of mobile over fixed services. Globally, the number of mobile-cellular subscriptions grew from 2005 to 2017 from 33.9 per 100 inhabitants to an estimated 103.5. In the least developed countries (LDCs), the growth has been more impressive, increasing from 5.0 in 2005 to an estimated 70.4 in 2017.

These trends are brought further into evidence by the ICT Development Index (IDI). The IDI is a powerful tool for monitoring progress towards a global information society and is a core feature of this report. The latest IDI ranks the performance of 176 economies with regard to ICT infrastructure, use and skills, allowing for comparisons to be made between countries and over time. The most important aspect of the IDI is that countries should track their own year on year progress and make policy adjustments to grow their countries' telecommunication/ICT sector.

This year's Index shows that there has been continued improvement in IDI performance by the great majority of countries. The average value for all economies in the Index rose by 0.18 points between IDI 2016 and IDI 2017, reaching 5.11 points, the first time that it has exceeded the halfway point along its scale. Improvements have been most significant among countries in the middle of the IDI rankings, many of which are middle-income developing countries, testifying to the fact that these countries are catching up with the top performers when it comes to ICT development. But LDCs as well improved their average IDI value, by 0.15 points during the year, close to the overall average growth recorded. Mobile broadband is the driving force behind this trend, bringing online previously unconnected individuals and catering for the ubiquitous data needs of the ICT ecosystem. Worldwide, active mobile-broadband subscriptions increased from 11.5 per 100 inhabitants to 56.4 in only 7 years. Here as well, growth in LDCs was even stronger, from 0.4 in 2010 to 22.3 in 2017, offering hope that they are on a path to catch up with the rest of the world.

Recent developments in ICT markets have led to the adoption of proposals for change in the composition of the Index. A revised set of indicators will be introduced from IDI 2018 which should add further insights into the performance of individual countries and the relative performance of countries at different development levels.

Over and above reporting on the overall telecommunication/ICT progress achieved, the IDI also shows that the digital divide between more and less connected countries remains a challenge which needs to be addressed if inclusive information societies are to contribute to the achievement of the Sustainable Development Goals (SDGs). Digital divides are also evident within countries, for example between urban and rural areas and between age groups. In many countries, urban residents and young people are more likely to be online than rural dwellers and the elderly. Women are less likely than men to make use of the Internet in most countries, but are more under-represented online in developing countries, particularly in LDCs, than in developed countries.

This year's report also features a chapter presenting IDI findings at regional level and compares different regions. Given that there is a strong correlation between economic development and IDI performance, there are considerable differences between geographic regions in the levels of ICT development reflected by the IDI, and significant variation in the experiences of individual countries within each region.

Drawing conclusions from the report, it is clear that the area of ICTs is very dynamic and that another digital revolution is approaching- one which will transform business, government and society. Four key developments are at the heart of this revolution: the Internet of Things (IoT), cloud computing, big data analytics, and artificial intelligence (AI). These are described in greater detail in the last chapter of the report.

All these trends are interrelated. Fully harnessing the economic and social benefits of these developments requires efficient and affordable physical infrastructures and services, more advanced user skills, and internationally comparable benchmarks and indicators supported by enabling public policies. Promising ICT applications in areas such as manufacturing, precision agriculture, government, education, health care, smart cities, and smart transportation, will contribute to accelerating the attainment of the SDGs. Reliable and meaningful measures of the deployment and use of advanced ICTs are critical. This topic will undoubtedly be dealt with further in future editions of the *Measuring the Information Society Report*.

For the first time, this year's report features country profiles highlighting the ICT market structure and the latest developments in 192 economies worldwide. Each profile includes an overview of the policy and regulatory initiatives undertaken, as well as the current status of network roll-out and service uptake. These profiles are presented in Volume 2 of the *Measuring Information Society Report*. The profiles seek to highlight the achievements by each country and I am confident that these profiles will also help in identifying good practices as well as future challenges specific to each country.

It is my hope that this report will not only be of value to actors within the ITU membership (policy-makers, regulators, the ICT industry, academia) but to others also working towards the building of an inclusive global information society.



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## Chapter 1. The current state of ICTs

# Key findings

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**The latest data on ICT development from ITU show continued progress in connectivity and use of ICTs.** There has been sustained growth in the availability of communications in the past decade, led by growth in mobile cellular telephony and, more recently, in mobile broadband. Growth in fixed and mobile-broadband infrastructure has stimulated Internet access and use.

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**Young people are more likely to be online than their elders.** The proportion of people aged between 15 and 24 who are online is estimated to be over 70 per cent worldwide, compared with just 48 per cent of the population overall. Elderly people are less likely to be connected.

# Chapter 1. The current state of ICTs

## 1.1 Introduction

This chapter presents a global overview of principal trends in information and communications technology (ICT) access and use that can be observed through data sets which are annually gathered and assessed by ITU. It is divided into six sections:

- This introductory section summarizes overall global trends and outlines developments in network coverage and available bandwidth;
- Section 1.2 describes basic communications networks;
- Section 1.3 describes trends in broadband access;
- Section 1.4 describes trends in Internet access and use;
- Section 1.5 considers digital divides within society;

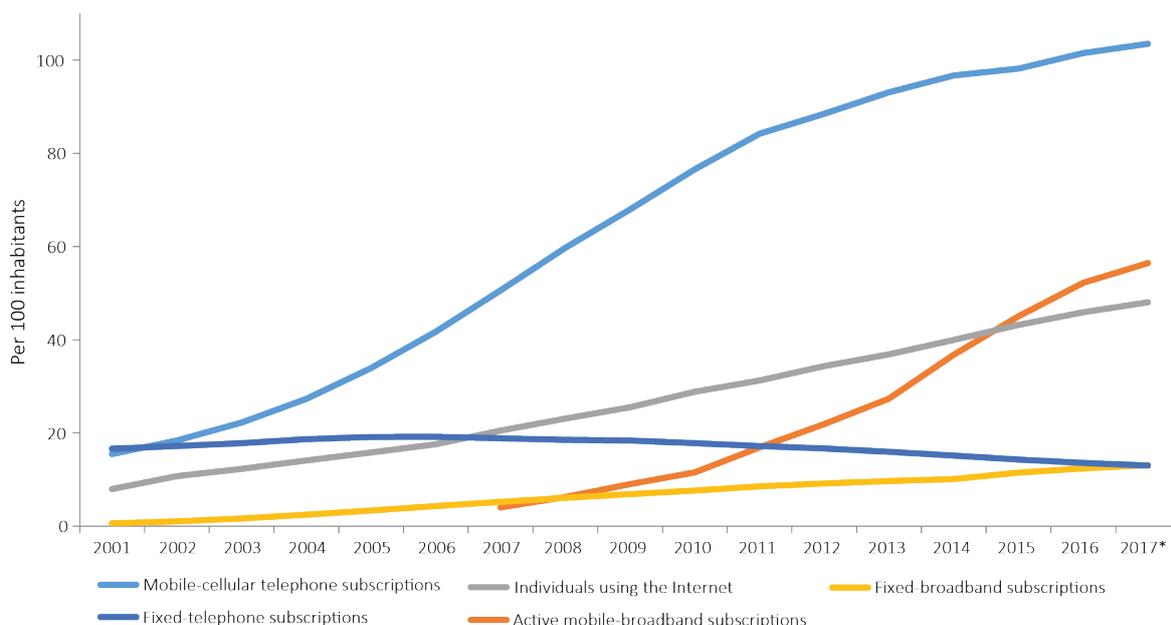
- Section 1.6 presents a summary and conclusion.

An overview of global ICT developments since the turn of the century is set out in Chart 1.1.

Three broad trends can be observed from this chart:

- The first is the long-term upward trend in the availability of communication services in general. The decade following the end of the World Summit on the Information Society (WSIS) in 2005 has seen an upsurge in mobile-cellular telephony, leading to near-saturation penetration rates in developed countries and many developing countries. This was complemented from around the start of the present decade by an upsurge in mobile-broadband take-up, particularly in developed countries, though this has yet to reach levels of access and use comparable to those for mobile telephony.

Chart 1.1: Global ICT developments, 2001-2017\*



Notes: \* ITU estimate.  
Source: ITU.

- The second long-term trend is the growth in broadband – defined in this report as services with speeds of 256 kbits/s and above. Broadband did not really begin to make a mark on communications services until the early years of this century, but after that its growth accelerated quickly. Between 2007 and 2017, fixed-broadband subscriptions increased by 183 per cent. Active mobile-broadband subscriptions grew extremely rapidly, from 4.0 subscriptions per 100 population in 2007 to an estimated 56.4 subscriptions per 100 population in 2017. The bandwidth available has also risen rapidly, particularly in developed countries. This growth in broadband, which shows no signs of faltering, has enabled much more extensive and effective use to be made of the Internet and is facilitating today’s growth in advanced services.
- The third long-term trend is the growing predominance of mobile over fixed services. Mobile cellular subscriptions now make up more than 90 per cent of voice subscriptions, and more than 98 per cent of those in least developed countries (LDCs).<sup>1</sup> The number of fixed-telephone subscriptions has steadily declined in recent years, however, by 22.5 per cent since 2007, as increasing numbers of people have preferred mobile to fixed access. Mobile subscriptions have also been predominant in the broadband market, now accounting for just over 80 per cent of broadband subscriptions worldwide (though this has been accompanied by an increase in fixed-broadband penetration).

Caution is required when comparing data for mobile and fixed penetration rates such as these, as subscriptions do not equate with subscribers. It is much more common, for example, for mobile subscribers to have more than one subscription than is the case for subscribers to fixed networks. At the same time, however, mobile subscriptions are more often linked to individual use, while fixed network subscriptions are often shared by several people.

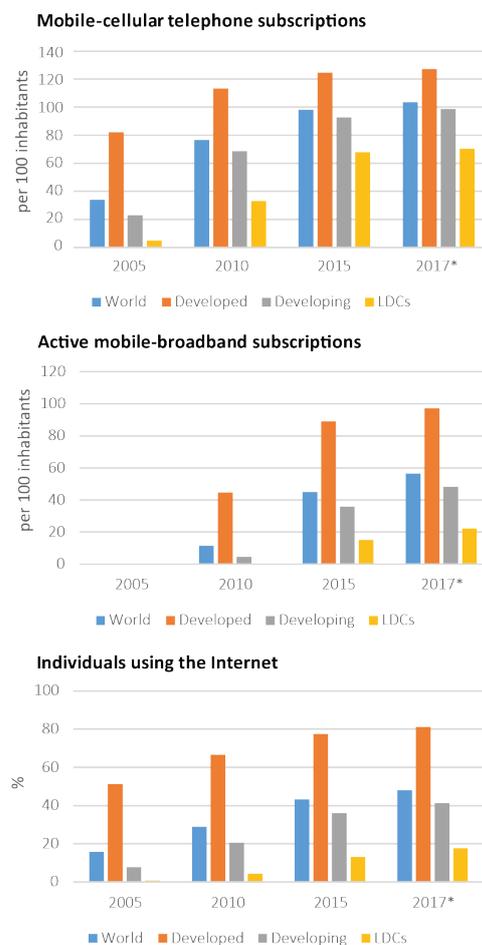
As with broadband, the capabilities of mobile networks and devices have improved rapidly, particularly since smartphones became widely available some ten years ago, enabling them to deliver more effective Internet access, and

stimulating operators to roll out mobile-broadband in response to growing demand.

There are significant differences in subscription levels, where all three of these trends are concerned, between countries at different levels of development and in different regions. These are illustrated, for three selected indicators, in Charts 1.2 and 1.3.

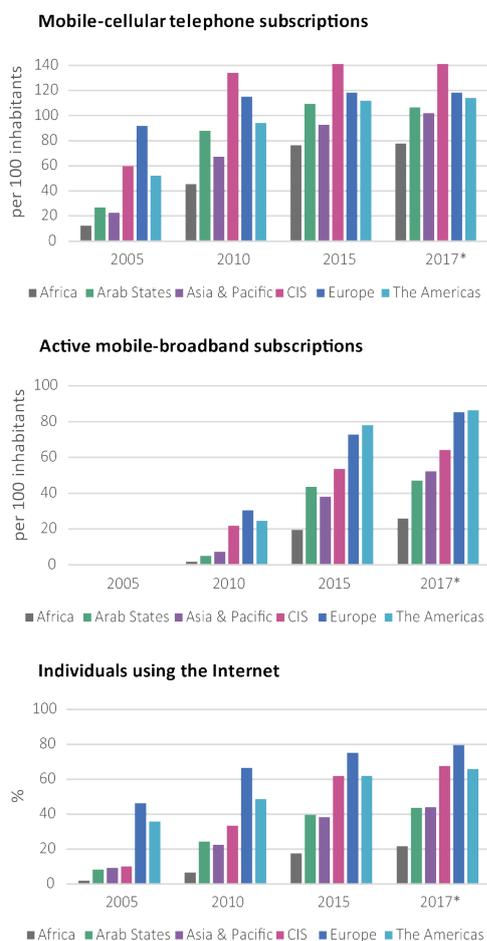
Chart 1.2 shows that there is a strong association between development status and ICT access and use. Developed countries have a significant lead over developing countries in mobile-cellular subscriptions, and approximately twice as many active mobile-broadband subscriptions and Internet users per 100 population as developing countries. LDCs fall behind developing countries in general by similar margins. At the regional level (Chart 1.3), it is clear that Europe, the Americas

**Chart 1.2: Global ICT access and use, selected years, by development status**



Notes: \* ITU estimate.  
Source: ITU.

**Chart 1.3: Global ICT access and use, selected years, by region**



Notes: \* ITU estimate.  
Source: ITU.

and the Commonwealth of Independent States (CIS) regions are ahead of other regions in all three indicators, with Africa well behind the Asia and the Pacific and Arab States regions.

## 1.2 Basic communication networks

### 1.2.1 Network coverage

The growing preponderance of mobile-cellular subscriptions over fixed-telephone subscriptions has been one of the most prominent trends in ICTs since the beginning of the century, with mobile networks establishing themselves as the consumer norm in today's communications markets. Only one country in the ICT Development Index (IDI) 2017 (Monaco) recorded more fixed-telephone than mobile-cellular subscriptions. This

growing preponderance is particularly marked in developing countries, especially LDCs, and in Africa, where fixed lines are often very expensive, not available, or only available after a lengthy waiting period.

The predominance of mobile over fixed network subscriptions reflects the much wider geographical availability of mobile networks in most national markets, especially in rural areas of developing countries, where the improved supply of connectivity following mobile network deployment has facilitated growing demand. As mobile networks have become more available at lower prices, some users have subscribed to mobile networks in addition to keeping their fixed subscriptions, while some new subscribers have chosen to use mobile networks only and some fixed subscribers have chosen to drop their fixed subscriptions in favour of mobile.

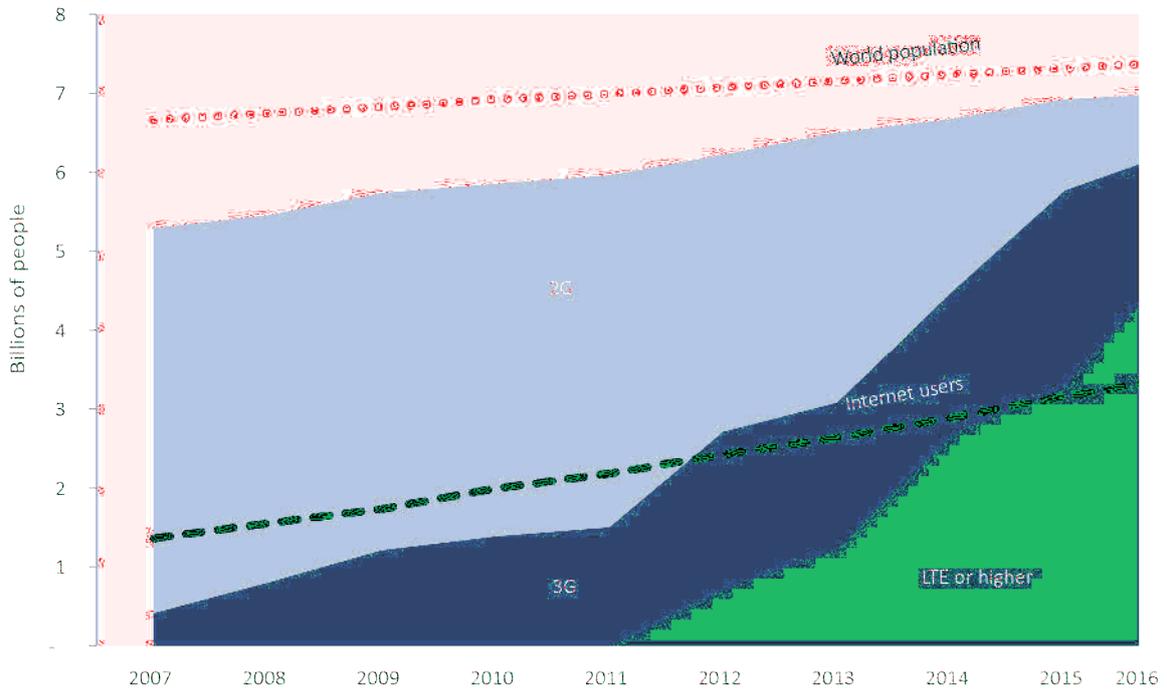
Improvements in the capabilities of mobile networks have also played an important part where this trend is concerned. The transition from 2G to 3G and higher-quality mobile networks, capable of effective delivery of Internet services, is illustrated in Chart 1.4. Most mobile subscribers worldwide now have access to higher-quality networks (though these have been slower to arrive in developing than in developed countries). Chart 1.4 also shows, however, that this transition has not been immediately paralleled by a comparable upsurge in the number of Internet users.

### 1.2.2 Mobile cellular subscriptions

Chart 1.5 presents the growth in mobile-cellular subscriptions worldwide, and the number of subscriptions per 100 population, since 2005. The total number of mobile-cellular subscriptions has increased from 2.20 billion in 2005 to 5.29 billion in 2010, 7.18 billion in 2015 and an estimated 7.74 billion in 2017. The number of subscriptions per 100 population has grown from 33.9 in 2005 to 76.6 in 2010, 98.2 in 2015 and an estimated 103.5 in 2017.

As noted above, it is important to distinguish between the number of subscriptions, shown in Chart 1.5, and the number of subscribers. The number of subscriptions worldwide now exceeds the global population, with subscriptions also

Chart 1.4: Changing mobile coverage by type of network, 2007-2016



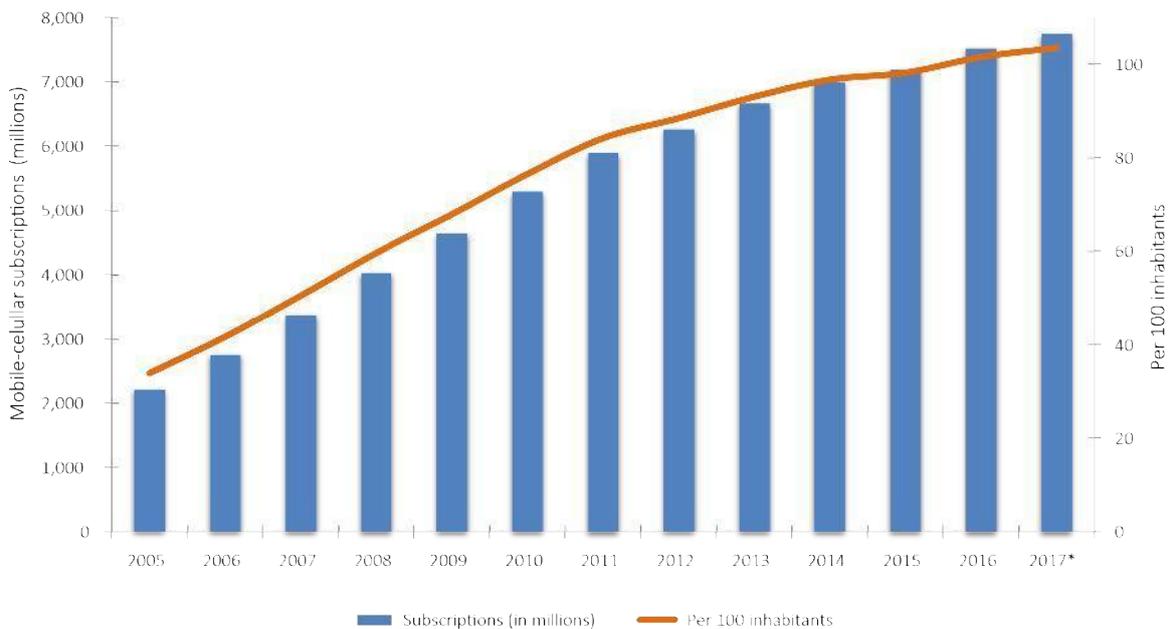
Source: ITU.

exceeding population in 112 of the 176 countries included in IDI 2017 (see Annex 2).

There are several reasons for the difference between data for subscriptions and subscribers,

the extent of which varies between countries. These include the proportion of subscriptions which are held by businesses and other organizations, and the tendency for users to have more than one subscription in order to

Chart 1.5: Global mobile-cellular subscriptions, total and per 100 inhabitants, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

take advantage of differential prices offered by competing operators or to compensate for weaknesses in different operators' network coverage.

As highlighted in *Measuring the Information Society Report 2016* (ITU, 2016b), additional indicators – such as the number of mobile phone users or mobile phone owners – need to be gathered in order to enable more accurate assessments of mobile uptake. Household survey data from developing countries show that a significant proportion of the population presently does not use mobile-cellular services at all. In those developing economies for which recent household data are available, close to 20 per cent of the population, on average, still do not use a mobile phone.<sup>2</sup> The proportion of phone ownership is even lower in some large developing economies – including Bangladesh, India, Indonesia and Pakistan – where more than 40 per cent of the population do not own a mobile phone.<sup>3</sup>

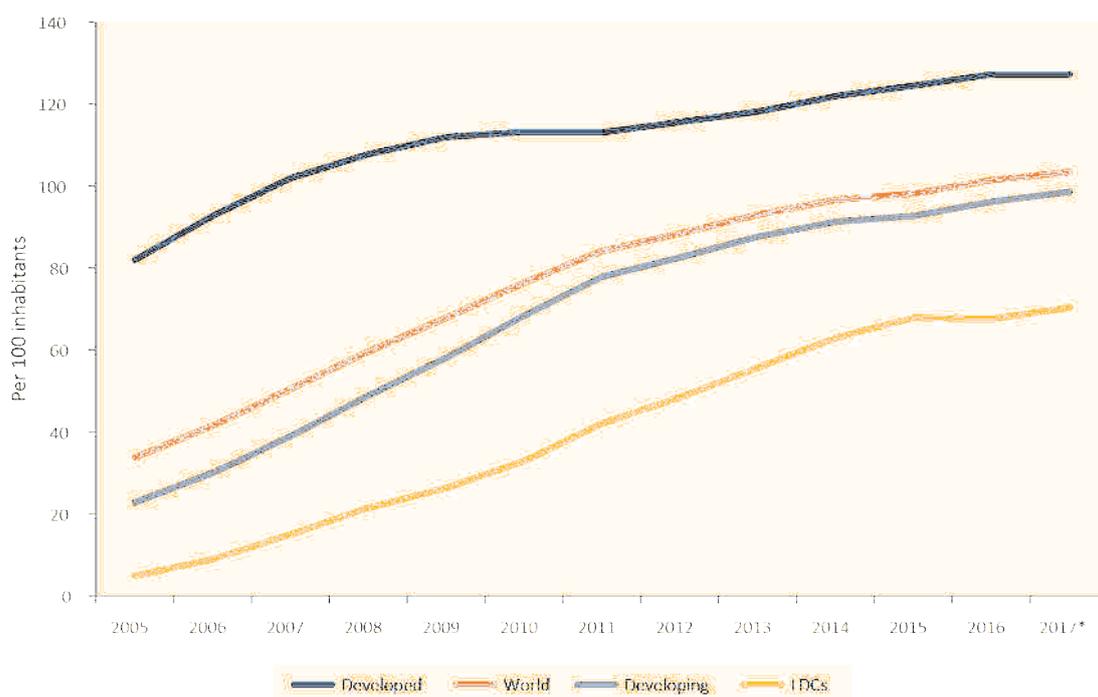
Although the global subscription rate for mobile-cellular telephony is high, as shown in Charts 1.6 and 1.7, there are marked differences between developed and developing countries, and between different ITU world regions.<sup>4</sup>

Chart 1.6 shows that there are substantial margins between the penetration rates for developed and developing countries, and for LDCs. The gap between developed countries and developing countries narrowed somewhat – from 35.2 to 28.6 subscriptions per 100 population – between 2011 and 2017, as developed countries moved towards market saturation, while the margin between developed countries overall and LDCs also narrowed – from 35.8 to 28.2 subscriptions per 100 population – but these still represent very substantial digital divides.

Chart 1.7 shows that only one of the ITU regions, Africa, now has a penetration rate for mobile-cellular subscriptions below 100 per 100 population. The rates of growth for most world regions have tailed off in recent years as mobile-cellular penetration has approached market saturation, with the highest recent regional growth rate being experienced in the Asia and the Pacific region. After steady growth in the decade to 2015, the figures for Africa have also been relatively stable during the past two years.

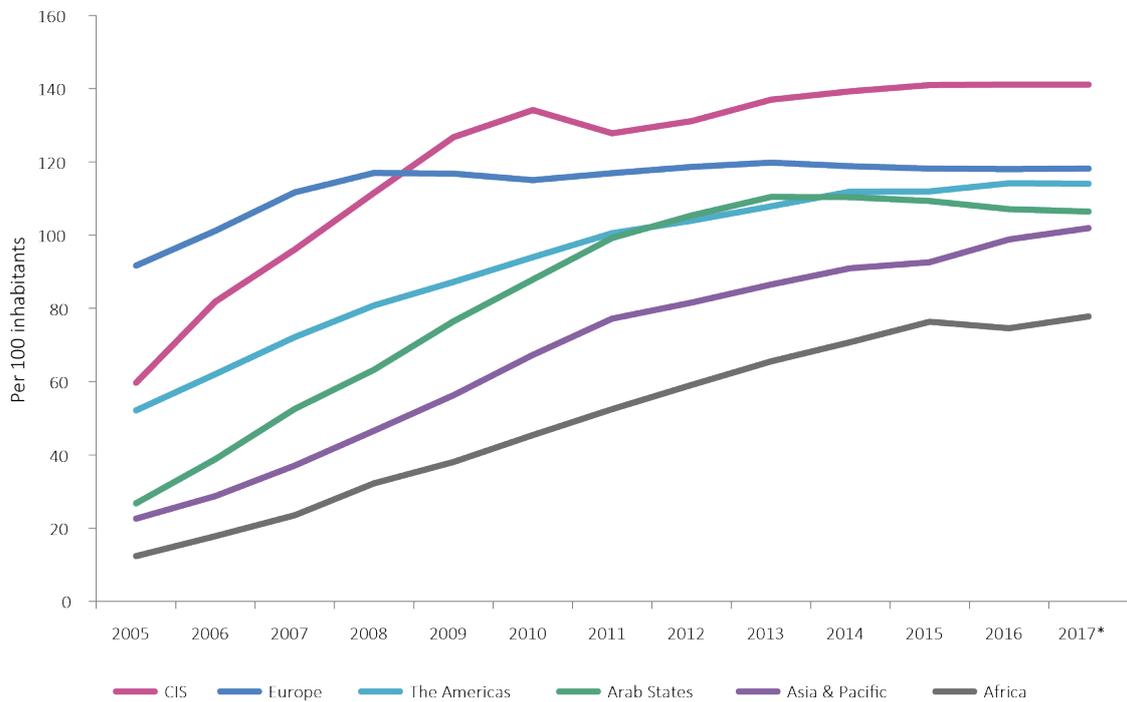
Data analysis at this global and regional level does not address differences in access to telephony between different social groups within the

**Chart 1.6: Mobile cellular subscriptions per 100 inhabitants by level of development, 2005–2017\***



Notes: \* ITU estimate.  
Source: ITU.

Chart 1.7: Mobile cellular subscriptions per 100 inhabitants by region, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

population of different countries (see section 1.5) or variations in national geography. There are still rural areas in some developing countries which are not adequately covered by a mobile-cellular signal, while the lower incomes which prevail in rural areas of some countries are also likely to reduce take-up and usage. Levels of educational experience may be an additional factor in some cases. Differences in mobile-cellular usage within a number of developing countries were illustrated in *Measuring the Information Society Report 2016* (ITU, 2016b: 170).

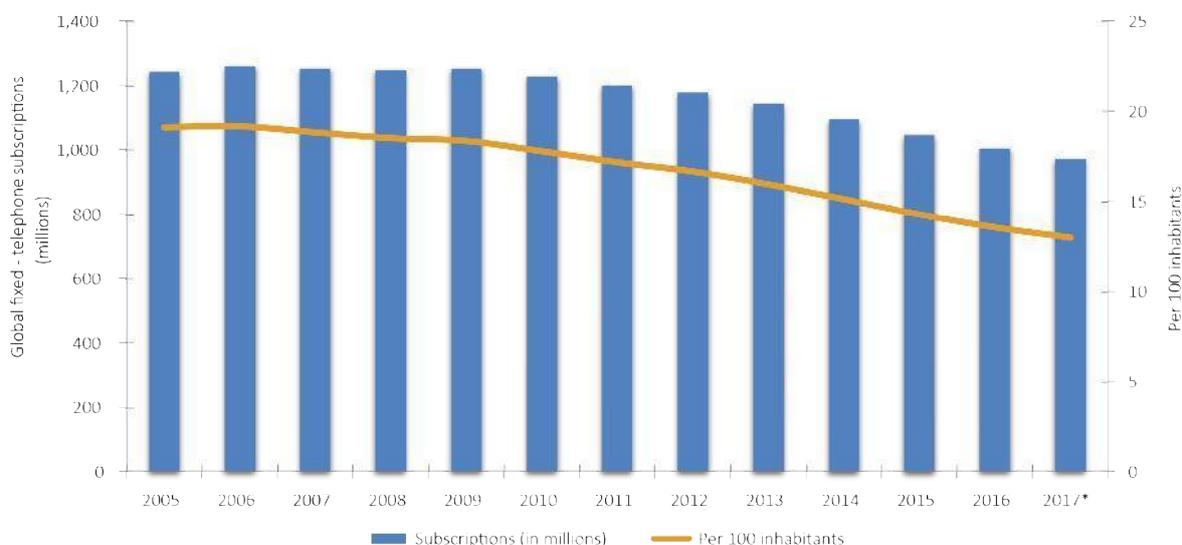
### 1.2.3 Fixed-telephone subscriptions

The growth in mobile-cellular subscriptions worldwide in recent years has been accompanied by a fall in the number of fixed-telephone subscriptions. The total number of these subscriptions has fallen from a peak of 1.26 billion in 2006 to 1.00 billion in 2016 and an estimated 972 million in 2017. Chart 1.8 illustrates this gradual decline in both subscriptions and the number of subscriptions per 100 population since 2006.

As with mobile-cellular subscriptions, there are marked differences between the penetration rates for fixed telephony in developed and developing countries, and in different world regions. These are illustrated in Charts 1.9 and 1.10. These show that there has been a steady decline in the fixed-telephone subscription rate in both developed and developing countries, and in most regions, since 2005, with this decline setting in more recently in the CIS region than in other regions.

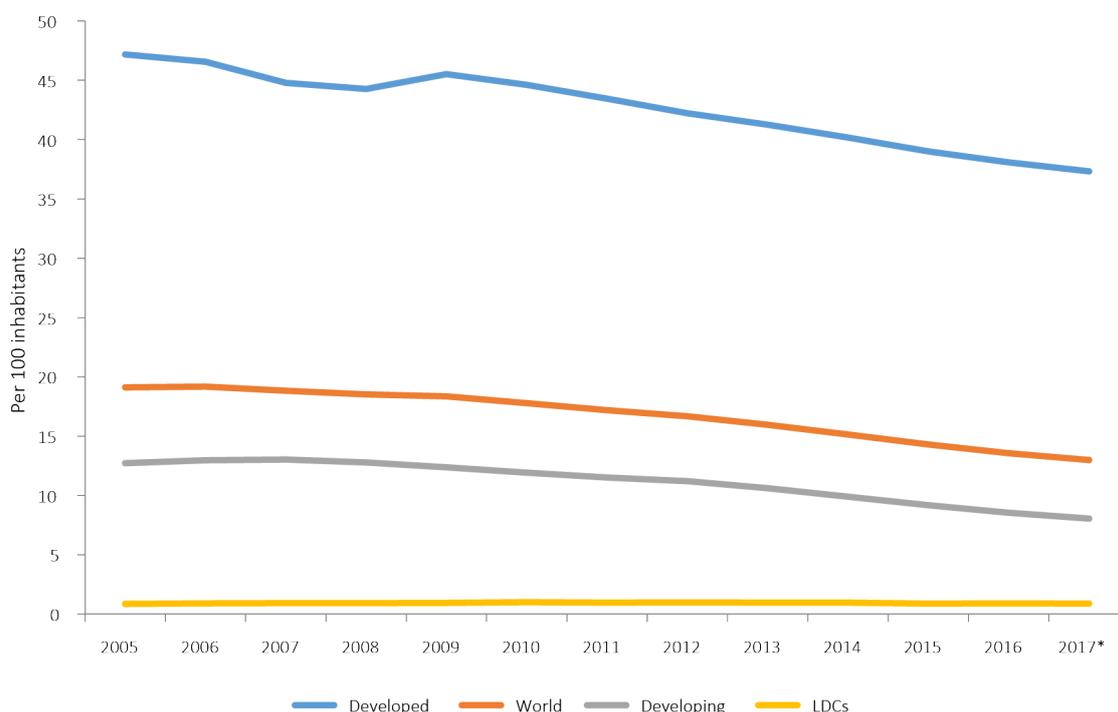
The low level of fixed telephony in developing countries has persisted since before the introduction of mobile telephony, and reflects historically low levels of fixed infrastructure deployment. Penetration rates in the LDC group of countries have been at or below 1.0 per 100 population throughout the period under review, while those for Africa have fallen from 1.5 to 1.0 per 100 population since 2005. As many as 26 countries recorded fixed-telephone penetration rates below 1.0 per 100 population in the IDI 2017, including three LDCs which recorded no fixed-telephone subscriptions whatsoever (the Democratic Republic of Congo, Guinea and Guinea-Bissau).

Chart 1.8: Global fixed-telephone subscriptions, total and per 100 inhabitants, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

Chart 1.9: Fixed-telephone subscriptions per 100 inhabitants by level of development, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

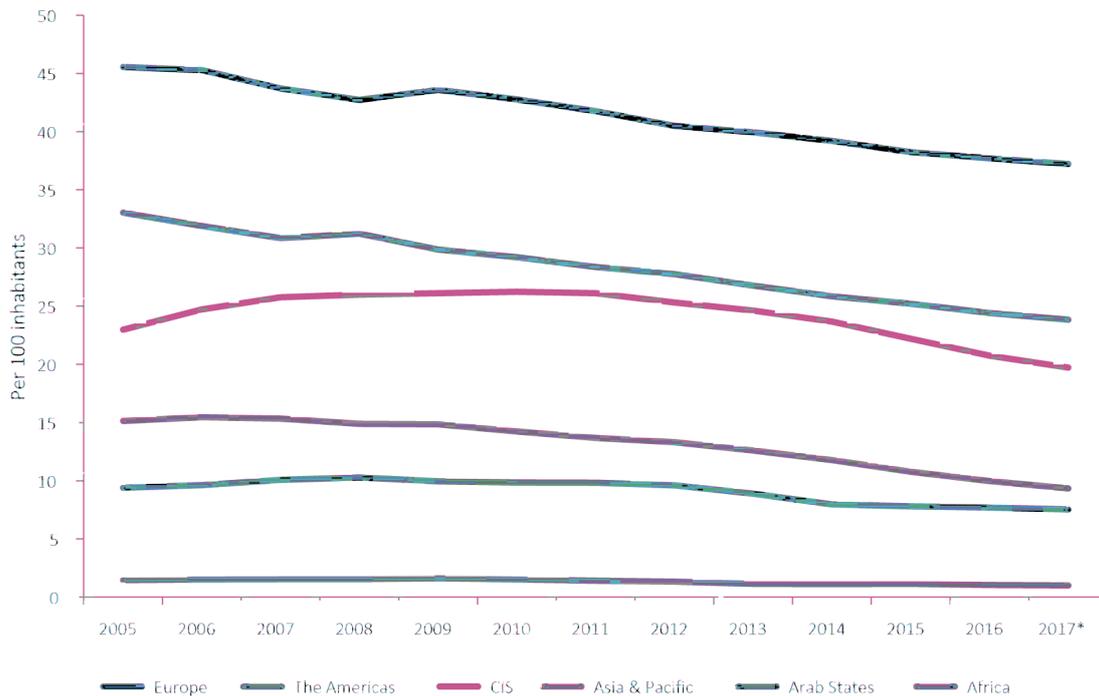
### 1.3 Trends in broadband access

Broadband networks and services are increasingly central to economic and social life, and to prospects for development, in both developed and developing countries. Access to broadband, as a

result, has become a more fundamental indicator of ICT performance and potential than access to voice telephony and other basic services.

A variety of definitions has been used for broadband in analyses from different sources,

Chart 1.10: Fixed-telephone subscriptions per 100 inhabitants by region, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

some of these changing over time as more bandwidth has become available. For the purposes of this chapter, and of the IDI reported in Chapters 2 and 3, broadband is defined as services with speeds of 256 kb/s and above.

As with voice telephony, mobile networks and devices now provide the majority of broadband access in most countries. Only 6 of the 176 economies included in IDI 2017 recorded higher levels of fixed-broadband than mobile-broadband penetration (Comoros, Cuba, Equatorial Guinea, Eritrea, Guyana and Palestine<sup>5</sup>), four of these recording very low levels of access in both modes. It should be noted, in this context, that fixed-broadband subscriptions are more likely to be shared by several people than mobile-broadband subscriptions. Fixed-broadband speeds are also usually higher than mobile-broadband speeds.

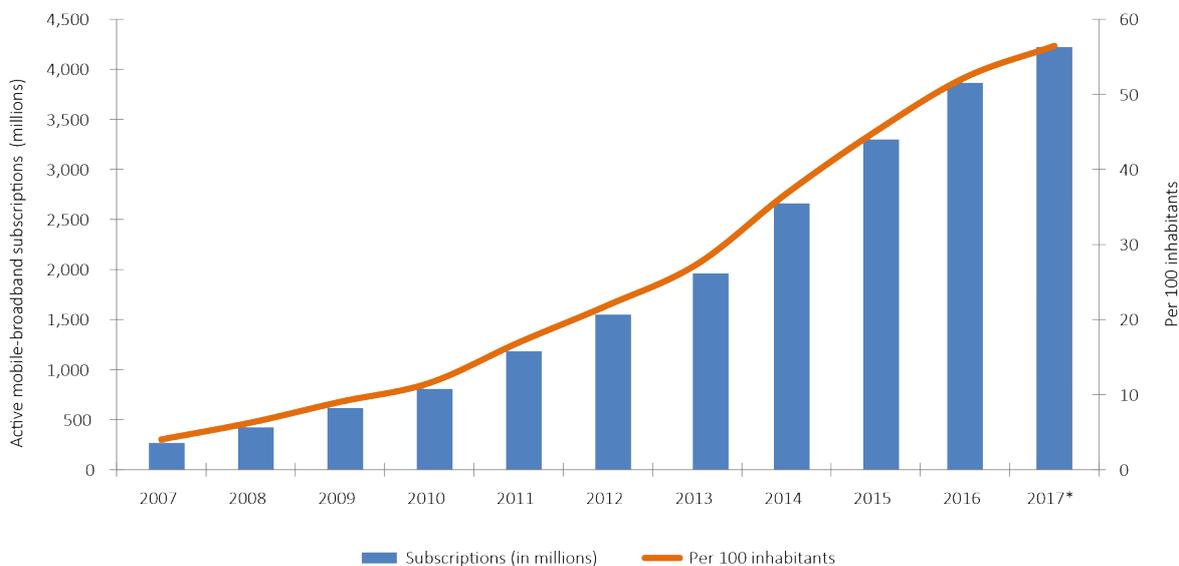
### 1.3.1 Active mobile-broadband subscriptions

The number and penetration rate of active mobile-broadband subscriptions have grown rapidly since mobile-broadband networks first became available in the middle of the previous decade. Growth in these subscriptions has broadly mirrored that for

mobile-cellular subscriptions, but with a time lag and at a lower level, since around 2010, with a faster growth rate being experienced since around 2013. The advent of smartphones and tablets has accelerated the use of mobile-broadband alongside more extensive network deployment. This suggests that many people who started with a voice-only mobile phone subscription have switched to smartphones with mobile-broadband. Smartphone traffic is expected to exceed computer traffic by 2020, while traffic from wireless and mobile devices will then account for two-thirds of all IP traffic.<sup>6</sup>

Chart 1.11 illustrates the growth that has taken place in active mobile-broadband subscriptions globally since these were first recorded in 2007. The total number of subscriptions has risen from 268 million in 2007 to 807 million in 2010, 3.30 billion in 2015 and an estimated 4.22 billion in 2017. The global penetration rate has risen from 4.0 per 100 population in 2007 to 11.5 in 2010, 45.1 in 2015 and an estimated 56.4 in 2017. Two countries in IDI 2017 (Australia and Finland) recorded penetration rates for mobile-broadband above those for mobile-cellular subscriptions.

Chart 1.11: Global active mobile-broadband subscriptions, total and per 100 inhabitants, 2007–2017\*

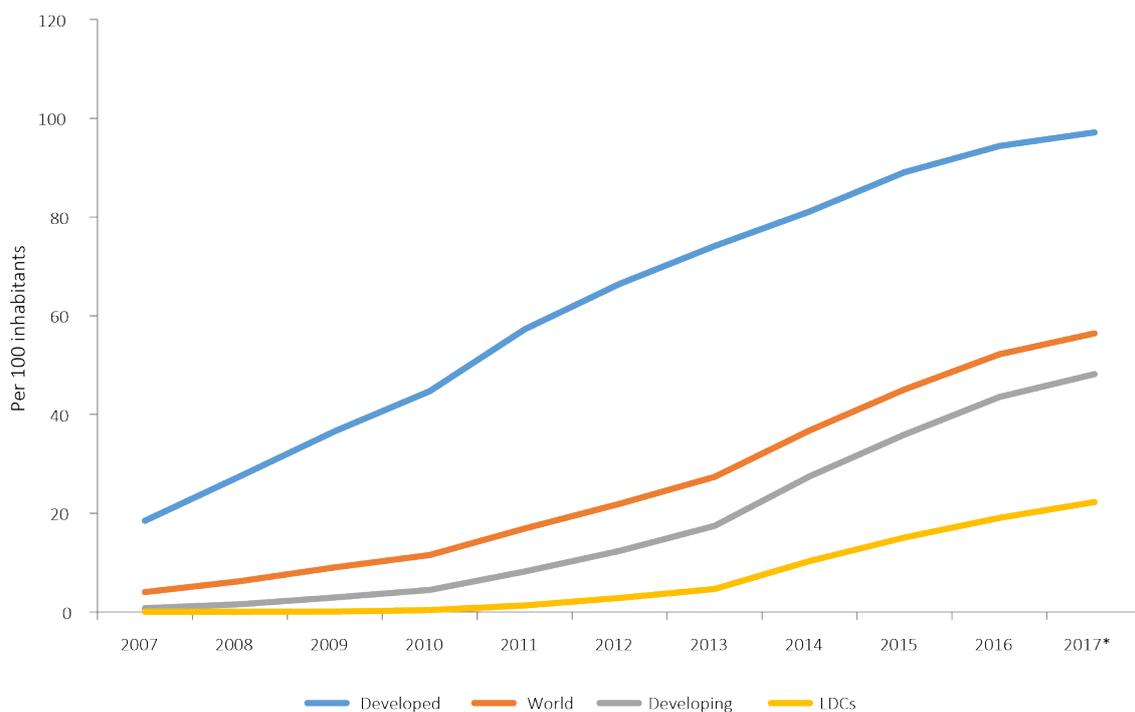


Notes: \* ITU estimate.  
Source: ITU.

Once again, there are marked differences between the experience in developed and developing countries and in different world regions, with an upward trend comparable to that for mobile-

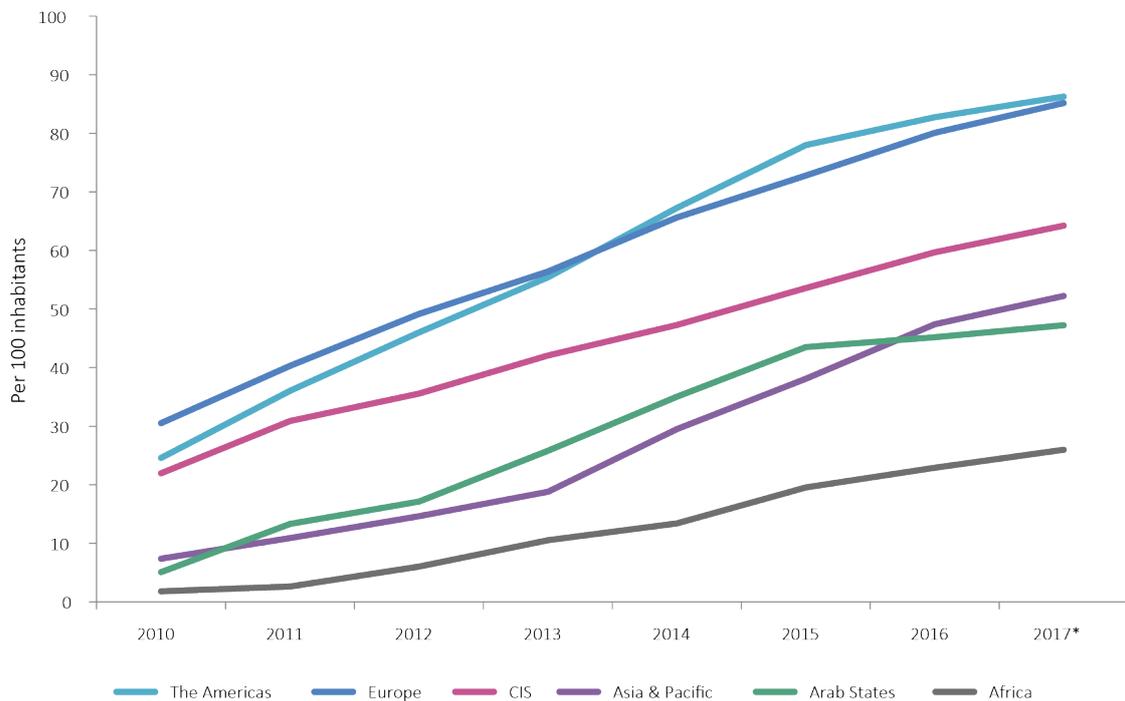
cellular subscriptions at lower subscription levels. These differences are illustrated in Charts 1.12 and 1.13.

Chart 1.12: Active mobile-broadband subscriptions per 100 inhabitants by level of development, 2007–2017\*



Notes: \* ITU estimate.  
Source: ITU.

Chart 1.13: Active mobile-broadband subscriptions per 100 inhabitants by region, 2010–2017\*



Notes: \* ITU estimate.  
Source: ITU.

The penetration rate for mobile-broadband in developed countries has almost reached 100 per 100 population, just over twice that for developing countries and more than four times that for LDCs. The gap between developed and developing countries has narrowed slightly between 2012 and 2017, from 54.1 to an estimated 49.0 percentage points. That between developing countries as a whole and LDCs, however, has risen from 9.5 subscriptions per 100 population in 2012 to an estimated 25.9 per 100 population in 2017. This suggests that LDCs may presently be falling further behind where this important indicator is concerned.

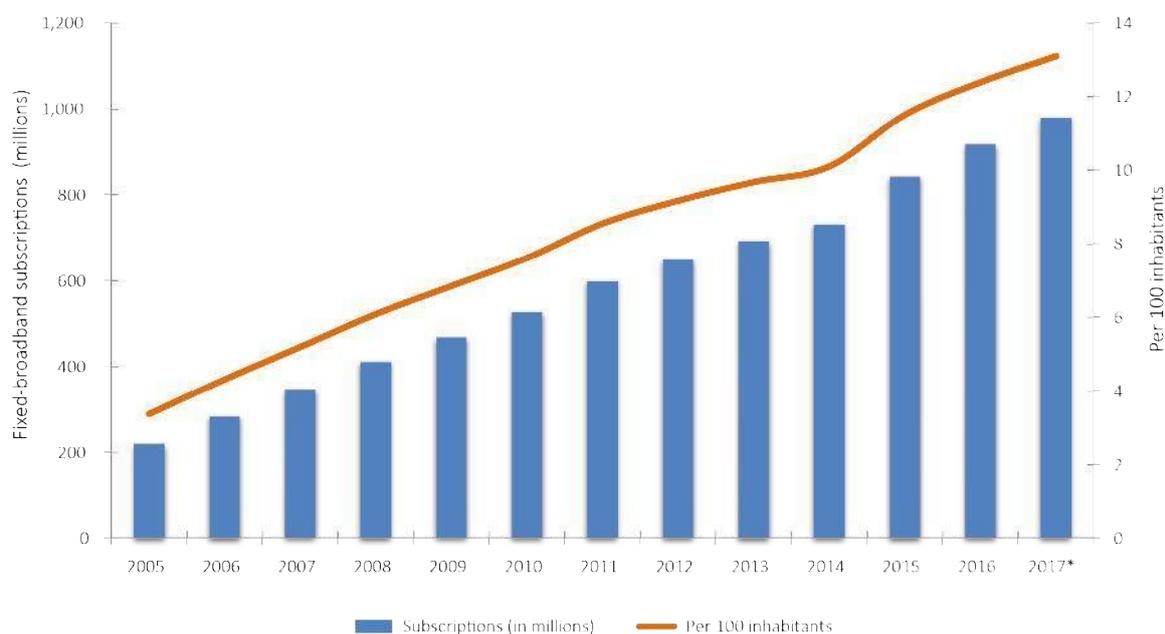
Chart 1.13 shows similarly marked differences between regions to those noted for mobile-cellular subscriptions, with high penetration rates in Europe and the Americas, medium rates in the CIS, Asia and the Pacific and Arab States regions, and much lower penetration rates in Africa. The growth rates for most regions have been broadly similar, but with a significant slowdown in growth in the Arab States since 2015. The growth rate in Africa is also slightly below that in most other regions.

### 1.3.2 Fixed-broadband subscriptions

As with fixed and mobile telephony, the number and penetration rate for fixed-broadband subscriptions fall far below those for mobile-broadband. Although the indicators for fixed and broadband subscriptions are not directly comparable (see above), the figure for fixed-broadband subscriptions is less than a quarter of that for active mobile-broadband subscriptions and just 18.8 per cent of all broadband subscriptions.

Worldwide, the number of fixed-broadband subscriptions has risen from 220 million in 2005 to 526 million in 2010, 842 million in 2015 to an estimated 979 million in 2017 (a figure which, for the first time, exceeds the estimate for fixed-telephone subscriptions). This rate of growth has been, to some extent, dependent on the prior availability of fixed-telephone networks, which are much less widespread in many developing countries, and particularly LDCs, than they are in developed countries. Concern has been expressed in previous *Measuring the Information Society Reports* and other analyses about the potential importance of fixed-broadband connectivity in

Chart 1.14: Global fixed-broadband subscriptions, total and per 100 inhabitants, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

enabling developing countries to maximize the use of more advanced communications services.<sup>7</sup>

Chart 1.14 illustrates the growth which has taken place in fixed-broadband subscriptions globally since 2005. The differences between the experience of developed and developing countries, and the experiences of different regions, are set out in Charts 1.15 and 1.16.

Charts 1.15 and 1.16 illustrate the extent to which fixed-broadband networks are more prevalent in developed countries, and in the Europe region, than they are elsewhere. The level of fixed-broadband access is also notably lower in the Arab States region than it is in the Americas, the CIS region and the Asia and the Pacific region. Together with the slower rate of growth in mobile-broadband identified in Chart 1.13, this suggests that the Arab States region is falling behind other developing regions in broadband access, irrespective of access mode.

The most striking feature of these charts, however, is the exceptionally low penetration rates that they show for LDCs and Africa. The ITU Africa region, with a population of almost 1 billion, is estimated to have only some 4 million fixed-broadband subscriptions in 2017, fewer than the number of fixed-broadband subscriptions in Belgium, which

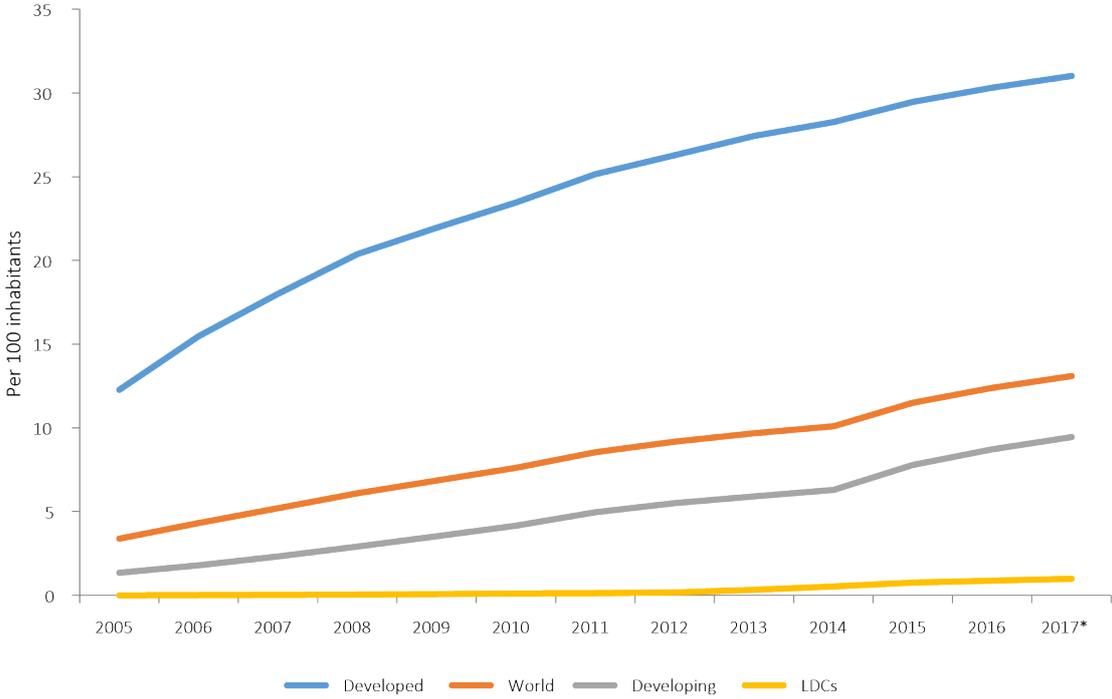
has a population of less than 11.5 million. There are estimated to be less than 10 million fixed-broadband subscriptions in LDCs, approximately 1.0 per cent of the global total, though LDCs include 13 per cent of world population.<sup>8</sup>

Chart 1.17 shows the uneven distribution of fixed-broadband subscriptions by speed. Chart 1.17 also shows the much greater reliance of low-income countries, where broadband is concerned, on mobile access, which may prove a constraint if fixed access proves to be more appropriate for the use of future high-specification services. In any event, the bandwidth available through mobile networks in African and other LDCs is generally much less per user than is the case in developed countries and high-income developing countries.

## 1.4 Internet access and use

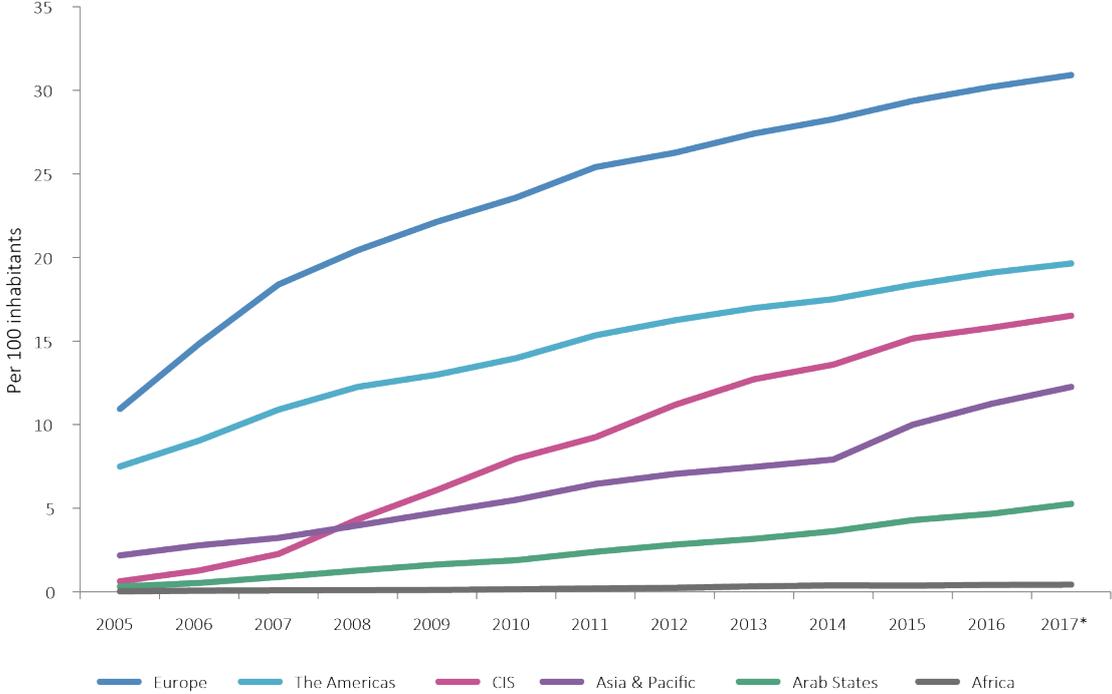
Data communications have replaced voice communications as the most important use of both fixed and mobile networks during the period since WSIS. Access to and use of the Internet have become critically important not just in terms of ICTs but also in prospects for economic and social development, including achievement of the Sustainable Development Goals.

Chart 1.15: Fixed-broadband subscriptions per 100 inhabitants by level of development, 2005–2017\*



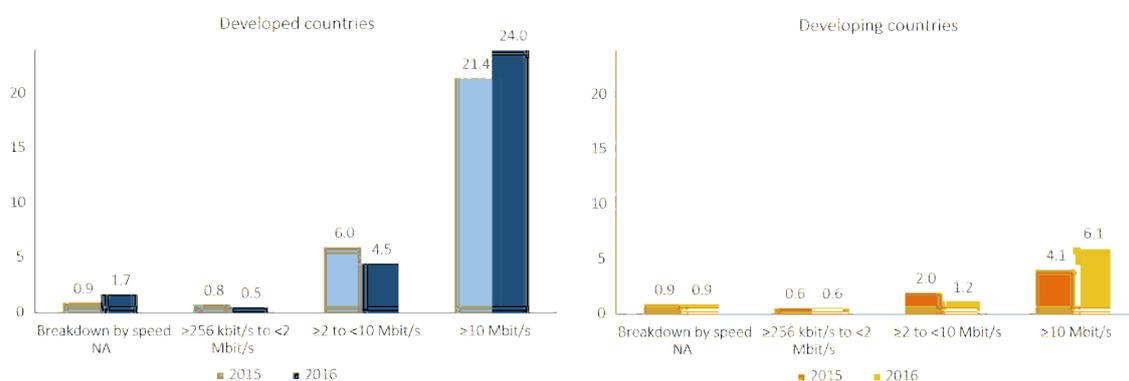
Notes: \* ITU estimate.  
Source: ITU.

Chart 1.16: Fixed-broadband subscriptions per 100 inhabitants by region, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

Chart 1.17: Fixed-broadband subscriptions per 100 inhabitants, by speed, 2015-2016



Source: ITU.

Household access to the Internet is the most effective way of enabling an inclusive information society in which all people, irrespective of age, gender, disability, or economic or social context, can access the Internet and the resources which it makes available. Household access can be supplied through either fixed or mobile connectivity, and may be shared among family members. Many of the broadband strategies that have been adopted by governments worldwide seek to enable access for all households nationwide as a means of achieving universal access to the Internet.

The latest ITU data estimate that more than half of the world's households (53.6 per cent) now have access to the Internet at home, compared with less than 20 per cent in 2005 and just over 30 per cent in 2010. Chart 1.18 shows that the proportion of households with Internet access around the world grew steadily, by between 7.5 and 13.5 per cent each year, between 2005 and 2015, but that the rate of growth in the last two years has been slower, at or below 5.0 per cent.

Charts 1.18 and 1.19 show that the digital divides between developed and developing countries and between regions that were observed for fixed and mobile connectivity earlier in this chapter are also evident in levels of household access to the Internet.

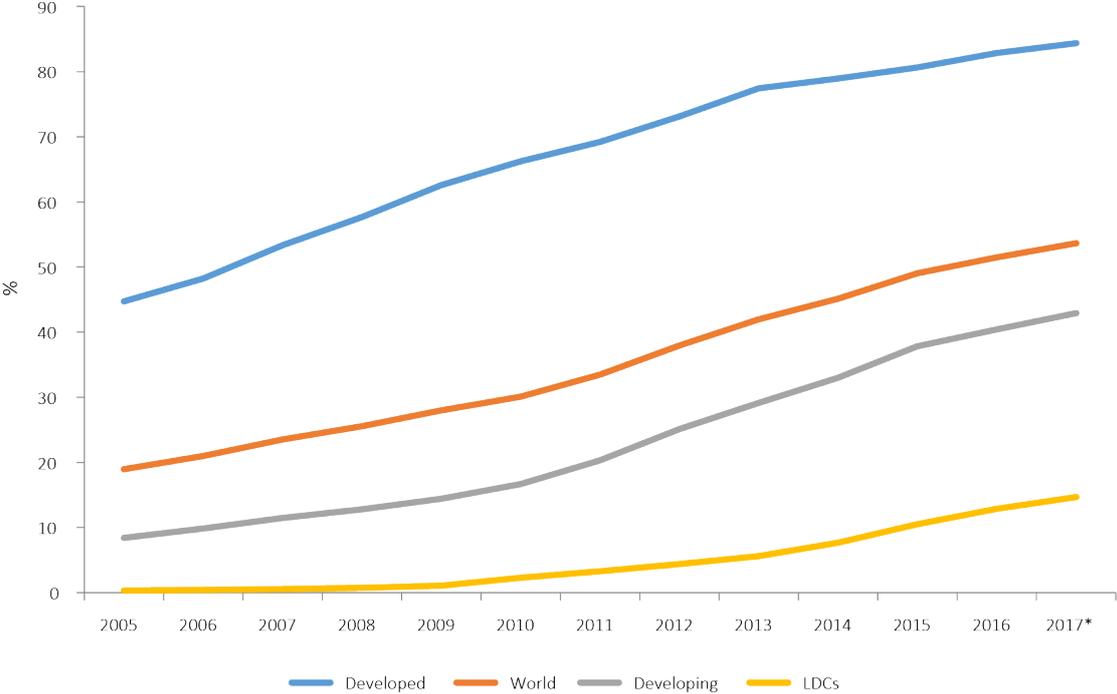
ITU's Connect 2020 targets, agreed to in 2014, call for 50 per cent of households in developing countries, and 15 per cent of households in LDCs, to have Internet access by 2020. By 2017, it is estimated that 84.4 per cent of households in developed countries will have Internet access, compared with 42.9 per cent in developing

countries and just 14.7 per cent in LDCs. As can be seen from Chart 1.18, the gap between LDCs and developing countries in general appears to be widening, though the figure for LDCs is now close to achieving the Connect 2020 target set in 2014. Progress towards the Connect 2020 targets will be reviewed at ITU's Plenipotentiary Conference in 2018.

Chart 1.19 reveals that there are similarly large differences between different world regions. Europe has the highest proportion of households with Internet access, almost 85 per cent, while the CIS and Americas regions also record figures well over 50 per cent. There has been particularly rapid growth in household access to the Internet in the CIS region since 2008. The Arab States and the Asia and the Pacific region both record just under half of households having Internet access. The figure for Africa, however, is much lower, at 18.0 per cent, though this has continued a steady rise since 2010, when it was 3.9 per cent.

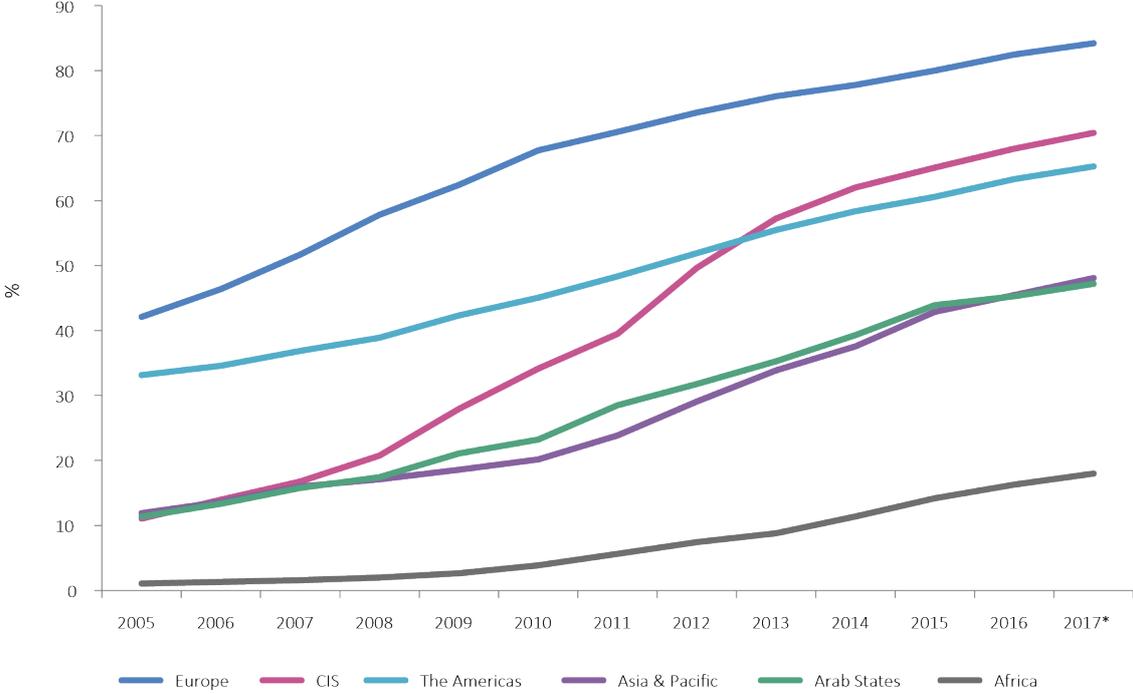
Not surprisingly, ITU data on the number of individuals using the Internet show a pattern broadly similar to those for household access to the Internet. Chart 1.20 shows the growth in the global number of individuals using the Internet and the proportion of the world's population using the Internet. ITU estimates that the number of individuals using the Internet will exceed 3.5 billion in 2017, representing 48.0 per cent of the world population. This compares with 1.0 billion (15.8 per cent) in 2005, 2.0 billion (28.9 per cent) in 2010 and 3.15 billion (43.2 per cent) in 2015, continuing a steady upward trend throughout the period.

Chart 1.18: Global proportion of households with access to the Internet, 2005–2017\*



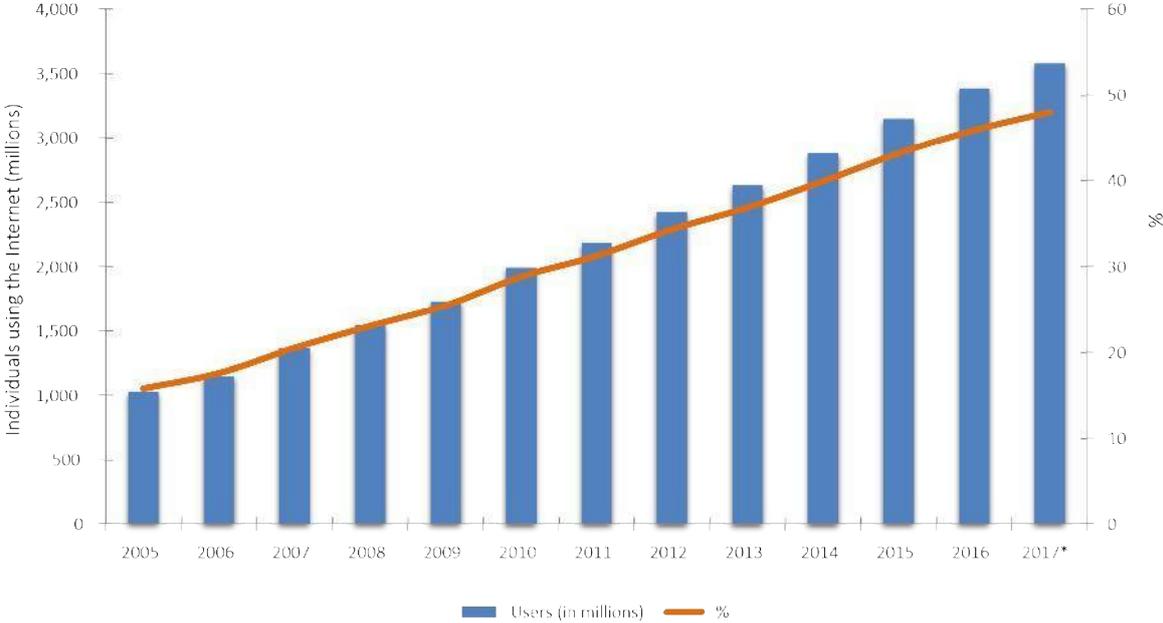
Notes: \* ITU estimate.  
Source: ITU.

Chart 1.19: Proportion of households with access to the Internet by region, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

Chart 1.20: Individuals using the Internet, 2005–2017\*

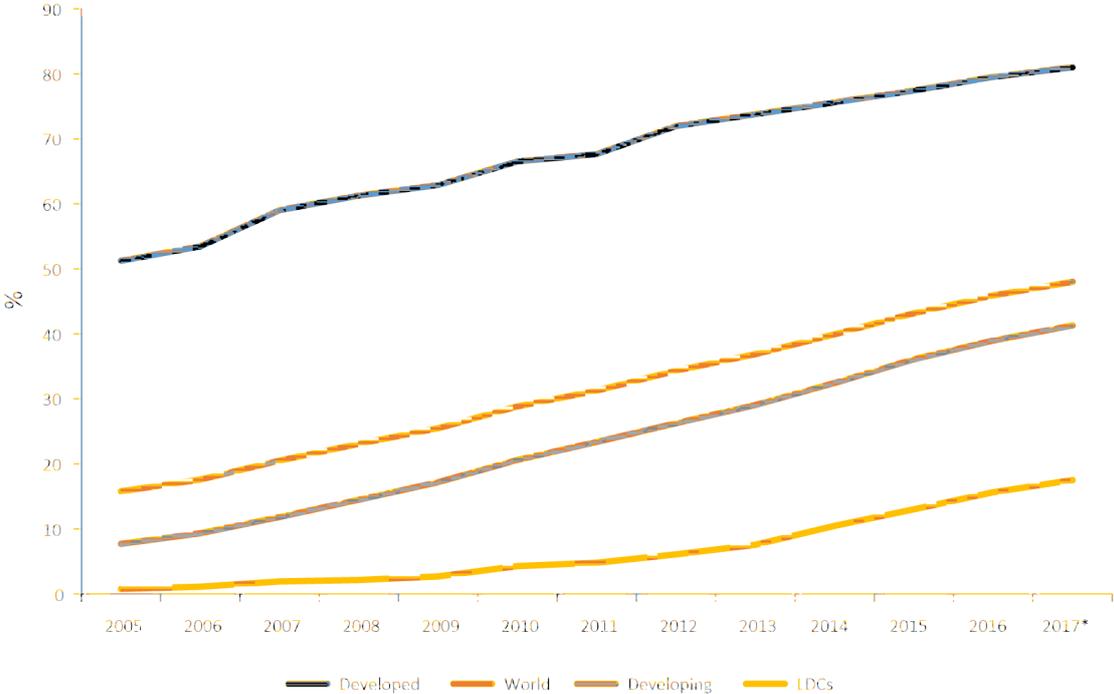


Notes: \* ITU estimate.  
Source: ITU.

As with household access, Charts 1.21 and 1.22 show that there are considerable differences in the experience of countries in different development categories and in different regions. Chart 1.21

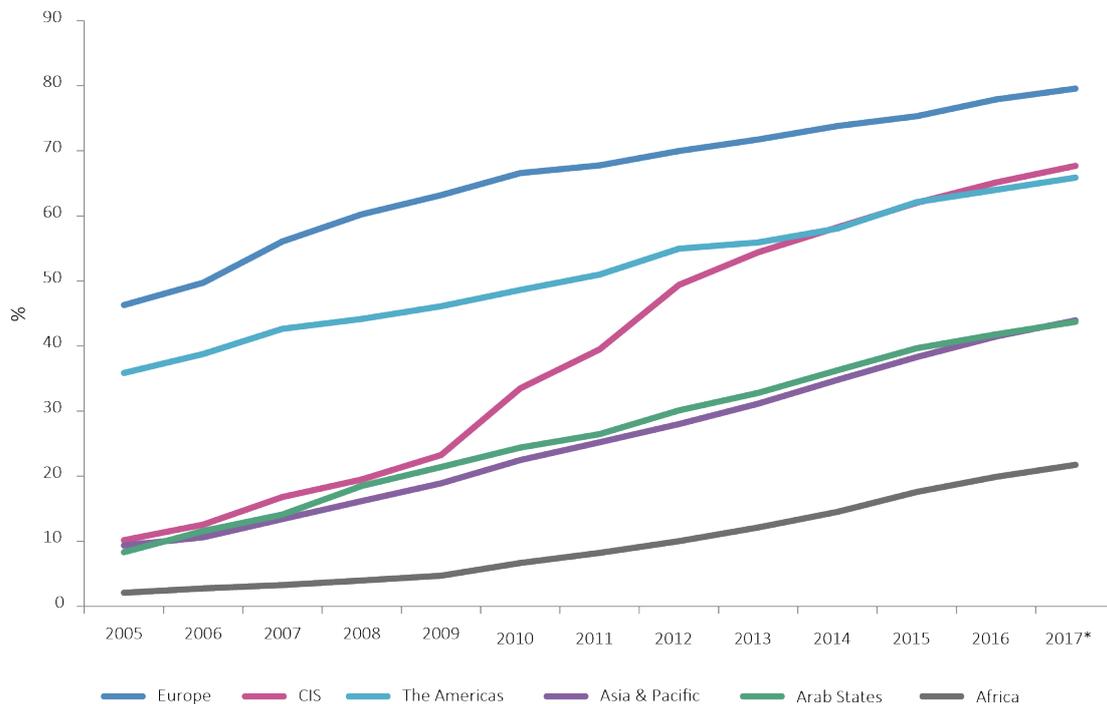
shows the evolution in the number of individual users in countries with different development status during the period 2005–2017. This shows a substantial digital divide between developed

Chart 1.21: Proportion of individuals using the Internet by development status, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

Chart 1.22: Proportion of individuals using the Internet by region, 2005–2017\*



Notes: \* ITU estimate.  
Source: ITU.

countries, in which 81.0 per cent of individuals are now estimated to use the Internet, and developing countries, in which the figure is 41.3 per cent, and a similar digital divide between these groups of countries and LDCs, for which the comparable figure is 17.5 per cent.

ITU’s Connect 2020 targets, agreed to in 2014, called for the proportion of individuals using the Internet (i.e. those using the Internet at least once within a three-month period) to reach 50 per cent in developing countries, and 20 per cent in LDCs, by 2020.

Chart 1.22 presents findings for the same indicator by ITU region, and shows outcomes similar to those identified for household access. Europe is again the region with the highest outturn figure for this indicator, while the CIS region and the Americas also have figures well above 50 per cent, the CIS region having made particularly strong gains between 2009 and 2013. Outturn figures for the Arab States and Asia and the Pacific regions are approaching 50 per cent and should, at current rates of growth, reach or exceed that target by the end of the decade. The figure for Africa is steadily

growing but, at 21.8 per cent, is well below that for any other region.

## 1.5 Digital divides within society

There are significant differences in the levels of Internet adoption by different groups within society. Particular attention has been paid to the digital gender gap, while increasing attention is also being paid to differences between age groups.

### Gender equality

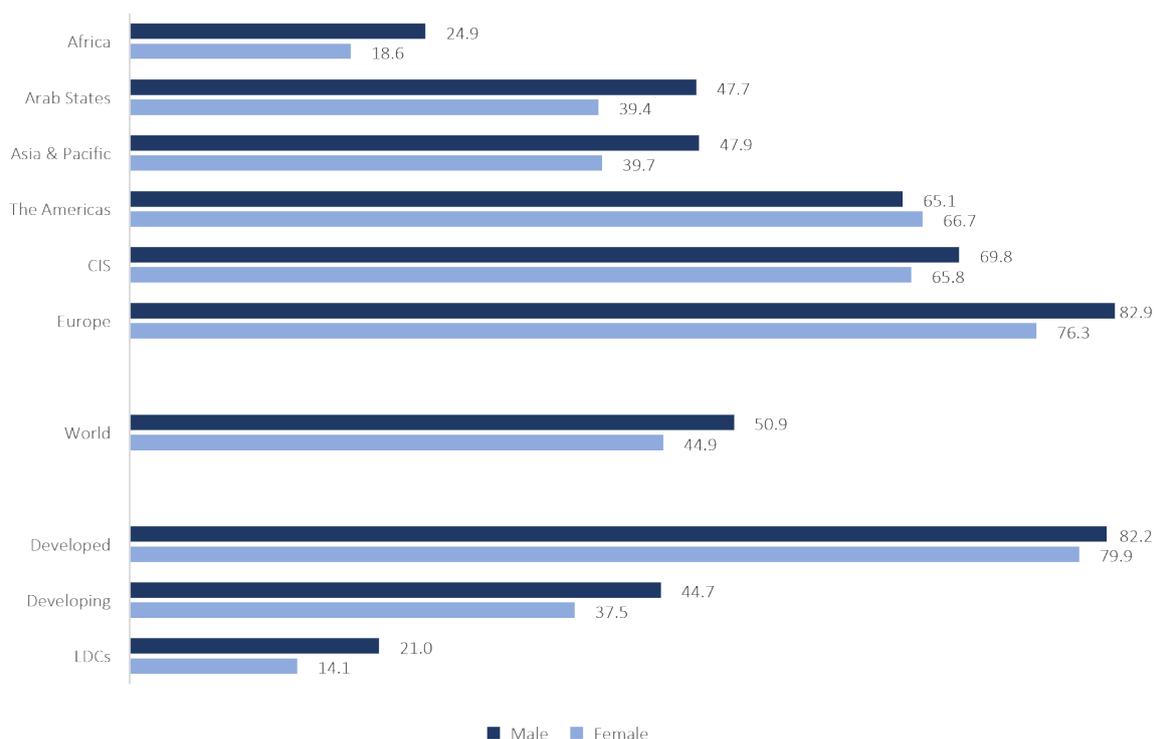
There has been increasing international concern in recent years about gender imbalance in access to the Internet and other ICTs. Addressing this imbalance was among the priorities identified by the United Nations General Assembly in its ten-year review of the outcomes of WSIS in 2015. Added significance is attached to this by the Sustainable Development Goals, which include an explicit commitment to enhance the use of ICTs to promote women’s empowerment.<sup>9</sup> ITU’s Connect 2020 targets seek to ensure that gender equality among Internet users is reached by 2020.

Although there is a need for more gender-disaggregated data to be developed, the latest data compiled by ITU suggest that the proportion of men using the Internet is higher than the proportion of women doing so in two-thirds of countries worldwide. Internet penetration rates

for men and women, and the gender gap between men and women, are illustrated in Charts 1.23 and 1.24.

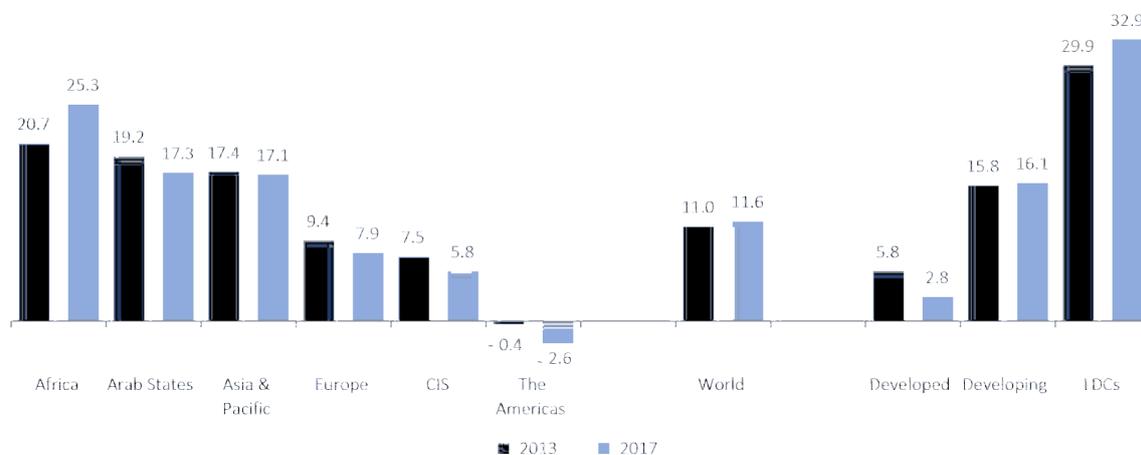
These charts suggest that the digital gender gap fell between 2013 and 2017 in developed

**Chart 1.23: Internet penetration rates for men and women, 2017\***



Notes: \* Estimates. Penetration rates in this chart refer to the number of women/men using the Internet, as a percentage of the respective total female/male population.  
Source: ITU.

**Chart 1.24: Internet user gender gap, percentages, 2013 and 2017\***



Notes: \* Estimates. The gender 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.

countries, where more than 80 per cent of the population is now estimated to be online. The gap in developed countries is now estimated to be just 2.8 per cent. It is much more pronounced, at 16.1 per cent, in developing countries, where overall Internet access is 41.3 per cent, just over half the rate in developed countries. The digital gender gap is most pronounced, rising to 32.9 per cent, in LDCs, where overall Internet usage is lowest, including just 17.5 per cent of the population. In LDCs, only one out of seven women is using the Internet compared with one out of five men.

The gender gap is also more pronounced in Africa, where the majority of LDCs are concentrated, than in other ITU regions. While the gap has fallen in other regions since 2013, it is estimated to have increased in Africa between 2013 and 2017, from 20.7 to 25.3 percentage points. This suggests that, while Internet access rates in Africa are currently increasing, men are disproportionately represented in that increase.

Evidence from household surveys suggests that the digital gender gap is strongly associated with indicators of other socio-economic disadvantages experienced by women in many societies, such as fewer years spent in education and lower levels of income. There is a particularly strong association between gender parity in tertiary education and gender parity in Internet use. The only region where a higher proportion of women than men are using the Internet, for example, is the Americas,

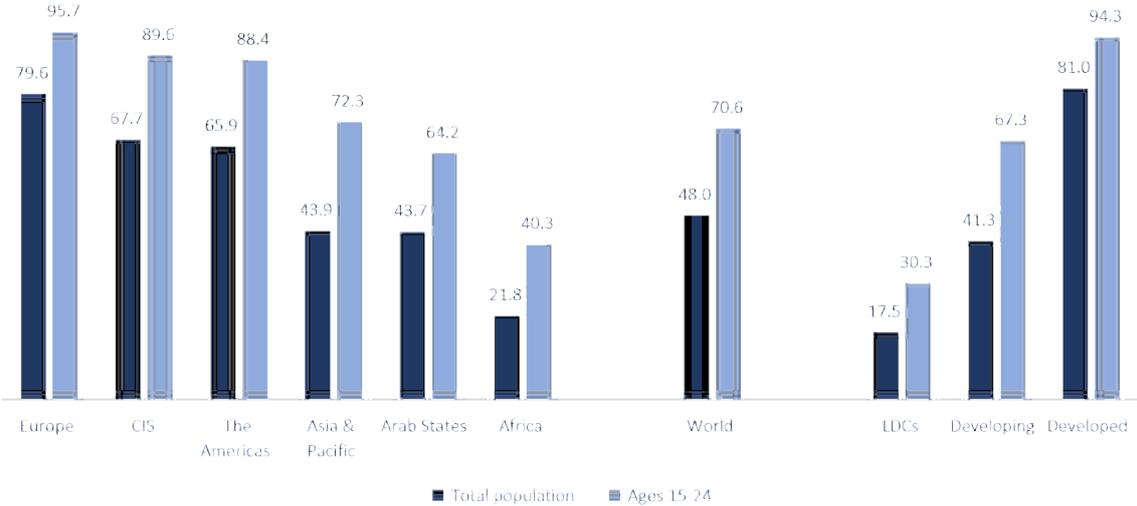
where countries also score highly on gender parity in tertiary education. The association between the digital gender gap and structural inequalities between men’s and women’s access to education and income implies that efforts to address these structural inequalities will be essential if the goal of gender equality in ICT access is to be achieved.

**Differences between age groups**

Young people, particularly those aged between 15 and 24, have been more particularly strongly engaged with the Internet. As indicated in Charts 1.25 and 1.26, the proportion of people in this age group who are using the Internet, 70.6 per cent worldwide, is much higher than the proportion of the total population which is online (48.0 per cent). This higher rate of Internet adoption by young people is apparent in all development categories and regions. In LDCs, 35.1 per cent of individuals using the Internet fall into this age group, which forms 20.3 per cent of their population, compared with just 13.0 per cent in developed countries (where they comprise 11.2 per cent of the population).

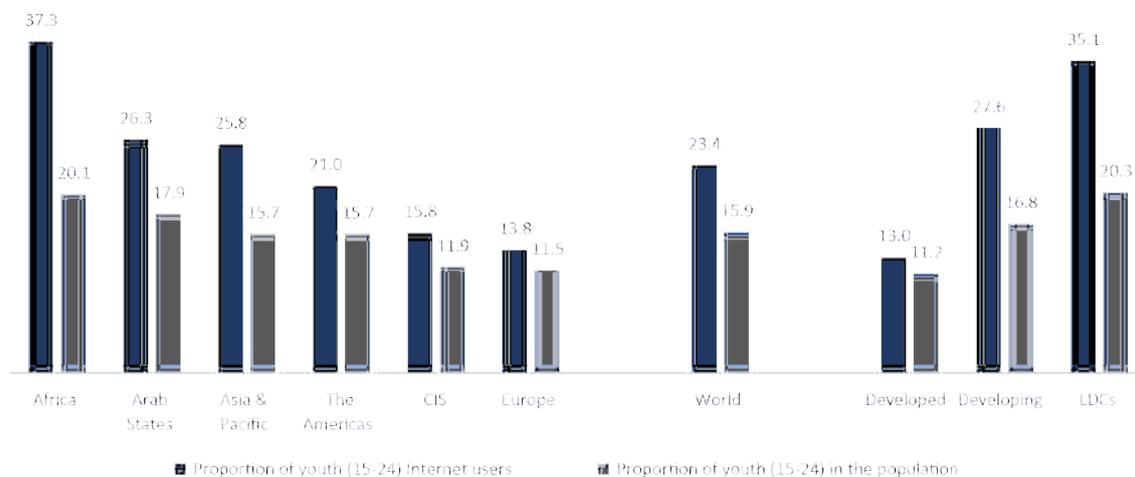
While young people have been particularly enthusiastic adopters of the Internet, significantly lower rates of adoption are found in older age groups. The 2016 edition of this *Report* found that, in most countries, Internet adoption among those aged over 75 is below 10 per cent, adding that possible explanations include lower incomes,

**Chart 1.25: Proportion of individuals using the Internet, by age, 2017\***



Notes: \* Estimates. Proportions in this chart refer to the number of people using the Internet, as a percentage of the total population, and the number of people aged 15-24 using the Internet, as a percentage of the total population aged 15-24, respectively. Source: ITU.

Chart 1.26: Young people aged 15–24 as a proportion of population and of Internet users, 2017\*



Notes: \* Estimates. Proportions in this chart refer to the number of people aged 15-24 using the Internet, as a percentage of the total population using the Internet, and the number of people aged 15-24, as a percentage of the total population, respectively.  
Source: ITU.

lower educational attainment, social isolation, medical problems and psychological barriers such as anxiety about computers and the Internet.<sup>10</sup>

## 1.6 Summary and conclusion

Progress continues to be made in connectivity and use of ICTs in all world regions, but digital divides and inequalities continue to affect the extent to which the Information Society is contributing towards the economic and social development of different regions, countries, households and individuals.

Several long-term trends are evident. The substantial growth in mobile-cellular telephony which took place following WSIS (2003–2005) has greatly increased access to basic communications services. Mobile communications have become much more widespread, and are particularly predominant in developing countries. Recent years have also seen rapid growth in broadband networks and services, particularly mobile-broadband. This has enabled much greater use of ICTs for Internet and thereby for applications that support economic development and individual empowerment.

The digital divides that are apparent in access to and use of both basic and broadband communications, however, remain substantial. Developed countries have significantly higher

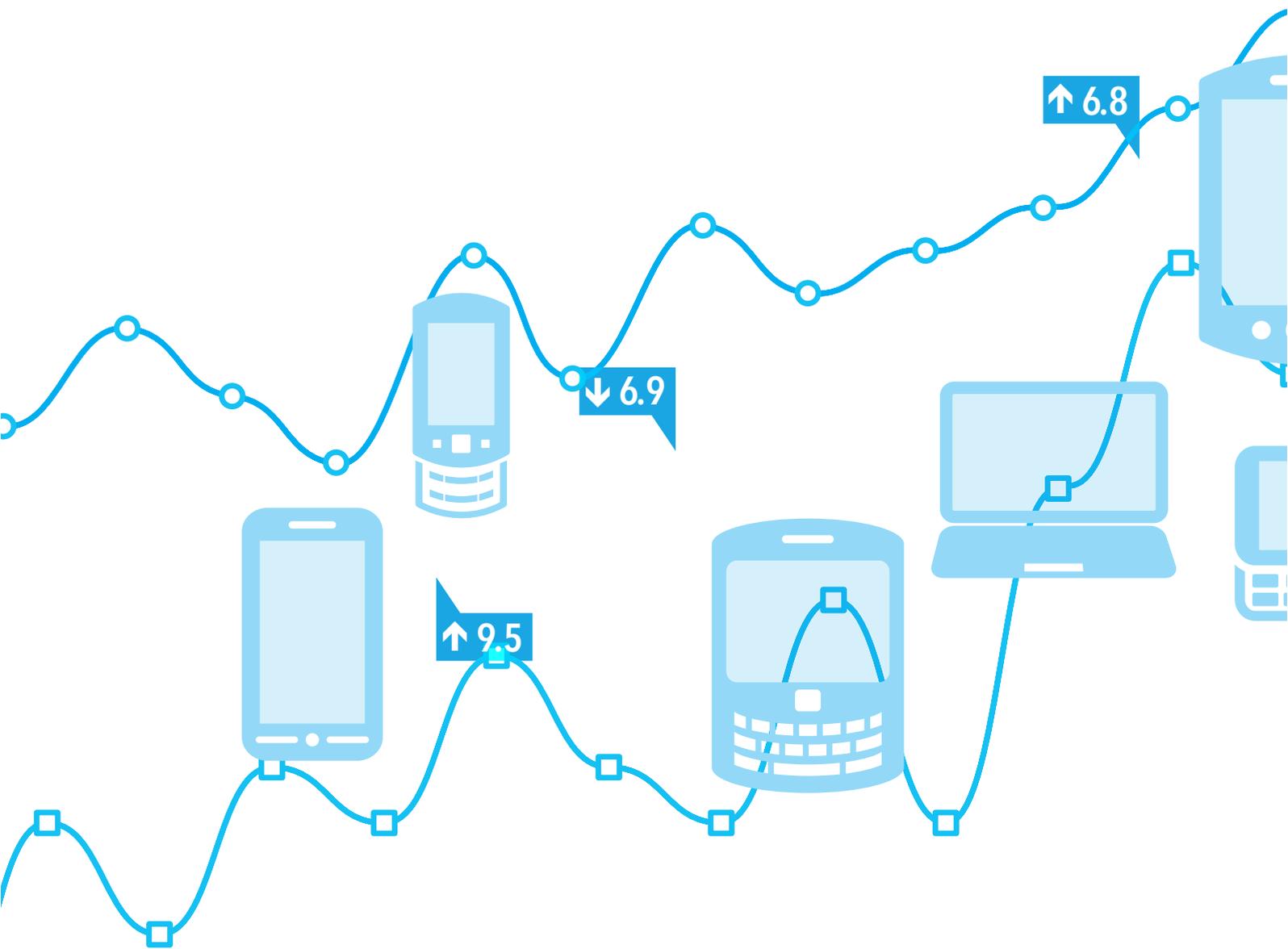
subscription and penetration rates for basic communications, broadband and Internet, while particularly low subscription and penetration rates are evident in LDCs. People in Europe and high-income countries in North America and parts of the Asia and the Pacific region are also much more likely to be connected and to make full use of the Internet than those in other regions, particularly Africa. There is some evidence that the gap between LDCs and other developing countries may be increasing, raising concerns about possible impacts on efforts to achieve the Sustainable Development Goals.

Digital divides are also evident within countries, for example between urban and rural areas and between age groups. Urban residents and young people are more likely to be online in many countries than are rural dwellers and the elderly. Particular concern has been expressed about the digital gender gap. Women are less likely than men to make use of the Internet in most countries, but are more underrepresented online in developing countries than in developed countries, and are especially underrepresented in LDCs.

ITU adopted the Connect 2020 targets – which focus on access and use of broadband and Internet, with particular attention to developing countries, LDCs, gender equity and affordability – at its Plenipotentiary Conference in 2014. Progress toward achieving these will be reviewed at the next Plenipotentiary Conference in 2018.

## Endnotes

- <sup>1</sup> Calculated as mobile-cellular subscriptions as a proportion of the total of mobile-cellular plus fixed-telephone subscriptions.
- <sup>2</sup> This will be affected by variations in the proportion of young children in the population, which is significantly higher in many developing countries.
- <sup>3</sup> See ITU, 2016b and ITU, 2017a.
- <sup>4</sup> These differ from the regions used in other UN data sets – see Volume 1 Chapter 2 of this *Report*.
- <sup>5</sup> Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (Rev. Busan, 2014) of the ITU Plenipotentiary Conference.
- <sup>6</sup> See ITU, 2016b: 183. For a discussion of evolving trends, see ITU, 2017a.
- <sup>7</sup> See e.g. the *Reports* for 2014 (ITU, 2014: Chapter 5) and 2015 (ITU, 2015: Chapter 5).
- <sup>8</sup> United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, “LDCs in Facts and Figures”, available from <http://unohrrls.org/about-ldcs/facts-and-figures-2/>.
- <sup>9</sup> Sustainable Development Goal Target 5.B: Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women.
- <sup>10</sup> Van Deursen and Helsper, 2015.



## Chapter 2. The ICT Development Index – global analysis

## Key findings

**The ITU ICT Development Index (IDI) is a unique benchmark of the level of ICT development in countries across the world.** The IDI combines eleven indicators on ICT access, use and skills, capturing key aspects of ICT development in one measure that allows for comparisons to be made between countries and over time. IDI 2017 covers 176 economies worldwide. Comparison with IDI 2016 shows that progress has continued to be made in ICT access and use in almost all countries. However, it also demonstrates that there are still great disparities in ICT development between more and less connected countries which need to be addressed if inclusive information societies are to contribute to the achievement of sustainable development and other international goals.

**Iceland tops the IDI rankings in 2017, with an IDI value of 8.98.** It is followed by six other countries in Europe and three economies in the Asia-Pacific region which have competitive ICT markets that have experienced high levels of ICT investment and innovation over many years. Countries at the top of the IDI distribution also have high levels of economic prosperity, literacy and other skills that enable citizens to take full advantage of access to communications.

**The average value for all economies in the Index rose by 0.18 points between IDI 2016 and IDI 2017,** reaching 5.11 points, the first time that it has exceeded the halfway point along its scale. As in IDI 2016, improvements were particularly significant among countries in the middle of the distribution, many of which are middle-income developing countries, although there were only limited changes in positions in the rankings. The most substantial improvements in IDI value were recorded by Namibia, the Islamic Republic of Iran and Gabon, all of whose values rose by 0.50 points or more. All but eight countries improved their overall IDI values.

**As in previous years, the ICT use sub-index grew more rapidly, by 0.31 points, than did the access and skills sub-indices,** both of which rose by an average 0.10 points. The most significant contribution to improvements in IDI values was made by the indicator for mobile-broadband subscriptions, the average value for which rose by 12.9 per cent during the year. The indicator for fixed-telephone subscriptions, by contrast, continued to show a gradual decline in the majority of countries.

**The reduction of the digital divide between more and less connected countries continues to be challenging.** The gap between the highest and lowest performing countries in the Index rose to 8.02 points (out of 10.0) in IDI 2017. As in previous years, there is a strong association between economic and ICT development, with least developed countries (LDCs) filling 37 of the 44 places in the lowest (least connected) quartile of the distribution. LDCs improved their average IDI value by 0.15 points during the year, compared with 0.22 points for other developing countries, suggesting that they may be falling further behind in ICT development.

**Recent developments in ICT markets have led to the adoption of proposals for change in the composition of the Index.** A revised set of indicators will be introduced from IDI 2018 which should add further insights into the performance of individual countries and the relative performance of countries at different development levels.

# Chapter 2. The ICT Development Index – global analysis

## 2.1 Introduction

This chapter introduces the ITU Information and Communication Technology Development Index (ICT Development Index, or IDI), which brings together indicators concerned with ICT access, use and skills into a single comparative measure of development towards the information society. It presents findings from the latest edition of the Index (IDI 2017) for 176 economies for which data are available, assesses the experience of top-performing and most dynamic countries, and relates these findings to development status and the digital divide. Analysis of IDI 2017 from a regional perspective can be found in Chapter 3.

Section 2.2 describes the objectives, conceptual framework and methodology of the IDI, and reports on changes that will be introduced into the Index from 2018 following recommendations by the ITU Expert Group on Telecommunication/ICT Indicators (EGTI) and the ITU Expert Group on ICT Household Indicators (EGH).

Section 2.3 presents and analyses global findings for IDI 2017 and for its access, use and skills sub-indices, and compares these with those for IDI 2016. Regional outcomes are analysed in Chapter 3.

Section 2.4 analyses IDI 2017 in relation to the digital divide, including the relative performance of least connected countries (LCCs) and least developed countries (LDCs).

A brief summary of the chapter can be found in section 2.5.

## 2.2 The ICT Development Index

The IDI is a composite index that combines 11 indicators into one benchmark measure that can be used to monitor and compare developments in ICTs between countries and over time. The IDI was developed by ITU in 2008 in response to ITU Member States' request to establish an overall

ICT index, was first presented in *Measuring the Information Society Report 2009* (ITU, 2009), and has been published annually since then.<sup>1</sup>

The findings for IDI 2017, which are presented in this chapter, were calculated using data for the end-of-year 2016, and assess progress by comparing these data with those for IDI 2016 (calculated using data for end-of-year 2015).

### Objectives

The main objectives of the IDI are to measure:

- the *level and evolution over time* of ICT developments within countries and of their experience 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 in the context of available capabilities and skills.

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

### Conceptual framework

The recognition that ICTs can be development enablers, if applied and used appropriately, is critical to countries that are moving towards information or knowledge-based societies, and is central to the IDI's conceptual framework. The ICT development process, and a country's

transformation to becoming an information society, can be depicted using the three-stage model illustrated in Figure 2.1:

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

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

The first two stages correspond to two major components of the IDI: ICT access and ICT use.

Reaching the final stage, and maximizing the impact of ICTs, crucially depends on ICT skills. ICT and other skills determine the effective use that is made of ICTs, and are critical to leveraging their full potential for social and economic development. Economic growth and development will remain below potential if economies are not capable of exploiting new technologies

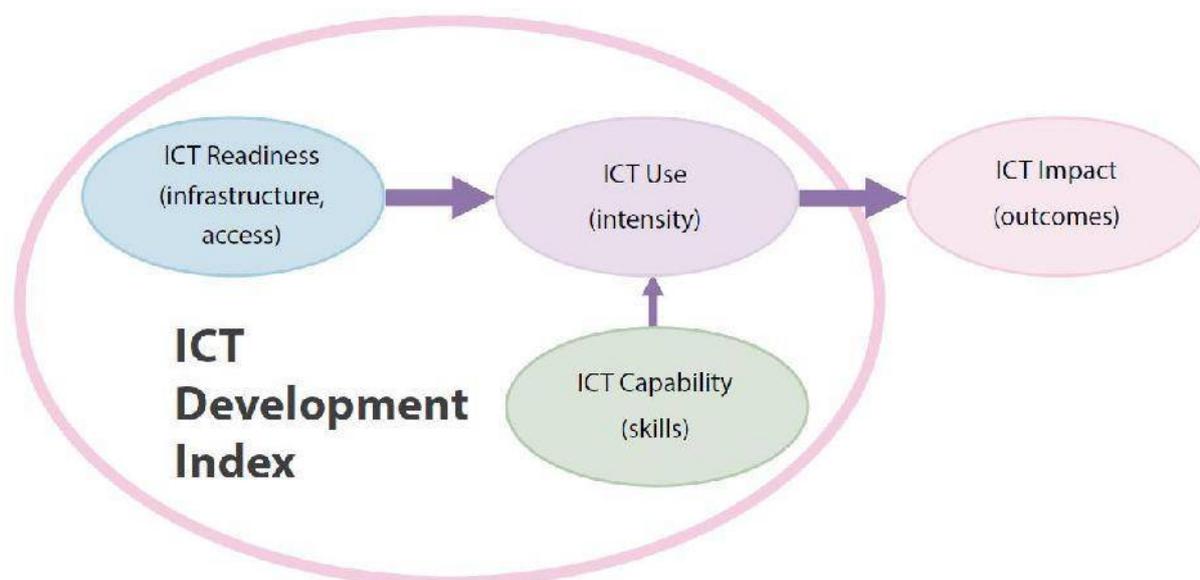
and reaping their benefits. The IDI therefore also includes proxy indicators concerned with capabilities within countries, which affect people’s ability to use ICTs effectively.

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

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

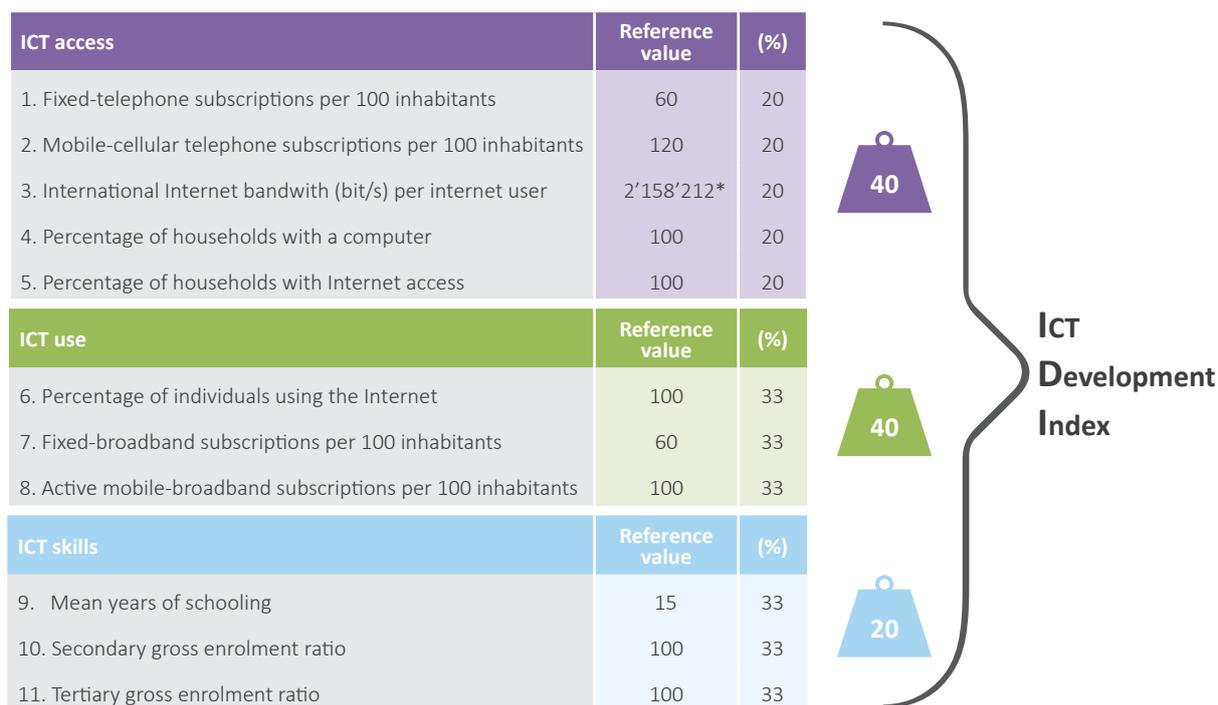
- **Access sub-index:** This sub-index captures ICT readiness, and includes five infrastructure and access indicators (fixed-telephone subscriptions, mobile-cellular telephone subscriptions, international Internet bandwidth per Internet user, households with a computer, and households with Internet access);
- **Use sub-index:** This sub-index captures ICT intensity, and includes three intensity and usage indicators (individuals using the Internet, fixed-broadband subscriptions and mobile-broadband subscriptions);

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



Source: ITU.

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



Note: \* This corresponds to a log value of 6.33, which was used in the normalization step.  
Source: ITU.

- Skills sub-index:** This sub-index seeks to capture capabilities or skills that are important for ICTs. It includes three proxy indicators (mean years of schooling, gross secondary enrolment, and gross tertiary enrolment). As these are proxy indicators, rather than directly measuring ICT-related skills, the skills sub-index is given less weight in the computation of the IDI than the other two sub-indices.<sup>2</sup>

The choice of indicators included in these sub-indices reflects the corresponding stage of transformation to the information society. The indicators in each sub-index may therefore be revised to reflect changes in technology and markets over time, and improvements in the availability and quality of data.

Some of the indicators in the Index are more susceptible to rapid change than others. The speed with which mobile infrastructure can be deployed, for example, has enabled improvements to be made more rapidly in mobile-cellular access and mobile-broadband usage than has been experienced with fixed-telephone and fixed-broadband. These indicators are also likely to be affected by changes in regulation and in the degree of competition within relevant markets.

Experience has shown that economies which are more open to innovation in technology and services, and which are more competitive, tend to achieve better outcomes in access and usage than those where infrastructure and service deployment are more constrained.

Other changes in regulations – for example, in the legal framework for user identification or subscriber identification module (SIM) registration – may lead to reductions in the number of *subscriptions* to mobile networks, which will have a downward impact on indicators for mobile-cellular and mobile-broadband subscriptions without necessarily reducing the number of individual *subscribers*.

Some additional challenges of interpretation arise in relation to the indicator for mobile-cellular subscriptions, which now exceeds 100 per 100 population in a majority of economies within the Index. A number of reasons have been identified for this, including the choice by many users to hold multiple subscriptions in order to take advantage of differential on-net/off-net prices and/or to compensate for variations in the extent of network coverage. Adjustments to the indicator framework that will be introduced in IDI 2018, described

below, should mitigate this problem, as well as that described in the previous paragraph.

The indicator for international Internet bandwidth is vulnerable to sudden change in individual countries, resulting from the deployment of significant new infrastructure, such as new cable landing points. It should be noted that, as this indicator is concerned with the amount of bandwidth available per Internet user, it will vary with *both* the availability of bandwidth *and* the number of Internet users. An increase in Internet users, in the absence of increased bandwidth, will lead to a reduction in the value of the indicator used in the calculation of the Index.

The indicators in the skills sub-index are gathered by the United Nations Educational, Scientific and Cultural Organization Institute for Statistics (UIS), primarily to measure educational performance, and are used as proxies for ICT skills in the IDI. These educational indicators tend to move more slowly than the ICT indicators in the access and use sub-indices. Where sharp changes are reported in these indicators, this may result from changes in the statistical methodology used in individual countries.

## Methodology

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

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

- The relevance of a particular indicator in contributing to the main objectives and conceptual framework of the IDI: For example, the selected indicators must be relevant to both developed and developing countries, and should reflect, so far as possible, the framework's three components as described above;
- Data availability and quality: Data are required for a large number of countries, as the IDI is a global index. There is a shortage of ICT-related data, especially on usage, in the majority of developing countries. In addition, as indicators which are directly related to ICT skills are not available for most countries, it has been

necessary to use proxy rather than direct indicators in the skills sub-index;

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

While the core methodology of the IDI has remained the same since it was first published, adjustments are made year-on-year in accordance with the criteria listed above, while also reflecting the dynamic nature of the ICT sector and related data availability.

The indicators included in the IDI and its sub-indices are regularly reviewed by ITU, in consultation with experts. Indicator definitions and the IDI methodology are discussed in the Expert Group on Telecommunication/ICT Indicators (EGTI) and the Expert Group on ICT Household Indicators (EGH) (see Box 2.1).

## Changes to the IDI from 2018

A number of changes to the IDI will be made with effect from IDI 2018, as a result of decisions taken by an extraordinary meeting of the EGTI and the EGH, which took place in Geneva from 1 to 3 March 2017. The main objective of this extraordinary meeting was to discuss, debate and agree on a revised set of indicators to be included in the IDI. Input documents were prepared by a special EGTI/EGH subgroup, formed following a joint EGTI/EGH meeting in October 2016, and by an independent group of experts.

The extraordinary meeting adopted a total of 14 indicators to be included in the IDI with effect from IDI 2018, compared with the present list of 11 indicators.

Two existing indicators will be dropped from the IDI (both of which are currently in its access sub-index):

- fixed-telephone subscriptions per 100 inhabitants; and
- mobile-cellular subscriptions per 100 inhabitants.

### Box 2.1: The ITU Expert Group on Telecommunication/ICT Indicators and the ITU Expert Group on ICT Household Indicators

Much of ITU's work in the area of indicator definitions and methodologies is carried out through its two expert groups, EGTI<sup>3</sup> and EGH.<sup>4</sup> Created in 2009 and 2012, respectively, these expert groups review and revise ITU's supply-side and demand-side statistics, and discuss methodological issues and new indicators. Both groups, which are open to all ITU members and to experts in ICT statistics and data collection, work through online discussion forums and face-to-face meetings. They periodically report to the World Telecommunication/ICT Indicators Symposium, ITU's main forum on ICT statistics. Interested experts are invited to join the EGTI and/or EGH discussion to share experiences, contribute to discussions and participate in the decision-making process.

The indicator concerning fixed-broadband subscriptions will be transferred from the use sub-index to the access sub-index. It will also be modified to measure fixed-broadband subscriptions – in tiers representing broadband speed – as a percentage of total fixed-broadband subscriptions. Five indicators will be added to the Index:

- percentage of population covered by mobile networks (at least 3G and at least long-term evolution (LTE/WiMax) (access sub-index);
- mobile-broadband Internet traffic per mobile-broadband subscription (use sub-index);
- fixed-broadband Internet traffic per fixed-broadband subscription (use sub-index);
- percentage of individuals who own a mobile phone (use sub-index);
- proportion of individuals with ICT skills (skills sub-index).

The inclusion of five new indicators in the IDI necessitates additional efforts by countries to collect the data in 2017 for the indicators to be included in IDI 2018. It is especially important to improve data availability for the two indicators on Internet traffic and the indicators on mobile phone ownership and ICT skills, for which data currently only exist for about one-third of countries. Ensuring data availability is a prerequisite for the inclusion in the IDI.

### Data sets in this report

Data for IDI 2017 were collected at the beginning of 2017 and refer to the end of year 2016.

Data for IDI 2016, which are used for comparative purposes in this report, have been adjusted to take account of corrections and updates to data that were published in the 2016 edition of the *Report*.

IDI 2017 was computed using the same methodology as in previous years, applying the following steps (see also Figure 2.2 and Annex 1):

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

Table 2.1: IDI values and changes in value, 2017 and 2016

	IDI 2017						IDI 2016						Change in average value 2017-2016
	Average value*	Min.	Max.	Range	StDev	CV	Average value*	Min.	Max.	Range	StDev	CV	
IDI	5.11	0.96	8.98	8.02	2.22	43.52	4.93	0.89	8.80	7.91	2.23	45.31	0.18
Access sub-index	5.59	1.38	9.54	8.16	2.14	38.25	5.49	1.20	9.54	8.34	2.16	39.30	0.10
Use sub-index	4.26	0.04	8.94	8.90	2.49	58.41	3.95	0.04	8.90	8.87	2.50	63.26	0.31
Skills sub-index	5.85	1.37	9.28	7.90	2.18	37.23	5.75	1.30	9.18	7.88	2.18	37.93	0.10

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

## 2.3 Global IDI analysis

The IDI 2017 results maintain the upward trend in IDI values that has been apparent since the inception of the IDI, but also show that there continue to be great differences in the levels of ICT development between countries and regions around the world. The average IDI value among the 176 economies included in IDI 2017 was 5.11, up 0.18 points (3.72 per cent) from IDI 2016. Individual economies' IDI values in IDI 2017 range from a low of 0.96 in Eritrea to a high of 8.98 in Iceland (within a possible range from 0.0 to 10.0). The gap between the highest and lowest values increased from 7.91 to 8.02 points between IDI 2016 and IDI 2017.

Summary data for the IDI and its three sub-indices in 2017 and 2016 are set out in Table 2.1. Full details of the rankings and values for the Index and sub-indices in both years are set out in Tables 2.2 to 2.5. Tables 2.7, 2.9 and 2.11, presented later in this chapter, rank countries according to the change in value they have achieved during the course of the year in the overall Index and in the access and use sub-indices.

Data for IDI 2016 in these and subsequent tables have been recalculated to accommodate changes arising from corrections and updates to the data received since publication of the *Measuring the Information Society Report 2016* (ITU, 2016b). They may therefore differ from the IDI 2016 values published in the 2016 Report.

Table 2.1 presents changes in average value (the sum of the values for all countries in the Index divided by the number of those countries). This shows that the average IDI value rose by 0.18 points during the year, from 4.93 to 5.11. Almost exactly half of the economies in the Index had IDI

values above (89) and below (87) the average value in IDI 2017. As in the year between IDI 2015 and IDI 2016, the average value for the use sub-index between IDI 2016 and 2017 (which rose by 0.31 points, from 3.95 to 4.26 points) grew more rapidly than those for the access and skills sub-indices, which both rose by 0.10 points.

The IDI results for all economies included in IDI 2016 and IDI 2017 are set out in Table 2.2, while results for the access, use and skills sub-indices are set out in Tables 2.3, 2.4 and 2.5. The economies listed in Table 2.2 have been divided into four quartiles according to their IDI 2017 rankings, as follows:

- The high quartile includes the 44 top-ranked economies, from Iceland, with an IDI value of 8.98, to Portugal, with an IDI value of 7.13;
- The upper-middle quartile includes the 44 economies ranked next below these, from the Russian Federation, with an IDI value of 7.07, to Suriname, with an IDI value of 5.15;
- The lower-middle quartile includes the next group of 44 economies, from Albania, with an IDI value of 5.14, to Sao Tome and Principe, with an IDI value of 3.09;
- The low quartile is made up of the 44 least connected countries (LCCs), from Lesotho, with an IDI value of 3.04, to Eritrea, with an IDI value of 0.96.

### Overall distribution of IDI rankings

The country with the highest IDI ranking in 2017 is Iceland, with an IDI value that has risen from 8.78 in 2016 to 8.98 in 2017.

Table 2.2: IDI rankings and values, 2017 and 2016

Economy	Rank 2017	IDI 2017	Rank 2016	IDI 2016
Iceland	1	8.98	2	8.78
Korea (Rep.)	2	8.85	1	8.80
Switzerland	3	8.74	4	8.66
Denmark	4	8.71	3	8.68
United Kingdom	5	8.65	5	8.53
Hong Kong, China	6	8.61	6	8.47
Netherlands	7	8.49	10	8.40
Norway	8	8.47	7	8.45
Luxembourg	9	8.47	9	8.40
Japan	10	8.43	11	8.32
Sweden	11	8.41	8	8.41
Germany	12	8.39	13	8.20
New Zealand	13	8.33	12	8.23
Australia	14	8.24	16	8.08
France	15	8.24	17	8.05
United States	16	8.18	15	8.13
Estonia	17	8.14	14	8.16
Singapore	18	8.05	20	7.85
Monaco	19	8.05	18	8.03
Ireland	20	8.02	19	7.90
Austria	21	8.02	24	7.70
Finland	22	7.88	21	7.83
Israel	23	7.88	22	7.71
Malta	24	7.86	25	7.65
Belgium	25	7.81	23	7.70
Macao, China	26	7.80	29	7.55
Spain	27	7.79	27	7.61
Cyprus	28	7.77	31	7.30
Canada	29	7.77	26	7.64
Andorra	30	7.71	28	7.58
Bahrain	31	7.60	30	7.46
Belarus	32	7.55	32	7.29
Slovenia	33	7.38	33	7.20
Barbados	34	7.31	37	7.11
Latvia	35	7.26	40	7.05
Croatia	36	7.24	42	6.96
St. Kitts and Nevis	37	7.24	35	7.18
Greece	38	7.23	38	7.08
Qatar	39	7.21	36	7.12
United Arab Emirates	40	7.21	34	7.18
Lithuania	41	7.19	41	6.97
Uruguay	42	7.16	48	6.75
Czech Republic	43	7.16	39	7.06
Portugal	44	7.13	44	6.88
Russian Federation	45	7.07	43	6.91
Slovakia	46	7.06	47	6.84
Italy	47	7.04	46	6.84
Hungary	48	6.93	49	6.74
Poland	49	6.89	50	6.73
Bulgaria	50	6.86	53	6.66
Argentina	51	6.79	52	6.68
Kazakhstan	52	6.79	51	6.72
Brunei Darussalam	53	6.75	54	6.56
Saudi Arabia	54	6.67	45	6.87
Serbia	55	6.61	55	6.51
Chile	56	6.57	59	6.28
Bahamas	57	6.51	58	6.29
Romania	58	6.48	61	6.23
Moldova	59	6.45	63	6.21
Costa Rica	60	6.44	57	6.29
Montenegro	61	6.44	56	6.30
Oman	62	6.43	64	6.14
Malaysia	63	6.38	62	6.22
Lebanon	64	6.30	65	6.09
Azerbaijan	65	6.20	60	6.25
Brazil	66	6.12	67	5.89
Turkey	67	6.08	72	5.66
Trinidad & Tobago	68	6.04	71	5.71
TFYR Macedonia	69	6.01	68	5.88
Jordan	70	6.00	66	5.97
Kuwait	71	5.98	70	5.75
Mauritius	72	5.88	75	5.51
Grenada	73	5.80	77	5.39
Georgia	74	5.79	73	5.59
Armenia	75	5.76	74	5.56
Antigua & Barbuda	76	5.71	76	5.48
Dominica	77	5.69	69	5.76
Thailand	78	5.67	79	5.31
Ukraine	79	5.62	78	5.31
China	80	5.60	83	5.17
Iran (I.R.)	81	5.58	85	5.04
St. Vincent & the Grenadines	82	5.54	80	5.27
Bosnia and Herzegovina	83	5.39	81	5.23
Colombia	84	5.36	84	5.12
Maldives	85	5.25	86	4.97
Venezuela	86	5.17	82	5.22
Mexico	87	5.16	90	4.87
Suriname	88	5.15	94	4.77

Economy	Rank 2017	IDI 2017	Rank 2016	IDI 2016
Albania	89	5.14	89	4.90
Seychelles	90	5.03	92	4.80
Mongolia	91	4.96	87	4.91
South Africa	92	4.96	88	4.91
Cape Verde	93	4.92	91	4.83
Panama	94	4.91	93	4.80
Uzbekistan	95	4.90	103	4.48
Peru	96	4.85	97	4.61
Ecuador	97	4.84	101	4.52
Jamaica	98	4.84	96	4.63
Tunisia	99	4.82	95	4.70
Morocco	100	4.77	98	4.57
Philippines	101	4.67	100	4.52
Algeria	102	4.67	106	4.32
Egypt	103	4.63	104	4.44
St. Lucia	104	4.63	99	4.53
Botswana	105	4.59	102	4.51
Dominican Rep.	106	4.51	107	4.26
Fiji	107	4.49	105	4.34
Viet Nam	108	4.43	108	4.18
Kyrgyzstan	109	4.37	110	4.06
Tonga	110	4.34	109	4.13
Indonesia	111	4.33	114	3.85
Bolivia	112	4.31	115	3.84
Paraguay	113	4.18	111	4.02
Gabon	114	4.11	118	3.62
Libya	115	4.11	112	3.93
Ghana	116	4.05	113	3.88
Sri Lanka	117	3.91	116	3.77
Namibia	118	3.89	123	3.33
El Salvador	119	3.82	117	3.62
Belize	120	3.71	120	3.54
Bhutan	121	3.69	119	3.58
Timor-Leste	122	3.57	127	3.11
Palestine	123	3.55	122	3.42
Guyana	124	3.44	121	3.44
Guatemala	125	3.35	125	3.19
Syria	126	3.34	124	3.32
Samoa	127	3.30	129	2.95
Cambodia	128	3.28	128	3.04
Honduras	129	3.28	126	3.14
Nicaragua	130	3.27	132	2.85
Côte d'Ivoire	131	3.14	134	2.84
S. Tomé & Príncipe	132	3.09	131	2.91
Lesotho	133	3.04	130	2.94
India	134	3.03	138	2.65
Myanmar	135	3.00	140	2.59
Zimbabwe	136	2.92	133	2.85
Cuba	137	2.91	135	2.80
Kenya	138	2.91	137	2.67
Lao P.D.R.	139	2.91	144	2.43
Nepal	140	2.88	139	2.60
Vanuatu	141	2.81	136	2.75
Senegal	142	2.66	142	2.48
Nigeria	143	2.60	143	2.44
Gambia	144	2.59	145	2.43
Sudan	145	2.55	141	2.56
Zambia	146	2.54	149	2.19
Bangladesh	147	2.53	146	2.37
Pakistan	148	2.42	148	2.21
Cameroon	149	2.38	150	2.14
Mozambique	150	2.32	147	2.23
Mauritania	151	2.26	152	2.08
Uganda	152	2.19	158	1.90
Rwanda	153	2.18	151	2.10
Kiribati	154	2.17	155	2.04
Mali	155	2.16	153	2.05
Togo	156	2.15	159	1.86
Solomon Islands	157	2.11	154	2.04
Djibouti	158	1.98	161	1.80
Afghanistan	159	1.95	165	1.71
Angola	160	1.94	156	2.00
Benin	161	1.94	157	1.92
Burkina Faso	162	1.90	163	1.74
Equatorial Guinea	163	1.86	160	1.82
Comoros	164	1.82	162	1.78
Tanzania	165	1.81	164	1.73
Guinea	166	1.78	166	1.71
Malawi	167	1.74	169	1.58
Haiti	168	1.72	168	1.63
Madagascar	169	1.68	167	1.70
Ethiopia	170	1.65	171	1.42
Congo (Dem. Rep.)	171	1.55	170	1.48
Burundi	172	1.48	172	1.39
Guinea-Bissau	173	1.48	173	1.38
Chad	174	1.27	174	1.06
Central African Rep.	175	1.04	176	0.89
Eritrea	176	0.96	175	0.96

Note: Palestine is not an ITU member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

Table 2.3: IDI access sub-index rankings and values, 2017 and 2016

Economy	Rank in access sub-index 2017	IDI access sub-index 2017	Rank in access sub-index 2016	IDI access sub-index 2016	Economy	Rank in access sub-index 2017	IDI access sub-index 2017	Rank in access sub-index 2016	IDI access sub-index 2016
Luxembourg	1	9.54	1	9.54	China	89	5.58	90	5.37
Iceland	2	9.38	2	9.32	South Africa	90	5.48	91	5.29
Hong Kong, China	3	9.22	3	9.16	Thailand	91	5.48	88	5.39
United Kingdom	4	9.15	4	9.12	Egypt	92	5.40	93	5.23
Malta	5	9.02	6	8.96	Jamaica	93	5.29	97	5.02
Germany	6	8.93	5	8.97	Mexico	94	5.28	95	5.04
Korea (Rep.)	7	8.85	7	8.90	Uzbekistan	95	5.24	98	4.96
Switzerland	8	8.85	8	8.83	St. Lucia	96	5.17	94	5.16
Japan	9	8.80	9	8.73	Venezuela	97	5.15	92	5.28
Netherlands	10	8.65	10	8.62	Algeria	98	5.14	102	4.83
France	11	8.64	13	8.55	Tunisia	99	5.11	99	4.96
Singapore	12	8.61	12	8.56	Ecuador	100	4.93	104	4.78
Sweden	13	8.55	11	8.58	Botswana	101	4.90	101	4.84
Denmark	14	8.39	14	8.35	Peru	102	4.90	107	4.68
Austria	15	8.38	15	8.31	Fiji	103	4.88	100	4.90
New Zealand	16	8.34	20	8.16	Philippines	104	4.87	103	4.81
United States	17	8.27	17	8.18	Indonesia	105	4.85	108	4.68
Monaco	18	8.26	16	8.21	Albania	106	4.80	105	4.70
Israel	19	8.17	21	8.16	Libya	107	4.80	111	4.58
Estonia	20	8.16	18	8.18	Viet Nam	108	4.75	110	4.64
Belgium	21	8.15	19	8.16	El Salvador	109	4.75	106	4.68
Bahrain	22	8.14	27	7.92	Mongolia	110	4.74	96	5.03
Ireland	23	8.14	22	8.13	Sri Lanka	111	4.66	112	4.52
United Arab Emirates	24	8.11	23	8.07	Tonga	112	4.64	113	4.43
Barbados	25	8.04	24	8.05	Syria	113	4.58	109	4.66
Australia	26	8.00	28	7.90	Kyrgyzstan	114	4.54	114	4.43
Norway	27	8.00	26	8.00	Guatemala	115	4.52	115	4.38
Andorra	28	7.99	25	8.01	Gabon	116	4.51	116	4.36
Spain	29	7.98	31	7.84	Bolivia	117	4.42	119	4.26
Canada	30	7.93	30	7.86	Paraguay	118	4.41	117	4.30
Portugal	31	7.91	34	7.77	Namibia	119	4.39	120	4.23
Slovenia	32	7.91	29	7.87	Ghana	120	4.36	122	4.20
Qatar	33	7.90	32	7.80	Guyana	121	4.36	118	4.27
Belarus	34	7.87	37	7.69	Dominican Rep.	122	4.30	121	4.20
Cyprus	35	7.86	33	7.78	Nicaragua	123	4.19	124	4.02
Macao, China	36	7.83	35	7.73	Cambodia	124	4.16	125	4.01
Hungary	37	7.78	38	7.65	Bhutan	125	4.09	126	3.95
Greece	38	7.76	36	7.73	Honduras	126	4.08	123	4.04
Croatia	39	7.60	41	7.46	Belize	127	4.07	127	3.88
Poland	40	7.58	42	7.41	Côte d'Ivoire	128	3.92	130	3.72
St. Kitts and Nevis	41	7.57	39	7.63	Timor-Leste	129	3.84	128	3.74
Moldova	42	7.56	43	7.32	Gambia	130	3.77	129	3.73
Kazakhstan	43	7.55	40	7.48	Lesotho	131	3.72	134	3.52
Brunei Darussalam	44	7.47	47	7.25	S. Tomé & Príncipe	132	3.69	131	3.62
Latvia	45	7.41	44	7.31	Vanuatu	133	3.65	132	3.57
Finland	46	7.35	46	7.28	Samoa	134	3.64	136	3.43
Italy	47	7.33	48	7.23	Kenya	135	3.63	133	3.56
Oman	48	7.32	45	7.30	Nepal	136	3.62	138	3.24
Uruguay	49	7.28	52	7.17	India	137	3.60	139	3.24
Russian Federation	50	7.23	54	7.12	Senegal	138	3.57	135	3.48
Slovakia	51	7.22	50	7.19	Myanmar	139	3.48	144	3.09
Saudi Arabia	52	7.21	49	7.20	Lao P.D.R.	140	3.47	143	3.17
Serbia	53	7.20	53	7.16	Zimbabwe	141	3.40	137	3.31
Trinidad & Tobago	54	7.18	57	6.94	Palestine	142	3.35	141	3.21
Czech Republic	55	7.14	55	7.08	Pakistan	143	3.34	142	3.18
Kuwait	56	7.12	51	7.17	Sudan	144	3.23	140	3.23
Lithuania	57	7.11	56	6.97	Nigeria	145	3.16	146	3.01
Mauritius	58	7.04	61	6.78	Mali	146	3.16	145	3.07
Montenegro	59	7.03	58	6.87	Bangladesh	147	3.05	147	2.99
Romania	60	6.98	60	6.80	Mauritania	148	2.96	148	2.91
Bahamas	61	6.97	66	6.67	Zambia	149	2.85	149	2.77
Malaysia	62	6.93	67	6.67	Cameroon	150	2.84	152	2.72
Lebanon	63	6.92	63	6.70	Burkina Faso	151	2.82	153	2.72
Argentina	64	6.87	59	6.81	Solomon Islands	152	2.81	150	2.73
Bulgaria	65	6.83	62	6.78	Equatorial Guinea	153	2.71	155	2.68
Chile	66	6.79	65	6.69	Togo	154	2.71	158	2.58
Iran (I.R.)	67	6.74	76	6.33	Rwanda	155	2.67	157	2.58
Antigua & Barbuda	68	6.73	70	6.55	Djibouti	156	2.63	163	2.48
TFYR Macedonia	69	6.66	69	6.56	Benin	157	2.63	151	2.73
Azerbaijan	70	6.62	64	6.69	Angola	158	2.62	154	2.69
Ukraine	71	6.60	72	6.45	Comoros	159	2.59	159	2.53
Armenia	72	6.52	71	6.46	Afghanistan	160	2.56	162	2.48
Seychelles	73	6.46	73	6.36	Mozambique	161	2.53	156	2.64
Costa Rica	74	6.40	74	6.35	Tanzania	162	2.52	160	2.51
Dominica	75	6.34	68	6.60	Guinea	163	2.51	164	2.45
Grenada	76	6.32	78	6.20	Uganda	164	2.46	166	2.31
St. Vincent and the Grenadines	77	6.31	75	6.35	Guinea-Bissau	165	2.43	165	2.39
Turkey	78	6.30	80	6.11	Cuba	166	2.40	169	2.12
Georgia	79	6.26	77	6.21	Haiti	167	2.37	161	2.49
Brazil	80	6.25	79	6.19	Ethiopia	168	2.35	168	2.16
Maldives	81	6.22	82	6.04	Kiribati	169	2.32	170	2.05
Morocco	82	6.06	83	5.99	Madagascar	170	2.29	167	2.29
Jordan	83	6.03	81	6.08	Malawi	171	2.18	172	1.95
Panama	84	5.95	84	5.81	Burundi	172	2.14	171	2.04
Colombia	85	5.88	86	5.74	Chad	173	2.01	173	1.84
Bosnia and Herzegovina	86	5.84	85	5.74	Congo (Dem. Rep.)	174	1.68	174	1.79
Suriname	87	5.83	89	5.38	Central African Rep.	175	1.57	176	1.20
Cape Verde	88	5.76	87	5.53	Eritrea	176	1.38	175	1.32

Note: Palestine is not an ITU member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

Table 2.4: IDI use sub-index rankings and values, 2017 and 2016

Economy	Rank in use sub-index 2017	IDI use sub-index 2017	Rank in use sub-index 2016	IDI use sub-index 2016
Denmark	1	8.94	1	8.90
Switzerland	2	8.88	3	8.76
Norway	3	8.82	2	8.77
Korea (Rep.)	4	8.71	4	8.56
Iceland	5	8.70	5	8.44
Sweden	6	8.40	6	8.36
United Kingdom	7	8.38	8	8.13
Luxembourg	8	8.30	7	8.17
Netherlands	9	8.28	9	8.10
Hong Kong, China	10	8.21	14	7.95
Japan	11	8.15	10	8.07
New Zealand	12	8.08	11	8.03
Monaco	13	8.01	12	8.01
Finland	14	7.99	13	7.97
Estonia	15	7.97	15	7.95
Australia	16	7.97	16	7.74
France	17	7.93	17	7.61
Germany	18	7.77	23	7.35
Macao, China	19	7.72	19	7.54
United States	20	7.67	18	7.56
Cyprus	21	7.61	33	6.63
Ireland	22	7.59	22	7.38
Bahrain	23	7.53	20	7.48
Singapore	24	7.45	21	7.44
Austria	25	7.39	30	6.74
Israel	26	7.34	29	6.92
Canada	27	7.27	25	7.01
Spain	28	7.23	27	6.97
Belgium	29	7.22	28	6.95
Malta	30	7.16	32	6.73
United Arab Emirates	31	7.09	24	7.07
Qatar	32	7.07	26	6.99
Andorra	33	7.07	31	6.74
Uruguay	34	7.03	38	6.20
St. Kitts and Nevis	35	6.76	34	6.53
Slovakia	36	6.67	40	6.14
Latvia	37	6.65	37	6.25
Lithuania	38	6.63	39	6.18
Czech Republic	39	6.62	35	6.44
Belarus	40	6.54	42	6.05
Croatia	41	6.45	41	6.05
Italy	42	6.35	43	6.03
Barbados	43	6.30	46	5.88
Brunei Darussalam	44	6.30	44	5.98
Bulgaria	45	6.23	48	5.86
Lebanon	46	6.20	50	5.80
Costa Rica	47	6.18	49	5.85
Malaysia	48	6.17	45	5.94
Slovenia	49	6.16	53	5.69
Portugal	50	6.15	54	5.67
Russian Federation	51	6.13	47	5.87
Argentina	52	5.96	51	5.79
Greece	53	5.82	58	5.47
Jordan	54	5.73	57	5.52
Oman	55	5.71	64	5.12
Hungary	56	5.71	61	5.28
Brazil	57	5.69	56	5.58
Kazakhstan	58	5.69	55	5.63
Saudi Arabia	59	5.68	36	6.32
Bahamas	60	5.59	60	5.33
Romania	61	5.59	66	5.08
Azerbaijan	62	5.55	52	5.70
Serbia	63	5.54	59	5.37
Poland	64	5.47	62	5.24
Chile	65	5.39	67	4.86
Montenegro	66	5.38	63	5.21
TFYR Macedonia	67	5.36	65	5.09
Thailand	68	5.33	68	4.78
China	69	5.27	71	4.63
Moldova	70	5.12	70	4.71
Trinidad & Tobago	71	5.07	72	4.51
Kuwait	72	4.99	73	4.42
Turkey	73	4.92	77	4.18
Maldives	74	4.80	74	4.30
Dominica	75	4.78	69	4.73
Mexico	76	4.65	75	4.27
St. Vincent and the Grenadines	77	4.61	84	3.89
Suriname	78	4.55	78	4.18
Bosnia and Herzegovina	79	4.52	76	4.21
Georgia	80	4.47	80	4.09
Antigua & Barbuda	81	4.46	81	4.06
Mauritius	82	4.44	90	3.78
Armenia	83	4.42	88	3.85
Albania	84	4.42	85	3.88
Colombia	85	4.11	87	3.85
Tunisia	86	4.11	82	3.96
Cape Verde	87	4.11	79	4.10
Dominican Rep.	88	4.04	95	3.49
Grenada	89	4.04	89	3.78
Peru	90	3.96	94	3.55
Venezuela	91	3.94	83	3.95
Jamaica	92	3.94	92	3.64
Uzbekistan	93	3.93	103	3.23
Ecuador	94	3.92	99	3.34
South Africa	95	3.91	86	3.86
Mongolia	96	3.90	91	3.64
Gabon	97	3.85	112	2.77
Botswana	98	3.73	93	3.60
Philippines	99	3.70	96	3.44
Morocco	100	3.68	97	3.40
St. Lucia	101	3.68	98	3.39
Viet Nam	102	3.65	105	3.18
Ghana	103	3.55	100	3.29
Iran (I.R.)	104	3.54	111	2.78
Seychelles	105	3.47	101	3.24
Fiji	106	3.44	106	3.10
Bolivia	107	3.38	114	2.40
Algeria	108	3.38	110	2.92
Namibia	109	3.36	118	2.16
Tonga	110	3.35	108	3.08
Egypt	111	3.35	104	3.20
Panama	112	3.32	102	3.24
Paraguay	113	3.29	107	3.10
Bhutan	114	3.21	109	3.08
Indonesia	115	3.19	117	2.22
Ukraine	116	3.17	113	2.56
Timor-Leste	117	3.00	125	2.02
Kyrgyzstan	118	2.91	116	2.25
Cambodia	119	2.56	122	2.09
Côte d'Ivoire	120	2.50	121	2.10
Myanmar	121	2.43	128	1.84
Palestine	122	2.42	115	2.25
Belize	123	2.29	124	2.07
El Salvador	124	2.25	127	1.86
Mozambique	125	2.24	123	2.07
Lesotho	126	2.15	119	2.15
Zimbabwe	127	2.10	120	2.12
Libya	128	1.98	129	1.75
Samoa	129	1.94	145	1.23
Zambia	130	1.93	148	1.17
Sri Lanka	131	1.91	130	1.69
Lao P.D.R.	132	1.90	149	1.11
Honduras	133	1.89	132	1.63
Uganda	134	1.87	146	1.22
Guatemala	135	1.78	140	1.45
Sudan	136	1.78	126	1.87
S. Tomé & Príncipe	137	1.77	137	1.49
Senegal	138	1.76	131	1.64
Kenya	139	1.76	144	1.23
Nicaragua	140	1.73	152	1.00
Nepal	141	1.73	134	1.52
Vanuatu	142	1.63	139	1.47
Syria	143	1.63	133	1.53
India	144	1.62	142	1.25
Guyana	145	1.62	136	1.51
Mauritania	146	1.62	141	1.29
Nigeria	147	1.58	135	1.52
Rwanda	148	1.58	138	1.47
Bangladesh	149	1.41	147	1.17
Gambia	150	1.34	151	1.01
Cuba	151	1.30	143	1.25
Pakistan	152	1.24	154	0.95
Mali	153	1.19	153	0.97
Cameroon	154	1.16	157	0.84
Burkina Faso	155	1.13	155	0.89
Togo	156	1.06	166	0.49
Angola	157	1.03	150	1.10
Djibouti	158	0.99	160	0.73
Malawi	159	0.94	156	0.85
Afghanistan	160	0.83	167	0.48
Guinea	161	0.83	159	0.74
Equatorial Guinea	162	0.82	158	0.74
Solomon Islands	163	0.81	161	0.73
Tanzania	164	0.75	162	0.64
Haiti	165	0.75	170	0.41
Ethiopia	166	0.72	165	0.54
Congo (Dem. Rep.)	167	0.68	171	0.41
Benin	168	0.63	164	0.55
Madagascar	169	0.51	163	0.58
Kiribati	170	0.49	168	0.45
Chad	171	0.49	174	0.17
Burundi	172	0.45	169	0.42
Guinea-Bissau	173	0.36	175	0.12
Comoros	174	0.28	172	0.26
Central African Rep.	175	0.24	173	0.21
Eritrea	176	0.04	176	0.04

Note: Palestine is not an ITU member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

Table 2.5: IDI skills sub-index, rankings and values, 2017 and 2016

Economy	Rank in skills sub-index 2017	IDI skills sub-index 2017	Rank in skills sub-index 2016	IDI skills sub-index 2016	Economy	Rank in skills sub-index 2017	IDI skills sub-index 2017	Rank in skills sub-index 2016	IDI skills sub-index 2016
Australia	1	9.28	2	9.10	Qatar	89	6.09	89	6.03
Korea (Rep.)	2	9.15	3	9.08	Oman	90	6.07	97	5.83
United States	3	9.05	1	9.18	TFYR Macedonia	91	6.03	84	6.13
Greece	4	9.00	4	9.01	Panama	92	6.01	94	5.89
Belarus	5	8.93	5	8.96	South Africa	93	6.00	80	6.23
Denmark	6	8.87	6	8.87	Bolivia	94	5.96	91	5.89
New Zealand	7	8.81	8	8.77	Mexico	95	5.93	100	5.74
Slovenia	8	8.79	7	8.87	Dominican Rep.	96	5.89	90	5.90
Iceland	9	8.75	20	8.40	St. Vincent and the Grenadines	97	5.85	96	5.86
Finland	10	8.73	10	8.65	Fiji	98	5.83	102	5.68
Norway	11	8.71	9	8.70	Belize	99	5.80	99	5.81
Ireland	12	8.65	16	8.48	Jamaica	100	5.78	98	5.83
Russian Federation	13	8.62	14	8.55	Malaysia	101	5.70	95	5.87
Netherlands	14	8.59	12	8.56	Kuwait	102	5.69	108	5.59
Ukraine	15	8.56	11	8.57	Tonga	103	5.68	107	5.61
Austria	16	8.56	21	8.38	Botswana	104	5.67	101	5.69
Germany	17	8.54	23	8.36	Tunisia	105	5.67	103	5.68
Spain	18	8.50	19	8.41	Trinidad & Tobago	106	5.67	104	5.67
Chile	19	8.49	25	8.30	Egypt	107	5.66	113	5.33
Canada	20	8.47	17	8.44	United Arab Emirates	108	5.63	106	5.63
Andorra	21	8.44	18	8.43	Indonesia	109	5.54	110	5.48
Lithuania	22	8.44	13	8.55	Paraguay	110	5.52	114	5.28
Estonia	23	8.43	15	8.54	St. Lucia	111	5.46	109	5.52
Israel	24	8.38	22	8.38	Samoa	112	5.37	112	5.44
Poland	25	8.35	24	8.35	Viet Nam	113	5.31	115	5.25
Belgium	26	8.31	26	8.27	Seychelles	114	5.28	119	4.79
Argentina	27	8.30	28	8.18	Guyana	115	5.26	105	5.66
Czech Republic	28	8.27	27	8.25	Lebanon	116	5.23	111	5.46
Grenada	29	8.26	64	6.99	Kiribati	117	5.20	116	5.18
Japan	30	8.22	35	7.97	El Salvador	118	5.11	117	5.02
Switzerland	31	8.21	31	8.15	Suriname	119	4.97	120	4.72
Hong Kong, China	32	8.19	33	8.11	Cape Verde	120	4.89	118	4.89
United Kingdom	33	8.17	29	8.18	India	121	4.73	124	4.29
Latvia	34	8.17	32	8.12	Nicaragua	122	4.51	126	4.23
Bulgaria	35	8.17	34	8.04	S. Tomé & Príncipe	123	4.50	123	4.33
Sweden	36	8.15	30	8.17	Honduras	124	4.44	122	4.36
Singapore	37	8.14	56	7.27	Ghana	125	4.43	121	4.44
Croatia	38	8.11	38	7.79	Morocco	126	4.35	129	4.09
France	39	8.06	36	7.94	Syria	127	4.28	127	4.22
Turkey	40	7.97	39	7.72	Maldives	128	4.25	128	4.15
Cyprus	41	7.93	43	7.68	Timor-Leste	129	4.14	130	4.01
Macao, China	42	7.91	59	7.19	Guatemala	130	4.13	125	4.29
Italy	43	7.86	41	7.69	Namibia	131	3.96	131	3.85
Barbados	44	7.85	42	7.69	Cameroon	132	3.87	136	3.60
Monaco	45	7.70	40	7.70	Bhutan	133	3.86	132	3.84
Hungary	46	7.70	37	7.82	Gabon	134	3.86	133	3.81
Venezuela	47	7.64	44	7.63	Kenya	135	3.79	134	3.76
Saudi Arabia	48	7.57	55	7.30	Lao P.D.R.	136	3.78	137	3.60
Serbia	49	7.57	48	7.48	Nepal	137	3.73	139	3.50
Slovakia	50	7.54	45	7.57	Bangladesh	138	3.72	138	3.51
St. Kitts and Nevis	51	7.53	46	7.55	Zimbabwe	139	3.58	140	3.38
Mongolia	52	7.51	58	7.23	Nigeria	140	3.53	145	3.13
Portugal	53	7.50	47	7.51	Lesotho	141	3.48	141	3.37
Georgia	54	7.49	53	7.34	Vanuatu	142	3.47	135	3.65
Kazakhstan	55	7.48	50	7.41	Comoros	143	3.38	142	3.33
Bahamas	56	7.41	49	7.43	Solomon Islands	144	3.33	143	3.27
Montenegro	57	7.37	54	7.34	Togo	145	3.22	144	3.16
Iran (I.R.)	58	7.32	66	6.96	Myanmar	146	3.21	146	3.06
Albania	59	7.26	52	7.36	Benin	147	3.18	148	3.06
Romania	60	7.25	51	7.37	Zambia	148	3.13	147	3.06
Uruguay	61	7.18	62	7.02	Congo (Dem. Rep.)	149	3.03	149	3.01
Cuba	62	7.16	57	7.25	Cambodia	150	2.98	150	3.00
Costa Rica	63	7.05	61	7.04	Pakistan	151	2.95	151	2.78
Libya	64	6.99	63	6.99	Afghanistan	152	2.94	154	2.65
Kyrgyzstan	65	6.96	67	6.96	Côte d'Ivoire	153	2.88	157	2.57
Armenia	66	6.94	60	7.17	Madagascar	154	2.80	152	2.77
Malta	67	6.94	68	6.86	Gambia	155	2.75	153	2.66
Moldova	68	6.89	65	6.97	Sudan	156	2.75	155	2.62
Colombia	69	6.81	75	6.44	Djibouti	157	2.69	156	2.59
Thailand	70	6.72	81	6.21	Senegal	158	2.62	166	2.17
Brazil	71	6.71	92	5.89	Tanzania	159	2.49	161	2.33
Azerbaijan	72	6.67	73	6.47	Malawi	160	2.45	163	2.30
Bahrain	73	6.65	72	6.50	Angola	161	2.41	158	2.43
Luxembourg	74	6.65	71	6.59	Rwanda	162	2.40	160	2.42
Peru	75	6.54	70	6.60	Haiti	163	2.35	162	2.33
Ecuador	76	6.53	77	6.37	Uganda	164	2.29	159	2.43
Jordan	77	6.49	69	6.68	Equatorial Guinea	165	2.24	164	2.27
Mauritius	78	6.43	74	6.45	Guinea	166	2.23	165	2.19
Sri Lanka	79	6.41	76	6.41	Burundi	167	2.23	170	2.01
Algeria	80	6.29	87	6.10	Mauritania	168	2.15	169	2.02
China	81	6.28	93	5.89	Mali	169	2.12	167	2.15
Bosnia and Herzegovina	82	6.23	79	6.27	Ethiopia	170	2.11	173	1.71
Brunei Darussalam	83	6.23	78	6.31	Mozambique	171	2.06	172	1.74
Dominica	84	6.23	86	6.11	Eritrea	172	1.97	168	2.10
Palestine	85	6.22	82	6.18	Guinea-Bissau	173	1.82	171	1.87
Philippines	86	6.20	85	6.11	Central African Rep.	174	1.61	174	1.61
Uzbekistan	87	6.17	88	6.04	Burkina Faso	175	1.59	175	1.48
Antigua & Barbuda	88	6.16	83	6.17	Chad	176	1.37	176	1.30

Note: Palestine is not an ITU member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

Six other countries in Europe (Switzerland, Denmark, the United Kingdom, the Netherlands, Norway and Luxembourg) fall within the top ten economies in the rankings, along with three economies in the Asia and the Pacific region (the Republic of Korea, which topped the rankings in 2016; Hong Kong (China); and Japan, which moved into the top ten rankings at the expense of Sweden). The range of IDI values among these ten top-ranking countries has increased, from 0.40 points in 2016 to 0.56 points in 2017.

All these countries have achieved high levels of ICT development as a result of high levels of investment in ICT infrastructure, high-quality networks, and high levels of take-up of services by consumers. These high-performing countries also rank towards the top of the rankings for gross national income (GNI) per capita and other economic indicators.

There has been relatively little change in the IDI rankings for most economies between 2016 and 2017. Only six countries (Croatia, Uruguay, Suriname, Uzbekistan, Uganda and Afghanistan) rose by more than five places in the rankings between 2016 and 2017, while three (the United Arab Emirates, Saudi Arabia and Dominica) fell by more than five places.

Only one country (Japan) has risen into the top ten ranked economies; only one (Uruguay) has risen into the highest quartile; and only two (Mexico and Suriname) have moved into the upper half of the distribution. There has also been little change in the countries included in the lowest quartile (LCCs). Only one country (Côte d'Ivoire) moved out of this quartile, at the expense of Lesotho, which now tops the quartile, while the ten countries at the bottom of the rankings are the same as in 2016.

Of the 44 countries ranked as LCCs, 28 are in the Africa region, including all but one of the lowest-ranking decile, while 4 are in the Arab states region, 2 in the Americas region and 10 in the Asia and the Pacific region. The largest gains in rankings among these LCCs were made by Uganda and Afghanistan (up six places), and by Myanmar and Lao P.D.R. (up five places).

## Overall distribution of IDI values

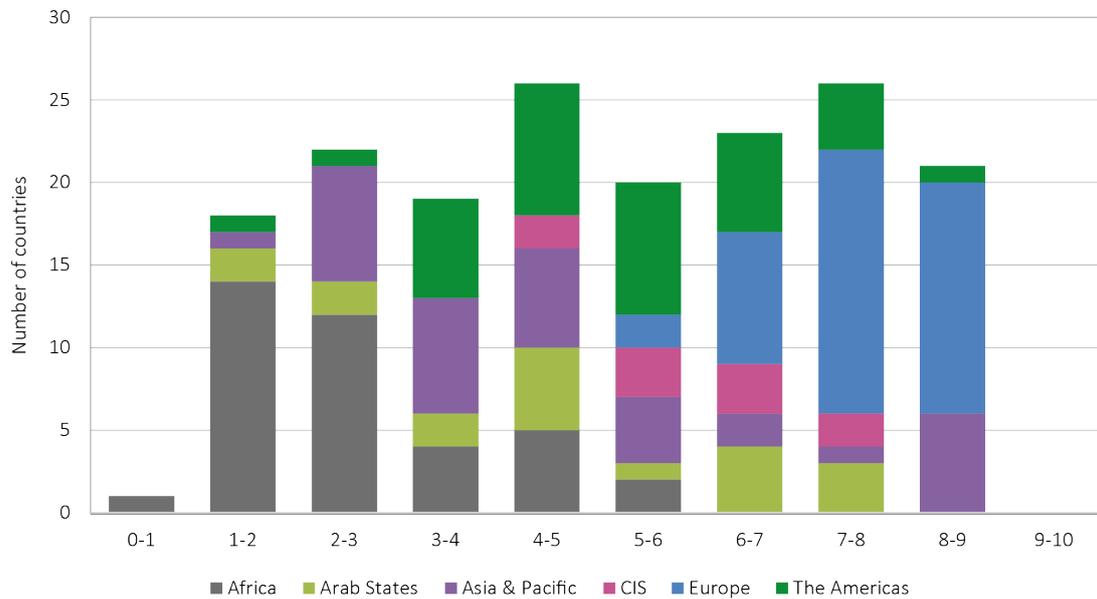
The relative stability of the Index year-on-year reflects steady progress towards higher IDI values in the large majority of countries. Only eight countries showed a decline in their overall IDI value – Estonia, Saudi Arabia, Azerbaijan, Dominica and Venezuela in the upper half of the distribution; and Sudan, Angola and Madagascar in the lower half. The reduction in value was below 0.10 points in all but one of these countries (Saudi Arabia, where there was a fall of 0.64 points in the use sub-index value).

The average improvement in IDI value across all economies was 0.18 points, from 4.93 points in IDI 2016 to 5.11 points in IDI 2017. The margin of improvement in overall values was highest in the middle of the distribution. The improvement in IDI values for the top ten countries was on average half the overall rate, at 0.09 points, reflecting the fact that markets in these high-performing countries are relatively saturated and approaching the maximum attainable figure within the current Index. Improvements in IDI values at the bottom of the distribution are constrained by the low levels of many indicators within the Index in LCCs, where significant improvements in the proportion of citizens with access do not necessarily translate into large increases in indicator levels.

The distribution between developed and developing countries, and the particular challenges faced by LDCs, are discussed in section 2.4 below. This distribution suggests that the gap in IDI values has continued to diminish between those countries at the top of the distribution – principally developed countries and developing countries with high levels of GNI per capita (such as the Republic of Korea; Hong Kong (China); and Singapore) and developing countries with lower levels of GNI per capita in the middle of the distribution. This is partly because higher gains have been made by middle-ranking developing countries in a number of indicators where developed countries had already attained high levels of performance.

However, developed countries and high-income, highly-connected developing countries now have access to much higher broadband speeds and more sophisticated digital services, which are not included in IDI 2017, and the gap between these higher-income countries and the majority of developing countries may be widening where

Chart 2.1: Distribution of IDI values between regions



Source: ITU.

these higher speeds and more sophisticated services are concerned. Adjustments to the Index that are to be introduced next year (see section 2.2) will address this question.

Section 2.4 also shows that there is a widening gap between the majority of developing countries on the one hand, and LDCs and LCCs on the other. This widening digital divide is a cause of particular concern in light of the role that ICTs are expected to play in efforts to achieve the Sustainable Development Goals.

The distribution of IDI values between regions is illustrated in Chart 2.1. This shows the continuing dominance of countries in the Europe region among those performing highly in the Index, and of countries in the Africa region at the lower end of the distribution. Both these regions are economically relatively homogeneous. All but three countries in the Europe region are developed countries, while all of those in the Africa region are developing countries, and 25 of those included in the Index are LDCs. The CIS region, most of whose countries fall into the upper half of the distribution, is also relatively homogeneous, with almost all of its IDI rankings and values falling within the upper-middle and lower-middle quartiles. Other regions are more heterogeneous, including countries with both high and low levels of GNI per capita (and one or more LDCs), and

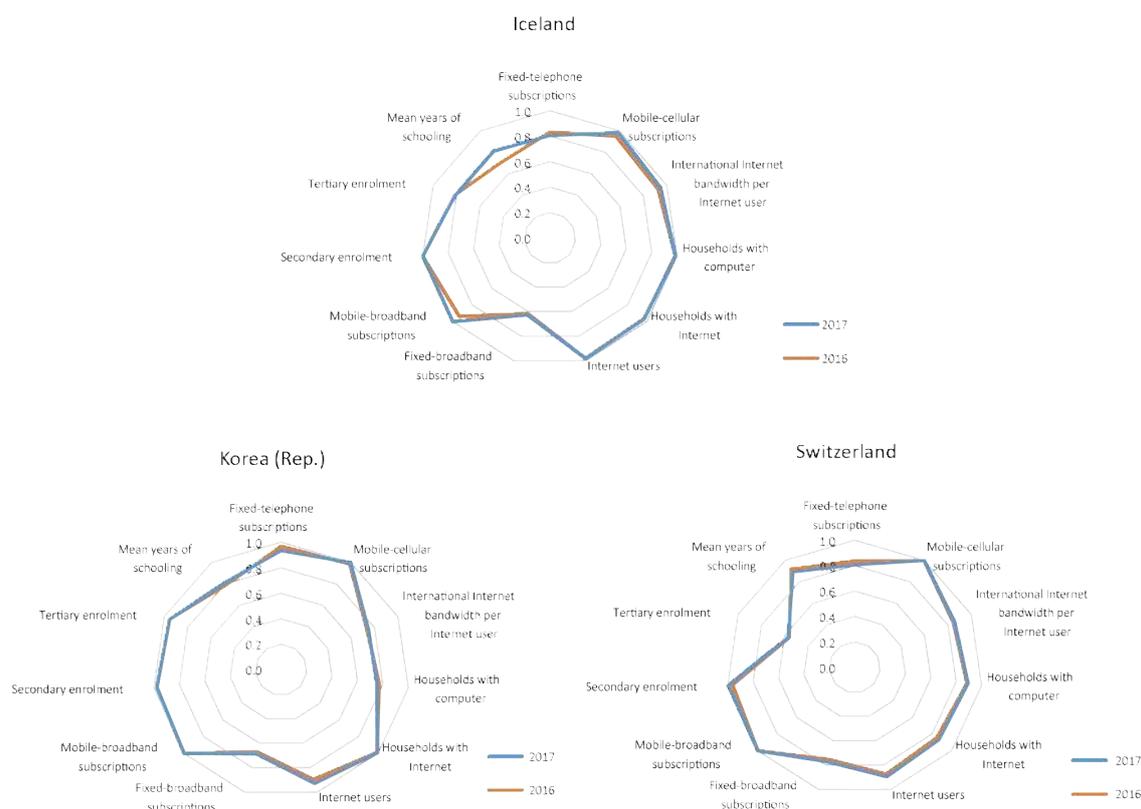
both high and low levels of IDI performance. These regional characteristics are discussed in Chapter 3.

### Top-performing countries

The top-performing economy in IDI 2017 is Iceland. The Republic of Korea, which was the top-performing country in IDI 2016, is in second place, followed by three more European countries – Switzerland, Denmark and the United Kingdom – and by another Asian economy, Hong Kong (China). Spider charts illustrating the IDI values of the top three economies are presented in Chart 2.2. As is to be expected of economies with very high IDI scores, these show high levels of attainment across the range of indicators in the Index. Individual country profiles can be found in Volume 2 of the present *Report*.

There has been relatively little change in most of the individual indicators for economies at the top of the IDI distribution. Each of these achieved very high values in some indicators, including mobile-cellular subscriptions and mobile-broadband subscriptions, some years ago, leaving little scope for further improvement where these particular indicators are concerned. However, there are some significant differences between the performances of these countries where other indicators are concerned.

Chart 2.2: IDI values for top-ranking countries, 2017 and 2016



Source: ITU.

Iceland has overtaken the Republic of Korea to rise to the top of the rankings, because of improvements in mobile-broadband subscriptions in the use sub-index and mean years of schooling in the skills sub-index. It scores particularly high in the proportion of households with a computer (for which it has the highest score of any economy in the Index, 98.5 per cent, compared with 75.3 per cent in the Republic of Korea) and in international bandwidth per Internet user (for which it has the fourth-highest score of any economy), but achieved lower scores than the Republic of Korea for all four subscription indicators (fixed-telephone, mobile-cellular, fixed-broadband and mobile-broadband).

The Republic of Korea's performance, in second place, is boosted by high values for fixed-telephone subscriptions and for tertiary enrolment, but its values for the percentage of households with a computer and for international Internet bandwidth per Internet user are notably lower than those in Iceland and Switzerland.

Switzerland's overall IDI value is affected by a low score, relative to other developed countries, for tertiary enrolment, in which it ranked 53rd worldwide. It scored more highly than either Iceland or the Republic of Korea on mobile-cellular and fixed-broadband subscriptions, and outranked the latter (but not the former) in international Internet bandwidth per Internet user.

### Most dynamic countries

Movements in the position of countries within the IDI can be measured by changes in both/either their IDI ranking and their IDI value. Table 2.6 sets out the most dynamic improvements made by individual countries between IDI 2016 and IDI 2017 in terms of both ranking and value. As can be seen from the table, there are significant differences between the outcomes from these two approaches, and both should be taken into account when assessing improvements in performance.

Table 2.6: Most dynamic countries in IDI rankings and values, 2016–2017

Change in IDI ranking			Change in IDI value (absolute)		
IDI rank 2017	Country	IDI rank change	IDI rank 2017	Country	IDI value change
95	Uzbekistan	8	118	Namibia	0.57
159	Afghanistan	6	81	Iran (I.R.)	0.54
36	Croatia	6	114	Gabon	0.50
88	Suriname	6	139	Lao P.D.R.	0.47
152	Uganda	6	28	Cyprus	0.47
42	Uruguay	6	111	Indonesia	0.47
139	Lao P.D.R.	5	112	Bolivia	0.47
35	Latvia	5	122	Timor-Leste	0.46
135	Myanmar	5	67	Turkey	0.43
118	Namibia	5	80	China	0.42
122	Timor-Leste	5	135	Myanmar	0.42
67	Turkey	5	95	Uzbekistan	0.42
			130	Nicaragua	0.42

Source: ITU

The most dynamic country in terms of IDI ranking is Uzbekistan, which rose eight places overall between IDI 2016 and IDI 2017, from 103rd to 95th position, lifting its IDI value by 0.42 points, from 4.48 to 4.90. Uzbekistan made significant improvements in both access and use sub-indices. It rose three places in the access sub-index, from 98th to 95th, and improved its access sub-index value by 0.28 points, from 4.96 to 5.24. It rose even more substantially in the use sub-index, where it improved its ranking by ten positions (from 103rd to 93rd) and its sub-index value by 0.70 points, from 3.23 to 3.93. The most substantial contributions came from mobile-broadband subscriptions (use sub-index). The country's overall IDI performance was, however, adversely affected by a fall in its recorded secondary enrolment.

The most dynamic country in terms of IDI value, however, was Namibia, whose 0.57-point improvement from 3.33 to 3.89 points enabled a rise of five positions in the rankings. Namibia's improvement was even more concentrated than Uzbekistan's in the use sub-index, where it achieved the highest sub-index value increase, 1.20 points, from 2.16 to 3.36, which enabled a rise of nine places, from 118th to 109th, in the sub-index rankings. Although there was also a significant increase in the proportion of Internet users in the country, this improvement in the use sub-index was driven by a large increase in mobile-broadband subscriptions, which rose from 35.82 to 66.15 per 100 inhabitants over the year. Namibia

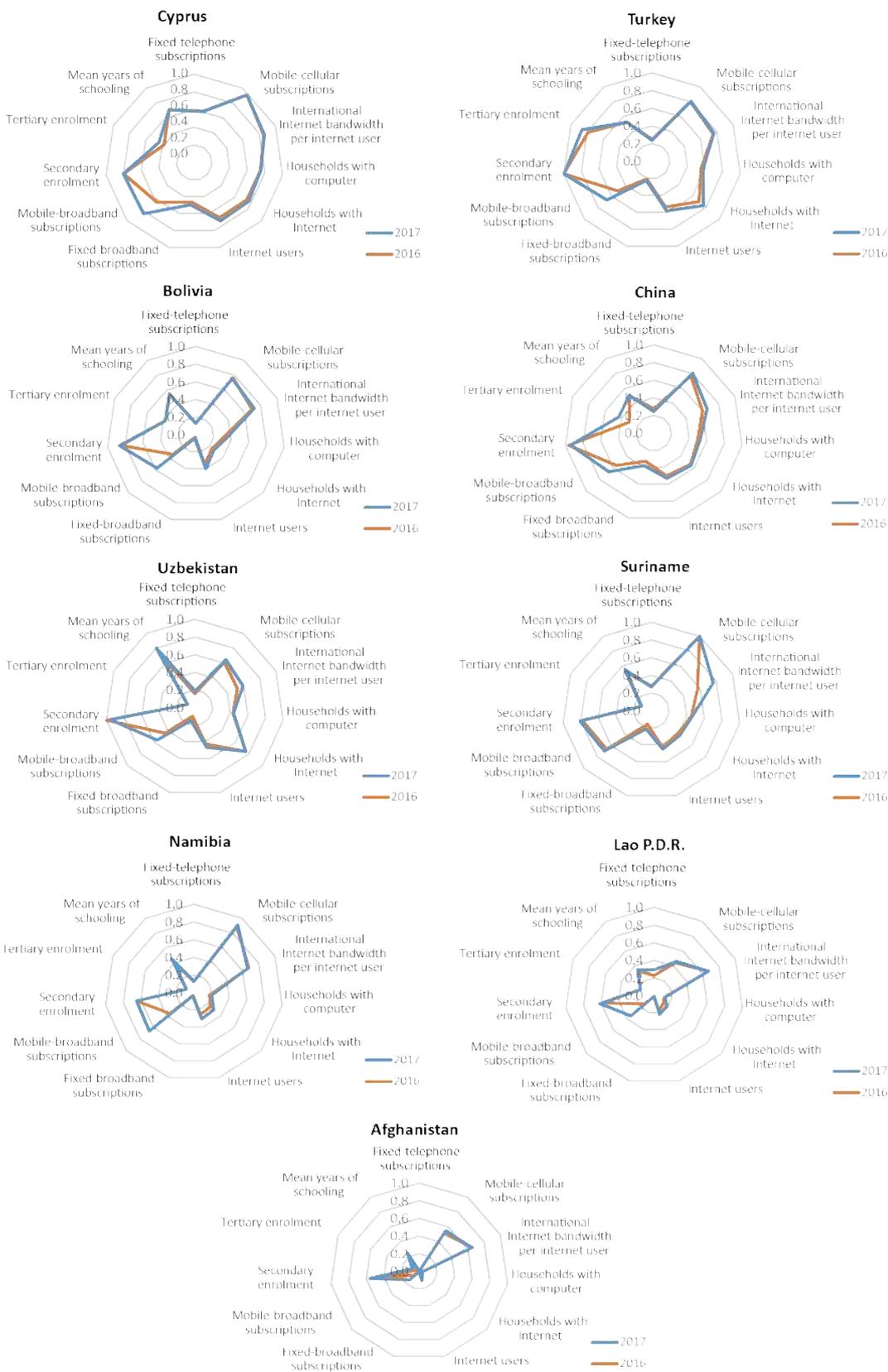
also improved its value in the access sub-index by 0.16 points, from 4.23 to 4.39 points, and in the skills sub-index by 0.11 points, from 3.85 to 3.96 points.

Spider charts illustrating the IDI values of a number of these dynamic countries, ranging from high to low performers in the overall Index, are presented in Chart 2.3. These charts illustrate differences and similarities in the experience of dynamic countries at different levels in the overall distribution. More detailed analysis of the performance of individual countries is included in the regional analysis in Chapter 3 and in the country profiles in Volume 2.

Cyprus, which comes 28th in IDI 2017, is the highest-ranking country illustrated in Chart 2.3. Its spider chart has a shape broadly similar to those for countries at the top of the distribution, but is less rounded because its scores for several indicators are lower than those for top-performing countries. Cyprus' gain in IDI value between 2016 and 2017 is derived almost entirely from rapid growth in its score for mobile-broadband subscriptions per 100 population, which rose from 75.71 in IDI 2016 to 97.46 in IDI 2017, a rise of 28.7 per cent following aggressive marketing of mobile data packages in a competitive market.

Three other countries whose IDI outcomes are illustrated in Chart 2.3 fall within the upper half of the overall distribution (Turkey, China and Suriname). These are typical of countries at this ranking level in having both lower overall values

Chart 2.3: IDI values for most dynamic countries, 2017 and 2016



Source: ITU.

for the majority of indicators than countries towards the top of the distribution and especially lower values for fixed-telephone and fixed-broadband indicators. This makes their spider charts less rounded than those of countries that rank higher in the distribution. As with Cyprus, the most significant improvements in Turkey's and China's IDI scores have been in mobile-broadband subscriptions per 100 population. These countries also saw marked improvements in their scores for tertiary enrolment. The most significant improvement in Suriname, however, lay in international Internet bandwidth per Internet user.

The spider charts for the remaining countries in Chart 2.3 are typical of those for developing countries within the lower half of the overall distribution, though here too there are significant variations between individual countries. The most prominent gains in all five of these countries – Bolivia, Uzbekistan, Namibia, the Lao P.D.R. and Afghanistan – have been made on mobile-broadband subscriptions. Namibia had already achieved more than 100 mobile-cellular subscriptions per 100 inhabitants in IDI 2016, and Bolivia is now approaching this level, while Uzbekistan, the Lao P.D.R. and Afghanistan are still significantly below. All five countries score relatively high (compared with other indicators) on international Internet bandwidth per Internet user, though only Bolivia is above the global average where this is concerned, while Uzbekistan scores relatively high on households with Internet access. Among skills indicators, all five score much higher for secondary enrolment and mean years of schooling than they do for tertiary enrolment.

### Changes in overall IDI values

As well as assessing economies' performance in terms of their overall IDI value, it is important to assess the progress that they are making in relation to their own previous performance. Table 2.7 lists economies in order of the improvement achieved in their overall IDI value between IDI 2016 and IDI 2017. Tables 2.9 and 2.11 do the same for the access and use sub-indices.

IDI values were very evenly balanced between the top and bottom halves of the distribution. Table 2.7 shows that, of the 176 economies in the IDI 2017, just under half (87) equalled or exceeded this average improvement, 17 doing so by more

than twice the global average. Thirty-nine of the economies in IDI 2017 saw improvements in IDI value of less than half the average (i.e. less than 0.9 points), of which eight countries experienced a fall in their IDI value.

Changes in the IDI values for the four quartiles of economies in IDI 2017, for the overall IDI and its three sub-indices, are set out in Table 2.8.

As this indicates, the average improvement in IDI 2017 value was greater in the two middle-ranking quartiles than at either end of the distribution, suggesting that middle-ranking countries are catching up with highly-connected countries, at least so far as the indicators included in the Index are concerned, while LCCs may be falling further behind. Comparisons between improvements by development status and by region can be found in section 2.4 below and in Chapter 3 respectively.

### The access, use and skills sub-indices

As in previous years, significant differences can be identified between the overall IDI rankings and values and the three sub-indices of which the Index is composed. As described in section 2.2, the access and use sub-indices each make up 40 per cent of IDI 2017, with the remaining 20 per cent derived from the skills sub-index. While the access and use sub-indices comprise ICT-specific indicators, the skills sub-index comprises proxy indicators, published by UIS which are primarily concerned with educational attainment. The skills sub-index is therefore less directly related to ICTs than the other two sub-indices are.

There is closer association between rankings in the overall Index and those in the access and use sub-indices, and greater disparity between the overall Index and the skills sub-index. These disparities are reflected also in the individual indicators from which the Index is compiled. For example, the proportion of individuals using the Internet ranges from less than 10 per cent of the population in some LDCs to nearly the entire population in some developed countries. Furthermore, the large range of values within the middle quartiles (quartiles 1 to 3) also suggests great variability across countries in the middle of the distribution.

Table 2.7: IDI value change, 2016–2017

Economy	IDI value change	IDI 2016	IDI 2017	Rank IDI 2017
Namibia	0.57	3.33	3.89	118
Iran (I.R.)	0.54	5.04	5.58	81
Gabon	0.50	3.62	4.11	114
Lao P.D.R.	0.47	2.43	2.91	139
Cyprus	0.47	7.30	7.77	28
Indonesia	0.47	3.85	4.33	111
Bolivia	0.47	3.84	4.31	112
Timor-Leste	0.46	3.11	3.57	122
Turkey	0.43	5.66	6.08	67
China	0.42	5.17	5.60	80
Myanmar	0.42	2.59	3.00	135
Uzbekistan	0.42	4.48	4.90	95
Nicaragua	0.42	2.85	3.27	130
Uruguay	0.41	6.75	7.16	42
Grenada	0.40	5.39	5.80	73
Suriname	0.38	4.77	5.15	88
India	0.38	2.65	3.03	134
Mauritius	0.36	5.51	5.88	72
Thailand	0.36	5.31	5.67	78
Samoa	0.35	2.95	3.30	127
Zambia	0.35	2.19	2.54	146
Algeria	0.34	4.32	4.67	102
Austria	0.32	7.70	8.02	21
Trinidad & Tobago	0.32	5.71	6.04	68
Ecuador	0.32	4.52	4.84	97
Kyrgyzstan	0.31	4.06	4.37	109
Ukraine	0.31	5.31	5.62	79
Côte d'Ivoire	0.30	2.84	3.14	131
Togo	0.29	1.86	2.15	156
Chile	0.29	6.28	6.57	56
Oman	0.29	6.14	6.43	62
Uganda	0.29	1.90	2.19	152
Maldives	0.29	4.97	5.25	85
Mexico	0.29	4.87	5.16	87
Croatia	0.28	6.96	7.24	36
Nepal	0.28	2.60	2.88	140
St. Vincent and the Grenadines	0.27	5.27	5.54	82
Belarus	0.26	7.29	7.55	32
Macao, China	0.26	7.55	7.80	26
Dominican Rep.	0.26	4.26	4.51	106
Romania	0.25	6.23	6.48	58
Portugal	0.25	6.88	7.13	44
Viet Nam	0.25	4.18	4.43	108
Moldova	0.25	6.21	6.45	59
Cambodia	0.24	3.04	3.28	128
Kenya	0.24	2.67	2.91	138
Peru	0.24	4.61	4.85	96
Albania	0.24	4.90	5.14	89
Brazil	0.23	5.89	6.12	66
Cameroon	0.23	2.14	2.38	149
Colombia	0.23	5.12	5.36	84
Afghanistan	0.23	1.71	1.95	159
Seychelles	0.23	4.80	5.03	90
Kuwait	0.23	5.75	5.98	71
Antigua & Barbuda	0.23	5.48	5.71	76
Ethiopia	0.23	1.42	1.65	170
Slovakia	0.22	6.84	7.06	46
Bahamas	0.22	6.29	6.51	57
Lithuania	0.22	6.97	7.19	41
Latvia	0.21	7.05	7.26	35
Jamaica	0.21	4.63	4.84	98
Malta	0.21	7.65	7.86	24
Chad	0.21	1.06	1.27	174
Pakistan	0.21	2.21	2.42	148
Armenia	0.21	5.56	5.76	75
Tonga	0.21	4.13	4.34	110
Georgia	0.20	5.59	5.79	74
Lebanon	0.20	6.09	6.30	64
Singapore	0.20	7.85	8.05	18
Iceland	0.20	8.78	8.98	1
Italy	0.20	6.84	7.04	47
El Salvador	0.20	3.62	3.82	119
Brunei Darussalam	0.20	6.56	6.75	53
Barbados	0.20	7.11	7.31	34
Bulgaria	0.20	6.66	6.86	50
Hungary	0.19	6.74	6.93	48
Germany	0.19	8.20	8.39	12
Morocco	0.19	4.57	4.77	100
France	0.19	8.05	8.24	15
Egypt	0.19	4.44	4.63	103
Slovenia	0.19	7.20	7.38	33
Djibouti	0.18	1.80	1.98	158
Libya	0.18	3.93	4.11	115
Mauritania	0.18	2.08	2.26	151
Spain	0.18	7.61	7.79	27
S. Tomé & Príncipe	0.18	2.91	3.09	132
Senegal	0.18	2.48	2.66	142
Israel	0.17	7.71	7.88	23
Nigeria	0.17	2.44	2.60	143
Australia	0.17	8.08	8.24	14
Paraguay	0.17	4.02	4.18	113
Gambia	0.17	2.43	2.59	144
Ghana	0.17	3.88	4.05	116
Poland	0.16	6.73	6.89	49
Belize	0.16	3.54	3.71	120
Burkina Faso	0.16	1.74	1.90	162
Russian Federation	0.16	6.91	7.07	45
Bangladesh	0.16	2.37	2.53	147
Malaysia	0.16	6.22	6.38	63
Fiji	0.16	4.34	4.49	107
Malawi	0.16	1.58	1.74	167
Bosnia and Herzegovina	0.16	5.23	5.39	83
Central African Rep.	0.16	0.89	1.04	175
Guatemala	0.16	3.19	3.35	125
Costa Rica	0.15	6.29	6.44	60
Greece	0.15	7.08	7.23	38
Hong Kong, China	0.15	8.47	8.61	6
Philippines	0.14	4.52	4.67	101
Sri Lanka	0.14	3.77	3.91	117
Honduras	0.14	3.14	3.28	129
Bahrain	0.14	7.46	7.60	31
Montenegro	0.13	6.30	6.44	61
Palestine	0.13	3.42	3.55	123
Canada	0.13	7.64	7.77	29
TFYR Macedonia	0.13	5.88	6.01	69
Kiribati	0.13	2.04	2.17	154
Andorra	0.13	7.58	7.71	30
Ireland	0.12	7.90	8.02	20
Tunisia	0.12	4.70	4.82	99
Cuba	0.12	2.80	2.91	137
Panama	0.12	4.80	4.91	94
Mali	0.11	2.05	2.16	155
Argentina	0.11	6.68	6.79	51
United Kingdom	0.11	8.53	8.65	5
Bhutan	0.11	3.58	3.69	121
Belgium	0.11	7.70	7.81	25
Japan	0.11	8.32	8.43	10
St. Lucia	0.10	4.53	4.63	104
New Zealand	0.10	8.23	8.33	13
Guinea-Bissau	0.10	1.38	1.48	173
Lesotho	0.10	2.94	3.04	133
Serbia	0.10	6.51	6.61	55
Burundi	0.10	1.39	1.48	172
Czech Republic	0.10	7.06	7.16	43
Netherlands	0.10	8.40	8.49	7
Haiti	0.09	1.63	1.72	168
Cape Verde	0.09	4.83	4.92	93
Mozambique	0.09	2.23	2.32	150
Qatar	0.08	7.12	7.21	39
Botswana	0.08	4.51	4.59	105
Tanzania	0.08	1.73	1.81	165
Solomon Islands	0.08	2.04	2.11	157
Rwanda	0.07	2.10	2.18	153
Switzerland	0.07	8.66	8.74	3
Congo (Dem. Rep.)	0.07	1.48	1.55	171
Zimbabwe	0.07	2.85	2.92	136
Guinea	0.07	1.71	1.78	166
Kazakhstan	0.06	6.72	6.79	52
Vanuatu	0.06	2.75	2.81	141
Luxembourg	0.06	8.40	8.47	9
St. Kitts and Nevis	0.06	7.18	7.24	37
Korea (Rep.)	0.06	8.80	8.85	2
South Africa	0.05	4.91	4.96	92
United States	0.05	8.13	8.18	16
Finland	0.05	7.83	7.88	22
Mongolia	0.04	4.91	4.96	91
Equatorial Guinea	0.04	1.82	1.86	163
Comoros	0.04	1.78	1.82	164
Denmark	0.03	8.68	8.71	4
Jordan	0.03	5.97	6.00	70
United Arab Emirates	0.02	7.18	7.21	40
Syria	0.02	3.32	3.34	126
Monaco	0.02	8.03	8.05	19
Norway	0.02	8.45	8.47	8
Benin	0.02	1.92	1.94	161
Guyana	0.00	3.44	3.44	124
Eritrea	0.00	0.96	0.96	176
Sweden	0.00	8.41	8.41	11
Sudan	-0.01	2.56	2.55	145
Estonia	-0.02	8.16	8.14	17
Madagascar	-0.02	1.70	1.68	169
Azerbaijan	-0.05	6.25	6.20	65
Venezuela	-0.06	5.22	5.17	86
Angola	-0.06	2.00	1.94	160
Dominica	-0.06	5.76	5.69	77
Saudi Arabia	-0.20	6.87	6.67	54

Note: Palestine is not an ITU member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

Table 2.8: IDI values by IDI quartile, 2017 and 2016

IDI Levels	2016				2017				% change			
	Access	Use	Skills	IDI	Access	Use	Skills	IDI	Access	Use	Skills	IDI
High	8.15	7.25	8.09	7.78	8.21	7.52	8.15	7.92	0.7	3.7	0.8	1.9
Upper-middle	6.55	4.85	6.83	5.93	6.67	5.22	6.91	6.14	1.8	7.5	1.2	3.5
Lower-middle	4.59	2.78	5.30	4.01	4.70	3.11	5.39	4.20	2.6	12.1	1.7	5.0
Low	2.71	0.97	2.86	2.04	2.78	1.19	2.95	2.18	2.8	22.3	3.3	6.7

Source: ITU.

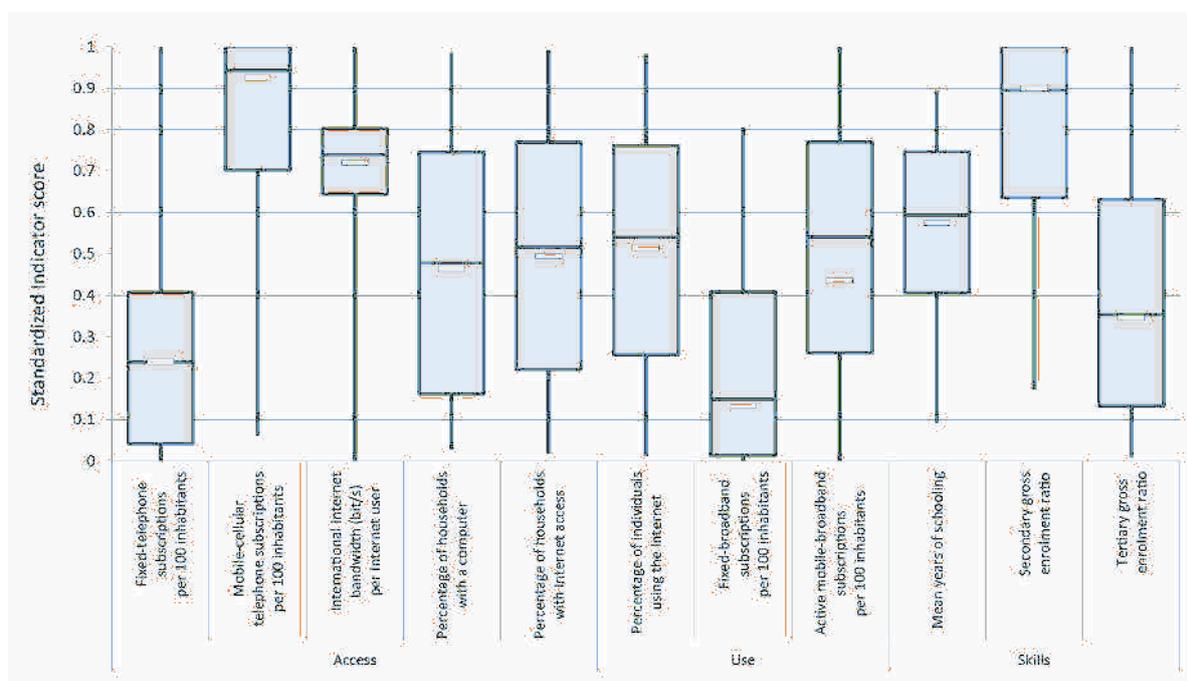
In contrast, some of the indicators in the access sub-index, such as the indicators on mobile-cellular subscriptions and international Internet bandwidth, show a narrower range. For example, considering that the number of mobile-cellular subscriptions per 100 inhabitants in many countries is close to, or exceeds, the reference value of 120, the potential for countries to improve their overall IDI ranks through this indicator is limited.

Chart 2.4 shows the range of values for all indicators in a box plot, with the box representing the middle quartiles (quartiles 1 to 3) and the line in the middle of the box representing the median. The top and bottom lines represent the maximum and minimum values. The blue area in this figure represents the distribution of values in the middle quartiles as in the IDI 2017, while

the orange line shows the median value in the IDI 2016. While most indicators show an increase in the median value, the largest improvement was in active-mobile broadband subscriptions per 100 inhabitants.

All but two of the top ten economies in IDI 2017 also come within the top ten in the access sub-index, the exceptions – Denmark and Norway – being displaced in this sub-index by two other European countries, Malta and Germany. Norway ranks only 27th in the access sub-index, primarily because of its low value, compared with other developed countries, for fixed-telephone subscriptions. The highest-performing country in the sub-index, as in 2016, is Luxembourg, which occupies ninth place in the overall Index. Other countries with significantly higher performance towards the top of this sub-index include France,

Chart 2.4: Variability of scores across the IDI indicators



Source: ITU.

Austria, Singapore, Bahrain and Barbados. In some cases, among countries towards the top of the Index, it is possible that relatively low positions in the access sub-index result from low values for fixed-telephone subscriptions as a result of fixed-mobile substitution. Norway, for example, ranks 77th worldwide for this indicator, and Finland 104th.

The top 11 economies in IDI 2017 also comprise the top 11 in the use sub-index. Denmark is the highest-performing country in the use sub-index, as it was in 2016. Other economies that score particularly highly in the use sub-index, within the upper quartile, are Monaco (which has the highest score for fixed-broadband subscriptions among economies within the Index), Finland (which has an exceptionally low score for fixed-telephone subscriptions in the access sub-index, giving it a lower position in the IDI than would be expected from other indicators), Macao (China), Cyprus and three of the Gulf Cooperation Council (GCC) countries in the Arab States region – Bahrain, Qatar and the United Arab Emirates.

There is also strong consistency between IDI 2017 and its access and use sub-indices at the bottom of the distribution. Six of the ten countries at the bottom of the access sub-index are also in the bottom ten countries in the use sub-index. Only seven countries in the lowest quartile in the access sub-index are in a higher quartile for the use sub-index, of which one (Mozambique) exceeded its access ranking by more than 30 places, and Zambia, Myanmar and Zimbabwe by between 10 and 20 places. Uganda also had a ranking in the use sub-index that was 30 places above its access sub-index ranking, though it remained just within the lowest quartile of the use sub-index. The Gambia and Guatemala, by contrast, ranked 20 places higher in the access sub-index than in the use sub-index.

Fourteen countries within IDI 2017 have rankings for access that are 20 or more places higher than their rankings for usage, the greatest differences being those for Ukraine (45 places), Iran (37 places), Seychelles (32 places) and the Syria (30 places). The highest-ranking country to fall into this category is Malta (5th for access, 30th for use) and the lowest-ranking is Gambia (130th and 150th respectively). These imbalances in favour of the access sub-index suggest that there is scope

for policy interventions to stimulate demand and usage in these countries.

Thirteen countries, meanwhile, have rankings in the use sub-index that are 20 or more places higher than their rankings for access, the largest differences being those for Finland (32 places) and Norway (24 places) near the top of the IDI; the Dominican Republic (34 places), Jordan (29 places) and Costa Rica (27 places) in the middle of the distribution; and Mozambique (36 places) and Uganda (30 places) towards the bottom. In both Finland and Norway, this is due to those countries' exceptionally low levels of fixed-telephone subscriptions, which may be a result of fixed-mobile substitution (i.e. of households choosing not to have both fixed and mobile connections). In other cases, policy interventions to stimulate investment in further infrastructure deployment may be desirable to match strong demand for services.

There is much more variation between IDI 2017 and the skills sub-index which, as noted above, is derived from non-ICT-specific indicators. Only three of the economies in the top ten rankings for IDI 2017 (the Republic of Korea, Denmark and Iceland) fall within the top ten countries in the skills sub-index. Four of the top ten performers in IDI 2017 are ranked between 30th and 33rd in the skills sub-index (Japan; Switzerland; Hong Kong (China); and the United Kingdom), while one (Luxembourg) ranks as low as 74th in the skills sub-index. Methodological and definitional differences may affect these sub-index values, as may demographic factors, including different age profiles within the populations of developed and developing countries.

### The access sub-index

Rankings and values for the access sub-index for IDI 2017 and IDI 2016 are set out in Table 2.3. Table 2.9 presents the changes in access sub-index value for all economies in the Index during the year between 2016 and 2017. Table 2.10 identifies those countries which have seen the most significant rise in their access sub-index rankings and values in the year. It should be noted that, while some of these economies also feature among the most dynamic performers in IDI 2017 as a whole (Table 2.6), this is far from universally the case.

Table 2.9: Access sub-index value change, 2016–2017

Economy	IDI access value change	IDI access sub-index 2016	IDI access sub-index 2017	Rank IDI access sub-index 2017
Suriname	0.46	5.38	5.83	87
Iran (I.R.)	0.41	6.33	6.74	67
Myanmar	0.39	3.09	3.48	139
Nepal	0.38	3.24	3.62	136
Central African Rep.	0.36	1.20	1.57	175
India	0.36	3.24	3.60	137
Algeria	0.31	4.83	5.14	98
Lao P.D.R.	0.30	3.17	3.47	140
Bahamas	0.29	6.67	6.97	61
Cuba	0.28	2.12	2.40	166
Uzbekistan	0.28	4.96	5.24	95
Kiribati	0.27	2.05	2.32	169
Jamaica	0.27	5.02	5.29	93
Mauritius	0.26	6.78	7.04	58
Malaysia	0.25	6.67	6.93	62
Trinidad & Tobago	0.25	6.94	7.18	54
Mexico	0.24	5.04	5.28	94
Moldova	0.24	7.32	7.56	42
Malawi	0.23	1.95	2.18	171
Peru	0.22	4.68	4.90	102
Bahrain	0.22	7.92	8.14	22
Cape Verde	0.22	5.53	5.76	88
Libya	0.22	4.58	4.80	107
Brunei Darussalam	0.22	7.25	7.47	44
Lebanon	0.22	6.70	6.92	63
China	0.21	5.37	5.58	89
Tonga	0.21	4.43	4.64	112
Samoa	0.21	3.43	3.64	134
Côte d'Ivoire	0.20	3.72	3.92	128
Turkey	0.19	6.11	6.30	78
Lesotho	0.19	3.52	3.72	131
Belize	0.19	3.88	4.07	127
South Africa	0.19	5.29	5.48	90
Ethiopia	0.19	2.16	2.35	168
New Zealand	0.18	8.16	8.34	16
Belarus	0.18	7.69	7.87	34
Antigua & Barbuda	0.18	6.55	6.73	68
Romania	0.17	6.80	6.98	60
Indonesia	0.17	4.68	4.85	105
Maldives	0.17	6.04	6.22	81
Chad	0.17	1.84	2.01	173
Poland	0.17	7.41	7.58	40
Nicaragua	0.17	4.02	4.19	123
Egypt	0.17	5.23	5.40	92
Namibia	0.17	4.23	4.39	119
Ukraine	0.16	6.45	6.60	71
Ghana	0.16	4.20	4.36	120
Pakistan	0.16	3.18	3.34	143
Montenegro	0.16	6.87	7.03	59
Bolivia	0.16	4.26	4.42	117
Nigeria	0.15	3.01	3.16	145
Djibouti	0.15	2.48	2.63	156
Tunisia	0.15	4.96	5.11	99
Ecuador	0.15	4.78	4.93	100
Gabon	0.15	4.36	4.51	116
Uganda	0.15	2.31	2.46	164
Cambodia	0.14	4.01	4.16	124
Bhutan	0.14	3.95	4.09	125
Portugal	0.14	7.77	7.91	31
Croatia	0.14	7.46	7.60	39
Lithuania	0.14	6.97	7.11	57
Panama	0.14	5.81	5.95	84
Spain	0.14	7.84	7.98	29
Palestine	0.14	3.21	3.35	142
Guatemala	0.14	4.38	4.52	115
Colombia	0.14	5.74	5.88	85
Sri Lanka	0.13	4.52	4.66	111
Togo	0.13	2.58	2.71	154
Cameroon	0.12	2.72	2.84	150
Hungary	0.12	7.65	7.78	37
Grenada	0.12	6.20	6.32	76
Kyrgyzstan	0.12	4.43	4.54	114
Uruguay	0.11	7.17	7.28	49
Viet Nam	0.11	4.64	4.75	108
Seychelles	0.11	6.36	6.46	73
Russian Federation	0.11	7.12	7.23	50
Chile	0.11	6.69	6.79	66
Latvia	0.11	7.31	7.41	45
Timor-Leste	0.11	3.74	3.84	129
Albania	0.11	4.70	4.80	106
Paraguay	0.11	4.30	4.41	118
Burkina Faso	0.10	2.72	2.82	151
Australia	0.10	7.90	8.00	26
Macao, China	0.10	7.73	7.83	36
TFYR Macedonia	0.10	6.56	6.66	69
Italy	0.10	7.23	7.33	47
France	0.10	8.55	8.64	11
Bosnia and Herzegovina	0.10	5.74	5.84	86
Qatar	0.10	7.80	7.90	33
Burundi	0.10	2.04	2.14	172
Dominican Rep.	0.10	4.20	4.30	122
Senegal	0.09	3.48	3.57	138
Mali	0.09	3.07	3.16	146
Guyana	0.09	4.27	4.36	121
Zimbabwe	0.09	3.31	3.40	141
Rwanda	0.09	2.58	2.67	155
Zambia	0.09	2.77	2.85	149
Thailand	0.09	5.39	5.48	91
United States	0.08	8.18	8.27	17
Vanuatu	0.08	3.57	3.65	133
Solomon Islands	0.08	2.73	2.81	152
Cyprus	0.08	7.78	7.86	35
Afghanistan	0.08	2.48	2.56	160
S. Tomé & Príncipe	0.07	3.62	3.69	132
Japan	0.07	8.73	8.80	9
Austria	0.07	8.31	8.38	15
Morocco	0.07	5.99	6.06	82
El Salvador	0.07	4.68	4.75	109
Canada	0.07	7.86	7.93	30
Iceland	0.07	9.32	9.38	2
Kenya	0.06	3.56	3.63	135
Finland	0.06	7.28	7.35	46
Botswana	0.06	4.84	4.90	101
Kazakhstan	0.06	7.48	7.55	43
Brazil	0.06	6.19	6.25	80
Eritrea	0.06	1.32	1.38	176
Comoros	0.06	2.53	2.59	159
Malta	0.06	8.96	9.02	5
Philippines	0.06	4.81	4.87	104
Guinea	0.06	2.45	2.51	163
Singapore	0.06	8.56	8.61	12
Hong Kong, China	0.06	9.16	9.22	3
Armenia	0.05	6.46	6.52	72
Bangladesh	0.05	2.99	3.05	147
Bulgaria	0.05	6.78	6.83	65
Mauritania	0.05	2.91	2.96	148
Czech Republic	0.05	7.08	7.14	55
Georgia	0.05	6.21	6.26	79
Argentina	0.05	6.81	6.87	64
Costa Rica	0.05	6.35	6.40	74
Monaco	0.05	8.21	8.26	18
Serbia	0.04	7.16	7.20	53
Guinea-Bissau	0.04	2.39	2.43	165
Slovenia	0.04	7.87	7.91	32
Gambia	0.04	3.73	3.77	130
Denmark	0.04	8.35	8.39	14
Honduras	0.04	4.04	4.08	126
Slovakia	0.04	7.19	7.22	51
United Arab Emirates	0.04	8.07	8.11	24
Netherlands	0.03	8.62	8.65	10
Equatorial Guinea	0.03	2.68	2.71	153
Greece	0.03	7.73	7.76	38
United Kingdom	0.03	9.12	9.15	4
Oman	0.02	7.30	7.32	48
Switzerland	0.02	8.83	8.85	8
Saudi Arabia	0.01	7.20	7.21	52
Tanzania	0.01	2.51	2.52	162
Israel	0.01	8.16	8.17	19
Ireland	0.01	8.13	8.14	23
Madagascar	0.01	2.29	2.29	170
St. Lucia	0.00	5.16	5.17	96
Sudan	0.00	3.23	3.23	144
Luxembourg	0.00	9.54	9.54	1
Norway	-0.01	8.00	8.00	27
Belgium	-0.01	8.16	8.15	21
Barbados	-0.01	8.05	8.04	25
Estonia	-0.01	8.18	8.16	20
Fiji	-0.01	4.90	4.88	103
Andorra	-0.02	8.01	7.99	28
Germany	-0.04	8.97	8.93	6
Sweden	-0.04	8.58	8.55	13
St. Vincent and the Grenadines	-0.05	6.35	6.31	77
Jordan	-0.05	6.08	6.03	83
Korea (Rep.)	-0.05	8.90	8.85	7
Kuwait	-0.05	7.17	7.12	56
St. Kitts and Nevis	-0.06	7.63	7.57	41
Angola	-0.07	2.69	2.62	158
Azerbaijan	-0.07	6.69	6.62	70
Syria	-0.08	4.66	4.58	113
Benin	-0.10	2.73	2.63	157
Mozambique	-0.11	2.64	2.53	161
Congo (Dem. Rep.)	-0.11	1.79	1.68	174
Haiti	-0.12	2.49	2.37	167
Venezuela	-0.13	5.28	5.15	97
Dominica	-0.27	6.60	6.34	75
Mongolia	-0.29	5.03	4.74	110

Note: Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

Table 2.10: Access sub-index, most dynamic countries, 2016–2017

Change in access ranking			Change in access value		
Access rank 2017	Country	Access rank change	Access rank 2017	Country	Access value change
67	Iran (I.R.)	9	87	Suriname	0.46
156	Djibouti	7	67	Iran (I.R.)	0.41
139	Myanmar	5	139	Myanmar	0.39
102	Peru	5	136	Nepal	0.38
62	Malaysia	5	175	Central African Rep.	0.36
61	Bahamas	5	137	India	0.36
22	Bahrain	5	98	Algeria	0.31
154	Togo	4	140	Lao P.D.R.	0.30
107	Libya	4	61	Bahamas	0.29
100	Ecuador	4	166	Cuba	0.28
98	Algeria	4	95	Uzbekistan	0.28
93	Jamaica	4	169	Kiribati	0.27
50	Russian Federation	4	93	Jamaica	0.27

Source: ITU.

The average value of the access sub-index, at 5.59, is significantly higher than that for the use sub-index (4.26) and for the Index as a whole (5.11), but there has been less movement in the access sub-index than in the use sub-index between IDI 2016 and IDI 2017. The access sub-index has improved by an average of 0.10 points over the year compared with an improvement of 0.31 in the use sub-index and 0.18 in the Index as a whole.

The highest values achieved in the access sub-index are also significantly higher than those in the use sub-index. Luxembourg tops the rankings for the access sub-index for 2017 with a sub-index value of 9.54, the same as it scored in 2016, followed by Iceland (9.38); Hong Kong (China) (9.22); and the United Kingdom (9.15). At the other end of the distribution, 28 of the 30 lowest-ranking countries are LDCs. The three lowest-ranking countries in this sub-index which are not LDCs are Nigeria (145th), Cameroon (150th) and Cuba (166th).

A total of 29 economies improved their access sub-index value by twice or more than twice the average increase (by 0.20 points or more). All of these dynamic performers in the access sub-index were developing countries. The most substantial increases in sub-index values were achieved by Suriname (up 0.46 points), Iran (up 0.41 points) and Myanmar (up 0.39 points). In the case of Suriname, this was due to a substantial improvement in international Internet bandwidth per Internet user

and to growth in mobile-cellular subscriptions. In Myanmar, growth in mobile-cellular subscriptions was the principal factor, backed by increases in households with computers and Internet access. Iran saw improvements in all access indicators.

At the same time, 23 economies experienced a fall in their access sub-index values between IDI 2016 and IDI 2017. The most substantial falls were experienced by Mongolia (down 0.29 points), Dominica (down 0.27 points) and Venezuela (down 0.13 points). In some cases, these reductions may be due in part or in whole to changes in methodologies for calculating indicators (for example, in accounting for non-active subscriptions). Data adjustments were made by one of the mobile-cellular providers in Dominica, for example. A reduction of 10.47 points in the indicator for mobile-cellular subscriptions in Botswana can be attributed at least in part to the introduction of a new methodology which reduced the number of non-active subscriptions in its response. As noted above, the substitution of mobile-cellular for fixed-telephone subscriptions may also have played a part in some countries.

The rankings of most economies in the access sub-index have changed little over the year, with Iran showing the highest gain (up 9 places) and Mongolia the greatest fall (down 14 places).

A number of countries have access sub-index rankings that are considerably higher than their

rankings in IDI 2017 as a whole. These include Malta, the United Arab Emirates and Kuwait towards the top of the distribution; Seychelles, Morocco and Moldova in the middle of the distribution; and Gambia towards the lower end of the distribution. In these cases, the difference may indicate that greater efforts to increase usage of available infrastructure would have a positive impact on ICT development.

Two countries – Cuba and Finland – have IDI 2017 rankings that are more than 20 places higher than their access rankings. The overall IDI ranking for Cuba is elevated by the country's high performance in the skills sub-index, where it ranks 62nd, compared with 151st in use and 166th in access. In the case of Finland, its comparatively poor performance in the access sub-index is primarily due to its low penetration of fixed-telephone subscriptions (see above). Other economies whose access sub-index rankings are markedly lower than their overall IDI 2016 rankings include Norway and Lithuania towards the top of the overall distribution; the Dominican Republic, Albania, Mongolia and Palestine in the middle of the distribution; and Kiribati towards the bottom of the distribution. In some cases, the difference may indicate that infrastructure limitations are the principal constraint on ICT development.

There were significant improvements in average global performance on four of the five indicators in the access sub-index:

- The number of fixed-telephone subscriptions per 100 population has been falling since 2006, as new subscribers have increasingly chosen to rely solely on mobile connectivity, and has now fallen to a global average of 17.5. Only 46 of the 176 economies in IDI 2017 recorded an increase for fixed-telephone subscriptions between IDI 2016 and IDI 2017. While 9 economies recorded fixed-telephone penetration rates above 50 per 100 inhabitants in IDI 2017, 26 countries – all but two of which are LDCs – recorded scores below 1 per 100 inhabitants;
- The number of mobile-cellular subscriptions, by contrast, now exceeds 100 per 100 inhabitants, both globally and in 112 of the 176 economies in IDI 2017. The average figure recorded for mobile-cellular subscriptions per 100 inhabitants in IDI 2017 was 111.32,

while the lowest figure recorded, for Eritrea, was 7.29 subscriptions per 100 inhabitants. There has been a slowdown in the rate of improvement in this indicator, as many economies approach market saturation. As many as 80 of the 176 economies in the Index recorded a fall in the number of mobile-cellular subscriptions between IDI 2016 and IDI 2017, and the average change for all 176 countries was much lower than in previous years;

- There was a 2.4 per cent increase between IDI 2016 and IDI 2017 in the average indicator value for Internet bandwidth per Internet user which, as noted in section 1.2, varies with both the total amount of international Internet bandwidth available and the number of Internet users. Thirty-two countries experienced a decline in this indicator during the year;
- There was a 2.8 per cent increase in the proportion of households with a computer (raising the global average from 45.6 per cent to 46.8 per cent), with a very wide range of values apparent between countries at the top and bottom of the distribution. Eight economies recorded figures above 90 per cent for this indicator, while 11 fell below the 5 per cent mark;
- There was a 5.3 per cent increase in the average figure for the proportion of households with Internet access (from a global average of 46.8 per cent to 49.3 per cent), with a similarly wide range of values. Fifteen economies recorded a proportion of households with Internet access above 90 per cent, while eight countries recorded figures below 5 per cent.

### The use sub-index

Rankings and values for the use sub-index for IDI 2017 and IDI 2016 are set out in Table 2.4. Table 2.11 ranks countries according to the change in use sub-index value they have achieved during the course of the year. Table 2.12 identifies those countries which have seen the most significant rise in their use sub-index rankings and values in the period 2016–2017.

Table 2.11: Use sub-index value change, 2016–2017

Economy	IDI use value change 2016-2017	IDI use sub-index 2016	IDI use sub-index 2017	Rank IDI use sub-index 2017
Namibia	1.20	2.16	3.36	109
Gabon	1.07	2.77	3.85	97
Cyprus	0.98	6.63	7.61	21
Bolivia	0.98	2.40	3.38	107
Timor-Leste	0.98	2.02	3.00	117
Indonesia	0.97	2.22	3.19	115
Uruguay	0.83	6.20	7.03	34
Lao P.D.R.	0.80	1.11	1.90	132
Zambia	0.77	1.17	1.93	130
Iran (I.R.)	0.76	2.78	3.54	104
Turkey	0.75	4.18	4.92	73
Nicaragua	0.73	1.00	1.73	140
St. Vincent and the Grenadines	0.72	3.89	4.61	77
Samoa	0.71	1.23	1.94	129
Uzbekistan	0.70	3.23	3.93	93
Kyrgyzstan	0.67	2.25	2.91	118
Mauritius	0.66	3.78	4.44	82
Uganda	0.65	1.22	1.87	134
China	0.65	4.63	5.27	69
Austria	0.65	6.74	7.39	25
Ukraine	0.61	2.56	3.17	116
Oman	0.59	5.12	5.71	55
Myanmar	0.58	1.84	2.43	121
Armenia	0.58	3.85	4.42	83
Togo	0.58	0.49	1.06	156
Kuwait	0.57	4.42	4.99	72
Ecuador	0.57	3.34	3.92	94
Thailand	0.56	4.78	5.33	68
Dominican Rep.	0.56	3.49	4.04	88
Trinidad & Tobago	0.56	4.51	5.07	71
Albania	0.54	3.88	4.42	84
Chile	0.53	4.86	5.39	65
Slovakia	0.53	6.14	6.67	36
Kenya	0.52	1.23	1.76	139
Romania	0.51	5.08	5.59	61
Maldives	0.50	4.30	4.80	74
Belarus	0.49	6.05	6.54	40
Portugal	0.48	5.67	6.15	50
Viet Nam	0.47	3.18	3.65	102
Slovenia	0.47	5.69	6.16	49
Cambodia	0.47	2.09	2.56	119
Lithuania	0.46	6.18	6.63	38
Algeria	0.45	2.92	3.38	108
Malta	0.43	6.73	7.16	30
Germany	0.43	7.35	7.77	18
Hungary	0.43	5.28	5.71	56
Barbados	0.42	5.88	6.30	43
Moldova	0.42	4.71	5.12	70
Israel	0.41	6.92	7.34	26
Peru	0.40	3.55	3.96	90
Latvia	0.40	6.25	6.65	37
Lebanon	0.40	5.80	6.20	46
Côte d'Ivoire	0.40	2.10	2.50	120
Antigua & Barbuda	0.40	4.06	4.46	81
Croatia	0.40	6.05	6.45	41
El Salvador	0.39	1.86	2.25	124
Georgia	0.38	4.09	4.47	80
Mexico	0.38	4.27	4.65	76
Bulgaria	0.37	5.86	6.23	45
India	0.37	1.25	1.62	144
Suriname	0.37	4.18	4.55	78
Afghanistan	0.35	0.48	0.83	160
Greece	0.35	5.47	5.82	53
Haiti	0.34	0.41	0.75	165
Fiji	0.34	3.10	3.44	106
Mauritania	0.33	1.29	1.62	146
Andorra	0.33	6.74	7.07	33
Guatemala	0.33	1.45	1.78	135
Cameroon	0.33	0.84	1.16	154
Gambia	0.33	1.01	1.34	150
Costa Rica	0.33	5.85	6.18	47
France	0.32	7.61	7.93	17
Chad	0.32	0.17	0.49	171
Italy	0.32	6.03	6.35	42
Brunei Darussalam	0.31	5.98	6.30	44
Bosnia and Herzegovina	0.31	4.21	4.52	79
Jamaica	0.29	3.64	3.94	92
S. Tomé & Príncipe	0.29	1.49	1.77	137
St. Lucia	0.28	3.39	3.68	101
Pakistan	0.28	0.95	1.24	152
TFYR Macedonia	0.28	5.09	5.36	67
Morocco	0.28	3.40	3.68	100
Congo (Dem. Rep.)	0.27	0.41	0.68	167
Tonga	0.27	3.08	3.35	110
Honduras	0.27	1.63	1.89	133
Belgium	0.27	6.95	7.22	29
Hong Kong, China	0.26	7.95	8.21	10
Bahamas	0.26	5.33	5.59	60
Colombia	0.26	5.33	5.59	60
Ghana	0.26	3.85	4.11	85
Grenada	0.26	3.29	3.55	103
Spain	0.26	3.78	4.04	89
Russian Federation	0.26	6.97	7.23	28
Djibouti	0.26	5.87	6.13	51
Iceland	0.26	0.73	0.99	158
Mongolia	0.26	8.44	8.70	5
United Kingdom	0.26	3.64	3.90	96
Philippines	0.25	8.13	8.38	7
Canada	0.25	3.44	3.70	99
Burkina Faso	0.24	7.01	7.27	27
Libya	0.24	0.89	1.13	155
Poland	0.24	1.75	1.98	128
Bangladesh	0.24	5.24	5.47	64
Guinea-Bissau	0.24	1.17	1.41	149
Australia	0.23	0.12	0.36	173
Malaysia	0.23	7.74	7.97	16
Seychelles	0.22	5.94	6.17	48
St. Kitts and Nevis	0.22	3.24	3.47	105
Belize	0.22	6.53	6.76	35
Sri Lanka	0.22	2.07	2.29	123
Jordan	0.22	1.69	1.91	131
Ireland	0.22	5.52	5.73	54
Mali	0.21	7.38	7.59	22
Nepal	0.20	0.97	1.19	153
Paraguay	0.19	1.52	1.73	141
Netherlands	0.19	3.10	3.29	113
Macao, China	0.19	8.10	8.28	9
Ethiopia	0.18	7.54	7.72	19
Argentina	0.18	0.54	0.72	166
Czech Republic	0.18	5.79	5.96	52
Palestine	0.17	6.44	6.62	39
Mozambique	0.17	2.25	2.42	122
Vanuatu	0.17	2.07	2.24	125
Montenegro	0.16	1.47	1.63	142
Serbia	0.16	5.21	5.38	66
Korea (Rep.)	0.15	5.37	5.54	63
Egypt	0.15	8.56	8.71	4
Tunisia	0.15	3.20	3.35	111
Botswana	0.14	3.96	4.11	86
Switzerland	0.13	3.60	3.73	98
Luxembourg	0.13	8.76	8.88	2
Bhutan	0.12	8.17	8.30	8
Senegal	0.12	3.08	3.21	114
Brazil	0.12	1.64	1.76	138
Guyana	0.11	5.58	5.69	57
Tanzania	0.11	1.51	1.62	145
Syria	0.11	0.64	0.75	164
United States	0.11	1.53	1.63	143
Rwanda	0.10	7.56	7.67	20
Guinea	0.09	1.47	1.58	148
Malawi	0.09	0.74	0.83	161
Panama	0.09	0.85	0.94	159
Equatorial Guinea	0.08	3.24	3.32	112
Qatar	0.08	0.74	0.82	162
Solomon Islands	0.08	6.99	7.07	32
Benin	0.08	0.73	0.81	163
Japan	0.08	0.55	0.63	168
Nigeria	0.07	8.07	8.15	11
Kazakhstan	0.06	1.52	1.58	147
New Zealand	0.05	5.63	5.69	58
Norway	0.05	8.03	8.08	12
South Africa	0.05	8.77	8.82	3
Cuba	0.05	3.86	3.91	95
Bahrain	0.05	1.25	1.30	151
Dominica	0.05	7.48	7.53	23
Sweden	0.04	4.73	4.78	75
Kiribati	0.04	8.36	8.40	6
Denmark	0.04	0.45	0.49	170
Burundi	0.03	8.90	8.94	1
Central African Rep.	0.03	0.42	0.45	172
United Arab Emirates	0.03	0.21	0.24	175
Comoros	0.02	7.07	7.09	31
Estonia	0.02	0.26	0.28	174
Finland	0.02	7.95	7.97	15
Singapore	0.01	7.97	7.99	14
Cape Verde	0.01	7.44	7.45	24
Lesotho	0.00	4.10	4.11	87
Eritrea	0.00	2.15	2.15	126
Monaco	0.00	0.04	0.04	176
Venezuela	-0.01	8.01	8.01	13
Zimbabwe	-0.02	3.95	3.94	91
Angola	-0.06	2.12	2.10	127
Madagascar	-0.07	1.10	1.03	157
Sudan	-0.09	0.58	0.51	169
Azerbaijan	-0.14	1.87	1.78	136
Saudi Arabia	-0.64	5.70	5.55	62

Note: Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

Table 2.12: Use sub-index, most dynamic countries, 2016–2017

Change in use ranking			Change in use value		
Use rank 2017	Country	Use rank change	Use rank 2017	Country	Use value change
130	Zambia	18	109	Namibia	1.20
132	Lao P.D.R.	17	97	Gabon	1.07
129	Samoa	16	21	Cyprus	0.98
97	Gabon	15	107	Bolivia	0.98
21	Cyprus	12	117	Timor-Leste	0.98
140	Nicaragua	12	115	Indonesia	0.97
134	Uganda	12	34	Uruguay	0.83
93	Uzbekistan	10	132	Lao P.D.R.	0.80
156	Togo	10	130	Zambia	0.77
109	Namibia	9	104	Iran (I.R.)	0.76
55	Oman	9			

Source: ITU.

There is a closer correspondence between these high performers in the use sub-index and those in the IDI 2017 than there is between those in the access sub-index and IDI 2017.

The average value of the use sub-index, at 4.26, is significantly lower than that for the access sub-index (5.59) and for the Index as a whole (5.11). However, the use sub-index has seen a more substantial improvement in its average value between IDI 2016 and IDI 2017 than has the access sub-index. The average value for the use sub-index in IDI 2017, at 4.26, is 0.31 points above the figure of 3.95 in IDI 2016, compared with increases of just 0.10 points for both the access and skills sub-indices. As a result, the use sub-index has had more influence on rankings in the IDI between 2016 and 2017 than the other sub-indices.

Two countries – Namibia and Gabon – achieved increases of more than one whole point in this sub-index between IDI 2016 and IDI 2017, with another four countries (Cyprus, Bolivia, Timor-Leste and Indonesia) following close behind. All of these countries except Timor-Leste (which experienced a fractional decline in fixed-broadband subscriptions) increased their scores for all three indicators in the sub-index. In all cases, the overall improvement in this sub-index was strongly driven by growth in mobile-broadband subscriptions.

Seven countries experienced reductions in their value for this sub-index during the year. Saudi Arabia saw the largest decrease (0.64 points),

resulting primarily from a substantial fall in the number of active mobile-broadband subscriptions. This followed the introduction of fingerprint registration and of legislation limiting the number of subscriptions per user, and the effect of the economic slowdown, which resulted in a reduction in the number of migrant workers.

The highest-ranking economies in the use sub-index closely resemble those in IDI 2017. With one exception – Sweden replacing Japan – the 10 highest-ranking countries are the same as those in IDI 2017, and there are only two differences in the top 20, Finland and Macao (China) taking the places of Singapore and Ireland. It is a similar story at the bottom of the distribution, where 19 of the 20 lowest-ranking countries in IDI 2017 appear among the 20 lowest in the use sub-index, the exception (Burkina Faso) being displaced by Kiribati.

As with the access sub-index, a number of countries perform significantly better in the use sub-index than they do in the Index as a whole. None of these is in the upper quartile of the sub-index distribution. High performers for this sub-index, relative to their overall IDI performance, include the Dominican Republic, Jordan and Lebanon in the middle of the distribution; and Gabon, Mozambique, Uganda and Zambia towards the bottom of the distribution. In these cases, where use is growing rapidly, limitations in the availability of infrastructure and devices could become constraints on ICT development,

suggesting a need for greater policy focus on these areas.

Another group of countries performs less well in the use sub-index than in the access sub-index or in IDI 2016. These include Greece, Slovenia and Poland towards the top of the distribution; Grenada, Guyana, Iran, Panama, Ukraine and Syria in the middle of the distribution; and Cuba and Kiribati towards the bottom of the distribution. In these cases, demand-side policies to stimulate greater use of available infrastructure are more likely to raise the level of ICT development.

The use sub-index is made up of three indicators, which measure individuals using the Internet and fixed-broadband and mobile-broadband subscriptions:

- The average value recorded for the proportion of individuals using the Internet rose from 49.5 per 100 population in IDI 2016 to 52.0 in IDI 2017, a rise of 5.1 per cent. Fourteen economies recorded scores above 90 per cent, while 10 recorded scores under 10 per cent. The biggest proportional improvements year-on-year were made by countries starting from a low base in IDI 2016;
- The average value for fixed-broadband penetration rose by 4.45 per cent, from 12.81 to 13.39 subscriptions per 100 population. The highest values for this indicator, over 40 subscriptions per 100 inhabitants, were reported by six European countries and by the Republic of Korea, while 32 countries recorded (mostly minor) reductions. Most countries with very limited fixed-telephone penetration have very limited fixed-broadband penetration, with 45 countries recording figures below one subscription per 100 inhabitants, all but 8 of which are LDCs. However, the largest percentage increases were recorded by countries towards the bottom of the distribution, building from low starting points in IDI 2016;
- The indicator for mobile-broadband penetration was the most dynamic indicator in IDI 2016 and is the most dynamic once again in IDI 2017. Its average value rose by 12.9 per cent over the year, from 50.91 to 57.48 subscriptions per 100 population. Echoing the experience with mobile-cellular subscriptions,

22 economies in IDI 2017 now show penetration rates above 100 subscriptions per 100 inhabitants, while three countries report higher mobile-broadband than mobile-cellular penetration. At the bottom end of the distribution, 15 economies report mobile-broadband penetration rates below 10 subscribers per 100 population.

### The skills sub-index

The skills sub-index is made up of three indicators that are concerned with educational outcomes, rather than with ICT-specific skills. Data for these indicators, which act as proxies for ICT-specific skills, are gathered and supplied by UIS.

Indicators in the skills sub-index carry less weight in calculating the overall IDI than do those in the access and use sub-indices (20 per cent of the total Index as against 40 per cent for each of the other two sub-indices). Nevertheless, the sub-index has a significant impact on overall IDI performance, since some countries perform particularly well or particularly poorly where skills indicators are concerned. The highest-performing country in the skills sub-index, for example, is Australia, which ranks only 14th on the overall Index (26th for access, 16th for use). Greece, which ranks fourth in the skills sub-index, is only 38th in the overall Index (38th in the access sub-index, 53rd in the use sub-index), while Belarus, fifth in the skills sub-index, ranks 32nd in the overall Index (34th and 40th for access and use respectively).

The largest positive differences between this sub-index and the overall Index, which have the effect of improving overall IDI 2017 performance, are those for Cuba (which ranks 62nd in the skills sub-index but 137th in the overall Index) and Ukraine (which ranks 15th in the skills sub-index but 79th overall). The largest negative differences, which impair overall IDI performance, are those for the United Arab Emirates (which ranks 108th in the skills sub-index but 40th in the overall Index) and Luxembourg (which ranks 74th in the skills sub-index but 9th in the overall Index and 1st in the access sub-index). It is possible that some of these differences may result from different definitions used for national data gathering.

## 2.4 The IDI and the digital divide

The term “digital divide” is used to describe differences in ICT development within and between countries, regions and socio-economic groupings. ITU and other United Nations agencies are committed to bridging such digital divides, to ensure that everyone is able to take advantage of the benefits of the emerging information society and that these benefits thereby contribute to sustainable development. The United Nations General Assembly reaffirmed this commitment in its ten- year review of the World Summit on the Information Society in December 2015.<sup>5</sup> The 2030 Agenda for Sustainable Development also states, “The spread of information and communications technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies.”<sup>6</sup>

There has been growing concern that – while the digital divide in basic services between developed and developing countries has narrowed since the World Summit on the Information Society, as a result of the spread of mobile cellular uptake in almost all economies – digital divides in the availability of broadband networks and services have been growing. There is also concern that

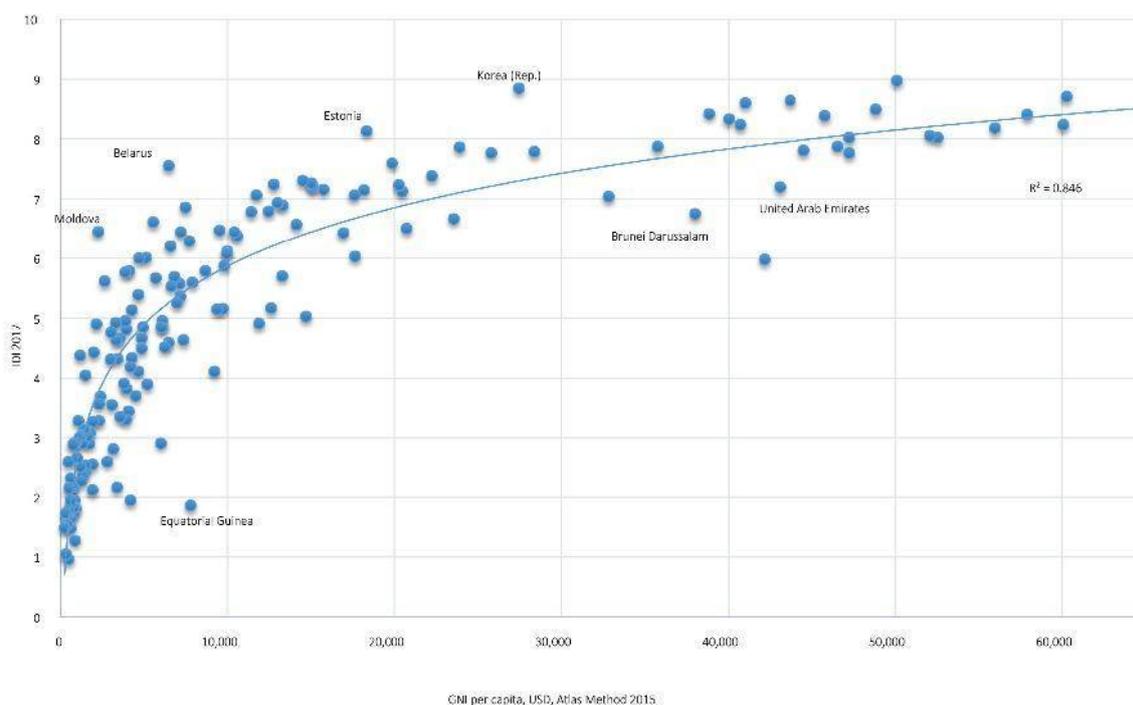
LDCs in particular may be falling further behind other countries. As a composite index, the IDI provides a useful tool for comparing differences between countries and regions which include countries with higher and lower levels of economic and ICT development.

The following paragraphs analyse the relationship between ICTs and development revealed by the IDI from four different perspectives: the relationship between the IDI and GNI per capita; the relationship between IDI and development status; the particular circumstances of LDCs; and the particular circumstances of LCCs which fall within the lowest quartile of the distribution.

### The relationship between the IDI and GNI per capita

The starting point for an analysis of what the IDI reveals about the digital divide is the relationship between GNI per capita and IDI performance. GNI represents the total domestic and foreign output of an economy. Its per capita distribution, GNI per capita, is widely used as a proxy indicator for the overall level of economic development in a country.

Chart 2.5: IDI and GNI per capita, 2017



Source: ITU.

Chart 2.5 plots IDI 2017 values against GNI per capita data for 2015 (the latest year for which World Bank data are available). As in previous years, this shows a strong and significant correlation between the two measures, suggesting that the level of economic development has a significant bearing on ICT development. This is probably, at least to some degree, a self-sustaining phenomenon: it is likely that GNI per capita levels influence *both* the level of consumer demand to make use of ICTs *and* the level of infrastructure investment in access networks to meet that demand.

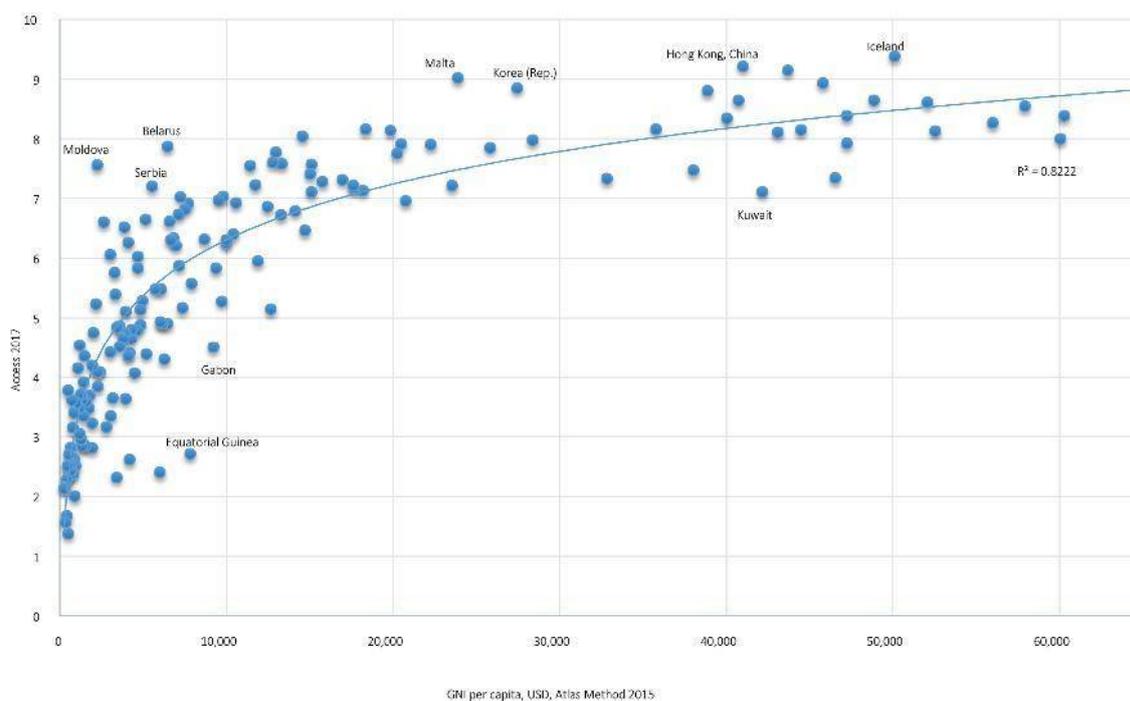
Outliers, which show significantly better or worse IDI performance than might be anticipated from GNI per capita, are worth considering further, as their experience may indicate that countries have made policy or investment choices which are more or less effective in leveraging ICT access and use. Not surprisingly, outliers that significantly outperform their GNI per capita level include countries at the top of the IDI 2017 distribution, such as Iceland, the Republic of Korea and Denmark. Overachieving countries at lower levels of economic performance include Estonia, Bulgaria, Belarus, Serbia, Ukraine and Moldova. Outliers that significantly underperform their

GNI per capita level include Kuwait, the United Arab Emirates and Brunei Darussalam near the top of the distribution; Seychelles, Panama and Gabon towards the middle of the distribution; and Equatorial Guinea, Cuba and Angola towards the bottom of the distribution.

As noted above, there is a degree of difference between countries' performance against the access and use sub-indices, which is reflected in their values and relative rankings for those sub-indices. Similar differences can be mapped by comparing the access and use sub-indices against GNI per capita, as set out in Charts 2.6 and 2.7.

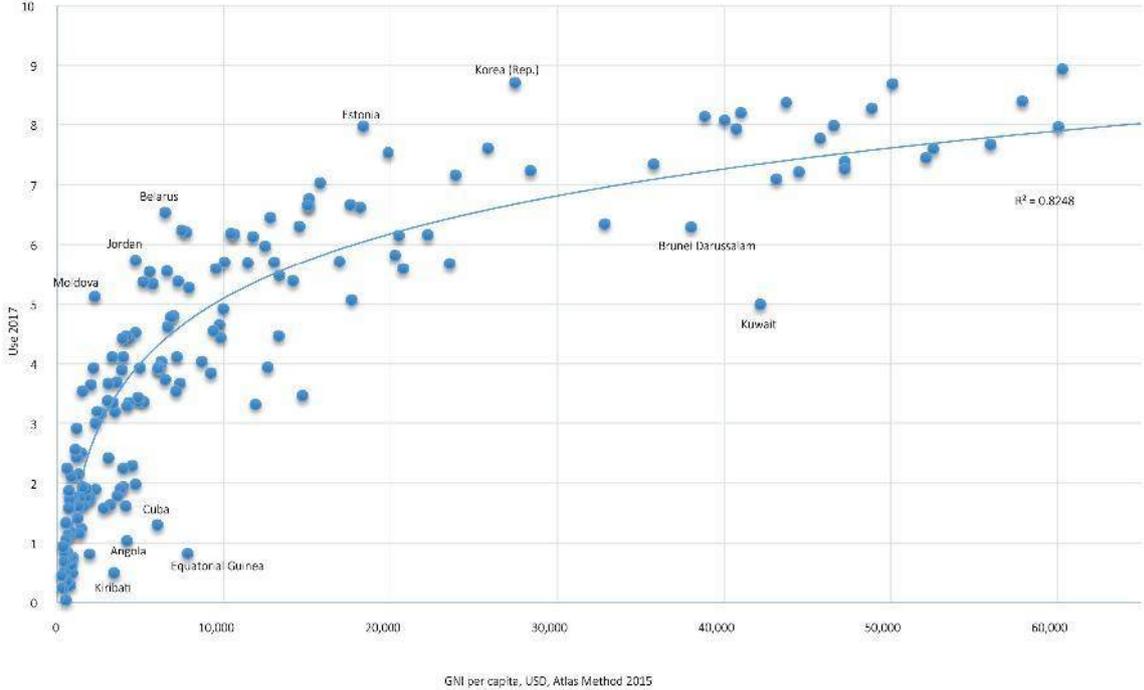
Economies which outperform GNI per capita expectations in the access sub-index include Iceland; Hong Kong (China); Malta; Belarus; and Moldova; while those that underperform expectations include Australia, Finland, Kuwait, Venezuela, Gabon, Equatorial Guinea and Cuba. Economies which outperform GNI per capita expectations in the use sub-index include Denmark, Iceland and the United Kingdom at the top of the distribution; Estonia, Belarus and Jordan in the middle of the distribution; and Moldova, Ghana and Kyrgyzstan at lower IDI levels. Those that underperform expectations in the use sub-

Chart 2.6: Access sub-index and GNI per capita, 2017



Source: ITU.

Chart 2.7: Use sub-index and GNI per capita, 2017



Source: ITU.

index include Kuwait, Brunei Darussalam, Italy, Seychelles, Panama, Equatorial Guinea, Angola, Cuba and Kiribati.

**The relationship between IDI and development status**

A second way to assess differences between economic groupings is to view IDI rankings and values in relation to the official development status of countries, in particular by differentiating between developed and developing countries, and considering the special circumstances of LDCs.

It is important to be clear about the composition of these development categories when interpreting data that distinguish between them. The developing-economies group, as defined in United Nations data sets, includes a number of economies with high GNI per capita, including several economies in East Asia as well as oil-exporting members of GCC. Some of these economies (notably the Republic of Korea; Hong Kong, China; and Singapore) have become ICT champions with very high rankings in the IDI. Five countries defined by the United Nations as developing countries – Chile, Israel, the Republic of Korea, Mexico and Turkey – are

also member countries of the Organisation for Economic Co-operation and Development. All of these economies tend to have GNI per capita and IDI scores that are comparable with those of developed countries.

The developed country grouping, by contrast, includes relatively few countries with GNI per capita levels that are significantly lower than average, and only one country (Albania) that falls within the lower half of the IDI rankings. As a result, the upward effect exerted by outliers in the developing country grouping on the average IDI value tends to be greater than the downward effect of outliers in the developed country category on the IDI average for that category.

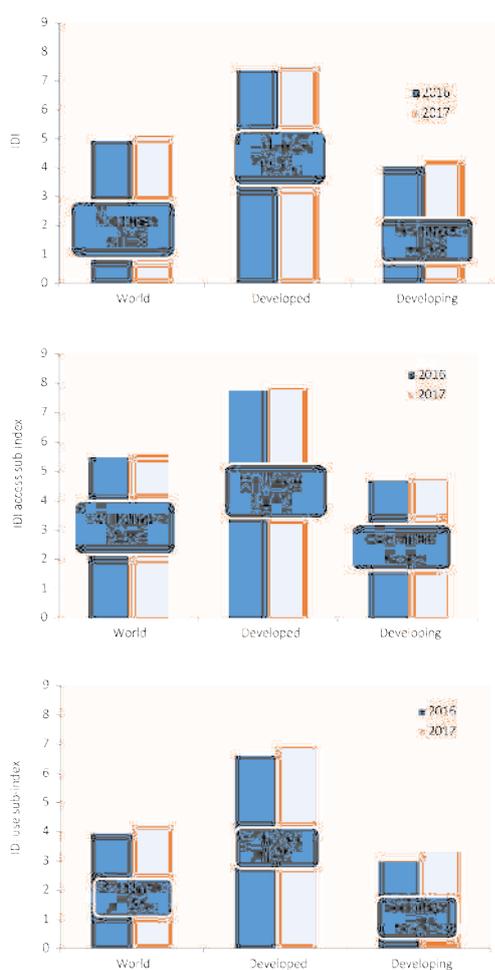
Data comparing IDI 2010 and IDI 2015, reported in the *Measuring the Information Society Report 2015* (ITU, 2015), showed that the average IDI values of developed and developing countries during that period had increased substantially, more or less in step with one another, leaving the digital divide between developed and developing countries largely unchanged. However, they also indicated that the gap between the majority of developing countries and LDCs had been growing in terms of overall IDI values.

Table 2.13: IDI by development status, 2017 and 2016

	IDI 2017						IDI 2016						Change in average value 2017-2016
	Average value*	Min.	Max.	Range	StDev	CV	Average value*	Min.	Max.	Range	StDev	CV	
World	5.11	0.96	8.98	8.02	2.22	43.52	4.94	0.89	8.80	7.91	2.23	45.20	0.17
Developed	7.52	5.14	8.98	3.84	0.92	12.22	7.37	4.90	8.78	3.88	0.96	13.05	0.15
Developing	4.26	0.96	8.85	7.89	1.90	44.65	4.06	0.89	8.80	7.91	1.89	46.44	0.19

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

Chart 2.8: IDI values by development status, 2017 and 2016



Source: ITU.

IDI values for 2016 and 2017 by level of development are illustrated in Table 2.13 and Chart 2.8. These show that there has been a slight reduction in the gap between average IDI scores for developed and developing countries over the year, from 3.31 points in 2016 to 3.26 points in 2017. The average figure for developing countries improved by 0.19 points (an increase of 4.8 per cent) as against 0.15 points (an increase of 2.1

per cent) for developed countries. Developing countries as a group experienced slightly higher improvements than developing countries in average values for both access and use sub-indices (0.11 points as against 0.08 points, and 0.32 points as against 0.29 points respectively). These translate into more substantial differences in terms of rates of progress, with developing countries improving their average access and use sub-index values by 2.4 per cent and 10.5 per cent respectively, compared with improvements of 1.0 per cent and 4.3 per cent for developed countries.

### ICT developments in Least Developed Countries<sup>7</sup>

Particular attention should be paid in this context to two groups of economies within the broader category of developing countries. These are Least Developed Countries (LDCs) and Least Connected Countries (LCCs).

LDCs are identified by the United Nations according to criteria concerned with GNI per capita, human assets and economic vulnerability.<sup>8</sup> LDC status is reviewed every three years. The United Nations identified 48 countries as LDCs during 2016, the year in which data for IDI 2017 were gathered,<sup>9</sup> 41 of which are represented in the IDI. Of these 41, 25 are in the Africa region, 11 in the Asia and the Pacific region, 4 in the Arab States region and one in the Americas. A number of these countries suffer from high levels of political instability or conflict, as well as low levels of development.

The bottom 27 countries in the IDI rankings are all LDCs, as are 37 of the 44 countries in the bottom (LCC) quartile, while a further 7 LDCs (including Niger, which ranked lowest in the 2016 Report (ITU, 2016b)) do not appear in the Index this year. Only four LDCs – Bhutan, Timor-Leste, Cambodia and Sao Tome & Principe – have rankings above

Table 2.14: IDI values for LDCs compared with global values and with other developing countries

Development status	IDI 2016				IDI 2017				% change			
	Access	Use	Skills	IDI	Access	Use	Skills	IDI	Access	Use	Skills	IDI
World	5.49	3.95	5.75	4.93	5.59	4.26	5.85	5.11	1.9	7.8	1.7	3.7
Developed	7.75	6.62	8.08	7.37	7.83	6.91	8.12	7.52	1.0	4.3	0.5	2.1
Developing	4.69	3.01	4.93	4.06	4.80	3.32	5.05	4.26	2.4	10.5	2.4	4.8
LDCs	2.72	1.03	2.73	2.05	2.82	1.27	2.82	2.20	3.7	23.1	3.3	7.5
Developing-LDCs	5.6	3.9	5.9	5.0	5.7	4.3	6.1	5.2	2.1	9.0	2.2	4.3

Source: ITU.

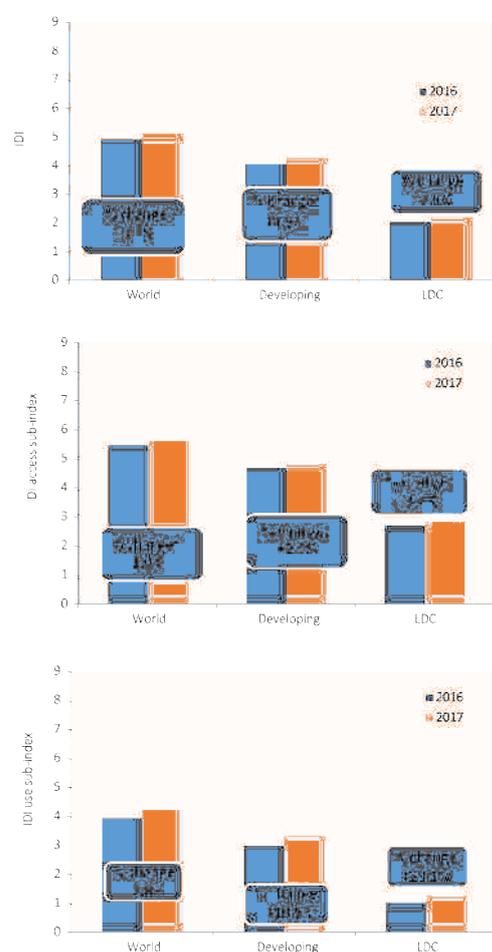
the bottom quartile, the highest of these (Bhutan) attaining 121st position in IDI 2017.

Table 2.14 and Chart 2.9 compare the IDI performance of LDCs between IDI 2016 and IDI 2017 with those of all developing countries, with non-LDC developing countries, and with the global average. The overall performance of LDCs has been lower, in terms of changes in actual IDI values, than that of other developing countries in recent years, though the average rate of improvement for LDCs, from a lower starting point, has been more rapid. This trend continued in the year under discussion. LDCs improved their average value for the overall IDI by 0.15 points between IDI 2016 and IDI 2017, below the world average improvement (0.18 points), the average improvement for all developing countries (0.19 points) and the average improvement for developing countries excluding LDCs (0.22 points).

The most significant improvements by LDCs within IDI 2017 as a whole were made by three countries in Asia and the Pacific – the Lao P.D.R. (up 0.47 points), Timor-Leste (up 0.46 points) and Myanmar (up 0.42 points). The most substantial improvement by an African LDC was that of Zambia (up 0.35 points). Four LDCs (Eritrea, Sudan, Madagascar and Angola) experienced no change or a slight fall in their overall IDI values.

The average improvement in LDC values in the access sub-index was almost the same as that for other developing countries (0.10 points compared with 0.11 points for all developing countries and 0.12 points for developing countries which are not LDCs), while that in the use sub-index was lower (0.24 points compared with 0.32 points for all developing countries and 0.35 points for developing countries which are not LDCs). LDCs also experienced little improvement in the skills sub-index by comparison with other developing countries.

Chart 2.9: IDI values for LDCs compared with global values and with all developing countries



Source: ITU.

These modest increases in IDI values suggest that LDCs may be falling further behind other developing countries in IDI performance. However, they can also be set alongside the rates of improvement which have been achieved by LDCs. LDCs improved their average performance for the overall IDI between IDI 2016 and IDI 2017 by 7.5 per cent year-on-year, compared with an

improvement of 3.7 per cent for all economies in the Index and of 4.3 per cent for developing countries other than LDCs. They improved their performance in the access sub-index by 3.7 per cent (compared with 1.9 per cent for all economies and 2.1 per cent for developing countries which are not LDCs). Their performance on this criteria was strongest in the use sub-index, where LDCs' average value increased by 23.1 per cent, compared with 7.8 for all economies, 10.5 per cent for all developing countries and 9.0 per cent for developing countries which are not LDCs.

These findings suggest that, while LDCs are still falling behind other developing countries in absolute terms, many of them are making significant gains, particularly in the use sub-index, from previously low levels of performance. This should provide a better platform for further gains to be secured in future.

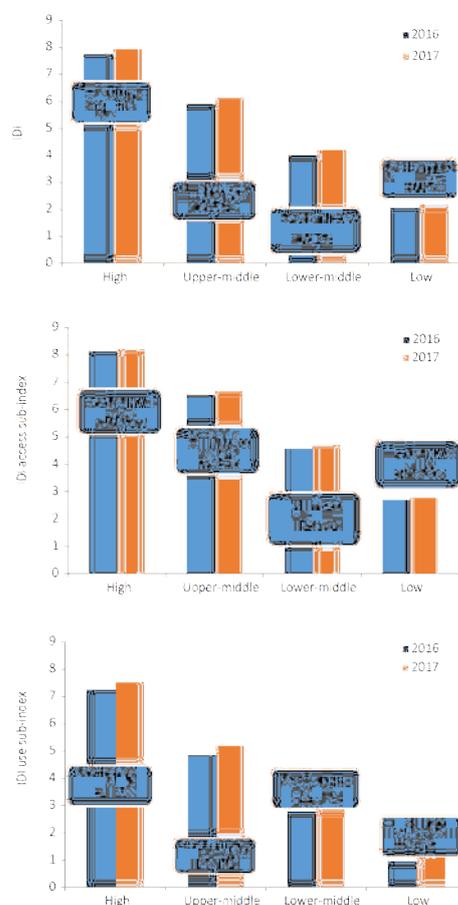
### IDI performance quartiles and least connected countries (LCCs)

The final approach to analysing the digital divide which is considered in this chapter divides the Index into four quartiles, representing high, upper-middle, lower-middle and low IDI outcome values. The group forming the lowest of these quartiles is also referred to in this report as least connected countries (LCCs).

Changes in the IDI values for the four quartiles of economies in IDI 2017, for the overall IDI and its three sub-indices, are set out in Table 2.8 and illustrated in Chart 2.10.

The map in Figure 2.3 shows how IDI performance differs between geographic regions as well as levels of economic development. Most of the highest-performing economies in the IDI are developed countries and high-income developing countries in Western Europe, North America, East Asia and Oceania. Countries in the upper and medium quartiles in the Index are found mostly in Eastern Europe, Latin America and the Caribbean, Central Asia and the GCC region in the Arabian peninsula. The only country in the Africa region which is in the top half of the distribution is the Indian Ocean State of Mauritius. All but 5 of the 44 LCCs are located in the Africa region and in South Asia. The populations of these LCCs together

Chart 2.10: IDI values by IDI quartile, 2017 and 2016



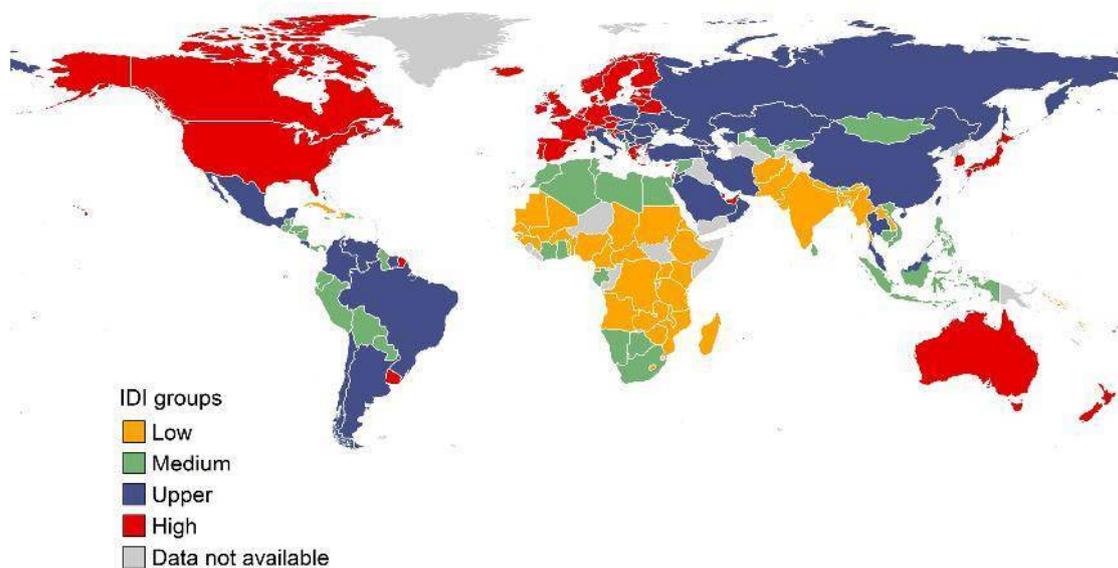
Source: ITU.

amount to 2.75 billion, some 35 per cent of the global population.

Chart 2.10 illustrates changing average IDI values for these four quartiles. The average improvement in IDI 2017 value was greater in the two middle-ranking quartiles of the distribution (0.21 points and 0.19 points, respectively, in the upper-middle and lower-middle quartiles) than it was in the high quartile or the LCC quartile (each of which saw an average improvement of 0.14 points). However, this represents a faster rate of improvement in the LCC quartile (6.7 per cent on average) than in the other quartiles (5.0 per cent in the lower-middle quartile, and less in other quartiles).

There is a close association between LDCs and LCCs. As noted in the previous section, 37 of the 44 LCCs in the lowest quartile are LDCs, while a further seven LDCs are not included in the Index

Figure 2.3: IDI quartiles by IDI value, 2017



The base map for this infographic is based on the UNmap database of the United Nations Cartographic Section.

UNCS Disclaimer: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Source: ITU.

and may well also have fallen into the LCC quartile had they done so. The non-LDCs in the LCC group are India, Zimbabwe, Cuba, Kenya, Nigeria, Pakistan and Cameroon.

Not surprisingly, in light of this correspondence between LDCs and LCCs, the IDI performance of the LCC group is similar to that of LDCs. They have grown their average IDI value by 0.14 points (compared with 0.14, 0.21 and 0.19 points for the high, upper-middle and lower-middle quartiles), their average access sub-index value by 0.07 points (compared with 0.06, 0.12 and 0.11 points for the other quartiles), and their average use sub-index value by 0.22 points (compared with 0.27, 0.37 and 0.33 points for the other quartiles). In each case, however, their rate of improvement – the percentage by which their performance has grown over the past year – has been higher than those of quartiles that are higher in the distribution (6.7 per cent for the Index as a whole compared with 1.9 per cent, 3.5 per cent and 5.0 per cent for the three higher quartiles; 2.8 per cent compared with 0.7 per cent, 1.8 per cent and 2.6 per cent for the access sub-index; and 22.3 per cent compared with 3.7 per cent, 7.5 per cent and 12.1 per cent for the use sub-index).

It is clear from these figures that LCCs, like LDCs, are still significantly behind other developing

countries in terms of the values they achieve for the IDI and its access and use sub-indices. Although their rate of progress, from their low base values, exceeds those of other quartiles, this is not yet sufficient to reduce the overall gap in IDI values between them and more connected countries. However, it should become so as their performance levels improve. Much may depend on the particular circumstances of individual countries.

## 2.5 Summary and conclusion

Measuring progress towards the information society is a complex task which entails striking a balance between different dimensions of ICT experience in different countries. The IDI brings together 11 indicators concerned with ICT access, ICT use and ICT skills into a composite index that reflects the diversity and complexity of that experience. Reported annually in ITU's *Measuring the Information Society Report*, the IDI has made an important contribution to building understanding of the spread of ICTs and their impact on economies and societies.

Data for 176 economies are included in IDI 2017. As in previous years, this year's Index shows that there has been continued improvement in IDI

performance by the large majority of countries, averaging 0.18 points overall. Europe is the region with the highest average IDI performance, while Africa's average is well below those of other regions.

As in 2016, improvements have been most significant among countries in the middle of the IDI rankings, many of which are middle-income developing countries. Some developed and higher-income developing economies towards the top of the rankings have attained very high levels of performance on many of the indicators included in the Index, which inhibits further improvement in their IDI values. Some LDCs towards the bottom of the distribution, by contrast, have very low levels of attainment on some indicators, and have achieved little improvement on low existing levels of performance.

Average IDI scores in the access sub-index are higher than those in the use sub-index. However, more progress was made during the year, on average, in the use sub-index, which rose by an average of 0.31 points, compared with 0.10 for both access and skills sub-indices.

The most significant increases in the access sub-index were for the proportion of households with computers and those with Internet access, particularly the latter, and in the volume of international Internet bandwidth per Internet user. Many countries have now attained or are approaching saturation in the market for mobile-cellular subscriptions, with the result that the contribution this indicator made to improvements in the sub-index was less significant than in recent years. There has been continued decline in the indicator for fixed-telephone subscriptions in many countries as fixed-mobile substitution becomes more prevalent.

The most significant increases in the use sub-index, and in IDI 2017 overall, came from the indicator for mobile-broadband subscriptions. This indicator rose globally by 12.90 per cent between IDI 2016 and IDI 2017, from 50.91 to 57.48 subscriptions per 100 population. Factors contributing to this improvement, as in 2016, include investment in new infrastructure, growing uptake of smartphones, and reductions in prices following increased competition or regulatory intervention. Fixed-broadband subscriptions also increased, though more slowly, during the

year. Together, these increases in broadband penetration contributed towards increased access to and use of the Internet by both households and individuals.

Data included in IDI 2017 also demonstrate the continued digital divide between developed and developing countries, and between different regions, with IDI values ranging from 8.98 out of 10.00 in the top-ranking country, Iceland, to 0.96 in the lowest-ranking, Eritrea. There has been relatively little movement within the rankings over the past year, as most countries have made relatively consistent improvements in performance. A number of countries have, however, shown particularly dynamic improvements, including Namibia and Gabon in Africa, Iran, the Lao P.D.R., Indonesia and Timor-Leste in the Asia and the Pacific region, Cyprus in the Europe region, and Bolivia.

The relatively poor performance of LDCs continues to cause concern. There is a strong correlation between LDCs and LCCs in the bottom quartile of the IDI distribution. Of the 44 LCCs, 37 are also LDCs. On average, LDCs improved their IDI performance by an average of 0.15 points, significantly less than the 0.22 point improvement made by developing countries other than LDCs – though this reflects a higher rate of improvement by LDCs from their generally very low performance levels. Given that ICT development is considered important for enabling progress towards sustainable development, poor IDI performance points to the need for policy interventions by governments and other stakeholders in order to improve levels of ICT access and use.

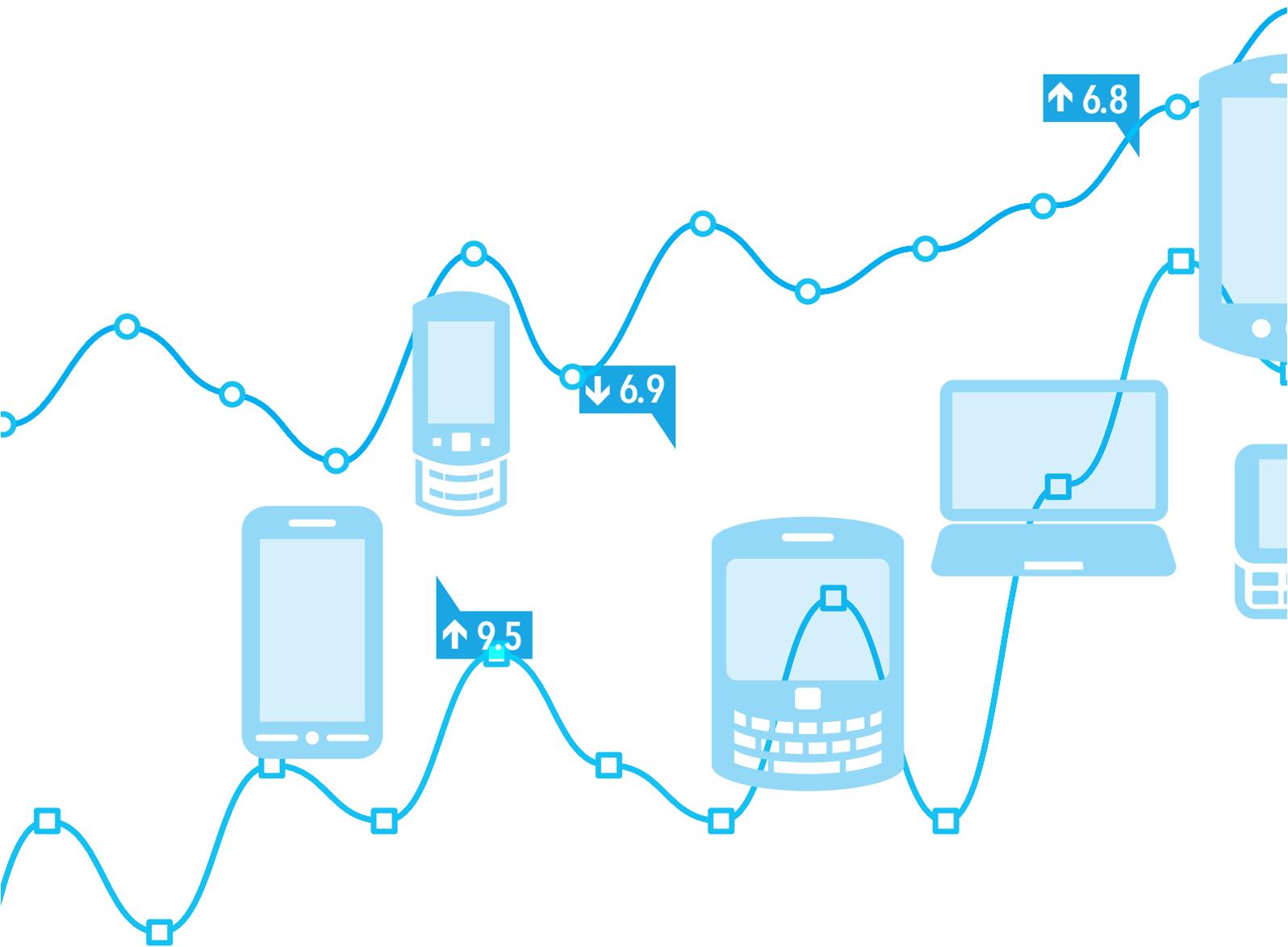
Recent developments in ICT markets – including the very high subscription rates for mobile-cellular networks, which are now widespread; the trend towards fixed-mobile substitution; and increases in bandwidth, both available and required for new services – have led to proposals for changes to be made in the indicators included in the Index. A revised set of indicators will therefore be introduced starting from IDI 2018, which should add additional insights into the performance of individual countries and into the relative performance of countries at different development levels.



## Endnotes

- <sup>1</sup> Previous reports can be accessed online at [www.itu.int/en/ITU-D/Statistics/Pages/publications/anapub.aspx](http://www.itu.int/en/ITU-D/Statistics/Pages/publications/anapub.aspx).
- <sup>2</sup> Data on the indicators included in the skills sub-index are sourced from the United Nations Educational, Scientific and Cultural Organization Institute for Statistics. See Annex 1 for more details on the definition of the indicators.
- <sup>3</sup> For more information on the work of EGTI, see the EGTI online forum at <http://www.itu.int/net4/ITU-D/ExpertGroup/default.asp>.
- <sup>4</sup> For more information on the work of EGH, see the EGH online forum at <http://www.itu.int/net4/ITU-D/forum/expertgrouponhouseholds/forum>.
- <sup>5</sup> General Assembly resolution 70/125, available at <http://workspace.unpan.org/sites/Internet/Documents/UNPAN96078.pdf>.
- <sup>6</sup> General Assembly resolution 70/1, para. 15, available at [http://www.un.org/ga/search/view\\_doc.asp?symbol=A/RES/70/1&Lang=E](http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).
- <sup>7</sup> The current list of LDCs can be found at [www.un.org/development/desa/dpad/least-developed-country-category/ldcs-at-a-glance.html](http://www.un.org/development/desa/dpad/least-developed-country-category/ldcs-at-a-glance.html).
- <sup>8</sup> Available from [www.un.org/development/desa/dpad/least-developed-country-category/ldc-criteria.html](http://www.un.org/development/desa/dpad/least-developed-country-category/ldc-criteria.html).
- <sup>9</sup> Equatorial Guinea graduated from this status in 2017, but is included as an LDC in IDI 2017 as the data concerned relate to a period when it held that status.





## Chapter 3. The ICT Development Index – regional and country analysis

## Key findings

**There are considerable differences between geographical regions in the levels of ICT development as demonstrated by the IDI.** There is also significant variation in the experience of individual countries within each region. The differences in the IDI between regions and individual countries are associated mainly with levels of economic development.

**Europe continues to lead the way in ICT development.** It has the highest average IDI value among world regions (7.50 points). This reflects the region's high levels of economic development, competitive communication markets, and high levels of ICT skills. Every country in the Europe region has an IDI value above the global average. As many as 28 of its 40 countries rank within the highest quartile, while only one, Albania, falls outside the top half of the distribution. The most substantial improvements in value were recorded by Cyprus and Turkey.

**The United States and Canada top the IDI ranking in the Americas region.** The majority of countries in the region fall within the two middle quartiles, with only two least connected countries (LCCs) in the bottom quartile (Cuba and Haiti). The most significant improvements in the Americas region were recorded by middle-ranking countries in South and Central America and the Caribbean.

**The Commonwealth of Independent States (CIS) is the most homogeneous region in ICT development,** reflecting its relative economic homogeneity. Only one country in the region, Belarus, is in the top quartile of the Index, but the region includes no LCCs. The most dynamic countries in terms of IDI value were those at the bottom of the regional rankings – Ukraine, Uzbekistan and Kyrgyzstan.

**Asia and the Pacific is, by contrast, the most heterogeneous region in terms of ICT development.** Seven economies in this region have IDI values above 7.50 points and rank within the highest quartile in the global IDI 2017, including the Republic of Korea, which is ranked second overall. However, ten countries in the region, including several with very large populations, are LCCs. Six countries improved their IDI values by more than 0.40 points, led by the second most dynamic country in IDI 2017, the Islamic Republic of Iran.

**The Arab States region is also very diverse in terms of IDI performance.** This region includes a number of oil-rich high-income economies, three of which are in the top quartile of the IDI, as well as a number of low-income countries, four of which are LCCs. The strongest improvements in this region were seen in middle-income countries, whose average value rose by more than twice that of countries at the top and bottom of the regional distribution.

**Africa continues to be the region with the lowest IDI performance.** The average value for this region in IDI 2017 is 2.64 points, little more than half the global average of 5.11. Only one country in the region, Mauritius, ranks in the upper half of the global IDI distribution, while 28 of the 38 African countries included in IDI 2017 fall into the lowest (LCC) quartile. This reflects the generally low level of economic development in the region. The region does, however, include two of the three countries which achieved the most dynamic improvements in their IDI value over the year – Namibia and Gabon.

# Chapter 3. The ICT Development Index – regional and country analysis

## 3.1 Introduction

Chapter 2 described the ICT Development Index (IDI) and compared global findings for IDI 2016 and IDI 2017. The present chapter extends this analysis by investigating IDI findings at the regional level and comparing different regions. Information concerning individual countries can be found in volume 2 of this report.

## 3.2 Regional IDI analysis

ITU Member States are divided into six regions – Africa, the Americas, Arab States, Asia and the Pacific, the Commonwealth of Independent States (CIS) and Europe. The distribution of countries between regions differs in a number of respects from the regional distributions used in other United Nations data series, most notably where the Europe and Africa regions are concerned, and this should be borne in mind when undertaking comparative analysis with other data sets.<sup>1</sup>

The IDI 2017 data published in this volume are derived from 176 economies, of which 38 are in the Africa region, 35 in the Americas, 19 in the Arab States, 34 in Asia and the Pacific, 10 in CIS and 40 in Europe. Of the 20 ITU Member States for which data are not available, 6 are in the Africa region, 3 in the Arab States, 6 in Asia and the Pacific (including 5 from the United Nations Oceania region), 2 in CIS and 3 small States in Europe.

Table 3.1 sets out the results of IDI 2017 for each of the six ITU regions, and compares them with the results for IDI 2016. Chart 3.1 shows the distribution of average, minimum and maximum IDI values in these regions, compared with the global average.

As in previous years, Europe records the highest regional average IDI value, at 7.50, an increase of 0.16 points (just over 2.2 per cent) over 2016. No country in the region falls below the global average of 5.11, and only one country in Europe, Albania, falls outside the upper half of the distribution, ranking 89th, the position just below the halfway point. The range of IDI values (3.84 points, or 2.97 if the two bottom countries are excluded) is narrower than those of most other regions, reflecting the relative economic homogeneity of the region, which includes only three developing countries.

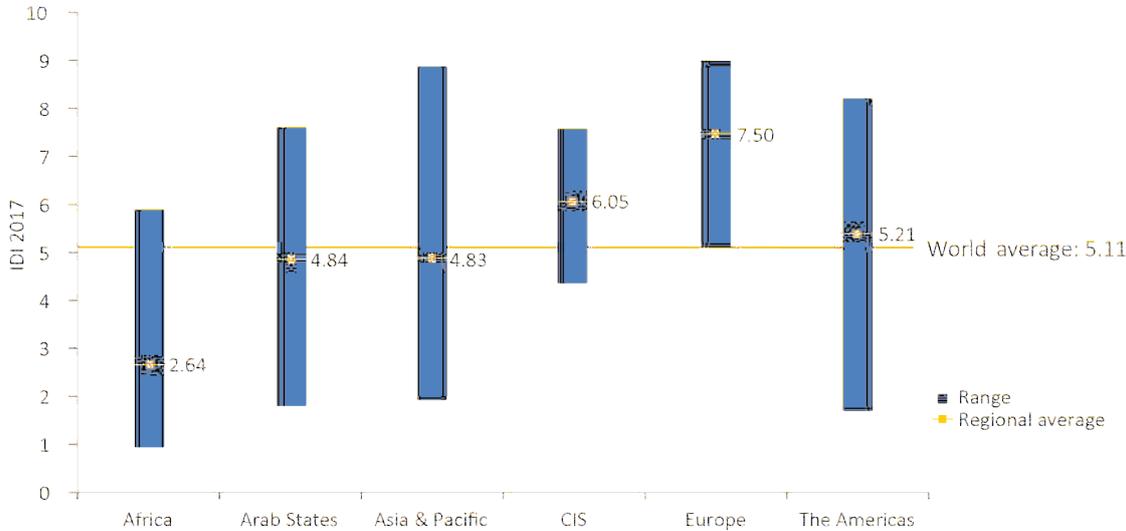
The regional average value for the CIS region rose more substantially than that in Europe – by 0.21 points, from 5.84 to 6.05 – and is also well above the global average (though it should be noted that two countries in this region are not included in the Index). As with Europe, the range of values within the CIS region is relatively small (3.18 points separate Belarus at the top of the regional distribution from Kyrgyzstan at the bottom), reflecting relative homogeneity in both economic and information and communication technology (ICT) development.

Table 3.1: IDI by region, 2017 and 2016

Region	Number of economies	IDI 2017						IDI 2016						Difference 2016-2017		
		Max.	Min.	Range	Average*	StDev	CV	Max.	Min.	Range	Average*	StDev	CV	Range	Average*	CV
Africa	38	5.88	0.96	4.92	2.64	1.23	46.37	5.51	0.89	4.63	2.48	1.18	47.64	0.29	0.16	-1.27
Arab States	19	7.60	1.82	5.78	4.84	1.87	38.71	7.46	1.78	5.68	4.71	1.88	39.95	0.10	0.13	-1.24
Asia & Pacific	34	8.85	1.95	6.91	4.83	2.17	44.99	8.80	1.71	7.08	4.60	2.21	48.02	-0.18	0.24	-3.03
CIS	10	7.55	4.37	3.18	6.05	0.97	16.04	7.29	4.06	3.23	5.84	1.04	17.83	-0.05	0.21	-1.79
Europe	40	8.98	5.14	3.84	7.50	0.92	12.22	8.78	4.90	3.88	7.34	0.96	13.09	-0.04	0.16	-0.87
The Americas	35	8.18	1.72	6.47	5.21	1.50	28.83	8.13	1.63	6.51	5.01	1.50	30.04	-0.04	0.20	-1.21

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

Chart 3.1: IDI by region compared with global average, 2017



Source: ITU.

The average IDI values in three of the remaining regions – the Americas, the Arab States, and Asia and the Pacific – is close to the global average. The average value for the Americas slightly exceeds the global average, at 5.21, while the average values for the Arab States and Asia and the Pacific – at 4.84 and 4.83 respectively – fall just below. Each of these regions includes countries with widely diverse levels of economic and ICT development. The average values for the Americas and Asia and the Pacific have increased more in the past year than has that for the Arab States (by 0.20 and 0.24 points, compared with 0.13 points), with a global increase of 0.18 points.

As in previous years, the Africa region records by far the lowest average IDI value, up 0.16 points on the year, from an IDI 2016 value of 2.48 to an IDI 2017 value of 2.64, not much more than half the global average. Only one country in this region (Mauritius) exceeds the global average value or ranks within the top half of the distribution, while 28 of the region’s 38 countries fall within the least connected country (LCC) quartile at the bottom of the rankings. This concentration of IDI values towards the bottom of the distribution also means that Africa has a narrower range of values than other regions, including other regions that are primarily made up of developing countries, reflecting the consistency between levels of economic and ICT development, discussed in Chapter 2.

Table 3.2 further illustrates the differences in range and average values between regions by setting out IDI outcomes for the highest- and lowest-ranking economies within each region. The characteristics of the top- and bottom-ranking countries in each region are discussed alongside those of each region’s most dynamic countries later in this chapter.

The factors contributing to high and low performance in IDI value, and to more or less dynamic movement in the rankings, vary between countries. Factors that are particularly important in the case of top-ranking countries globally are discussed in Chapter 2, while those that affect high- and low-performing countries in individual regions are considered in later sections of the present chapter.

Typically, countries towards the top of the global distribution score highly or relatively highly across the whole range of indicators, giving their spider diagrams – which represent the average scores achieved for each of the individual indicators that make up the Index – the characteristically rounded shape illustrated in Chart 2.2. There are, however, individual differences between countries that affect their overall rankings even at this level. Iceland, for example, at the top of the global distribution, scores significantly higher than does the Republic of Korea, which ranks second, in the proportion of households with a computer and in international Internet bandwidth per Internet user.

Table 3.2: Highest- and lowest-ranking economies by region, IDI 2017

Regional IDI rank	Economy	IDI	Global IDI rank
<b>Europe</b>			
1	Iceland	8.98	1
2	Switzerland	8.74	3
3	Denmark	8.71	4
4	United Kingdom	8.65	5
5	Netherlands	8.49	7
36	Montenegro	6.44	61
37	Turkey	6.08	67
38	TFYR Macedonia	6.01	69
39	Bosnia and Herzegovina	5.39	83
40	Albania	5.14	89
<b>Asia and the Pacific</b>			
1	Korea (Rep.)	8.85	2
2	Hong Kong, China	8.61	6
3	Japan	8.43	10
4	New Zealand	8.33	13
5	Australia	8.24	14
30	Bangladesh	2.53	147
31	Pakistan	2.42	148
32	Kiribati	2.17	154
33	Solomon Islands	2.11	157
34	Afghanistan	1.95	159
<b>The Americas</b>			
1	United States	8.18	16
2	Canada	7.77	29
3	Barbados	7.31	34
4	St. Kitts and Nevis	7.24	37
5	Uruguay	7.16	42
31	Guatemala	3.35	125
32	Honduras	3.28	129
33	Nicaragua	3.27	130
34	Cuba	2.91	137
35	Haiti	1.72	168
<b>Arab States</b>			
1	Bahrain	7.60	31
2	Qatar	7.21	39
3	United Arab Emirates	7.21	40
4	Saudi Arabia	6.67	54
5	Oman	6.43	62
15	Syria	3.34	126
16	Sudan	2.55	145
17	Mauritania	2.26	151
18	Djibouti	1.98	158
19	Comoros	1.82	164
<b>CIS</b>			
1	Belarus	7.55	32
2	Russian Federation	7.07	45
3	Kazakhstan	6.79	52
4	Moldova	6.45	59
5	Azerbaijan	6.20	65
6	Georgia	5.79	74
7	Armenia	5.76	75
8	Ukraine	5.62	79
9	Uzbekistan	4.90	95
10	Kyrgyzstan	4.37	109
<b>Africa</b>			
1	Mauritius	5.88	72
2	Seychelles	5.03	90
3	South Africa	4.96	92
4	Cape Verde	4.92	93
5	Botswana	4.59	105
34	Burundi	1.48	172
35	Guinea-Bissau	1.48	173
36	Chad	1.27	174
37	Central African Rep.	1.04	175
38	Eritrea	0.96	176

Note: Georgia exited CIS on 18 August 2009, but is included in the ITU BDT administrative region for the CIS countries.  
Source: ITU.

Lower down the distribution, at both global and regional levels, the spider charts representing indicator values for individual countries become more jagged and irregular. Countries at the bottom of the distribution tend to have low values for all indicators, though values for mobile-cellular subscriptions, international Internet bandwidth

and secondary enrolment often contribute more positively than do other indicators.

Countries that have moved dynamically up in the rankings or dynamically increased their IDI values over the year have often done so because of sharp improvements in individual indicators. In many cases, between IDI 2016 and IDI 2017,

active mobile-broadband subscriptions have contributed the most significant improvement in indicator scores, although some countries have seen dramatic improvements – and, in some cases, reductions – in scores for other indicators.

As highlighted in Chapter 2, caution must be exercised when comparing the improvements made in different indicators, which have different characteristics and dynamics. For instance, the value for mobile broadband can improve significantly between one year and the next if a 3G network is switched on in a country and customers are migrated from 2G to 3G. Fixed-broadband improvements, on the other hand, require costly and lengthy network roll-outs as well as longer-term commitment from each new customer subscribing to the service. However, each new fixed-broadband subscription may benefit not only an individual, but also a household or an organization. Education indicators also tend to change over a longer time period, because a change in the education system usually takes several years to have an impact on the enrolment indicators included in the IDI. Nevertheless, any progress in education may have a profound social and economic impact and thus, indirectly, support ICT development.

As a result of these different dynamics in the IDI indicators, the fact that mobile broadband has recorded the sharpest improvements does not imply that the more moderate progress achieved in the other indicators is not significant.

## Regional variations

The similarities and differences between regions can be explored in more detail by comparing spider diagrams of the average scores achieved in

the different regions for each sub-index and for each of the individual indicators making up the Index. Variations between the different sub-indices are presented in Table 3.3, while variations across the range of indicators are presented through spider diagrams in Chart 3.2, along with a diagram to enable comparison between regional and global averages. It should be remembered, when considering these, that they are concerned with average values and thus do not reflect the range of values within regions. Analysis of the range of values can be found in the subsequent discussion of spider diagrams from selected countries within each region.

Table 3.3 shows that improvements in the average value for the use sub-index were more substantial than those for the average value in the other two sub-indices – and therefore more influential on overall IDI outcomes – in all world regions between 2016 and 2017. The largest improvement in average value for the access sub-index was in Asia and the Pacific (up 0.15 points), less than the increase in the average value of the use sub-index in any region. The largest improvement for the use sub-index was in CIS region (0.40 points), followed by Asia and the Pacific and the Americas. Asia and the Pacific saw the largest improvement in the skills sub-index.

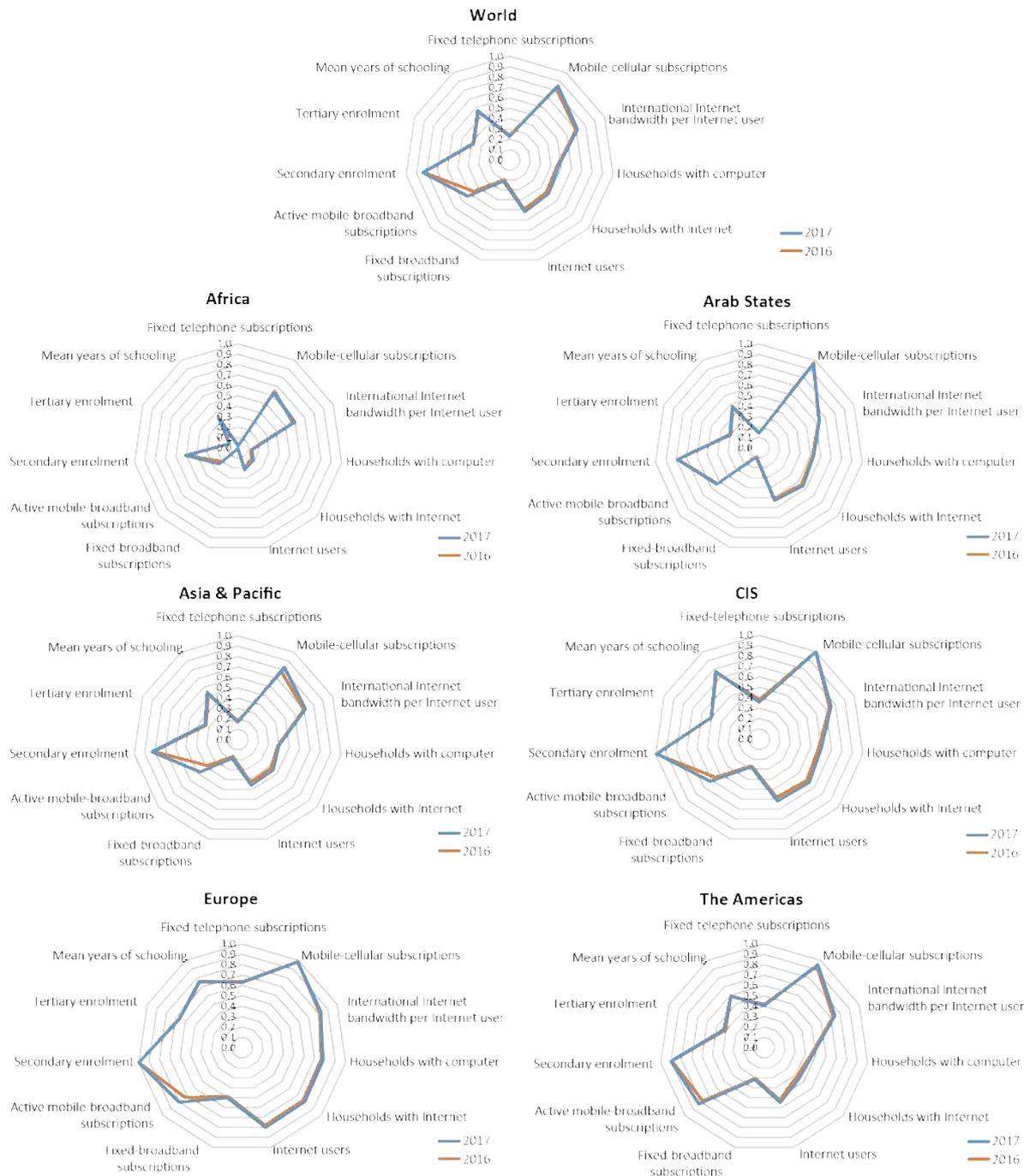
It is also worth considering the rate of improvement in each region, i.e. the improvement in average value as a proportion of IDI value in 2016. The average rate of improvement was much more substantial in the use sub-index (7.8 per cent) than in those for access and skills (1.9 per cent and 1.7 per cent respectively). The Africa region showed the highest proportional rate of improvement for the IDI as a whole, and for all three sub-indices, with an average improvement

**Table 3.3: Average IDI and sub-index values, world and regions, IDI 2017 and IDI 2016**

Region	Number of economies	IDI 2017				IDI2016				Value Change 2017-2016			
		Access	Use	Skills	IDI	Access	Use	Skills	IDI	Access	Use	Skills	IDI
Africa	38	3.28	1.74	3.16	2.64	3.18	1.48	3.07	2.48	0.10	0.26	0.10	0.16
Arab States	19	5.51	3.96	5.26	4.84	5.41	3.78	5.17	4.71	0.09	0.18	0.09	0.13
Asia and the Pacific	34	5.27	3.99	5.65	4.83	5.12	3.63	5.48	4.60	0.15	0.36	0.17	0.24
CIS	10	6.60	4.79	7.47	6.05	6.48	4.39	7.44	5.84	0.12	0.40	0.03	0.21
Europe	40	7.80	6.94	8.02	7.50	7.73	6.62	7.97	7.34	0.07	0.32	0.05	0.16
The Americas	35	5.64	4.21	6.34	5.21	5.54	3.86	6.24	5.01	0.11	0.34	0.11	0.20
World	176	5.59	4.26	5.85	5.11	5.49	3.95	5.75	4.93	0.10	0.31	0.10	0.18

Source: ITU.

Chart 3.2: Average IDI values for each indicator, world and regions, IDI 2017 and IDI 2016



Source: ITU.

of 6.6 per cent overall, and of 17.4 per cent for the use sub-index.

The spider diagrams in Chart 3.2 show there has been relatively little improvement in global average IDI performance for the majority of indicators in the Index during the year between

IDI 2016 and IDI 2017. The most notable exception to this is the significant improvement at the global level in active mobile broadband subscriptions, which was the most prominent source of improvement in all regions between IDI 2016 and IDI 2017.

Most regions showed modest increases in other access and use indicators, with the exception of fixed-telephone subscriptions, which fell marginally in all regions. This reflects continuing year-on-year improvement in those indicators for most countries. Little change was recorded in any region for the indicators in the skills sub-index, though significant changes were recorded for some individual countries.

Regions with lower average IDI values tend to have more jagged distributions of indicator values. The smoothest distribution of results across the range of indicators – with relatively high performance across the board – is that within the Europe region. The distribution of indicator results becomes more irregular as overall IDI performance falls, the most significant factors accounting for greater variation being the level of fixed-telephone subscriptions in the access sub-index, the level of fixed-broadband subscriptions in the use sub-index, and tertiary enrolment in the skills sub-index.

The spider diagrams for the CIS and Americas regions reveal stronger performance overall than those for the Arab States and Asia and the Pacific, with a more balanced distribution of indicator values than in these latter regions. The most jagged spider diagram is that for Africa. This reflects particularly low indicator values in that region for fixed-telephone and fixed-broadband subscriptions, and for tertiary enrolment. The indicator contributing most strongly to overall IDI values in Africa is that for mobile-cellular subscriptions, while the most prominent improvement in the region during the past year came from the indicators for mobile-broadband subscriptions, households with Internet and

Internet users. This suggests that the development of mobile broadband is helping to bring more people and households online in Africa.

The following sections describe the findings for each region in more detail, and explore the results achieved by a number of individual countries, including regional top performers and dynamic countries that have most significantly improved their positions in the rankings and/or IDI values.

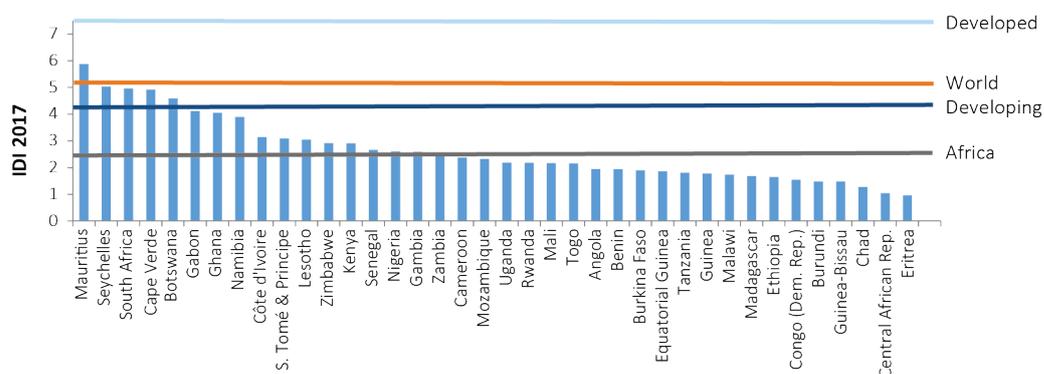
## Africa

IDI values and rankings for the Africa region are set out in Chart 3.3 and Table 3.4, where they are compared with the global average and with averages for developed and developing countries.

Africa has by far the lowest average IDI performance of any region. Only one country in the region – Mauritius – falls into the top half of the IDI distribution or exceeds the global average value for IDI 2017, while only four more countries – Seychelles, South Africa, Cape Verde and Botswana – exceed the average value of 4.26 for developing countries.

By contrast, 28 of the 38 countries in the Africa region that are included in the Index rank as LCCs in the lowest quartile of the distribution, including 9 of the 10 countries at the bottom of the global rankings. The average improvement in IDI value for African least developed countries (LDCs), 0.12 points, was also significantly lower than that for non-LDCs within the region (0.23 points). A number of African LDCs are not included in the Index because of lack of data. However, it is likely

Chart 3.3: IDI values, Africa region, IDI 2017



Source: ITU.

Table 3.4: IDI rankings and values, Africa, IDI 2017 and IDI 2016

Economy	Regional rank 2017	Global rank 2017	IDI 2017	Regional rank 2016	Global rank 2016	IDI 2016	Global rank change 2017-2016	Regional rank change 2017-2016
Mauritius	1	72	5.88	1	75	5.51	3	0
Seychelles	2	90	5.03	4	92	4.80	2	2
South Africa	3	92	4.96	2	88	4.91	-4	-1
Cape Verde	4	93	4.92	3	91	4.83	-2	-1
Botswana	5	105	4.59	5	102	4.51	-3	0
Gabon	6	114	4.11	7	118	3.62	4	1
Ghana	7	116	4.05	6	113	3.88	-3	-1
Namibia	8	118	3.89	8	123	3.33	5	0
Côte d'Ivoire	9	131	3.14	12	134	2.84	3	3
S. Tomé & Príncipe	10	132	3.09	10	131	2.91	-1	0
Lesotho	11	133	3.04	9	130	2.94	-3	-2
Zimbabwe	12	136	2.92	11	133	2.85	-3	-1
Kenya	13	138	2.91	13	137	2.67	-1	0
Senegal	14	142	2.66	14	142	2.48	0	0
Nigeria	15	143	2.60	15	143	2.44	0	0
Gambia	16	144	2.59	16	145	2.43	1	0
Zambia	17	146	2.54	18	149	2.19	3	1
Cameroon	18	149	2.38	19	150	2.14	1	1
Mozambique	19	150	2.32	17	147	2.23	-3	-2
Uganda	20	152	2.19	24	158	1.90	6	4
Rwanda	21	153	2.18	20	151	2.10	-2	-1
Mali	22	155	2.16	21	153	2.05	-2	-1
Togo	23	156	2.15	25	159	1.86	3	2
Angola	24	160	1.94	22	156	2.00	-4	-2
Benin	25	161	1.94	23	157	1.92	-4	-2
Burkina Faso	26	162	1.90	27	163	1.74	1	1
Equatorial Guinea	27	163	1.86	26	160	1.82	-3	-1
Tanzania	28	165	1.81	28	164	1.73	-1	0
Guinea	29	166	1.78	29	166	1.71	0	0
Malawi	30	167	1.74	31	169	1.58	2	1
Madagascar	31	169	1.68	30	167	1.70	-2	-1
Ethiopia	32	170	1.65	33	171	1.42	1	1
Congo (Dem. Rep.)	33	171	1.55	32	170	1.48	-1	-1
Burundi	34	172	1.48	34	172	1.39	0	0
Guinea-Bissau	35	173	1.48	35	173	1.38	0	0
Chad	36	174	1.27	36	174	1.06	0	0
Central African Rep.	37	175	1.04	38	176	0.89	1	1
Eritrea	38	176	0.96	37	175	0.96	-1	-1
<b>Average</b>			<b>2.64</b>			<b>2.48</b>		

Source: ITU.

that at least some of these would also have IDI values within the lowest quartile if data were available. These findings illustrate the extent to which Africa continues to lag behind other regions in ICT development, as well as the importance of addressing the region's ongoing digital divide.

All but three countries in the region (Angola, Madagascar and Eritrea) showed some improvement in IDI value between 2016 and 2017, although in 11 countries this improvement was marginal (less than 0.10 points). The average improvement recorded was 0.16 points, less than

Table 3.5: Most dynamic countries by IDI ranking and IDI value, Africa, 2016–2017

Change in IDI ranking				Change in IDI value (absolute)			
IDI rank 2016	Rank region	Country	IDI rank change	IDI rank 2017	Rank region	Country	IDI value change
2	20	Uganda	6	118	8	Namibia	0.57
4	8	Namibia	5	114	6	Gabon	0.50
4	6	Gabon	4	72	1	Mauritius	0.36
6	1	Mauritius	3	146	17	Zambia	0.35
3	9	Côte d'Ivoire	3	131	9	Côte d'Ivoire	0.30
3	17	Zambia	3				
2	23	Togo	3				

Source: ITU.

the average improvement of 0.20 points for all developing countries.

The most dynamic countries in Africa, by IDI ranking and value, are identified in Table 3.5. The greatest improvements in the overall IDI were made by Namibia (up 0.57 points), Gabon (up 0.50 points) and Mauritius (up 0.36 points). The greatest improvements in the access sub-index were made by the Central African Republic, Mauritius and Malawi, and in the use sub-index by Namibia, Gabon and Zambia.

As in other regions, there was relatively little movement in regional rankings between IDI 2016 and IDI 2017. At the top of the distribution, Seychelles moved from fourth to second position, at the expense of South Africa and Cabo Verde, while Gabon moved above Ghana, from seventh to sixth. The biggest gain in the regional rankings was made by Uganda, which moved from 24th to 20th position.

The ten countries at the top of the African rankings achieved an average improvement in their IDI values of 0.25 points, well above the global average of 0.18, thanks to substantial improvements by the region's three most dynamic countries (Namibia, Gabon and Mauritius), while the remaining countries in the region, all but one of which are in the LCC quartile, managed an average improvement of just 0.13 points.

Across the Africa region as a whole, the indicators that showed the greatest improvement in percentage terms between IDI 2016 and IDI 2017 were those for mobile-broadband penetration and households with Internet access, followed by those for Internet users, households with a computer and (from a generally low base) fixed-broadband

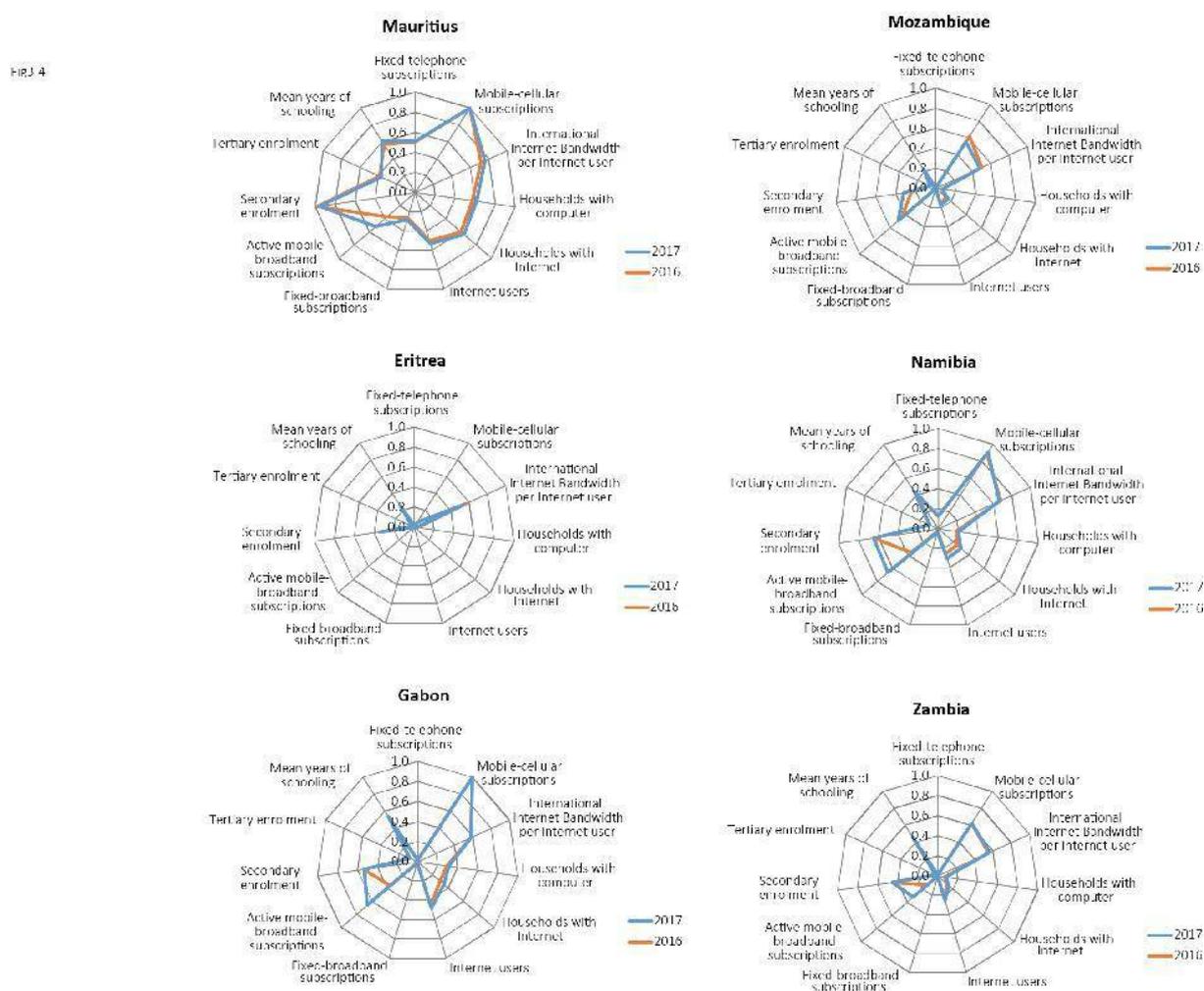
penetration. This can be compared with the trend identified in *Measuring the Information Society Report 2016* (ITU, 2016b), which found that the greatest improvements in the region in the previous year occurred in mobile-cellular subscriptions and mobile-broadband subscriptions.

The steep increase in mobile-broadband penetration (from an average of 22.40 per 100 population in IDI 2016 to 27.78 in IDI 2017) was driven by exceptionally high growth rates (which exceed 100 per cent in Chad, Togo, Cameroon and Zambia), reflecting the impact of developments in licensing and infrastructure on very low starting points for this indicator in IDI 2016. For instance, a second operator started offering 3G services in Togo in 2016, thus breaking the monopoly that the Togolese incumbent had in the mobile-broadband market (see Togo profile available in volume 2). Seven more countries in the region recorded growth rates for this indicator of more than 50 per cent.

The highest growth rates for fixed-broadband penetration, from an even lower base, were recorded by Cameroon, Nigeria and Mali. Only half of the countries in the region recorded increases in mobile-cellular penetration between IDI 2016 and IDI 2017, while a majority recorded a decline in fixed-telephone subscriptions. All countries in the region recorded an increase in the proportion of Internet users, the highest growth rates being in the Democratic Republic of the Congo, Togo and Chad, while all but one recorded an increase in the proportion of households with Internet access.

Chart 3.4 presents spider diagrams that illustrate the performance of the countries at the top, midpoint and bottom of the regional distribution,

Chart 3.4: IDI values, selected countries, Africa region, IDI 2017 and IDI 2016



Source: ITU.

in the upper row, and dynamic countries in the region by IDI value, in the lower.

The spider diagrams in Chart 3.4 illustrate the marked contrast between the performance of the region's highest-performing country (Mauritius) and the lowest-performing country in the IDI (Eritrea). The performance of Mauritius is typical of middle-ranking countries in the Index, with relatively high outturns for most indicators, but comparatively low scores for fixed-telephone and fixed-broadband subscriptions and for tertiary education. The position of Mauritius as first in the regional ranking reflects its historical role as a forerunner in ICT developments in the region: it was the first country in the southern hemisphere to launch commercial mobile services in 1989, the first African country to connect to an international undersea fibre-optic cable in 2002, and the first

African country to launch 3G services in (see Mauritius profile available in volume 2).

Mozambique's performance, halfway down the regional rankings but within the LCC quartile, is much more typical of low-income developing countries, with low scores for most indicators, its highest performance being in mobile-cellular subscriptions and international Internet bandwidth per Internet user. The country connected to the SEACOM international submarine cable in 2009, and to the Eastern Africa Submarine System a year later, thus easing its historical lack of international connectivity. Its relatively strong performance on mobile-broadband subscriptions, which is explained by the boost in competition that the third operator brought into the Mozambican mobile-broadband market in 2012 (see Mozambique profile available in volume 2).

Namibia, Gabon, Zambia and Mauritius are the four most dynamic countries in the regional IDI in terms of IDI value. The first three of these have spider diagrams whose shape resembles those of Mozambique and other countries in the lower-middle quartile (Gabon and Namibia) and the upper reaches of the LCC quartile (Zambia). The most substantial improvements in indicator scores in all four countries were experienced in mobile-broadband subscriptions. The use sub-index value for Mauritius rose by 17 per cent, largely as a result of strong growth in mobile-broadband subscriptions, compared with a 4 per cent increase in its access sub-index value. It also recorded significant improvements in international Internet bandwidth, households with Internet access and Internet users. The use sub-index values for Namibia, Gabon and Zambia rose by 56 per cent, 39 per cent and 66 per cent respectively, driven predominantly by mobile-broadband subscriptions with the support of improved scores for the proportion of Internet users in the population. In Gabon, the incumbent’s acquisition of the fourth mobile operator, Moov, granted access to the incumbent’s 3G and long-term evolution (LTE) network to the data subscribers of Moov, who could previously only access 2G services.

Uganda was only the seventh most dynamic country in the region in terms of IDI value, rising by 0.29 points, but made the largest upward movement in the regional rankings because it improved significantly more than almost every other country in the third quartile of the regional distribution. It also saw its use sub-index value

rise by more than 50 per cent, driven by mobile-broadband subscriptions, and it enjoyed significant improvements in the mobile-cellular subscriptions and the proportion of Internet users within the population.

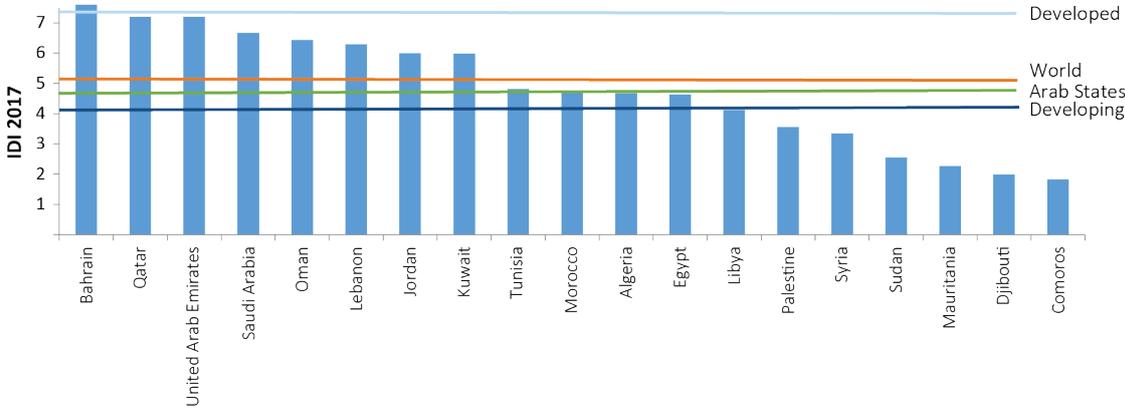
**Arab States**

IDI values and rankings for the Arab States region are set out in Chart 3.5 and Table 3.6, where they are compared with the global average and with averages for developed and developing countries.

There are marked differences in the economic and ICT characteristics of economies at different economic levels within these regional rankings. This partly explains why there were only two changes in position within the regional rankings between IDI 2016 and IDI 2017, with Qatar moving above the United Arab Emirates into 2nd position and Algeria above Egypt into 11th. However, the Arab States region saw the lowest average improvement in IDI values of any region in the Index. Consistent with this, 13 of its 19 economies dropped by one or more places in the global rankings.

Five of the six countries in the Gulf Cooperation Council sub-region occupy the top five regional positions, while the sixth, Kuwait, is in eighth position. These countries have high levels of gross national income (GNI) per capita, although, as indicated in Chapter 2, a number of them perform less well in the IDI rankings than developed

**Chart 3.5: IDI values, Arab States region, IDI 2017**



Note: Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (Rev. Busan, 2014) of the ITU Plenipotentiary Conference.  
Source: ITU.

Table 3.6: IDI rankings and values, Arab States, IDI 2017 and IDI 2016

Economy	Regional rank 2017	Global rank 2017	IDI 2017	Regional rank 2016	Global rank 2016	IDI 2016	Global rank change 2017-2016	Regional rank change 2017-2016
Bahrain	1	31	7.60	1	30	7.46	-1	0
Qatar	2	39	7.21	3	36	7.12	-3	1
United Arab Emirates	3	40	7.21	2	34	7.18	-6	-1
Saudi Arabia	4	54	6.67	4	45	6.87	-9	0
Oman	5	62	6.43	5	64	6.14	2	0
Lebanon	6	64	6.30	6	65	6.09	1	0
Jordan	7	70	6.00	7	66	5.97	-4	0
Kuwait	8	71	5.98	8	70	5.75	-1	0
Tunisia	9	99	4.82	9	95	4.70	-4	0
Morocco	10	100	4.77	10	98	4.57	-2	0
Algeria	11	102	4.67	12	106	4.32	4	1
Egypt	12	103	4.63	11	104	4.44	1	-1
Libya	13	115	4.11	13	112	3.93	-3	0
Palestine	14	123	3.55	14	122	3.42	-1	0
Syria	15	126	3.34	15	124	3.32	-2	0
Sudan	16	145	2.55	16	141	2.56	-4	0
Mauritania	17	151	2.26	17	152	2.08	1	0
Djibouti	18	158	1.98	18	161	1.80	3	0
Comoros	19	164	1.82	19	162	1.78	-2	0
<b>Average</b>			<b>4.84</b>			<b>4.71</b>		

Note: Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (Rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU.

countries with comparable economic indicators. All six have IDI values well above the world average of 5.11, as do two middle-income countries in the region, Lebanon and Jordan.

These eight top-ranking countries have improved their IDI values by an average of 0.10 points between IDI 2016 and IDI 2017. They are followed in the rankings by four middle-income countries in North Africa (Tunisia, Morocco, Algeria and Egypt) which have improved their performance by an average of 0.21 points, suggesting that middle-income countries in the region may be gaining on countries in the Gulf Cooperation Council. Countries lower down the regional distribution also improved their average IDI value by 0.10 points.

The most dynamic countries in the region, by IDI ranking and value, are identified in Table 3.7. The most substantial improvements in IDI value were made by Algeria (up 0.34 points), Oman (up 0.29 points) and Kuwait (up 0.23 points). The greatest improvements in the access sub-index were made by Algeria, Bahrain, Lebanon and Libya, while the

greatest improvements in the use sub-index were made by Oman, Kuwait, Algeria and Lebanon.

In Algeria, the expansion of 3G coverage and the launch of LTE services led to a significant increase in mobile-cellular subscriptions and, to a lesser extent, in mobile-broadband subscriptions. In Oman, the rising popularity of social media applications and the successful commercial strategy undertaken by the second operator, Ooredoo, have led to a remarkable increase in Ooredoo's data subscriptions. The operator has benefitted from the Telecommunications Regulatory Authority's permission to use the 900 MHz band for 3G services. The Authority's Information Memorandum detailing the process for the award of the country's third mobile network operator (MNO) license may also have contributed to the developments in the mobile market. Indeed, the international experience shows that disruptive effects of adding a new player in a mobile market with limited competition (a duopoly in the case of Oman) may start from the announcement of the regulatory decision.<sup>2</sup>

Table 3.7: Most dynamic countries by IDI ranking and IDI value, Arab States, 2016–2017

Change in IDI ranking				Change in IDI value (absolute)			
IDI rank 2017	Rank region	Country	IDI rank change	IDI rank 2017	Rank region	Country	IDI value change
102	11	Algeria	4	102	11	Algeria	0.34
158	18	Djibouti	3	62	5	Oman	0.29
62	5	Oman	2	71	8	Kuwait	0.23
64	6	Lebanon	1	64	6	Lebanon	0.20
103	12	Egypt	1	100	10	Morocco	0.19
151	17	Mauritania	1				

Source: ITU.

Saudi Arabia saw a marked fall in both access and use sub-indices, caused in particular by falls in recorded mobile-cellular and mobile-broadband subscriptions, which were the result of new fingerprint requirements for registration of SIM cards, new legislation limiting the number of subscriptions per user and an economic slowdown that resulted in the departure of many foreign workers. The decrease in mobile-broadband subscriptions, in combination with the halt on unlimited broadband packages, also resulted in less Internet traffic and thus a reduction in the used international Internet bandwidth per Internet user.

At the bottom end of the rankings, the region includes four LDCs which fall into the low (LCC) quartile of the IDI distribution. While two of these countries – Mauritania and Djibouti – have improved their IDI values by 0.18 points, Comoros has achieved only weak growth and Sudan has seen a marginal decline in IDI value.

The most significant rates of improvement across the Arab States region were made in international Internet bandwidth and fixed- and mobile-broadband subscriptions. Each of those rose by more than 15 per cent on average during the year. The average growth rate for fixed-broadband subscriptions was boosted by an exceptionally high rate of growth in one country, Libya, explained by an expansion of the capacity of the fixed wireless network. Despite the remarkable improvement, the starting base was very low and therefore fixed-broadband penetration only reached 3 per cent in Libya. Other particularly strong performances in the fixed-broadband arena were recorded in Kuwait, Jordan and Comoros.

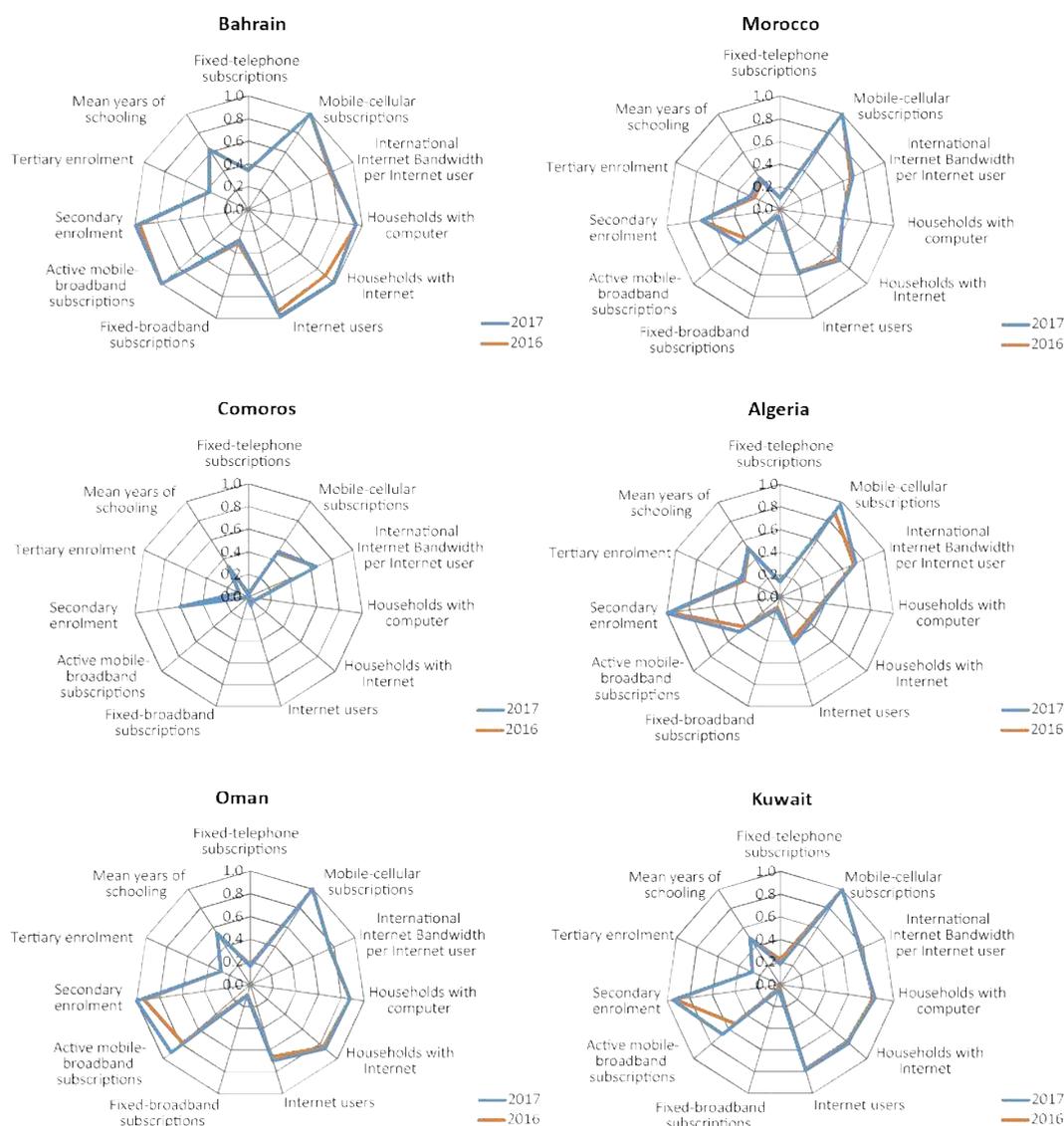
Djibouti showed a very high rate of improvement in mobile-broadband subscriptions coinciding

with the incumbent’s accelerated investment in the mobile network and the expansion of 3G coverage in the country. Nevertheless, mobile-broadband penetration in Djibouti remains low in comparison with other countries in the region, at 12 per cent, and the country is the only Arab State to maintain a monopoly in the mobile market. Other countries that stand out for their high growth rates in mobile-broadband subscriptions include Mauritania, Kuwait and Bahrain, whereas Saudi Arabia and Sudan registered significant declines. The indicator for international Internet bandwidth per Internet user is affected by changes in both bandwidth availability and numbers of Internet users. It grew markedly in the Syrian Arab Republic, Egypt and Djibouti. These countries share a remarkable increase in international connectivity in 2016 and a more modest increase in Internet users. In the case of Egypt, data show that these trends are explained by an increase in the data consumption per Internet user. Indeed, data consumption per subscription grew by 75 per cent and 31 per cent for mobile broadband and fixed broadband, respectively, in 2016. The highest growth rates for both Internet users and households with Internet access were recorded, from low base levels, in Mauritania.

Chart 3.6 presents spider diagrams that compare the performance of the countries at the top, midpoint and bottom of the regional distribution in the upper row, and the most dynamic countries in the region by IDI value in the lower row.

The upper row of these spider diagrams illustrates the differences between high-performing and low-performing countries in the region. As in other regions, high-performing countries such as Bahrain, which ranks 31st in the global distribution, exhibit relatively high scores across the majority of indicators, particularly those for mobile-cellular

Chart 3.6: IDI values, selected countries, Arab States region, IDI 2017 and IDI 2016



Source: ITU.

and mobile-broadband penetration. Bahrain's higher scores for mobile-broadband subscriptions, fixed-telephone subscriptions, Internet-related access and use indicators account for its lead over Oman and Kuwait, which rank 62nd and 71st respectively in the global distribution.

Bahrain already had a mobile-broadband penetration rate above 100 subscriptions per 100 population in IDI 2016, and therefore less scope for growth in this indicator. Its most significant improvements were made in the proportions of Internet users and households with Internet access. The early launch of LTE services in 2013 by all three MNOs has contributed to achieving almost universal Internet use in Bahrain.

Moreover, the success of LTE services in the country has led to the migration of Worldwide Interoperability for Microwave Access (WiMAX) customers to LTE services, resulting in a sustained decrease in fixed-broadband subscriptions since 2013.<sup>3</sup> The chart for Comoros, an LDC, is more typical of countries in the LCC quartile.

The most dynamic countries in the region – Algeria, Kuwait and Oman – improved their values for the use sub-index by 16, 13 and 12 per cent respectively. In Kuwait and Oman, this was driven overwhelmingly by increases in the proportion of mobile-broadband subscriptions, but in Algeria, improvement in the proportion of Internet users was also of substantial importance. While Algeria

also improved its access sub-index value, as a result of a substantial increase in mobile-cellular subscriptions, Oman’s value for the access sub-index was stagnant and Kuwait’s fell marginally as the result of a substantial fall in mobile-cellular subscriptions. Djibouti enjoyed the greatest improvement in its IDI ranking in the region, up three positions, because its performance in both access and use sub-indices was better than that of other countries with similar performance ratings in IDI 2016.

**Asia and the Pacific**

IDI values and rankings for the Asia and the Pacific region are set out in Chart 3.7 and Table 3.8, where they are compared with the global average and with averages for developed and developing countries.

Asia and the Pacific has the widest range of IDI values of any region in the Index (6.91 points between its highest and lowest ranking countries, compared with 6.47 points in the Americas and just 3.18 in the CIS region). As in the Arab States and the Americas, this results from major differences in the economic characteristics of different economies within the region.

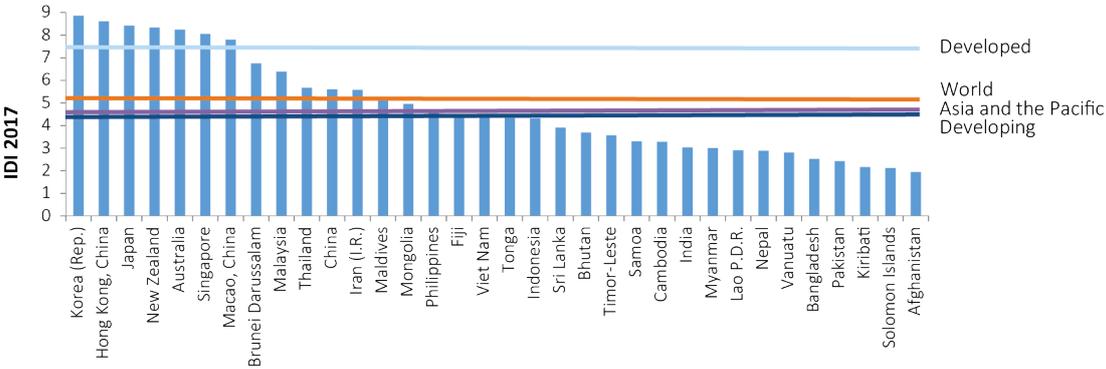
There were very few changes in position within the regional rankings between 2016 and 2017, the most significant being made by the Lao P.D.R., which rose from 144th to 139th in the global rankings and from 29th to 27th in the regional rankings.

The most dynamic countries in the region, by IDI ranking and value, are listed in Table 3.9. The biggest gains were made by Iran (up 0.54 points), the Lao P.D.R. and Indonesia (both up 0.47 points) and Timor-Leste (up 0.46 points). The most substantial improvements in value for the access sub-index were made by Iran, Myanmar, Nepal and India, while the most substantial improvements in the use sub-index were made by Timor-Leste, Indonesia, the Lao P.D.R., Iran and Samoa.

The top six positions in the region, which fall within the top 20 in the global rankings, are held by high-income economies. Four of these (the Republic of Korea, Japan, New Zealand and Australia) are members of the Organisation for Economic Co-operation and Development. Singapore and Hong Kong (China) also enjoy a very high level of GNI per capita. These six economies, together with Macao (China), which ranks seventh in the region, have IDI values above 7.75, compared with the global average of 5.11. This group of economies increased its average IDI value by 0.15 points between IDI 2016 and IDI 2017.

Seventeen countries in the region fall within the two middle quartiles of the IDI distribution. All but six of these have improved their IDI performance by more than the global average during the year, with an average improvement of 0.27 points. The most substantial improvements were made by three of the four most dynamic countries in the region – Iran, Indonesia and Timor-Leste. In Iran, the entry of the second and third MNOs into the mobile-broadband market in 2014 is bearing its fruits: mobile-broadband penetration has tripled in two years, while mobile-cellular penetration has continued its strong growth and reached the

**Chart 3.7: IDI values, Asia and the Pacific, IDI 2017**



Source: ITU.

Table 3.8: IDI rankings and values, Asia and the Pacific, IDI 2017 and IDI 2016

Economy	Regional rank 2017	Global rank 2017	IDI 2017	Regional rank 2016	Global rank 2016	IDI 2016	Global rank change 2017-2016	Regional rank change 2017-2016
Korea (Rep.)	1	2	8.85	1	1	8.80	-1	0
Hong Kong, China	2	6	8.61	2	6	8.47	0	0
Japan	3	10	8.43	3	11	8.32	1	0
New Zealand	4	13	8.33	4	12	8.23	-1	0
Australia	5	14	8.24	5	16	8.08	2	0
Singapore	6	18	8.05	6	20	7.85	2	0
Macao, China	7	26	7.80	7	29	7.55	3	0
Brunei Darussalam	8	53	6.75	8	54	6.56	1	0
Malaysia	9	63	6.38	9	62	6.22	-1	0
Thailand	10	78	5.67	10	79	5.31	1	0
China	11	80	5.60	11	83	5.17	3	0
Iran (I.R.)	12	81	5.58	12	85	5.04	4	0
Maldives	13	85	5.25	13	86	4.97	1	0
Mongolia	14	91	4.96	14	87	4.91	-4	0
Philippines	15	101	4.67	15	100	4.52	-1	0
Fiji	16	107	4.49	16	105	4.34	-2	0
Viet Nam	17	108	4.43	17	108	4.18	0	0
Tonga	18	110	4.34	18	109	4.13	-1	0
Indonesia	19	111	4.33	19	114	3.85	3	0
Sri Lanka	20	117	3.91	20	116	3.77	-1	0
Bhutan	21	121	3.69	21	119	3.58	-2	0
Timor-Leste	22	122	3.57	22	127	3.11	5	0
Samoa	23	127	3.30	24	129	2.95	2	1
Cambodia	24	128	3.28	23	128	3.04	0	-1
India	25	134	3.03	26	138	2.65	4	1
Myanmar	26	135	3.00	28	140	2.59	5	2
Lao P.D.R.	27	139	2.91	29	144	2.43	5	2
Nepal	28	140	2.88	27	139	2.60	-1	-1
Vanuatu	29	141	2.81	25	136	2.75	-5	-4
Bangladesh	30	147	2.53	30	146	2.37	-1	0
Pakistan	31	148	2.42	31	148	2.21	0	0
Kiribati	32	154	2.17	33	155	2.04	1	1
Solomon Islands	33	157	2.11	32	154	2.04	-3	-1
Afghanistan	34	159	1.95	34	165	1.71	6	0
<b>Average</b>			<b>4.83</b>			<b>4.60</b>		

Source: ITU.

threshold of 100 subscriptions per 100 inhabitants in 2016. Only one country in this group of middle-ranking countries improved its IDI value by less than 0.10 points (Mongolia).

Ten countries in the region fall within the LCC quartile. Six of these also experienced substantial improvements in their IDI values during the year – including the Lao P.D.R. (up 0.47 points), Myanmar (up 0.42 points) and India (up 0.38 points), as well as Pakistan, Nepal and the region's lowest-ranking

country, Afghanistan, all of which improved their IDI values by more than 0.20 points. In Myanmar, the opening of the mobile market to competition in 2014 has driven investment into the sector: 3G coverage grew from 50 per cent to almost the entire population in the period 2014–2016, and LTE services were launched in 2016. As a result, mobile-cellular and mobile-broadband subscription growth are leading ICT development in the country. India has seen an acceleration of subscription growth in the mobile market, both in

Table 3.9: Most dynamic countries by IDI ranking and IDI value, Asia and the Pacific region, 2016–2017

Change in IDI ranking				Change in IDI value (absolute)			
IDI rank 2017	Rank region	Country	IDI rank change	IDI rank 2017	Rank region	Country	IDI value change
159	34	Afghanistan	6	81	12	Iran (I.R.)	0.54
122	22	Timor-Leste	5	139	27	Lao P.D.R.	0.47
135	26	Myanmar	5	111	19	Indonesia	0.47
139	27	Lao P.D.R.	5	122	22	Timor-Leste	0.46
81	12	Iran (I.R.)	4	80	11	China	0.422
134	25	India	4	135	26	Myanmar	0.419

Source: ITU.

terms of mobile-cellular and mobile-broadband subscriptions. This follows the consolidation of the operations of some mobile operators, five of which now have a countrywide presence.

The most substantial average rate of improvement for any indicator in Asia and the Pacific was for mobile-broadband subscriptions. This indicator rose by an average 36.2 per cent between IDI 2016 and IDI 2017, with increases over 100 per cent, from very low baselines, in four countries (Samoa, Kiribati, the Lao P.D.R. and Afghanistan). The second most substantial average rate of improvement (12.4 per cent) was for the proportion of households with Internet access, the highest improvements for which came from three LDCs (Bangladesh, the Lao P.D.R. and the Solomon Islands). All but one country in the region (Mongolia) recorded an improvement in this indicator.

Only seven countries in the region recorded increases in the number of fixed-telephone subscribers per 100 population. Two of these (the Lao P.D.R. and the Philippines) recorded significant increases. Twenty-three of the region's 34 economies, however, recorded increases in the number of fixed-broadband subscriptions per 100 population.

Chart 3.8 presents spider diagrams that illustrate the performance of the countries at the top, midpoint and bottom of the regional distribution in the upper line, and the most dynamic countries in the region by IDI value in the lower.

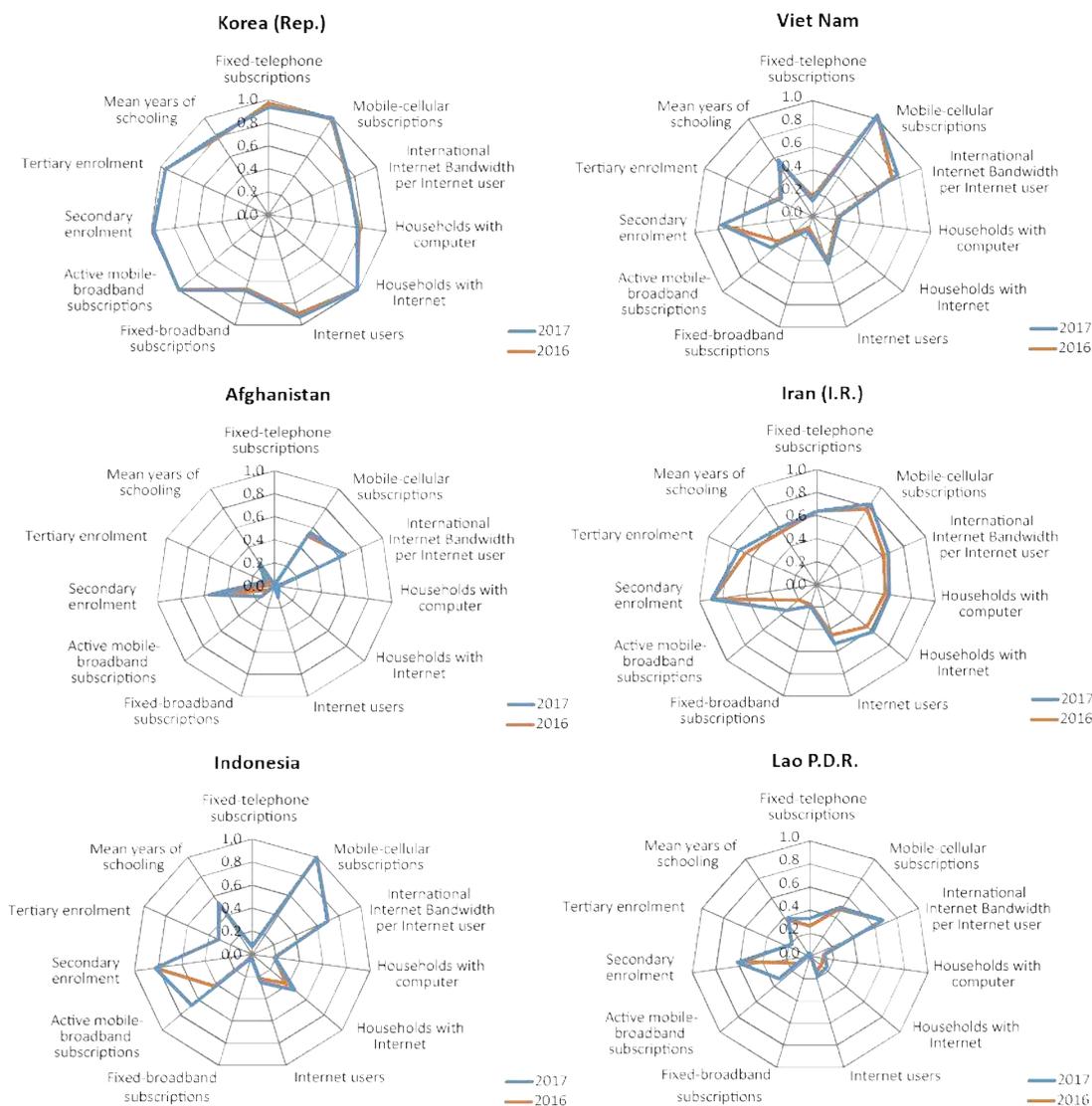
As in other regions, there are marked differences in the shape of these spider diagrams between countries at different levels of the IDI distribution. The Republic of Korea's chart is well-rounded, with high scores for all the indicators in the Index.

The diagrams for Viet Nam and Afghanistan, by contrast, are typical of those for countries around the middle of the distribution and in the LCC quartile respectively.

Iran, which was the region's most dynamic country in terms of IDI value, showed improvements in every indicator in the Index, with a particularly high rate of improvement (68.7 per cent) in the number of mobile-broadband subscriptions per 100 population, as well as notable improvements in Internet users and households with Internet access. By far the most substantial improvements for the other two dynamic countries illustrated – Indonesia and the Lao P.D.R. – were in the number of mobile-broadband subscriptions per 100 population. Both of these countries also saw significant growth in the proportion of households with Internet access, while the Lao P.D.R. also significantly improved its value for fixed-telephone subscriptions. The improvement in Timor-Leste's IDI value derived almost entirely from mobile-broadband and mobile-cellular subscriptions. China saw improvements in all indicators other than fixed-telephone subscriptions, but its highest percentage increase in any indicator came from tertiary enrolment.

Afghanistan improved its IDI value over the year by 0.23 points, which was only the 15th highest increase in the region (out of 34 economies), but this enabled it to jump six places in the IDI rankings because it was the highest improvement in value among the 20 countries at the bottom of the distribution. The most significant improvements in Afghanistan's access and use indicators were for mobile-broadband and mobile-cellular subscriptions, followed by the proportion of Internet users. Despite the country's challenging geographic and security environment, Afghanistan maintains a competitive mobile market, with five

Chart 3.8: IDI values, selected countries, Asia and the Pacific region, IDI 2017 and IDI 2016



Source: ITU.

operators offering services. The latest entrant, the State-owned fixed incumbent in 2014, has contributed to keeping the steady growth in mobile-cellular subscriptions and boosting mobile-broadband subscriptions. The latter more than doubled in 2016, reaching a rate of 14 mobile-broadband subscriptions per 100 inhabitants. This is a remarkable achievement given that only 40 per cent of the Afghan population is covered by a 3G signal.

### Commonwealth of Independent States

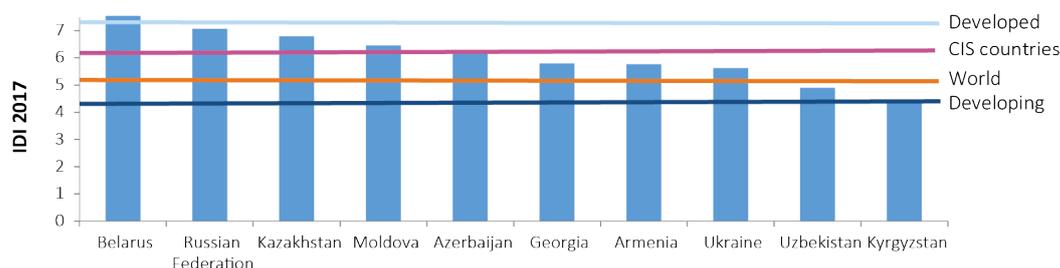
IDI values and rankings for the CIS region are set out in Chart 3.9 and Table 3.10, where they

are compared with the global average and with averages for developed and developing countries.

Ten of the 12 countries within the CIS region supply data for the IDI, the exceptions being Tajikistan and Turkmenistan. Four countries in the region (Belarus, Moldova, the Russian Federation and Ukraine) are categorized as developed countries, while the remainder are categorized as developing countries.

The CIS region includes fewer countries than other regions. It is also economically relatively homogeneous. Reflecting this relative homogeneity, it has the narrowest range of IDI values of any region (3.18 points between its

Chart 3.9: IDI values, CIS region, IDI 2017



Note: Georgia exited CIS on 18 August 2009 but is included in the ITU BDT administrative region for the CIS countries.  
Source: ITU.

Table 3.10: IDI rankings and values, CIS region, IDI 2017 and IDI 2016

Economy	Regional rank 2017	Global rank 2017	IDI 2017	Regional rank 2016	Global rank 2016	IDI 2016	Global rank change 2017-2016	Regional rank change 2017-2016
Belarus	1	32	7.55	1	32	7.29	0	0
Russian Federation	2	45	7.07	2	43	6.91	-2	0
Kazakhstan	3	52	6.79	3	51	6.72	-1	0
Moldova	4	59	6.45	5	63	6.21	4	1
Azerbaijan	5	65	6.20	4	60	6.25	-5	-1
Georgia	6	74	5.79	6	73	5.59	-1	0
Armenia	7	75	5.76	7	74	5.56	-1	0
Ukraine	8	79	5.62	8	78	5.31	-1	0
Uzbekistan	9	95	4.90	9	103	4.48	8	0
Kyrgyzstan	10	109	4.37	10	110	4.06	1	0
<b>Average</b>			<b>6.05</b>			<b>5.84</b>		

Note: Georgia exited CIS on 18 August 2009 but is included in the ITU BDT administrative region for the CIS countries.  
Source: ITU.

highest and lowest ranking countries). Only one country in the region, Belarus, falls within the high quartile of the IDI for 2017, while a second, the Russian Federation, has slipped from this quartile into top position in the upper-middle quartile, joining six other countries in the region. Two countries (Uzbekistan and Kyrgyzstan) fall into the lower-middle quartile, but the region includes no LCCs.

All but three countries in the region enjoyed improvements in their IDI values over the year that were above the global average of 0.18 points. The most dynamic countries in the region, by IDI ranking and value, are identified in Table 3.11. The biggest improvements were made by Uzbekistan (up 0.42 points), Kyrgyzstan and Ukraine (both up 0.31 points). Azerbaijan, which experienced a fall of 0.05 points, was the only country to drop a position in the regional rankings, being overtaken by Moldova. The biggest improvements in the

access sub-index were made by Uzbekistan and Moldova, and in the use sub-index by Uzbekistan and Kyrgyzstan.

As in most other regions, the most substantial rate of improvement for any individual indicator in the CIS region was that for mobile-broadband subscriptions, which rose by an average of 31.9 per cent over the year. This indicator rose most substantially – by over 175 per cent – in Ukraine, and also by substantial levels in Kyrgyzstan and Armenia. In Uzbekistan, there was also significant growth in the indicators for fixed-broadband and mobile-cellular subscriptions, and for international Internet bandwidth per Internet user.

Chart 3.10 presents spider diagrams that illustrate the performance of the countries at the top, midpoint and bottom of the regional distribution in the upper row, and the most dynamic countries in the region by IDI value in the lower.

Table 3.11: Most dynamic countries by IDI ranking and IDI value, CIS region, 2016–2017

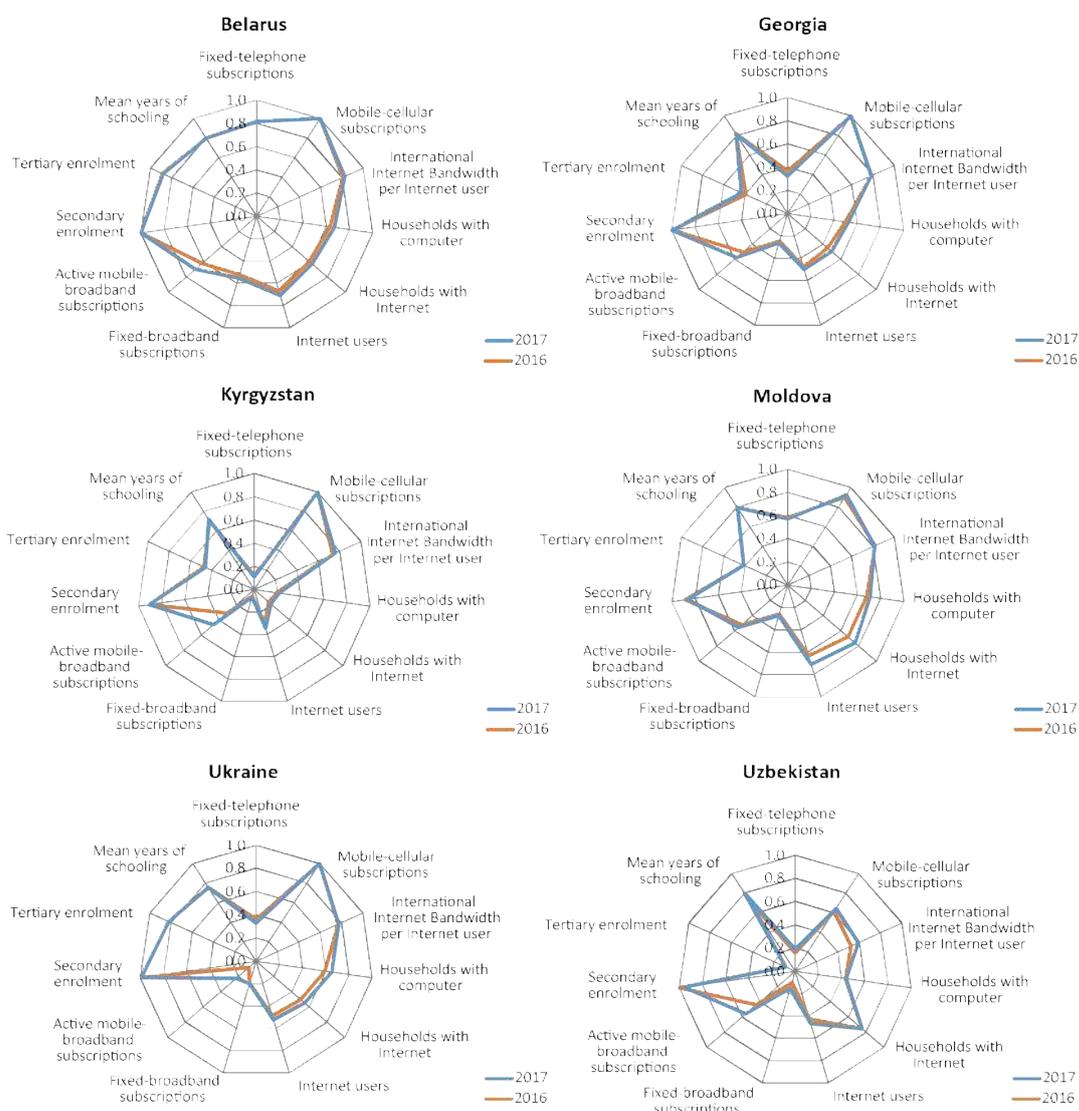
Change in IDI ranking				Change in IDI value (absolute)			
IDI rank 2017	Rank region	Country	IDI rank change	IDI rank 2017	Rank region	Country	IDI value change
95	9	Uzbekistan	8	95	9	Uzbekistan	0.42
59	4	Moldova	4	109	10	Kyrgyzstan	0.31
109	10	Kyrgyzstan	1	79	8	Ukraine	0.31
32	1	Belarus	0	32	1	Belarus	0.26
				59	4	Moldova	0.25

Source: ITU.

The spider diagrams in Chart 3.10 illustrate the relative homogeneity of IDI performance in the CIS region. Belarus is the only country illustrated

which shows the characteristically rounded form of countries near the top of the overall distribution, which score relatively highly on all

Chart 3.10: IDI values, selected countries, CIS region, IDI 2017 and IDI 2016



Note: Georgia exited CIS on 18 August 2009 but is included in the ITU BDT administrative region for the CIS countries.

Source: ITU.

indicators, though its indicator values are notably lower than those of the top-ranking countries in the Asia and the Pacific and Europe regions. Belarus has by far the largest fixed-broadband uptake in the region, at 33 subscriptions per 100 inhabitants. The fixed-broadband market in Belarus is highly concentrated, with over 75 per cent of the subscriptions belonging to the publicly-owned incumbent Beltelecom (see Belarus profile available in volume 2). Belarus also stands out for the high fixed-telephone penetration (49 subscriptions per 100 inhabitants), which has been stable in recent years.

Moldova, which is near the top of the upper-middle quartile, shows some of the same characteristics but notably lower values in fixed-telephone and fixed-broadband subscriptions, and in tertiary enrolment. Its weaker performance in terms of fixed connections is also demonstrated by the charts for Georgia<sup>4</sup> and Ukraine, which rank further down the upper-middle quartile, and particularly by Uzbekistan and Kyrgyzstan, which are in the lower-middle quartile. However, these two countries demonstrate much higher IDI values than do countries in the LCC quartile.

Among these countries, Belarus shows noticeably improved performance for all of the access and use indicators other than fixed-telephone subscriptions, where it showed a marginal fall, and mobile-cellular subscriptions, where it showed a small increase. The biggest improvements in Moldova came from the indicators for Internet users and households with Internet access. In the other four countries illustrated, mobile-broadband subscriptions have led the way, though with contributions from other indicators.

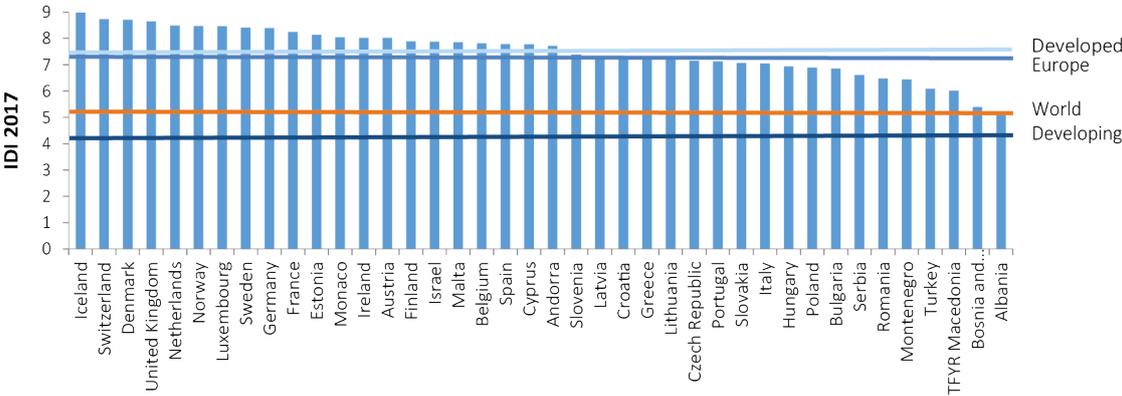
Uzbekistan was the most dynamic country in the region in terms of both IDI value and ranking. Like most dynamic countries in other regions, it increased its performance in the use sub-index (up 22 per cent) more significantly than its performance in the access sub-index. These improvements were driven, in turn, by significant improvements in mobile-broadband and mobile-cellular subscriptions, but the country also enjoyed significant improvements in fixed-broadband and fixed-telephone subscriptions, and in the proportion of Internet users. Five MNOs compete in Uzbekistan’s mobile market and their focus is progressively shifting from regular mobile service to mobile broadband. Indeed, the five MNOs have launched LTE services and they are expanding 3G and LTE coverage in the country, which reached 45 and 17 per cent of the population respectively. The reallocation of the 900/1800 MHz radio frequency bands in the first half of 2017 is expected further to boost LTE deployment (see Uzbekistan profile available in volume 2).

**Europe**

IDI values and rankings for the Europe region are set out in Chart 3.11 and Table 3.12, where they are compared with the global average and with averages for developed and developing countries.

Europe is the region with the highest average value in IDI 2017, 7.50 points, an improvement of 0.16 points on IDI 2016. This is just below the average value of 7.52 for developed countries. Every country in the region has an IDI value above the global average, while only one (Albania) is (just) within the lower half of the global distribution. As

**Chart 3.11: IDI values, Europe region, IDI 2017**



Source: ITU.

Table 3.12: IDI rankings and values, Europe region, IDI 2017 and IDI 2016

Economy	Regional rank 2017	Global rank 2017	IDI 2017	Regional rank 2016	Global rank 2016	IDI 2016	Global rank change 2017-2016	Regional rank change 2017-2016
Iceland	1	1	8.98	1	2	8.78	1	0
Switzerland	2	3	8.74	3	4	8.66	1	1
Denmark	3	4	8.71	2	3	8.68	-1	-1
United Kingdom	4	5	8.65	4	5	8.53	0	0
Netherlands	5	7	8.49	8	10	8.40	3	3
Norway	6	8	8.47	5	7	8.45	-1	-1
Luxembourg	7	9	8.47	7	9	8.40	0	0
Sweden	8	11	8.41	6	8	8.41	-3	-2
Germany	9	12	8.39	9	13	8.20	1	0
France	10	15	8.24	11	17	8.05	2	1
Estonia	11	17	8.14	10	14	8.16	-3	-1
Monaco	12	19	8.05	12	18	8.03	-1	0
Ireland	13	20	8.02	13	19	7.90	-1	0
Austria	14	21	8.02	17	24	7.70	3	3
Finland	15	22	7.88	14	21	7.83	-1	-1
Israel	16	23	7.88	15	22	7.71	-1	-1
Malta	17	24	7.86	18	25	7.65	1	1
Belgium	18	25	7.81	16	23	7.70	-2	-2
Spain	19	27	7.79	19	27	7.61	0	0
Cyprus	20	28	7.77	21	31	7.30	3	1
Andorra	21	30	7.71	20	28	7.58	-2	-1
Slovenia	22	33	7.38	22	33	7.20	0	0
Latvia	23	35	7.26	25	40	7.05	5	2
Croatia	24	36	7.24	27	42	6.96	6	3
Greece	25	38	7.23	23	38	7.08	0	-2
Lithuania	26	41	7.19	26	41	6.97	0	0
Czech Republic	27	43	7.16	24	39	7.06	-4	-3
Portugal	28	44	7.13	28	44	6.88	0	0
Slovakia	29	46	7.06	30	47	6.84	1	1
Italy	30	47	7.04	29	46	6.84	-1	-1
Hungary	31	48	6.93	31	49	6.74	1	0
Poland	32	49	6.89	32	50	6.73	1	0
Bulgaria	33	50	6.86	33	53	6.66	3	0
Serbia	34	55	6.61	34	55	6.51	0	0
Romania	35	58	6.48	36	61	6.23	3	1
Montenegro	36	61	6.44	35	56	6.30	-5	-1
Turkey	37	67	6.08	38	72	5.66	5	1
TFYR Macedonia	38	69	6.01	37	68	5.88	-1	-1
Bosnia and Herzegovina	39	83	5.39	39	81	5.23	-2	0
Albania	40	89	5.14	40	89	4.90	0	0
<b>Average</b>			<b>7.50</b>			<b>7.34</b>		

Source: ITU.

many as 28 of the region's 40 countries fall into the highest quartile, while the region takes up 7 of the top 10 – and 9 of the top 12 – positions in the global rankings. One of these countries, Iceland,

has moved above the Republic of Korea to the top of the global rankings.

As in previous years, most of the highest positions in the regional rankings are occupied by countries in Northern and Western Europe, with the five Nordic countries – Denmark, Finland, Iceland, Norway and Sweden – ranked particularly highly. All but one of the positions in the lower half of the regional distribution are occupied by countries on the Mediterranean and in Eastern Europe.

Although all but one country in the region (Estonia) has improved its IDI value over the year, there have been some significant movements in the regional rankings as a result of differences in performance. Switzerland has moved above Denmark to second place within the region, while the Netherlands has moved up three places, from eighth to fifth. France has moved above Estonia to tenth position in the region. Other significant gains in ranking were made by Austria (up three places to 14th) and Croatia (up three places to 24th).

The most dynamic countries in the region, by IDI ranking and value, are identified in Table 3.13.

The average improvement over the year in the Europe region was just below the global average improvement (0.16 versus 0.18 points), but there were significant variations between countries. The average increase in the use sub-index in Europe was much more substantial (an average of 0.32 points) than the increase in the access or skills sub-indices (0.07 and 0.05 points respectively), reflecting the fact that many countries in the region already have very high values for some access and skills indicators. At least partly for the same reason, the average improvement was higher in the lower half of the regional distribution (0.20 points) than in the upper half (0.13).

The most substantial improvements in IDI value were therefore, not surprisingly, mostly recorded by countries in the lower half of the regional distribution, headed by two of the region's three developing countries: Cyprus, which improved its IDI value by 0.47 points; and Turkey, which improved that value by 0.43 points. Cyprus' improvement was almost entirely attributable to a 15 per cent increase in its value for the use sub-index, led by the indicator for mobile-broadband but supplemented by improvements in those for fixed-broadband and Internet users.

Turkey's 18 per cent rise in use sub-index value was similarly driven, but it had a notable improvement also in the proportion of households with Internet access in the access sub-index.

The most substantial improvement in the access sub-index was recorded by Turkey, at 0.19 points, followed by Romania, Poland and Montenegro. Cyprus and Turkey recorded the biggest increases in the use sub-index, at 0.98 points and 0.75 points respectively, followed by Austria, Albania, Slovakia and Romania.

Average rates of improvement for individual indicators tend to be lower in Europe than in other regions because of the high starting point for each indicator in countries close to the top of the overall distribution. It should be noted, however, that highly developed countries in Europe are experiencing other improvements in ICT access and usage, such as the introduction of very high fixed-broadband speeds and the widespread use of cloud computing driving higher data volumes, which are not included in the current IDI but are also affecting their overall ICT performance. These advanced capabilities may tend to exacerbate

Table 3.13: Most dynamic countries by IDI ranking and IDI value, Europe region, 2016–2017

Change in IDI ranking				Change in IDI value (absolute)			
IDI rank 2017	Rank region	Country	IDI rank change	IDI rank 2017	Rank region	Country	IDI value change
36	24	Croatia	6	28	20	Cyprus	0.47
35	23	Latvia	5	67	37	Turkey	0.43
67	37	Turkey	5	21	14	Austria	0.32
7	5	Netherlands	3	36	24	Croatia	0.28
21	14	Austria	3	58	35	Romania	0.250
28	20	Cyprus	3	44	28	Portugal	0.247
50	33	Bulgaria	3				
58	35	Romania	3				

Source: ITU.

gaps in performance between more- and less-connected countries.

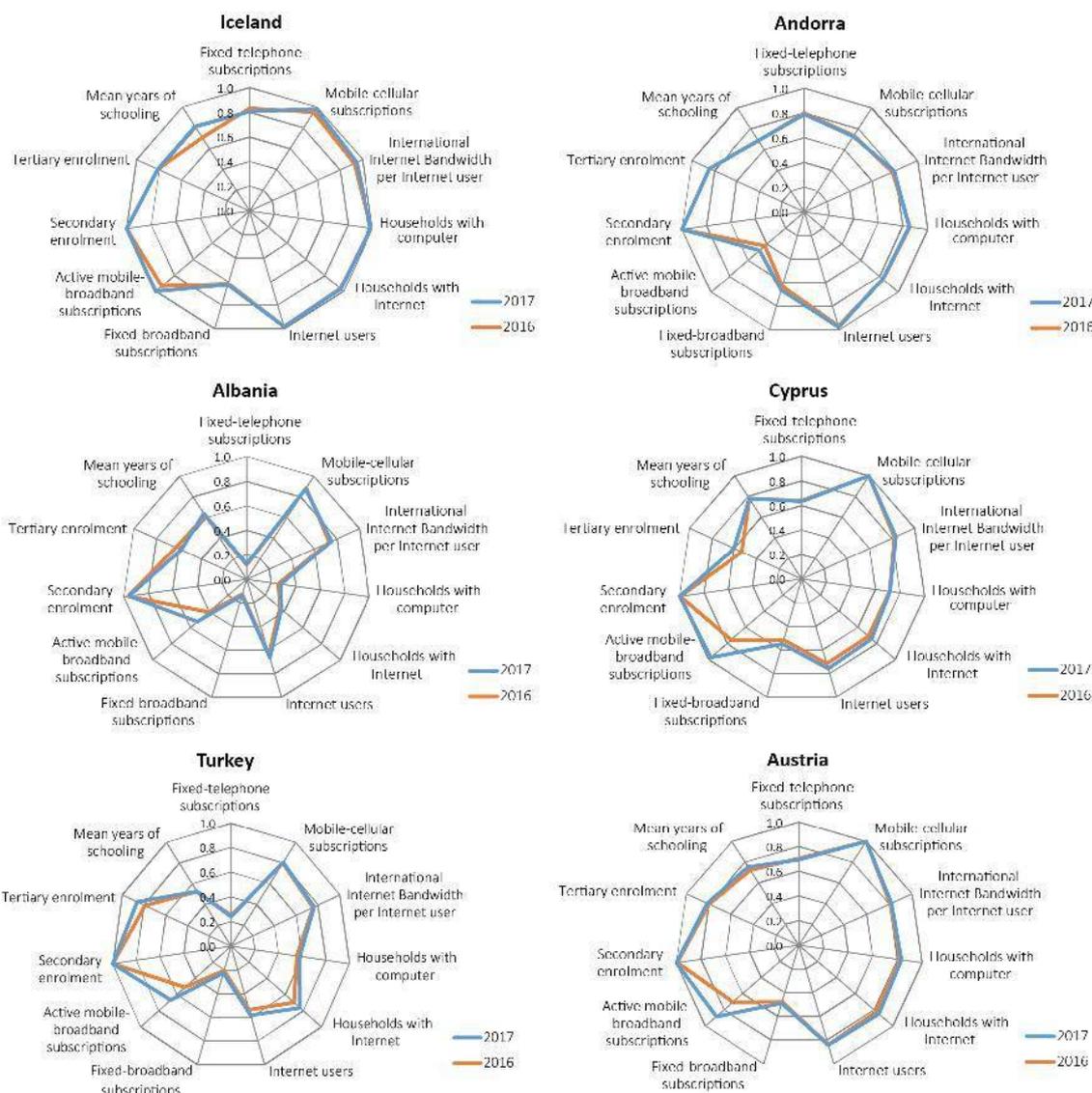
As elsewhere, the highest rate of improvement occurred with the mobile-broadband indicator. The highest improvement rates in mobile-broadband subscriptions occurred in Turkey, Albania, Austria and Cyprus, driving those countries' more dynamic performance overall. At the top end of the distribution, six countries in the region recorded mobile-broadband subscription rates of more than 100 per 100 population (Finland, Sweden, Denmark, Estonia, Switzerland and Norway). Only 8 of the 40 countries in the region recorded increases in fixed-telephone subscriptions, though all but one recorded increases in fixed-broadband subscriptions.

Levels of Internet access and use are particularly high in some European countries. More than 90 per cent of households were reported to have computers and Internet access in Denmark, Germany, Iceland, Luxembourg and Norway, with Iceland recording figures above 95 per cent for both these indicators and for the proportion of Internet users in the population.

Chart 3.12 presents spider diagrams that illustrate the performance of the countries at the top, midpoint and bottom of the regional distribution in the upper row, and the most dynamic countries in the region by IDI value in the lower.

Chart 3.12 illustrates the generally high levels of IDI performance that are prevalent in Europe.

Chart 3.12: IDI values, selected countries, Europe region, IDI 2017 and IDI 2016



Source: ITU

Iceland, which heads the global rankings, has high performance levels across the board, though it falls significantly behind the Republic of Korea, which is second in the global rankings, in the skills sub-index. Iceland’s scope for future improvements within the current set of indicators lies with fixed-broadband subscriptions, where it ranks only 12th in Europe. The chart for the small mountain country of Andorra, which ranks at the midpoint in Europe, shows a pattern broadly similar to that for Iceland but with lower outcome scores, particularly for active mobile-broadband subscriptions. The chart for the lowest-ranking country in the region, Albania, is marked by low scores (in regional terms) for fixed-telephone and fixed-broadband subscriptions, and for households with a computer (where its outcome figures are less than half those of any other country in the region), but is still much stronger than that for the lowest-ranking countries in other regions.

The three dynamic countries illustrated in Chart 3.12 include two of the region’s three developing countries, Cyprus and Turkey, as well as Austria. All three of these countries have experienced their highest rates of improvement during the year in mobile-broadband subscriptions. Developments in Cyprus’ mobile market were fuelled by the entry of the third MNO in 2016, which has led to aggressive promotions and an overall shift towards mobile data packages and post-paid contracts. In parallel, 3G and LTE network coverage was significantly extended in 2016, reaching 100 per cent and 73 per cent respectively of the population.

In Turkey, the launch of LTE-Advanced services in 2016 has prompted operators to capitalize the new

technology by attracting customers to mobile-broadband plans with convenient data offers and handset subsidies. As a result, not only has the number of mobile-broadband subscriptions increased by 32 per cent, but also the mobile data traffic per subscriptions has grown by 50 per cent. Turkey’s comparatively low scores for fixed-telephone and fixed-broadband subscriptions result in a less-consistent overall performance than those in the other countries in Chart 3.12, other than Albania, but Turkey has shared the improvement seen in Internet users and households with Internet access that is evident in many other middle-income developing countries.

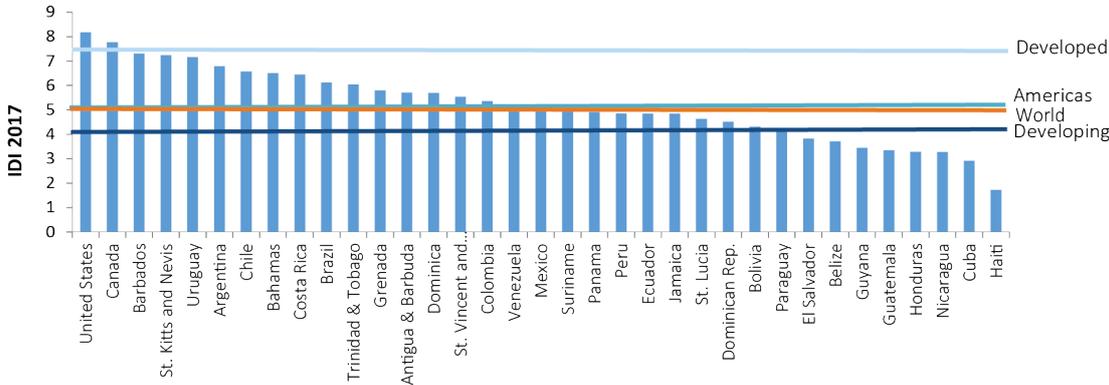
**The Americas**

IDI values and rankings for the Americas region are set out in Chart 3.13 and Table 3.14, where they are compared with the global average and with averages for developed and developing countries.

The Americas region, like Asia and the Pacific, is highly diverse, including two high-income developed countries in North America, large middle-income developing countries in Mexico and South America, and smaller developing countries and small island States in Central America and the Caribbean. The average improvement in IDI value in this region during the year, 0.20 points, was slightly above the global average. No country moved up or down the regional rankings by more than three positions.

At the top of the rankings are the region’s two large developed countries, the United States and Canada. These both rank within the

Chart 3.13: IDI values, Americas region, IDI 2017



Source: ITU.

Table 3.14: IDI rankings and values, Americas region, IDI 2017 and IDI 2016

Economy	Regional rank 2017	Global rank 2017	IDI 2017	Regional rank 2016	Global rank 2016	IDI 2016	Global rank change 2017-2016	Regional rank change 2017-2016
United States	1	16	8.18	1	15	8.13	-1	0
Canada	2	29	7.77	2	26	7.64	-3	0
Barbados	3	34	7.31	4	37	7.11	3	1
St. Kitts and Nevis	4	37	7.24	3	35	7.18	-2	-1
Uruguay	5	42	7.16	5	48	6.75	6	0
Argentina	6	51	6.79	6	52	6.68	1	0
Chile	7	56	6.57	9	59	6.28	3	2
Bahamas	8	57	6.51	8	58	6.29	1	0
Costa Rica	9	60	6.44	7	57	6.29	-3	-2
Brazil	10	66	6.12	10	67	5.89	1	0
Trinidad & Tobago	11	68	6.04	12	71	5.71	3	1
Grenada	12	73	5.80	14	77	5.39	4	2
Antigua & Barbuda	13	76	5.71	13	76	5.48	0	0
Dominica	14	77	5.69	11	69	5.76	-8	-3
St. Vincent and the Grenadines	15	82	5.54	15	80	5.27	-2	0
Colombia	16	84	5.36	17	84	5.12	0	1
Venezuela	17	86	5.17	16	82	5.22	-4	-1
Mexico	18	87	5.16	18	90	4.87	3	0
Suriname	19	88	5.15	20	94	4.77	6	1
Panama	20	94	4.91	19	93	4.80	-1	-1
Peru	21	96	4.85	22	97	4.61	1	1
Ecuador	22	97	4.84	24	101	4.52	4	2
Jamaica	23	98	4.84	21	96	4.63	-2	-2
St. Lucia	24	104	4.63	23	99	4.53	-5	-1
Dominican Rep.	25	106	4.51	25	107	4.26	1	0
Bolivia	26	112	4.31	27	115	3.84	3	1
Paraguay	27	113	4.18	26	111	4.02	-2	-1
El Salvador	28	119	3.82	28	117	3.62	-2	0
Belize	29	120	3.71	29	120	3.54	0	0
Guyana	30	124	3.44	30	121	3.44	-3	0
Guatemala	31	125	3.35	31	125	3.19	0	0
Honduras	32	129	3.28	32	126	3.14	-3	0
Nicaragua	33	130	3.27	33	132	2.85	2	0
Cuba	34	137	2.91	34	135	2.80	-2	0
Haiti	35	168	1.72	35	168	1.63	0	0
<b>Average</b>			<b>5.21</b>			<b>5.01</b>		

Source: ITU.

top 30 countries worldwide, but fall behind developed countries in Europe and Asia, which have comparably high GNI per capita, primarily because of lower values for international Internet bandwidth per Internet user, household computer and Internet access, the proportion of Internet users in the population and lower fixed-broadband connectivity. The improvement in their IDI values during the year also fell below the global average.

Three other countries in the region fall within the high quartile of the global rankings – the Caribbean island States of Barbados and St. Kitts and Nevis, and Uruguay in South America, which has risen six places in the global rankings, from 48th to 42nd, after improving its IDI value by 0.41 points.

All but two of the remaining 30 countries in the region fall within the two middle quartiles of the global rankings. All but two of these (Dominica and Venezuela) improved their IDI value, with the most substantial gains being made by the Bolivia (up 0.47 points), Grenada (up 0.40 points), Suriname (up 0.38 points) and, near the bottom of the regional distribution, Nicaragua (up 0.42 points).

The two countries in this region that fall into the LCC quartile are Cuba (which ranks 137th in the global rankings) and the region's only LDC, Haiti (which ranks 168th). Cuba exhibits an unusual IDI profile, scoring relatively highly in the skills sub-index but registering the region's lowest scores for mobile-cellular subscriptions and international bandwidth in the access sub-index and for fixed-broadband subscriptions in the use sub-index (0.13 per 100 citizens against a regional average of 13.24 per cent). It also has a very low score for households with Internet access (7.5 per cent against a regional average of 44.62 per cent), and a score of zero for mobile-broadband access. However, Cuba showed significant improvements between IDI 2016 and IDI 2017, from these low levels, for all access and use sub-indicators.

The greatest improvements in value between IDI 2016 and IDI 2017 were made by the Bolivia, Nicaragua, Uruguay and Grenada. The greatest improvements in the access sub-index were made by smaller countries – Suriname, Bahamas, Cuba and Jamaica. The highest improvements in the use sub-index were made by the Bolivia and Uruguay in South America, Nicaragua in Central America and the Caribbean island State of St. Vincent and the Grenadines. Grenada's IDI improvement was driven by improvement in the skills sub-index.

The most dynamic countries in the region by IDI ranking and value are identified in Table 3.15.

As in most regions, the most dynamic growth of any indicator in the Americas occurred with the indicator for mobile-broadband subscriptions. The average for this indicator was distorted by the effective introduction of services in Haiti, whose score rose from 0.10 subscriptions per 100 population in IDI 2016 to 10.29 subscriptions in IDI 2017. Nicaragua also experienced a high rate of growth from a low starting point for this indicator, and there were high growth rates in the Bolivia, Trinidad and Tobago, and El Salvador. The highest growth rates for fixed-broadband subscriptions, in Cuba, Nicaragua and the Bolivia, likewise came from very low starting points in IDI 2016.

Chart 3.14 presents spider diagrams that illustrate the performance of the countries at the top, midpoint and bottom of the regional distribution in the upper row, and the most dynamic countries in the region by IDI value in the lower.

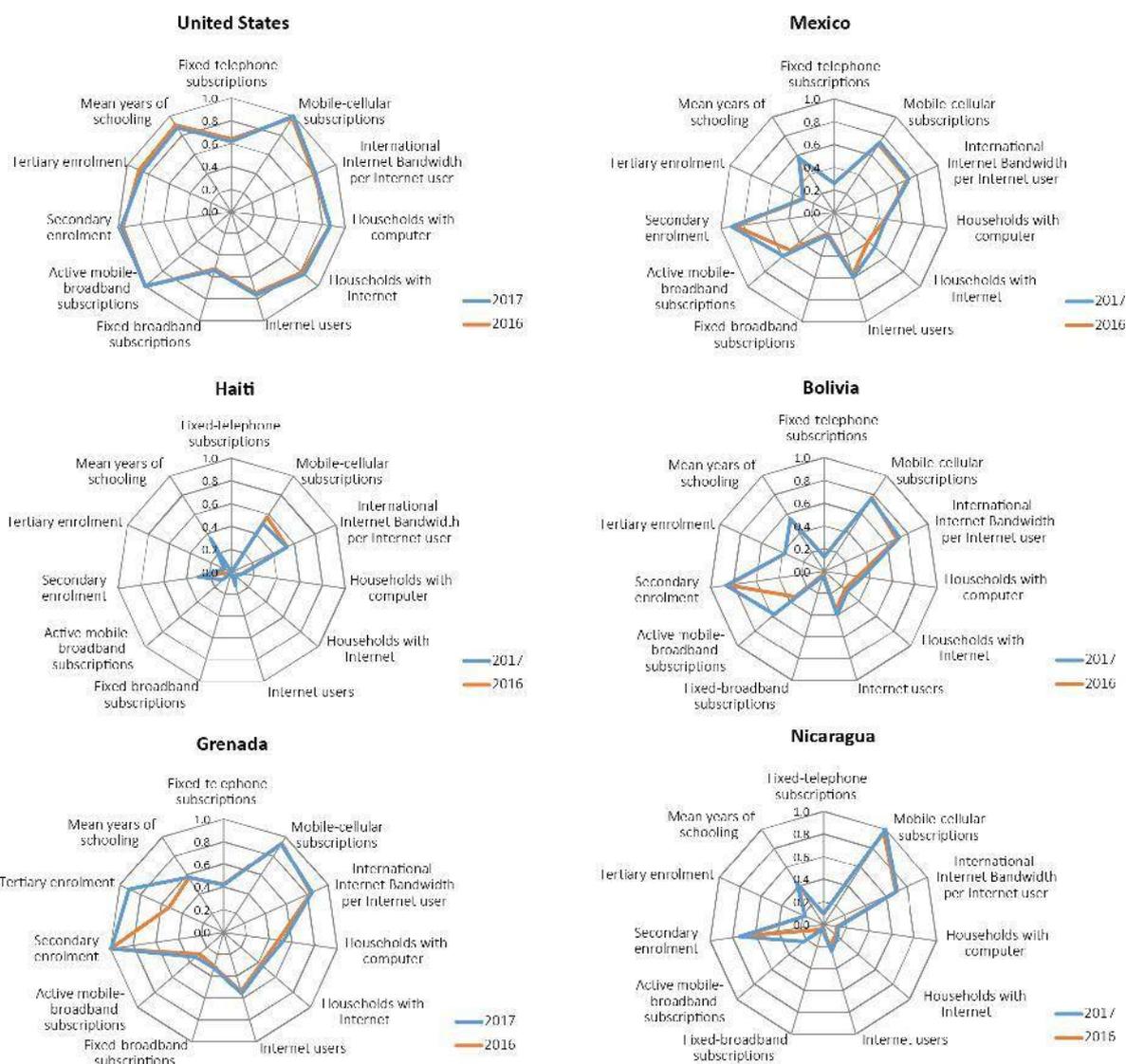
As Chart 3.14 shows, the range of IDI performance in the Americas is much wider than that in Europe, though only two countries in the region, Cuba and Haiti, fall into the LCC quartile. The chart for the United States shows the characteristic rounded shape for most developed countries, which have relatively high scores for all 11 indicators, though the country's performance is generally below that of leading European countries and the most connected countries in East Asia. Mexico's spider diagram is typical of many middle-income developing countries, with noticeably lower scores than developed countries for fixed-telephone and fixed-broadband penetration, and for tertiary

Table 3.15: Most dynamic countries by IDI ranking and IDI value, Americas region, 2016–2017

Change in IDI ranking				Change in IDI value (absolute)			
IDI rank 2017	Rank region	Country	IDI rank change	IDI rank 2017	Rank region	Country	IDI value change
42	5	Uruguay	6	112	26	Bolivia	0.47
88	19	Suriname	6	130	33	Nicaragua	0.42
73	12	Grenada	4	42	5	Uruguay	0.41
97	22	Ecuador	4	73	12	Grenada	0.40
34	3	Barbados	3	88	19	Suriname	0.38
56	7	Chile	3				
68	11	Trinidad & Tobago	3				
87	18	Mexico	3				
112	26	Bolivia	3				

Source: ITU.

Chart 3.14: IDI values, selected countries, Americas region, IDI 2017 and IDI 2016



Source: ITU.

enrolment. Haiti shows the typical characteristics of LDCs within the LCC quartile, scoring most strongly on the indicators for mobile-cellular penetration and international Internet bandwidth per Internet user, but very weakly on indicators for fixed connections, Internet use and skills.

There is some variation in the changes in performance of the three dynamic countries illustrated in the lower row of this chart. The shape of the diagrams for the Bolivia and Nicaragua is broadly similar, with relatively high performance in mobile-cellular subscriptions, international Internet bandwidth and secondary enrolment. Both countries saw substantial growth in their use sub-index values, by 41 per cent in the case

of Bolivia and 73 per cent in that of Nicaragua. In both cases, as in many other dynamic countries, this was led by substantial growth in the number of mobile-broadband subscriptions per 100 citizens during the year. In Bolivia, operators are migrating customers from 2G to 3G networks, following an increase in investment and remarkable progress in the coverage of 3G and LTE networks, which now reach 74 and 61 per cent of the population respectively. In Nicaragua, the commercial launch of a third mobile operator in 2016 has boosted competition and contributed to the expansion of mobile-broadband coverage. Indeed, the licence granted to the new entrant included coverage obligations concerning remote areas in the country. In parallel, the two other MNOs launched

LTE services in 2015 and are in the process of rolling out LTE networks. As a result of the coverage and competition developments, mobile-broadband uptake increased from 7 to 26 mobile-broadband subscriptions per 100 inhabitants in Nicaragua in 2016.

Mobile-broadband developments in Bolivia and Nicaragua have driven growth in the proportion of Internet users. In addition, Bolivia also improved significantly in households with a computer, and Nicaragua improved on mobile-cellular subscriptions.

### 3.3 Summary and conclusion

The IDI illustrates continued and persistent differences in ICT experience between different world regions. As discussed in Chapter 2, there is a strong correlation between economic development and IDI performance. The Europe region, which is economically more homogeneous than other regions, and largely composed of developed countries, has a much higher average IDI performance than the Asia and the Pacific, Arab States and Americas regions, which are more economically heterogeneous, including low- as well as high-income countries. The Africa region, which is also economically more homogeneous but composed largely of LDCs and other lower-income countries, has a much lower average performance than these other regions. From this low base, however, Africa also showed the highest proportional rate of improvement for the IDI as a whole and for all three sub-indices.

Each economy within the IDI faces different challenges, related to its geography, infrastructure requirements and social and economic structure, as well as the resources available to it. Policy interventions aimed at improving the ICT environment need to be tailored to those particular characteristics. Although there is a strong correlation between economic and IDI performance, as Chart 2.5 illustrates, the ICT sectors in some countries have been able to outperform expectations derived from their level of economic development.

This chapter has also identified countries which have achieved dynamic improvements in IDI values during the year between IDI 2016 and IDI 2017.

The mobile-broadband market is driving most of these developments, which are in many cases triggered by regulatory and policy interventions. Indeed, the transition from 2G to 3G mobile services in some countries, as well as the transition from 3G to LTE or LTE-Advanced services in some other countries, is providing a window of opportunity for policy-makers to shake up the mobile market. For instance, the granting of licences to new operators and the redistribution of the 3G and LTE spectrum have had a disruptive effect in several countries highlighted as dynamic in this chapter and have led to more competition and higher mobile-broadband uptake. Moreover, coverage obligations attached to the new licences have proved to be an efficient way to extend 3G and LTE network coverage to rural areas, particularly in those countries where market forces by themselves had not previously reached universal mobile-broadband coverage.

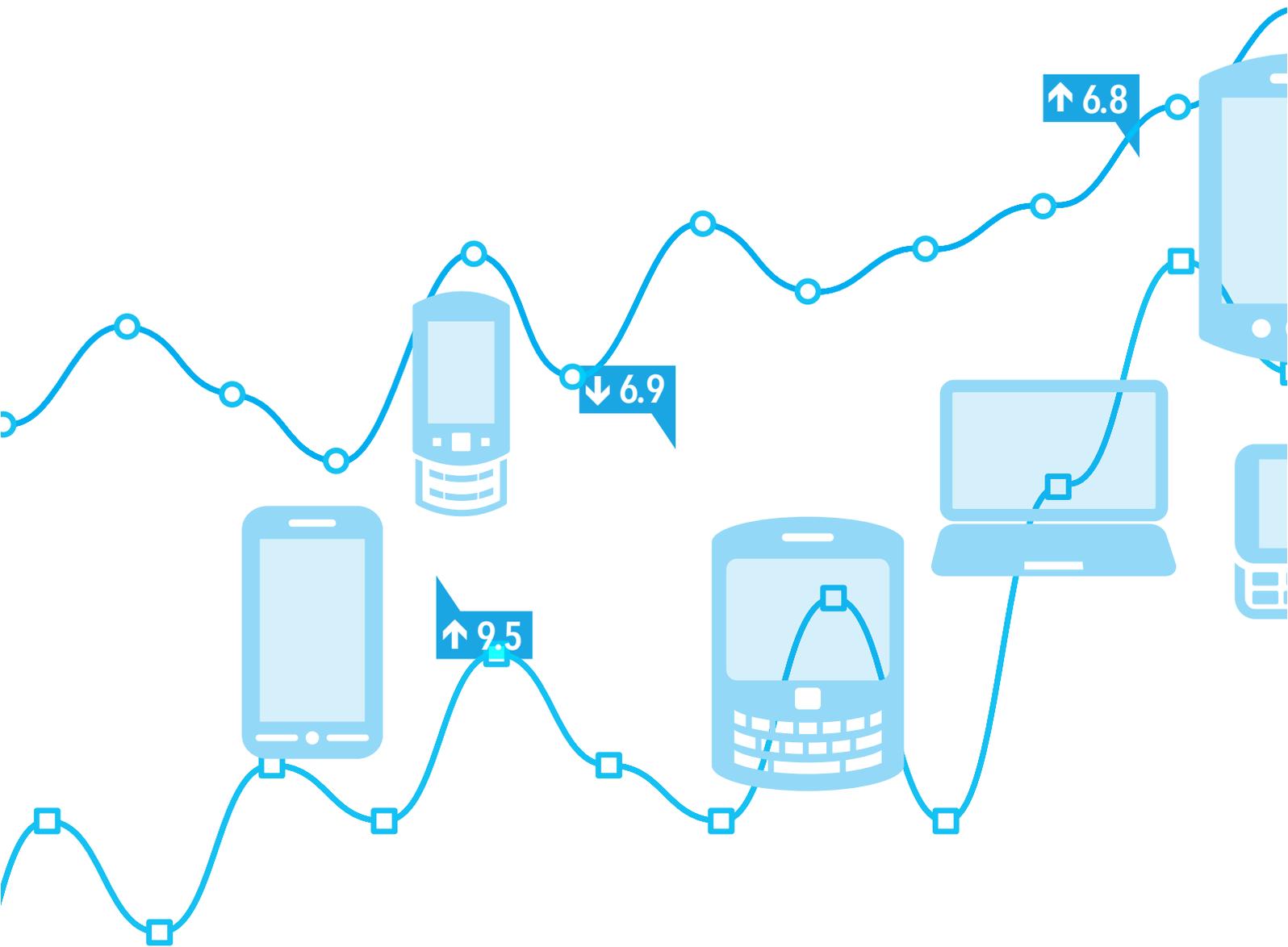
Operators have also played an important role in driving the impetus underpinning the developments seen in the mobile-broadband market. Some examples of successful operator-led initiatives observed in the dynamic countries include the aggressive promotions launched by some new entrants, most of them centred on data plans, and the large migration of customers from 2G to 3G services undertaken by some incumbents. Furthermore, high growth in mobile-broadband subscriptions in some countries with moderate penetration rates has acted as a stimulus for operator investment in the sector, thus creating a virtuous circle and driving further mobile-broadband subscription growth.

The successful experiences of the countries that have achieved higher rates of ICT development can help policy-makers and businesses elsewhere as they pursue better ICT performance which can, in turn, contribute towards sustainable economic and social development within their countries.

## Endnotes

- <sup>1</sup> The countries included in each regional grouping of the ITU Telecommunication Development Bureau (BDT) are listed at <http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx>. Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (Rev. Busan, 2014) of the ITU Plenipotentiary Conference.
- <sup>2</sup> For an example of how the entry of new players may affect mobile uptake, see the case of Costa Rica discussed in Box 2.5 of Measuring the Information Society Report 2013 (ITU, 2013).
- <sup>3</sup> In Bahrain, fixed-broadband subscriptions decreased from 22.5 to 16.8 per 100 inhabitants in the period 2013–2016. This equates to a compound annual growth rate of minus 9.3 per cent.
- <sup>4</sup> Georgia exited CIS on 18 August 2009 but is included in the ITU BDT administrative region for the CIS countries.





## Chapter 4. Emerging ICT trends

# Key findings

**Concurrent advances in the Internet of Things (IoT), big data analytics, cloud computing and artificial intelligence (AI) will enable tremendous innovations and fundamentally transform business, government, and society.** This revolution will unfold over the coming decades with opportunities, challenges, and implications that are not yet fully known. To harness these benefits, countries will need to create conditions supportive to the deployment of next-generation network and service infrastructures. They will also have to adopt policies that are conducive to experimentation and innovation, while mitigating potential risks to information security, privacy, and employment. Equally important, internationally comparable indicators are needed to track the growth and impact of these emerging ICT trends.

**The Internet of Things will greatly expand the digital footprint.** In addition to people, organizations and information resources, it will connect objects equipped with digital information sensing, processing, and communication capabilities. This ubiquitous infrastructure will generate abundant data that can be used to achieve efficiency gains in the production and distribution of goods and services, and improve human life in innovative ways.

**Big data analytics will extract useful knowledge from digital information flows.** It will enable us to better describe, understand and predict developments and to improve management and policy decisions. Making sense of proliferating information requires a workforce with appropriate analytical, computational and methodological skills, as well as a high-capacity ICT infrastructure.

**Cloud and other architectures will lower the entry barriers to scalable computing resources.** They are starting to deliver flexible and on-demand computational services over the Internet, lowering the fixed costs of ICT infrastructure, to the benefit of small and medium-sized organizations. Realizing their full potential will depend on the availability of reliable fixed and mobile broadband connectivity.

**Artificial intelligence will help human beings to make better decisions.** In order to achieve this objective, every algorithm needs to be tailored carefully to existing data and the objectives pursued. This requires considerable human expertise in machine learning and large datasets to train algorithms.

**Advanced ICTs, such as IoT, big data analytics, cloud computing and AI, contribute to realizing the Sustainable Development Goals (SDGs).** Promising applications exist in areas such as manufacturing, precision agriculture, government, education, health care, smart cities, and smart transportation. As part of broader initiatives, ICTs can contribute to achieving each of the 17 SDGs.

**Harnessing the benefits of advanced ICTs requires appropriate infrastructures, services, and skills.** Networks will have to support diverse quality-of-service demands from applications and users while delivering robust and ubiquitous connectivity. This will require roll-out of wireless IoT platforms, reliance on network virtualization and improved fibre connectivity. Moreover, it will require the development of advanced ICT skills among users.

**Advanced ICTs raise concerns over next-generation digital divides.** Network operators and users will have to adapt their business models to take advantage of the opportunities of the digital transformation. Policy-makers and regulators are called upon to create conditions facilitating entrepreneurial experiments and innovation. Policy will also have to mitigate challenges in the areas of information security, privacy, employment and income inequality.

**Advanced ICTs can be adapted to specific local and national needs.** Low entry barriers to many parts of the digital economy empower local entrepreneurs to develop innovative business models adapted to local conditions. It will be important to facilitate the development of culturally sensitive human-centred algorithms and applications.

**Reliable and meaningful measurements of the deployment and use of advanced ICTs are critical.** Fully harnessing the potential benefits of advanced ICTs requires reliable and meaningful metrics that go beyond existing data. This will require collaboration among various stakeholders and novel approaches to harvesting information from digital infrastructures and applications directly.

# Chapter 4. Emerging ICT trends

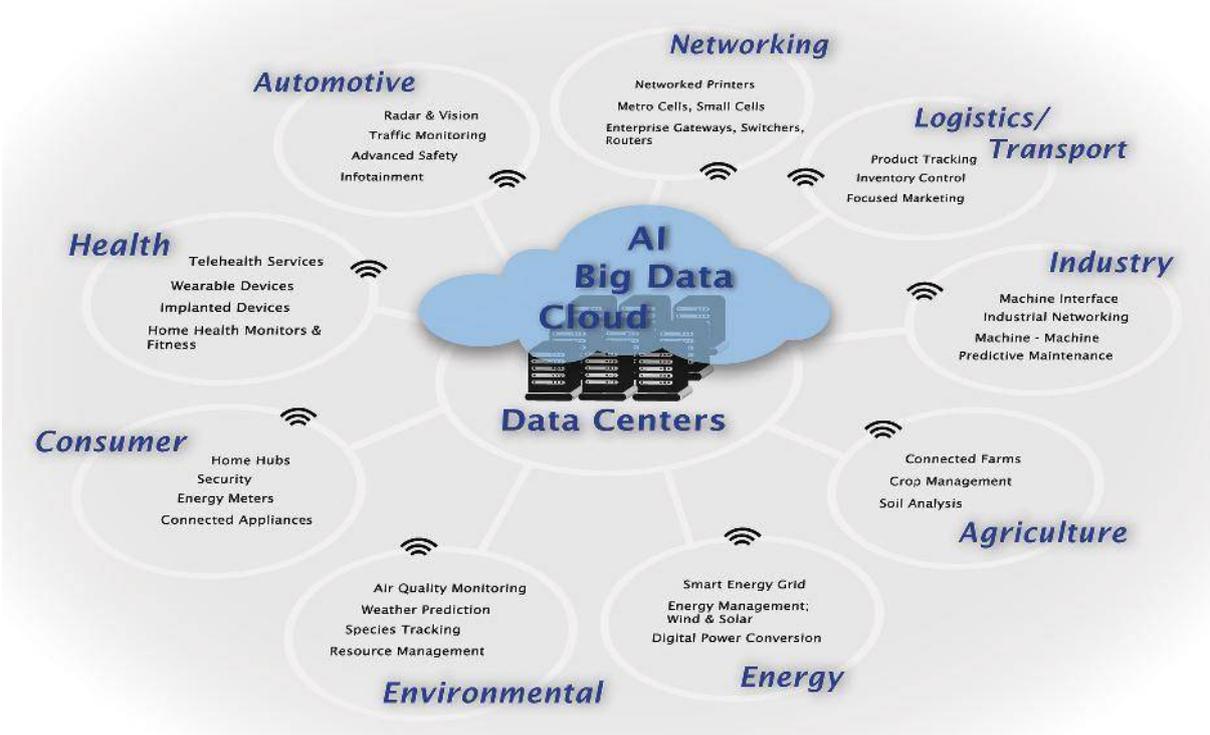
## 4.1 Introduction

The world is at the cusp of another digital revolution that will accelerate changes to business, government and society. This transformation will unfold over the coming decades with opportunities, challenges and implications that are not yet fully known. Four key developments — the Internet of Things (IoT), cloud computing, big data analytics and artificial intelligence — together with advances in information and communication technologies (ICTs), are at the heart of these developments. As illustrated in Figure 4.1, when these technologies are appropriately deployed and used, they enable a plethora of fundamental innovations that serve as the basis for new products and services, with tremendous benefits for individuals and society. At the same time, they will deeply alter the process and organization of production and distribution of goods and services. Often referred to as the “Second Machine Age” (Brynjolfsson and McAfee, 2014) or the “Fourth Industrial Revolution” (Schwab, 2016), ICTs

not only enhance technological capabilities, they also change the way humans, technology, businesses and society interact.<sup>1</sup> If their potential is realized, they will allow productivity increases that go beyond the contributions of ICTs during the past decades (Cardona et al., 2013; Corrado and Van Ark, 2016; Gordon, 2016). Because the four developments are closely intertwined and complement each other, their benefits can be more fully harnessed if they are used jointly.

As part of broader policy initiatives, these technologies will be instrumental in advancing the Sustainable Development Goals (SDGs) adopted in September 2015 by the United Nations as part of the 2030 Agenda for Sustainable Development (Earth Institute and Ericsson, 2016; Hilbert, 2016; Hilbert et al., 2016; United Nations, 2015). Taking advantage of these tremendous opportunities requires not only access to infrastructure, devices and software, it is also contingent on the availability of complementary skills and institutional arrangements (World Bank, 2016).

Figure 4.1: IoT, cloud computing, big data and artificial intelligence – the new drivers of the ICT ecosystem



Source: ITU.

At the same time, the all-encompassing nature and ubiquitous use of advanced ICTs create new concerns for individuals and society, ranging from threats to information security and violations of privacy to surveillance and control by private and public organizations. Consequently, stakeholders worldwide are re-evaluating their approaches to information and communication policy, and integrating them in new ways with broader initiatives toward the digital economy (ITU, 2016c).

This chapter begins with a brief overview of the four technological developments, their economic and societal repercussions, and their potential contribution to advancing the SDGs. It proceeds with a more detailed exposition of the main drivers of IoT, cloud computing, big data analytics and artificial intelligence. The third section reviews the state of adoption of these technologies, their use, and major ongoing developments on a global scale and in Telecommunication Development Bureau (BDT) regions. The fourth section focuses on the policy challenges, and sketches policy lessons that can be drawn from the experience with advanced ICTs and best practices. The fifth section discusses a framework for collection and curation of metrics documenting the current changes, with the goal of providing a better evidentiary basis for decision-makers. The chapter concludes with a summary of the main points.

#### 4.1.1 An overview of key technological trends

Four interrelated technological developments are further transforming the information society: the emergence of IoT, cloud computing, big data analytics and artificial intelligence (ITU, 2014, 2015; OECD, 2016). Research on and early development of these technologies dates back decades but they have now reached a level of maturity that allows their wide deployment and use (ITU, 2005; McAfee and Brynjolfsson, 2017). IoT will expand digital connectivity beyond people, organizations and information resources to objects equipped with digital information sensing, processing and communication capabilities. Connected objects could include household appliances (e.g. refrigerators, washing machines and thermostats), wearable devices (e.g. fitness monitors and health monitoring devices), machines (e.g. jet engines, cars and automated production plants) and devices to monitor the environment (e.g. agricultural, traffic, environmental and weather

monitoring sensors). These devices will generate large quantities of data that can be utilized in new ways to effectuate efficiency gains in the production and distribution of goods and services, and spawn innovative new services.

A second key technological development, closely related to IoT, is the emergence of and stronger reliance on new distributed computing architectures, cloud computing being the fastest growing among these. Cloud computing delivers on-demand computing resources — including applications, platforms and infrastructure — flexibly and on a pay-for-use base over the Internet. Other concepts, such as fog and mist computing, are under discussion and may contribute to a further restructuring of the locus of computing. In combination with smart devices, computing resources are increasingly available and ubiquitously diffused, complementing the opportunities provided by IoT and big data analytics.

Data are often seen as one of the most valuable resources of the twenty-first century. Communications and information flows in digital networks leave detailed traces that can be analysed to better understand users, better manage the communications infrastructure and resources, and improve service quality. The deployment of sensors in the natural and human-made environment, and in machines and objects, creates additional detailed data that can be harvested and analysed. Human and machine-generated data are often unstructured, voluminous and dynamic. They do not speak on their own but need appropriate theoretical and methodological approaches to unlock the insights embedded in the data streams. Thus, big data analytics are a necessary complement to and precondition for IoT.

The proliferation and wide adoption of digital technology, and the emergence of the open Internet as a general connectivity platform, have greatly benefited content production and accelerated the amounts of information generated. In part, this is an artefact of different types of information representation — such as audio, video and images with much higher quality — but much is new information generated by individuals and organizations. The massive amounts of information available often exceed the capacity of traditional models and software

packages to make sense of the ongoing processes and to make good decisions. Artificial intelligence and machine learning offer a solution to this dilemma of information overload by creating valuable insights from the torrents of data generated by people and objects. Advanced machine learning develops algorithms that enable computers to “learn without being explicitly programmed” (Samuel, 1959). This allows the design of machines that can replicate and often exceed the capabilities of humans. Such devices may act as intelligent agents that perceive their environment, learn from it to make decisions and take actions to maximize the likelihood of achieving desired outcomes (Marsland, 2015; McAfee and Brynjolfsson, 2017).<sup>2</sup>

#### 4.1.2 The new ICT ecosystem

These technological developments are an integral part of a broader reorganization of the ICT ecosystem that has unfolded since the 1970s. Technology, business models, uses of ICTs, and public policy develop interdependently. Whether the benefits of ICTs, in general and regarding the SDGs, can be harvested fully depends on how well these drivers are aligned to evolve in a virtuous, mutually enforcing cycle. The heart of the digital revolution continues to be major technological advances in components, networking, devices and software. Exponential growth in the performance of semiconductors (as reflected, for example, in Moore’s Law<sup>3</sup>) and similar performance increases in networking (as reflected in Cooper’s Law of Spectral Efficiency<sup>4</sup>) have resulted in greatly decreased costs per unit of information processing and transportation.

The dramatic performance improvements expand the capabilities of ICTs and are reshaping value generation in the digital economy. They put new demands on providers of telecommunication services and content providers. Originally deployed on the Internet, Internet Protocol networking principles have been adopted for next-generation networks (NGNs). Wireless and wireline, fixed and mobile communications are increasingly integrated in a seamless, converged communication infrastructure. In contrast to the specialized networks of the past (e.g. voice, data, audio and video), the Internet and NGNs are designed as general-purpose technology, suited to support a wide range of services and applications (Bresnahan

and Trajtenberg, 1995). Much of the intelligence on the Internet is located on the logical edges of the network rather than in its core. This unique network architecture, epitomized in the end-to-end principle and the modular design, greatly facilitates innovation within the modules and on the edges of the network (Greenstein, 2015; Van Schewick, 2010; Yoo, 2012). In the emerging ICT ecosystem, this arrangement may change again in a process of integration and differentiation, in which the locations of resources and functions are distributed in new ways, dependent on costs, functions, services and user needs.

Exponential performance increases have greatly expanded the diversity of networked devices, ranging from simple handsets to tablets, wearable devices and many types of sensors and actuators. Rapid cost decreases have allowed the development and production of affordable end-user devices. Consequently, smart handsets are increasingly available in low- and middle-income countries and for groups of the population with tighter budget constraints. The widespread adoption of more capable devices and networks has enabled new services and applications. Lower costs and a broader range of applications and services have stimulated increasing uses. In turn, higher user demand and efficiency gains support new business models based on innovative pricing and revenue models, which have further expanded the number of subscribers of mobile and fixed communication services. This virtuous cycle was further accelerated by the abundance of computing infrastructure that was brought online as part of the rapid dot.com growth during the 1990s, thus paving the way for cloud computing. It also made available ample, cheap online storage resources for online content and applications.<sup>5</sup>

A third factor transforming the ICT ecosystem, related to and enabled by the other two, is the proliferation and rapid growth of content and applications on the Internet. Much of that content is user-generated, but much is also commercially produced. Global social media platforms such as Facebook, Twitter, Instagram, WhatsApp, Tencent’s WeChat, as well as services with a more limited footprint, have built online platforms that allow users to share stories, images and videos. Each platform hosts massive amounts of commercial and user-uploaded videos.<sup>6</sup> Traditional media players, including television and radio stations, regularly stream their signals online in addition to

making them available over the air or via satellite. New digital media players – such as Netflix, iTunes, Spotify, Deezer and numerous others – produce content specifically for online streaming, taking advantage of the flexibility of digital technology to design innovative business models. A new wave of entrepreneurs is experimenting with “communitainment”, new forms of streamed media production, further expanding the amount and diversity of online content. As many of these services include a free tier and possibly zero-rated access, digital content is in high demand. Consequently, the traffic load of digital networks is increasingly dominated by video and real-time entertainment, although there are wide differences across regions.<sup>7</sup>

#### 4.1.3 Implications for the ICT industry and public policy

These changes have accelerated the transformation of value generation in the digital economy. Much of the value is related to content and applications and is thus generated at the higher layers of the ICT ecosystem. Network infrastructure and connectivity are necessary to realize the benefits of these services, but many market segments have become increasingly commoditized. This has generated considerable challenges for all players to find sustainable business models. Network operators, both traditional telecommunication network providers and new players offering Internet access services, face high costs of network expansion and upgrades to NGNs. Funding models for the infrastructure investments and upgrades needed for IoT are in the early stages of development and many uncertainties remain. While there are examples of players who have created successful applications with relatively limited resources, and digital technology has significantly reduced entry barriers for entrepreneurs, others face high initial and operating costs. Sustainable business models typically require combinations of multiple direct and indirect revenue streams.

Advanced ICTs need data communication support that is more heterogeneous than earlier communication flows. Until recently, specialized communications were provided in separate networks. With the migration to all-Internet Protocol networks, heterogeneous traffic will have to be supported by a network infrastructure that

allows better quality-of-service differentiation than the traditional best-effort Internet. Some IoT services, such as smart metering and other smart city applications, require relatively little bandwidth and are not sensitive to delay and jitter, and can thus be delivered via best-effort networks. Others, such as time-critical health applications, microgrids and videoconferencing, will require deterministic service quality. This creates considerable new challenges for network operators. While IPv4 and IPv6 both provide frameworks for better quality of service management, these tools have not been widely implemented on the public Internet. Yet other forms of emerging applications, such as connected vehicles and other verticals, will require highly secure communications. Most likely, these will at least initially be provided via separate network platforms and in a decentralized local environment.

Network operators and other firms in the digital economy have three principal strategies to overcome these challenges: vertical integration into complementary layers; mergers and acquisitions to increase market power; and differentiation of services and prices. Many of these options have repercussions for competition in the digital economy and may have detrimental effects on users. All these strategies are currently playing out in the marketplace. Consequently, the digital economy, both nationally and internationally, is more highly concentrated than the industrial economy. For example, digital storage resources are more highly concentrated on a global level than earlier forms of information preservation (Hilbert, 2016, p. 152). One challenge for public policy is to safeguard competition while not impeding the innovative energy of the digital economy. Traditional regulation is not designed to address these issues well, and antitrust policy does not yet have the tools needed to assess the effects of market concentration in virtual and big data markets (Ezrachi and Stucke, 2016; Stucke and Grunes, 2016).

In addition to these supply and demand-side challenges, public policy has an important role to play in helping to create the complementary knowledge and skills required to take advantage of the potential benefits of IoT, big data and cloud computing. The most effective measures to harness the potential benefits of these technologies will depend on the technological and institutional assets of a country, as well as

complementary human skills. Some steps in this direction will be relatively easy to achieve. For example, local and national governments can adopt open data policies; they can allow access to public infrastructures, such as street light poles, to facilitate the deployment of sensors and actuators; and they may grant rights of way along other public infrastructures. Other prerequisites will be more difficult to provide. Making the most efficient use of IoT and big data analytics requires computational resources and a workforce trained in data science techniques. In many countries and regions, there is a skills gap that may constrain the speed with which the potential benefits of the digital economy can be realized. In addition, moving beyond established routines to the new business and organizational models that can take full advantage of advanced ICTs will be challenging.

## 4.2 Description of key trends

### 4.2.1 Internet of Things

IoT constitutes a next phase of the development of the Internet. Like big data analytics and artificial intelligence, it is enabled by rapid performance increases in ICTs that have dramatically reduced the cost of information collection, processing and storage, and made possible the deployment of ubiquitous computing capabilities. No single, universally accepted definition of IoT exists, and many of the specifics are still unfolding, propelled by innovators, entrepreneurs and policy-makers.<sup>8</sup> Several terms are used in parallel, emphasizing certain aspects of the broader IoT. They include ambient intelligence (often referring to home environments), the industrial Internet or Industry 4.0 (focusing on applications in the manufacturing sectors), Agriculture 4.0 (focusing on applications in agricultural production), and various concepts of “smart” technologically enhanced environments (e.g. smart cities, smart power grids, and smart transportation) (Greengard, 2015; McKinsey and Company, 2015).

Despite this diversity of approaches, key elements are common to all scenarios. People, objects, organizations and their environment will be linked in new ways by ubiquitous digital connectivity and computing power. Environmentally aware sensors, objects and actuators will allow for managing and controlling objects and processes

to increase efficiency and optimize outcomes. This is done in a continuous feedback loop as the connected objects create information flows that can be integrated into the broader ICT ecosystem of computing and control resources. This will allow, for example, the fine-grained monitoring of air quality, traffic flows, road conditions, vital health signals, production processes, agricultural conditions and many others. Together with big data analytics, artificial intelligence, flexible forms of cloud computing and smart devices, these information streams can be utilized to reduce waste, achieve efficiency gains, develop monitoring and early warning systems, and design new and innovative services. A range of forecasts exists but all anticipate the deployment of billions of connected objects by 2020.<sup>9</sup> It is possible that, eventually, trillions of sensors and objects will be integrated into IoT (Diamandis and Kotler, 2012). McKinsey Global Institute estimates that IoT may contribute between USD 3.9 trillion and USD 11.1 trillion (in constant 2015 terms) to global gross domestic product (GDP) by 2025 (McKinsey and Company, 2015, pp. 1–14). This would correspond to about 4.5 to 11 per cent of the forecast global GDP.

Four main components make up IoT and allow for connecting physical objects and people in novel ways: a sensing layer; a network layer; a services layer; and an interface layer (Li et al., 2015). Since the late 1990s, when the notion of an IoT was first articulated, these components evolved in several stages. In this dynamic process, the sensing capabilities of things developed faster than the services built around these devices. The first stage was the development of RFID (radio frequency identification device) technology. These passive devices are widely used in manufacturing and retail logistics, greatly enhancing the trackability of parts and merchandise. The capabilities of RFID technology were enhanced by wireless sensor networks, the emergence of low-energy communications and cloud computing. Mobile computing and cooperation among connected objects further enhanced the capabilities. The current developments of advanced sensors, faster wireless connectivity and predictive analytic capability mark the next stages of IoT (*ibid.*, p. 244).

It is critical for the further development of IoT that these functions are designed and integrated in ways that enable them to adapt and evolve in

#### Box 4.1: Examples of IoT devices and apps

**Home, convenience:** Smart door locks, smart bike locks, smart appliances, smart grocery ordering, smart trash bins, smart silverware, smart pots and pans, smart faucets, digital assistants, integrated apps for smart homes.

**Health:** Fitness tracking devices, wearable health monitoring devices, wearable healthcare devices (e.g. insulin pumps), internal healthcare devices (e.g. embedded sensors), stationary devices (e.g. home monitoring devices and foetal monitors), disease outbreak warnings and monitoring.

**Energy management:** Smart outlets; home energy monitors; smart vents; heating, ventilation and air conditioning control devices and systems; smart lighting.

**Precision agriculture:** Remote monitoring of soil conditions, crops, livestock feed levels; precision agriculture analysis software and apps; irrigation optimization systems; crop disease detection.

**Environment:** Air quality monitoring, weather monitoring, severe weather alerts, water quality monitoring, foliage monitoring, forest fire prevention, earthquake warnings, tsunami warning systems, landslide warnings, noise monitoring and mapping, electromagnetic field measurement.

**Transportation:** Traffic congestion monitoring, transportation planning, smart streets, parking space management.

**Security and emergency:** Hazardous materials monitoring, radiation, perimeter access control.

Sources: <https://www.postscapes.com>; author's research.

response to technologies and needs. In each of the four layers, multiple technologies and protocols are available. For example, fixed and wireless communications coexist in the network layer. Wireless connectivity may be achieved in licensed and unlicensed spectrum and using different protocols (e.g. NB-IoT, LTE-M, LPWAN and ZigBee). Apart from their different regulatory treatment, these technologies have different cost and propagation characteristics and therefore allow configuring IoT solutions that are best suited for specific local contexts and conditions. Because of this diversity of possible solutions, standardization and interoperability are important prerequisites for IoT to develop its full potential. Moreover, given the large number of potential stakeholders and contributors, it will be important to develop overarching conventions for service architectures. With these elements in place, numerous potential applications in health care, personal services, early warning systems and smart infrastructures are possible, in addition to the existing applications of IoT in the production and transportation of goods and services.

Many of the devices linked to IoT are enterprise grade objects supporting the provision of more

efficient services (e.g. automated production lines and supply chain management). The diffusion of IoT and of cloud computing is also accelerated by the rapidly growing number of smart devices that are available for the consumer market. Like other advances in ICTs, these devices and the apps that help take full advantage of their capabilities are made possible by the exponential performance improvement and the concomitant cost decreases that drive the four major ICT trends. These devices can easily be configured and networked to centralized computing resources using personal, local or wide area mobile connectivity.

Box 4.1 provides selected examples of devices, services and apps in IoT. They range from a variety of objects in connected homes (e.g. appliances such as refrigerators, washers, dryers; kitchen and cooking tools; and applications that manage home security) to devices supporting better energy management, heating and cooling, health monitoring devices and lifestyle devices. All these devices are useful, but networking them and using them to collect data that can be mined and analysed allows the creation of additional value. Consumers can make better decisions by having more accurate and detailed information

#### Box 4.2: Focus areas of big data application development

- IoT
- Professional, scientific and technical services (non-computer related)
- Telecommunications
- Manufacturing (non-computer related)
- Finance and insurance
- Arts, entertainment and recreation
- Medical and health care
- Retail/wholesale
- Education/academic
- Government (non-military)
- Transportation (other than automotive)
- Utilities/energy
- Automotive
- Robotics
- Construction/heavy industrial
- Military/aerospace
- Others

Source: Forbes (n.d.).

available on energy use, water use, nutritional habits and exercise. Energy consumption can be reduced by allowing remote control of devices. Moreover, peer effects may be utilized by sharing consumption patterns in buildings and neighbourhoods (Ayres et al., 2013). With the power and increasing capabilities of these devices come growing concerns about information security and privacy, especially in the health domain.

#### 4.2.2 Big data analytics

Big data, broadly speaking, refers to the ability to generate useful knowledge from the vast amounts of data available in digital communication environments, where every action and every bit of information leaves a trail.<sup>10</sup> There is no single agreed definition of “big data”, but there is wide consensus that volume, variety, velocity and veracity are key characteristics, although each of them is a moving target (Feijóo et al., 2016; ITU, 2014; Kshetri, 2014). While large volumes of data that exceed the capacity of off-the-shelf software are often invoked, useful data do not necessarily have to be voluminous and the capabilities of standard software are increasing rapidly. Variety refers to the fact that data are harvested from a range of sources that will typically include structured and unstructured information. Some of this information is created as a by-product of

the communication process. Much more is either voluntarily divulged by users or is intentionally collected via sensing and other smart devices. High velocity refers to the dynamic, fast-paced processes in which information is generated. The notion of veracity or validity was introduced to highlight that big data analytics go beyond traditional forms of statistical inference. However, more recent experience suggests that traditional statistical concepts such as sampling and inference complement big data analytics.

The proliferation of data creates an enormous opportunity to extract useful knowledge from the rich and highly granular information that is generated, even though it also raises considerable concerns about potential abuses. The uses of big data analytics span a wide spectrum, including better understanding of complex phenomena, early warning about impending developments, and predictive analytics (see Box 4.2). Early enthusiasm about the tremendous potential of big data uncritically assumed that such knowledge would emerge directly from data. However, making sense of proliferating information requires considerable analytical and methodological savvy to ensure that detected patterns are not spurious or of little value. The initial focus of big data analytics was on prediction, although this is only one of four important uses. Big data methods have important applications in descriptive, explanatory, predictive

and prescriptive models. All four of these are relevant in the context of pursuing SDGs.

Much of the early interest in big data has focused on predictive uses. To this end, it is often sufficient to establish strong correlations between predictors and outcomes. Big data have facilitated finding better predictors and creating higher-dimensional predictive models. Such knowledge can be extremely useful and greatly improve individual lives, the efficiency of business and markets, and the pursuit of broader societal goals such as environmental stewardship. This approach is contingent on the existence of stable processes driving a phenomenon. If that assumption is not met, models based on past data will increasingly fail to predict accurately.<sup>11</sup> Another risk of that approach is that big data are predicated on existing social, legal and regulatory structures. If the *status quo ante* is undesirable, predictive big data analysis will be of limited help in understanding alternative futures. To that end, explanatory models that can also be used to simulate interventions and their potential effects will be necessary. Moreover, complementary qualitative and quantitative models may be necessary to create better foresight (Hilbert et al., 2016).<sup>12</sup>

While big data analytics alone are not sufficient to achieve any of the 17 SDGs, they can greatly contribute to their pursuit, especially if they are used beyond simple prediction. One important role is to help create accurate and reliable information about underlying causes and developments. Their biggest impact will perhaps be in the identification of problems, in the monitoring of effects of interventions, and in the calibration and adaptation of such measures. For example, big data analytical models will make it possible to reduce waste in the production and distribution of food. World food production currently exceeds nutritional needs, but inequities and waste in distribution continue to create significant hunger in the world. Big data can help detect, quantify and alleviate these connections. They can also contribute to more efficient energy production and distribution. As in food production, energy supply systems suffer from enormous losses. Moreover, the efficiency of energy use can be increased. In both areas, big data promise significant contributions. Pilot examples of such uses exist around the world, including projects to improve water management, waste

management, precision agriculture, education and empowerment (see section 4.2.6 for additional details).<sup>13</sup>

### 4.2.3 Cloud computing

Cloud computing is complementary to big data, IoT and artificial intelligence. Narrowly construed, it is a technical solution to deploy computing resources such as data processing, storage and analysis in a flexible way that is accessible from any device and any location. Cloud resources can be scaled according to user needs, are typically priced on the basis of actual usage, and are regularly upgraded. Neither big data nor IoT would be fully realized without cloud computing. Because cloud computing requires good levels of always-on connectivity, network infrastructure constraints may significantly impede the usability of cloud solutions. In turn, this may also limit the ability of places to take advantage of big data, IoT and artificial intelligence.

In a broader perspective, cloud computing is the latest stage in a continuous evolution of computing concepts. Since the early days of digital information processing, computing resources have been deployed in response to the available technology and its costs. How and where resources were located – centrally in the network or on the edges – is driven by cost and engineering considerations. However, such architectural choices also influence the type and range of uses that are supported. The importance of centralized mainframe computers was reduced by personal computers and both are now superseded by decentralized ubiquitous computing solutions, in which resources are flexibly allocated and tasks will be handled locally and/or centrally.

Key components of cloud computing are Infrastructure as a Service (IaaS), Platforms as a Service (PaaS) and Software as a Service (SaaS). More recently, Security as a Service and Backend as a Service have also become available in the marketplace. Because clients pay only for the services they use, cloud solutions replace capital and maintenance costs with variable expenses. If economies of scale and scope are very large, cloud solutions may allow the reduction of unit costs below those that could be achieved in an enterprise data centre. Moreover, because capacity can be scaled relatively easily in the

light of requirements, the cost of holding spare capacity can be minimized, if the resources are efficiently deployed.<sup>14</sup> Cloud services allow users to take advantage of the most recent software functionality. As major providers of IaaS, including Amazon Web Services, IBM, Google, AT&T, NTT and Fujitsu, as well as providers of PaaS and SaaS, operate on a global basis, clients can scale and extend services quickly beyond national and regional boundaries. With all these advantages, however, comes an increasing dependence on ubiquitous and always-available connectivity.

Private clouds are operated for single organizations. They can be managed internally or by third party service providers. Public cloud services are typically provided via public Internet connections, although the cloud infrastructure is located within the data centres of the major suppliers such as Amazon Web Services. The advantages of different deployment models can be combined in hybrid clouds, typically combinations of private, public, community and other cloud solutions. Emerging concepts such as fog and mist computing move computational resources closer to the edge of the system of connected devices (Bonomi et al., 2014; Stojmenovic and Wen, 2014). For example, computational power may be located at switches or routers, or it may even be embedded in devices. This allows offloading traffic from communication channels and taking care of computing tasks that can be handled locally in a decentralized fashion.

#### 4.2.4 Artificial intelligence

Artificial intelligence builds on insights that were developed by pioneers in computer science and other disciplines over the past 70 years. It has many different aspects, but at a generic level it refers to the reliance on machines to make routine decisions or to augment human capability for making difficult decisions. Many of the early challenges, such as optical character recognition and face recognition, have been solved and in many other areas, such as voice recognition, great progress has been made. These advances allow devices to better sense their environment (computer vision, audio processing), comprehend interactions with humans and other devices (natural language processing, knowledge representation), and make decisions and interact

with the physical world (machine learning, expert systems) (Purdy and Daugherty, 2016).

Nonetheless, many aspects of human intelligence, especially general tasks, remain beyond the capability of machines for the time being. Because of the lack of a general-purpose artificial intelligence, each algorithm needs to be tailored carefully to existing data and to the specific objectives pursued. This requires considerable human expertise in machine learning and large datasets to train algorithms. Advanced types of artificial intelligence are designed to support endogenous, evolutionary learning so that decisions will improve over time. Artificial intelligence has enabled great advances in robotics so that machines can take on an increasing number of routine and even non-routine tasks that only humans could do well until recently, such as harvesting, preparing food to order, and cleanup tasks. While artificial intelligence and robotics are likely to replace a range of existing jobs, in many other areas artificial intelligence will complement human labour and capital to enhance their productivity. Looking at artificial intelligence as a new factor of production, Accenture and Frontier Economics estimate that it could boost labour productivity by 2035 by up to 40 per cent in 12 high-income countries examined (*ibid.*).<sup>15</sup>

Advances in artificial intelligence are closely related to access to ubiquitous computing power and the availability of increasing amounts of data. There is a close complementarity between big data and artificial intelligence, as both rely on algorithms and machine learning to generate useful and executable knowledge. In principle, artificial intelligence can augment the power of big data and help put insights derived from big data analytical models into practice. However, the development of powerful and reliable artificial intelligence algorithms is highly dependent on the availability of sufficiently large data sets that can be used to train them (“supervised learning”). Many alternative learning models (e.g. regression analysis, logistical regression, decision trees, neural networks) are available, and their performance will vary with the type of problem. The amount of data needed to train an algorithm increases with the complexity of the problem, so that the lack of sufficient training data may be a serious barrier to reliance on artificial intelligence.

#### Box 4.3: Cases of use of artificial intelligence

- Image recognition, classification and tagging
- Improvement of algorithmic trading strategies
- Health care – patient data processing
- Predictive maintenance
- Object identification, detection, classification and tracking from geospatial images
- Text query of images
- Automated geophysical feature detection
- Content distribution on social media
- Object detection and classification – avoidance, navigation
- Cybersecurity threat prevention
- Contract analysis
- Text-based automated bots
- Sensor data analysis (IoT) and fusion
- Human emotion analysis

Source: Kaul and Wheelcock (2016), p. 8; author's research.

Applications range from the simple control of energy use (e.g. use of appliances only during off-peak periods), to systems that manage the energy consumption of office buildings, to highly complex systems governing traffic flows in smart cities that reroute traffic around congested areas or control traffic lights to optimize traffic flows. Examples include reliance on smart traffic management in Hangzhou provided by Alibaba Cloud, and traffic management systems in Los Angeles and Pittsburgh in the United States (see Kwong, 2016; and Patel, 2016). These technologies also have great potential in developing contexts, as shown by projects in Jakarta and Colombo, where mobile data have been mined in order to improve public transportation. Artificial intelligence also has numerous applications in health care, energy management and agriculture, as well as in logistics and supply chain management, with great potential to achieve considerable efficiency improvements (see Box 4.3). Moreover, big data and artificial intelligence can be deployed to significantly improve customer relations and redesign digital business models, allowing increases in customer satisfaction and consumer welfare (Rogers, 2016).

#### 4.2.5 Convergence and innovation opportunities

While IoT, cloud computing, big data analytics and artificial intelligence all have useful applications on a standalone basis, potentially much higher

benefits can be realized if they are used jointly to mutually enhance their capabilities. These four technologies form a highly complementary innovation system. As shown in Figure 4.2, these technologies, together with next-generation networks and new applications or services, comprise an emerging ICT ecosystem. IoT can unfold its true potential when combined with data analytical capability. Given the rapidly increasing amounts of information, their velocity and complexity, artificial intelligence can greatly help to make sense of the information and create semi-autonomous and autonomous cyber-physical systems (such as autonomous vehicles, smart homes, smart grids and smart transportation).

Sensors, actuators and networks form the physical backbone of IoT in a narrow sense. Cloud and other new computing architectures provide a complementary layer of data processing and storage capabilities that enables ubiquitously available services. Big data analysis helps to make descriptive, explanatory, predictive and prescriptive sense of the detailed data. Artificial intelligence enhances all these capabilities (e.g. computer vision allows new forms of sensing) but also, most importantly, adds another layer of analytical power. Most of the value in this new technology stack is in the applications and services that can be created by using IoT, cloud computing, big data analytics and artificial intelligence (Hunke et al., 2017) in a wide range of verticals (e.g. energy, transportation and health care) and across sectors.

Figure 4.2: Complementary innovation in advanced ICTs



Source: ITU.

#### 4.2.6 Advanced ICTs and SDGs

ICTs are important instruments in efforts to achieve the 17 SDGs. Table 4.1 provides selected examples as to how ICTs in general, and IoT, big data analytics and artificial intelligence in particular, may be used to advance SDGs. Cloud computing, as a critical component of ubiquitous computing resources, will also be an important contributor.

There are an increasing number of proofs of concept, pilot projects and limited-scale examples that illustrate the potential contribution of ICTs. For example, several mobile money projects, such as m-Pesa (Kenya), EcoCash (Zimbabwe), Modelo Perú (Peru), and EasyPaisa (Pakistan) have shown the positive effects of mobile money (contributing directly to SDGs 1, 5, 8 and 9). Technologies such as Blockchain hold great promise to increase security of and trust in transactions, to reduce transaction costs, and to mitigate corruption (contributing to SDGs 1, 10 and 16).

Cities such as Colombo and Jakarta have successfully utilized data from mobile network operators to better understand commuter flows and improve urban transportation systems in response. Others, such as Sao Paulo, Brazil, have made municipal data openly available to

developers. These and other initiatives contribute to SDGs 9 and 11. Mobile phone data have also been used to develop better responses to the 2010 cholera outbreak in Haiti, the Ebola crisis in Africa, and in disaster responses after earthquakes (contributing to SDG 3).

Many of the benefits of such initiatives can be reaped at the decentralized, local level. However, in other cases, such as creating national databases with medical information that can be accessed by remote healthcare workers, scaling up initial experiments will be critical. To be most effective, advances in ICTs are necessary but not sufficient to accomplish the SDGs. In other words, they will need to be used in conjunction with other policy initiatives and measures.

### 4.3 Global and regional developments

The extent to which a community or a nation can fully realize the benefits of the new ICT ecosystem is dependent on four complementary factors: (a) the availability of appropriate physical infrastructures, including networks, data processing and storage facilities, and devices; (b) basic services such as connectivity, computational services and information transportation channels; (c) user-side knowledge and skills; and (d) a

**Table 4.1: Utilizing advanced ICTs to pursue SDGs**

SDG	Ways in which advanced ICTs contribute to achieving SDG
Goal 1: End poverty in all its forms everywhere	ICTs help businesses to become part of the formal market economy; provision of better price information helps increase revenues and profits; mobile banking provides access to loans and microcredit; mobile payment systems reduce transaction costs; computer modelling and simulation can help develop better policies
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Smart agriculture solutions to monitor soil and weather conditions allow increasing crop yield; better coordination of food supply chains reduce waste; better crop management can restore soil conditions and create more sustainable agriculture
Goal 3: Ensure healthy lives and promote well-being for all at all ages	IoT allows innovative forms of low-cost health monitoring and diagnostics; ICTs can connect remote health workers with specialized diagnostic services; big data analytics allow forecasting of disease outbreaks
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	ICTs allow access to online educational resources and learning communities; big data analytics help identify learning challenges and create more effective instruction, and allow continuing education and specialized training
Goal 5: Achieve gender equality and empower all women and girls	ICTs can provide women access to empowering information and education, and access to microcredit and secure payment systems
Goal 6: Ensure availability and sustainable management of water and sanitation for all	Smart water management reduces losses; water quality monitoring enhances water safety; smart waste management reduces risks of contamination
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all	Smart metering and smart appliances allow better energy use management; microgrids and smart grids allow for building more sustainable energy supply while lowering the carbon footprint; green buildings reduce energy consumption
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	IoT and artificial intelligence have significant potential to increase productivity and economic growth while reducing the resource intensity and carbon footprint of production; additive manufacturing provides new opportunities for smaller scale, custom manufacturing
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	ICT, IoT, big data and artificial intelligence contribute to smarter infrastructures; preventative maintenance and continuous monitoring increase resilience; the plasticity of advanced ICTs allows accelerated learning, rapid prototyping and continuous innovation
Goal 10: Reduce inequality within and among countries	Advanced ICTs will allow further decentralized and localized production with the potential to reduce income inequality among countries; by improving education, they can contribute to reducing interpersonal inequality within countries
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable	IoT applications allow creating smart and energy-efficient cities; big data analytics and artificial intelligence can help in creating better urban transport systems, safer neighbourhoods and more accountable city government
Goal 12: Ensure sustainable consumption and production patterns	ICTs in combination with IoT and big data analytics can improve coordination between consumers and producers; additive manufacturing and just-in-time production will increase efficiency and sustainability
Goal 13: Take urgent action to combat climate change and its impacts	Big data analytics and artificial intelligence can help reduce the carbon footprint of production and consumption; information sharing and learning communities can develop and replicate better practices
Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	New sensing and monitoring technologies can help track oceanic resources; big data and artificial intelligence will facilitate better resource management practices and will allow early warning systems
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Monitoring of the use of land resources, deforestation, and soil conditions can contribute to the preservation of resources
Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Big data analytics combined with open data policies can empower citizens; monitors and big data analytics may help in increasing government transparency; direct trade relations may increase global tolerance and understanding
Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development	ICTs enable the formation of new communities of engaged citizens; big data analytics and artificial intelligence will allow advanced modelling of developments that can be shared rapidly and widely

Source: ITU.

policy environment conducive to the types of experiments needed to develop sustainable and scalable solutions. The absence of any one of these complementary factors will impede efforts to harness the potential benefits of the digital transformation, although it will not necessarily completely jeopardize them. As is well documented in detailed research and policy studies on digital divides, all four prerequisites are unevenly available across countries, regions and socio-demographic groups (Bagchi, 2005; Baller et al., 2016; ITU, 2016b; Pick and Azari, 2008; Van Deursen et al., 2017; Van Dijk, 2005). The well-known policy challenges of overcoming first (access) and second (skills) digital divides are compounded in the digital economy by the need to have access to even more advanced technology and user skills. Thus, while they offer considerable new opportunities for inclusion and empowerment, the four trends create new forms of digital exclusion that require additional policy initiatives to mitigate.

Many of the benefits of these four key technologies materialize in a broadly diffused way that may be difficult to measure empirically. Because they are general-purpose technologies and other factors are in play, it is challenging to isolate the specific contributions of big data or artificial intelligence to improved efficiency. For example, their application helps reduce inefficiencies and losses across all stages of the production and distribution process in verticals such as food production. Customization of products and services as well as location-based services may greatly enhance consumer surplus but are not always fully captured in measures of economic activity such as GDP (Moulton, 2000). Until reliable data on the effects of these technologies on outcomes are available, one is often forced to consider inputs such as spending for big data as proxies for national, regional and global adoption. Even with this caveat, empirical

data documenting the four key developments are incomplete and suffer from numerous gaps and inconsistencies. The following sections will discuss developments at the global and regional levels, with a separate look at the situation in the least developed countries (LDCs).

### 4.3.1 Global overview

Because IoT, cloud computing, big data and artificial intelligence are complementary and to some degree overlapping technologies, some authors refer to IoT as the overarching concept, while others refer instead to artificial intelligence. Depending on how they are delineated, this results in empirical information as to their global size and growth that varies very widely, sometimes by more than an order of magnitude. Table 4.2 summarizes estimated global revenues using numbers that are supported by multiple sources. Based on these forecasts, IoT (both services and devices) and public cloud services generate the highest revenues. While all activities are growing fast, public cloud services, and especially artificial intelligence, is forecasted to experience much higher growth.

The pervasive adoption of ICT across all aspects of the economy and society is generating an exponentially increasing amount of data. Industry forecasts anticipate that the volume of data generated globally will increase from 145 zettabytes (ZB)<sup>16</sup> in 2015 to 600 ZB by 2020 (Cisco, 2016, p. 3). Much of this information is ephemeral or local and may not be transmitted or stored for extended periods. For example, a connected factory may generate 50 petabytes (PB) of data per day but only 0.2 per cent is transmitted. A connected plane generates 40 terabytes (TB) per day (of which 0.1 per cent is transmitted) and a connected car 70 gigabytes (GB) per day (0.1 per cent transmitted). In total, a smart city with a

**Table 4.2: Estimated global market sizes for selected advanced ICTs (USD millions)**

	Estimated global revenues		
	2015	2020 <sup>a</sup>	2025 <sup>a</sup>
IoT <sup>b</sup>	193 500	267 000	640 000 <sup>c</sup>
Big data <sup>d</sup>	27 300	57 300	88 500
Public cloud <sup>e</sup>	75 300	278 200	489 800
Artificial Intelligence <sup>f</sup>	644 <sup>g</sup>	6 076	36 818

<sup>a</sup> Forecast. <sup>b</sup> Statista (2017b); Hunke et al. (2017). <sup>c</sup> Estimate based on expected compound annual growth rate. <sup>d</sup> Statista (2016, p. 22). <sup>e</sup> Statista (2017a, p. 13). <sup>f</sup> Kaul and Wheelcock (2016). <sup>g</sup> Information for 2016.

Sources: Statista (2016, 2017a, 2017b), Hunke et al. (2017), Kaul and Wheelcock (2016).

population of 1 million will generate approximately 200 PB of data per day (Cisco, 2016, p. 14). The amount of data stored in data centres is expected to grow at a compound annual growth rate of 40 per cent, from 171 exabytes (EB) in 2015 to 915 EB by 2020. By 2020, 247 EB of the data stored in data centres – about 27 per cent – will be related to big data analytics. This is a ten-fold increase from 2015, when this amount was about 25 EB. These numbers suggest that less than half of the data generated by IoT will be stored. In addition, as much as 5.3 ZB – five times the total amount stored in data centres – will be stored on devices.

This rich pool of data can be utilized to improve the efficiency of the production and distribution of goods and services, design products and services to improve welfare and well-being, and support a more open and inclusive society. Part of it can be mined, analysed and put to productive use locally. For example, information captured by smart traffic lights used to optimize traffic flows might be deleted after a short period. Selected information may be communicated to an aggregation point that collects data for a larger geographic area. Some applications, such as remote metering, monitoring of air quality, and monitoring of soil conditions, involve a massive number of devices, but require very limited bandwidth and network resources.<sup>17</sup> Others, such as vehicle-to-vehicle communications, are critical applications that require a higher quality of service and possibly higher bandwidth to support reliable real-time communications.

In the recent past, many of these applications were running over separate specialized networks on the edges of the Internet. The deployment of NGNs has supported a convergence into integrated networks that need to support differentiated communication needs. The availability of diverse, appropriately configured NGNs and services is therefore an important precondition to support decentralized storage, processing and analytics in online cloud spaces. It allows for making insights available everywhere in support of new and innovative services and applications. Network upload and download speeds, latency and other quality indicators, are all important parameters that will influence how widely the benefits of the digital economy can be realized in a given place.

Driven by steady cost decreases and policies in many countries that support private and public

investment, coverage with networks that support advanced digital transformation and adoption of generic services has increased considerably during the past decades. Nonetheless, substantial gaps remain between regions, between urban and rural access within countries, and between different access platforms. According to ITU data, by end-2016, approximately 85 per cent of the global population had access to 3G mobile phone services, and 66 per cent of the global population had coverage with long-term evolution (LTE) service. An estimated 48 per cent of the global population used the Internet in 2017 (ITU, 2017). There is great variation among regions, with Internet use ranging from 79.6 per cent of individuals in the European region, 67.7 per cent in the Commonwealth of Independent States (CIS) countries, 65.9 per cent in the Americas, 43.9 per cent in Asia and the Pacific, 43.7 per cent in the Arab States, to 21.8 per cent in Africa. In the 48 LDCs, 17.5 per cent of the population used the Internet (*ibid.*). Availability and use of fixed-broadband is much lower across all regions, which adds an additional challenge to taking advantage of the potential benefits from the new digital economy. A global survey by the Pew Research Center found that in 2015 the global median of smartphone ownership was 43 per cent. It was 68 per cent in advanced economies and 37 per cent in developing and emerging economies. While price declines have contributed to double-digit growth in many countries,<sup>18</sup> similar divides exist regarding smartphone ownership and use.

Similarly, while each region has made significant progress in improving the quality of digital networks and services, considerable differences in download and upload speeds and in quality of service (QoS) attributes prevail between regions. Speed measurements are afflicted with many potential problems and need to be used with caution (Bauer et al., 2010). Available data (e.g. from Ookla, Akamai, or M-Lab) are based on different measurement methods and often deviate from each other, although the data generally show similar patterns. Additional complications arise if data are averaged across regions.

With these caveats, in 2016 Asia could boast the highest fixed average download speeds, followed closely by North America and Europe (see Table 4.3). The highest average upload speeds were measured in Central and Eastern European countries, closely followed by Asia and the Pacific.

Table 4.3: Mean upload and download speeds by region (Mbps, 2016)

Regions <sup>a</sup>	Fixed networks		Mobile networks	
	Download	Upload	Download	Upload
Middle East and Africa	7.8	3.9	6.6	3.9
Asia and the Pacific	33.9	19.0	18.5	8.9
Central and Eastern Europe	29.1	19.3	11.0	6.8
Western Europe	30.2	11.0	18.2	7.9
North America	32.9	11.6	17.7	9.9
Latin America	9.3	3.3	8.4	4.1

<sup>a</sup> Owing to data availability regions differ from the ITU classification. Source: Cisco (2016).

North America and Western Europe were third and fourth, at a distance, with Latin America and Africa even slower. On mobile platforms, Asia and the Pacific, Western Europe and North America had the highest mean download speeds; North America, Asia and the Pacific, and Western Europe had the highest upload speeds.

Fixed and mobile network latency improved globally and in all regions. In 2016, fixed and mobile networks in the Middle East and Africa had the highest latency (see Table 4.4). Fixed networks in Asia and the Pacific and mobile networks in Western Europe exhibited the lowest latency. Differences in latency between regional fixed networks increased slightly between 2014 and 2016, but they declined for mobile networks, for which variation in latency was lower in 2016 than in 2014. Speed and latency are not the only QoS dimensions of importance. Some applications in IoT, such as some communication from autonomous vehicles, also require jitter to be within certain boundaries. Thus, provisioning the necessary quality of service will be important in harnessing some benefits of IoT.

### 4.3.2 Regional analysis

Emergent technologies require considerable experimentation to find sustainable applications and business models. Much innovation is a process of trial and error in which only a small number of initiatives will succeed. IoT, cloud computing, big data and artificial intelligence all have shown their tremendous potential but continue to be in fairly early stages of experimentation. In every region, numerous innovative projects are under way. Given differences in available infrastructure, basic services and skills, some regions and countries are further along in this process than others.

#### 4.3.2.1 Africa

The four ICT trends and related technological capabilities hold great promise for Africa. Potential applications with significant positive impacts range from precision agriculture to increased efficiency and yield, to programmes providing education on best agricultural practices, to remote provision of health and new models of education. Because digital applications can be customized to local and regional conditions, there are considerable opportunities for local entrepreneurs and start-ups to develop unique solutions. However, the

Table 4.4: Network latency by region (milliseconds, 2014–2016)

Regions <sup>a</sup>	Average fixed latency			Average mobile latency <sup>b</sup>		
	2014	2015	2016	2014	2015	2016
Middle East and Africa	87	77	62	328	156	118
Asia and the Pacific	40	35	26	182	82	65
Central and Eastern Europe	47	33	30	150	76	75
Western Europe	46	44	38	114	70	46
North America	49	42	38	100	90	85
Latin America	69	64	54	218	118	100

<sup>a</sup> Due to data availability, regions differ from the ITU classification. <sup>b</sup> Estimated. Source: Cisco (2016, p. 23).

Table 4.5: M2M subscriptions by region (millions, 2013–2016)

Regions <sup>a</sup>	M2M subscriptions			
	2013	2014	2015	2016
Middle East and Africa	8.6	10.9	14.0	17.9
Asia and the Pacific	67.5	85.4	106.3	128.5
Europe	50.4	59.4	71.9	91.8
North America	35.4	42.3	52.5	65.0
Latin America	14.5	17.1	25.0	25.2

<sup>a</sup> Due to data availability, regions differ from the ITU classification. Source: Berg Insight (2016, p. 116).

region faces numerous obstacles that need to be overcome to take full advantage of these developments. A first challenge is the state of ICT infrastructure in general. Despite major advances in mobile connectivity and Internet access, many African nations continue to lag behind other regions of the world in mobile connectivity. This gap is more pressing in the technologies that are critical for IoT, big data, artificial intelligence and cloud computing. Large-scale deployments of big data analytics, cloud computing and artificial intelligence will require fixed broadband infrastructure. The underdevelopment of fixed connectivity therefore constitutes a major challenge and obstacle to fully benefitting from advanced ICTs. Similar gaps will need to be overcome in enabling connectivity via advanced devices. In 2016, about 11.7 per cent of all smartphones, 165.5 million units, were sold in the Middle East and in Africa.<sup>19</sup> Smartphone ownership varies widely within the region. In 2015, South Africa had the highest rate of smartphone ownership, 37 per cent; Ethiopia and Uganda were among the lowest, at 4 per cent. The median of smartphone ownership across Africa was 19 per cent, compared with 37 per cent in Asia and the Pacific, 43 per cent in Latin America and 57 per cent in the Middle East (Poushter, 2016, pp. 16–18).

In 2016, there were about 17.9 million machine-to-machine (M2M) subscribers in the Middle East and in Africa (see Table 4.5).<sup>20</sup> Ericsson (2016b) estimates that between 2016 and 2022, cellular IoT devices will grow at a compound annual rate of 38 per cent, to about 80 million. Although cloud traffic will more than double, from 145 EB in 2017 to a forecast 304 EB in 2020, the Africa and Middle East region ranks last in terms of global cloud traffic generated (see Figure 4.3). The number of individuals who store data in the cloud or who use cloud-based software is also at the bottom end of

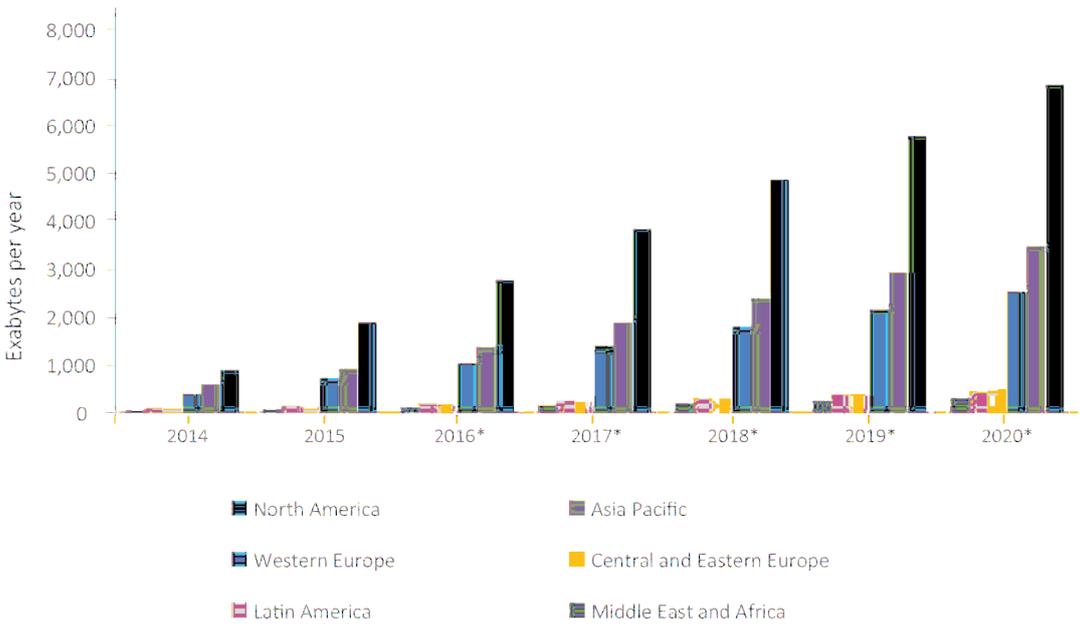
the global regions.<sup>21</sup> Market research suggests that Africa and the Middle East will capture about 4.5 per cent of the global big data market of USD 57.3 billion by 2020.<sup>22</sup>

#### 4.3.2.2 Arab States

Countries in the Arab States region have great potential to reap the benefits of the digital economy. A large percentage of young people in the age pyramid are social media- and technology-savvy. Qatar, the United Arab Emirates and Bahrain have the highest smartphone ownership rates in the world and among the highest rates of social media use. Citizens across the region have organized using social media. Several smart city initiatives – including initiatives in Dubai (United Arab Emirates) and in Bahrain – promise to demonstrate the potential of the concept in the region. Other projects, such as the participatory water management project in Tunisia using advanced ICTs to raise awareness and understanding, also demonstrate the potential contribution. Despite this potential, the region needs to overcome several challenges. A culture of digital entrepreneurship and empowerment is only slowly emerging. Businesses lag behind in terms of digitization, and government initiatives are limited. Moreover, venture capital funding is lower than in peer regions. McKinsey Global Institute estimates that only 1 per cent of the top 1,000 ICT companies globally by revenue are located in the region (Elmasry et al., 2016).

Infrastructure availability and important network quality indicators lag behind other regions. Even in the leading countries in the region, connectivity is provided at less than half the speeds available in Asia and the Pacific, North America or Europe, and the poorest performers lag significantly behind the lower performers of these regions. Average network latency in the region could also

Figure 4.3: Cloud traffic worldwide 2014–2020, by region (exabytes per year)



Notes: Regions differ from the ITU classification. \* denotes a forecast. Source: Cisco (2016).

be improved. Cloud traffic and use are low and the number of users who use cloud-based resources is only one-quarter of the comparable share in Asia and the Pacific. All this calls for concerted efforts to implement initiatives in government and business, and in the education sector, that will allow users to take better advantage of the digital opportunities.

4.3.2.3 Asia and the Pacific

Several countries and companies in the Asia and the Pacific region have grown into global leaders in the ICT sector, thus propelling the digital economy in the region. While countries vary greatly in their readiness to take advantage of the benefits of IoT, big data, cloud computing and artificial intelligence, a pattern is recurring in the leading countries. The strong performance of Asian nations is an outcome of a pragmatic series of policy reforms that have balanced private sector competition with government planning and the setting of overarching objectives. A project such as Songdo City in the Republic of Korea, a high-tech city taking full advantage of advanced ICTs, is an example of a successful, ambitious strategy. Similarly, Singapore has adopted several generations of plans to develop into a leading example of a smart city of the future. Japan, likewise, has supported its high-tech

industries for decades and invested strategically in emerging fundamental technologies such as quantum computing. Combined with a very tech-savvy population, education programmes, and a highly competitive work culture, several Asian nations score very well in national rankings of the readiness to take advantage of the digital economy (Baller et al., 2016) or related indicators such as network quality of service and uptake (OECD, 2017).<sup>23</sup>

Within Asia and the Pacific, there are considerable differences and gaps. The region encompasses both global top performers as well as countries that lag significantly behind others. Home to several of the most populous countries, the region has considerable potential. Considering average key performance metrics, it leads the world in ICT adoption, broadband speeds, mobile connectivity and network latency. The figure of 128.5 million M2M subscriptions in 2016 corresponds to an average rate of 3.8 per 100 inhabitants. The technological progress of the region is clearly shown in the position of major vendors of telecommunication equipment and their patent activity. Examining patent applications between 2000 and 2012, Ardito et al. (2017) demonstrate a strong standing of the region. In all categories studied, United States companies have registered the highest number of patents. In IoT-related

patents, China is second, followed by Japan and the Republic of Korea. Four players from Europe follow (Sweden, Finland, France and Germany).<sup>24</sup> Individual players, such as Huawei and Samsung, have taken advantage of the strong overall market dynamics and developed ambitious innovation programmes that have bolstered their global market share.

Given the rapid development of the ICT sector and of the country in general, IoT promises high incremental benefits in China (Kshetri, 2017). In this context, there are numerous applications. Given the high skill level of part of the workforce, China is in a good position to take advantage of these opportunities. This is further advanced by concerted government efforts to diffuse advanced production technologies across all sectors of the economy (OECD, 2017). Likewise, India is poised to take advantage of the enormous efficiency potential that can be unlocked with advanced ICT use. Internet access and smartphone use are growing rapidly and the cost of data communications is declining. Key sectors that will benefit from the wide application of IoT, big data, cloud computing and artificial intelligence (e.g. finance, manufacturing, agriculture, transportation and logistics) are ripe to apply these technologies. The Government has started several initiatives to accelerate adoption, including Digital India, Startup India, and training for entrepreneurship.<sup>25</sup>

#### 4.3.2.4 Commonwealth of Independent States

Regarding the state of the ICT infrastructure, the nine Member States and two associate States of CIS are positioned between the leading regions (Asia and the Pacific, North America and Europe) and the Arab States, Latin America and Africa. Use of advanced network services and smartphones is, likewise, in between the values of these regions. With an average download connection speed of 7.4 megabits per second (Mbps) (Akamai, 2017), there is a clear gap with the leading nations. At the same time, the region benefits from a large pool of highly educated engineers and computer scientists and a wage level that is below that of high-income countries. Armenia is sometimes referred to as the Silicon Valley of the region, and leading high-tech companies, including Microsoft and Cloudflare, a cloud service provider, have established offices and data centres in Yerevan.<sup>26</sup>

Among the major obstacles to benefitting from advanced ICTs are a low level of trust and limited venture capital funding. Successful digital entrepreneurs, after an initial start-up phase, often seek to migrate their businesses to the United States or Europe. Several policy initiatives, including the creation of Free Enterprise Zones with reduced or no taxes, are intended to support a culture of entrepreneurship. Given the potential of IoT solutions to contribute to institution-building, as well as to entrepreneurship and innovation, the region is well positioned to harvest considerable benefits of advanced ICTs.

#### 4.3.2.5 Europe

Several European countries are among the world leaders in Internet connectivity. The Nordic countries have historically had outstanding access infrastructures and they have been able to adapt their policy responses to support digital connectivity. Moreover, with Ericsson, the region has one of the world's leading network infrastructure technology companies. The European integration project has led to harmonization in important areas and, overall, helped boost connectivity across the region (Lemstra and Melody, 2015). Europe has dedicated several major research initiatives to technologies related to IoT, and numerous business and government activities across the region are pursuing promising innovation projects. Connectivity and participation in the digital economy across Europe continues to be heterogeneous. The composite Digital Economy and Society Index, published by the European Commission, shows much stronger performance in the North than in the South and the East of the Union.<sup>27</sup>

On average, network performance across Europe is high. Fixed network download and upload speeds are slightly below the Asia and the Pacific and North American average. Mobile upload and download speeds were also below the Asia and the Pacific region and mobile uploads were also below those of North America. Overall, however, the three regions exhibit, on average, quite comparable performance metrics. As in other regions, there is considerable variation within the region, with the highest download and upload speeds in the Nordic countries, Switzerland and, interestingly, countries such as Romania, which could leapfrog generations of networking

technology and roll out fibre networks that support high speeds. Cisco (2016) estimates that Europe will generate about 3 000 EB of cloud traffic per year in 2020, ranking third behind North America and Asia and the Pacific. With an estimated 91.8 million M2M subscriptions in 2016, the rate is about 12.4 per cent of the population. In 2015, Pew found that 60 per cent of Europeans owned smartphones. IDATE Digiworld (2016) estimates that the smart home market in Europe will grow from 53 million units in 2015 to 185 million in 2025. Overall, Europe is well positioned to take advantage of the technological opportunities. One potential weakness is the less aggressive culture of entrepreneurship. With the large number of small and medium-sized enterprises, the transition to digital business models may require additional support by government agencies and programmes.

#### 4.3.2.6 The Americas

Considerable differences exist between North America and South America, so a differentiated treatment is necessary. North America is home to leading technology companies with a strong footprint across all four areas. In 2016, eight of the ten most valuable digital technology companies in the world were American companies (Apple, Alphabet, Amazon, Facebook, Uber, YouTube, eBay and Instagram), with only two Asian companies (Alibaba and Tencent) in the group (Moazed and Johnson, 2016; Parker et al., 2016). Numerous other United States companies from the major technology centres in Silicon Valley, the Pacific North-west, the South and the East Coast are among the leaders in big data, IoT, cloud computing, robotics and artificial intelligence.

Despite this strong presence across major technology industries, there is still scope for reaping more of the potential efficiency gains of digital technologies. ICT industries, media, finance and professional services are leading, whereas manufacturing and utilities are only in the early stages of digitization (Manyika et al., 2015). Telecommunication infrastructure policy is strongly driven by market forces. Given the large land mass and low average population density of the United States, this has contributed to a stronger spatial differentiation than in most other high-income countries. Some locations enjoying much better quality of service than other countries, while other areas are worse

off.<sup>28</sup> Consequently, on average, United States performance metrics often trail the global leaders, although this perspective misses the degree of differentiation present in the United States (Bennett et al., 2013). Canada's network infrastructure and services are less differentiated but also of very high quality.

Internet usage and smartphone ownership in the United States and Canada are among the highest in the world. According to a Pew survey, 72 per cent of United States mobile users owned smartphones in 2015 (Poushter, 2016, p. 18). Network infrastructure has been upgraded continuously, with particularly rapid advances in the deployment of LTE. Upload and download speeds also are among the highest in the world. North America is expected to generate 6 844 EB per year by 2020, the highest cloud data traffic of all world regions and about twice the amount generated by the second-ranking Asia and the Pacific region. Fixed network performance ranks at par with Western Europe but below Asia and the Pacific and CIS countries (see Table 4.3). With 65 million M2M subscriptions by 2016, North America had a per-capita penetration of approximately 18.6 per cent (see Table 4.5). By 2025, the smart home market is estimated to be 254 million units.<sup>29</sup>

Given the lower average income in Latin America, many of the network and adoption metrics are weaker than in North America. With 9.3 Mbps average download speeds on fixed networks, the region ranks fifth in the world. It ranks sixth in terms of upload speeds on fixed networks (Table 4.3). Likewise, the average regional mobile network download and upload speeds are among the lowest in the world (fifth of the six regions distinguished in Table 4.3). Latency on both fixed and mobile networks also ranks fifth in the world. However, as in other regions, there are considerable differences between the best performing nations (Uruguay and Chile) and the weakest (Bolivarian Republic of Venezuela and Paraguay).<sup>30</sup> Average smartphone ownership in 2015 was 42 per cent, with considerable variation among individual countries. For example, smartphone ownership stood at 65 per cent in Chile but was lower in Peru, where only 25 per cent reported owning a smartphone (Poushter, 2016, p. 18). There were about 25.2 million M2M subscriptions, corresponding to approximately 4 subscriptions for each 100 inhabitants. By 2025,

the smart home market is estimated to be 37 million units.

### 4.3.3 A comparison of the regions

Within each region, there is great variation about how well the four prerequisites (physical infrastructure, appropriate connectivity services, complementary user skills and conducive public policies) are provided. Any comparison must be made with great caution, as there is considerable variation among the nations in each region. There are also major differences as to how far along they are in taking advantage of the next digital transformation. Asia and the Pacific, Europe and the Americas (especially North America) fare best at meeting the prerequisites overall. There are varying but generally strong traditions of transparent governance, and collaborative programmes involving multiple public-sector agencies, so that infrastructure and educational issues can be addressed. One challenge for policy-makers is to reconcile traditional regulation with the needed flexibility for network operators and entrepreneurs to experiment with new solutions. As a region, Africa is very well positioned in terms of opportunities for entrepreneurs. The limited development of a fixed broadband infrastructure will need to be overcome to take full advantage of big data analytics and other emerging services. Moreover, additional efforts will be needed to develop the necessary quality-differentiated connectivity, using the most appropriate wireless or wireline networks, for IoT and other advanced ICTs. The region also must redouble efforts to develop policy frameworks that support entrepreneurial experimentation and to adopt broader policies to develop user skills and competencies. The Arab States fare better regarding infrastructure availability and the adoption of smart devices. In that region, a major challenge will be to work on the development of more flexible policy frameworks and on complementary user skills to take advantage of the potential entrepreneurial opportunities. In many respects, the CIS region has a strong labour force that can take advantage of the new opportunities. Infrastructure availability and policy frameworks may need additional attention. Across all regions, countries and network operators face challenges to deploy the quality-differentiated service connectivity required for advanced ICT applications. Network virtualization, introduction

of quality of service guarantees by early adopters, and efforts by standardization bodies, will all be required to advance such networks and services.

### 4.3.4 Least developed countries

Although they have made progress in improving ICT infrastructures and services, and in some cases significant leaps forward, LDCs continue to lag behind other regions in terms of the key indicators that will influence their position in the emerging digital economy. Internet use on average is only 15.2 per cent of the population, the lowest in the world. Average Internet connection speeds in 2017 were 2.5 Mbps, also the lowest in the world. There are considerable differences among the countries in this group, with connection speeds ranging from below 1 Mbps (Comoros, Mali, Niger and Yemen) to average connection speeds of 7.7 Mbps in Rwanda.<sup>31</sup> LDCs face daunting challenges in taking advantage of the benefits offered by the digital transformation, although digital technology can partly help overcome these barriers. A range of applications in IoT is not contingent on high connection speeds. Reliance on unlicensed and licensed wireless connectivity may help to overcome constraints in the fixed networks. The ability of digital solutions to be adapted to local conditions also helps. A promising example is the joint initiative by the City of Kigali, Rwanda, Inmarsat and Actility to roll out a citywide Low-Power Wide-Area Network. Initially designed as a testbed for one year, the platform will provide connectivity for a range of innovative smart city projects (Information Age, 2017).

## 4.4 Lessons for policy: Facilitating digital innovation

The potential benefits of the four key technologies can best be harnessed in an environment that supports innovation. Historically, telecommunication regulation has paid only limited attention to the effects of policies on innovation (Bauer, 2010b, 2014; Vogelsang, 2016). Regulators and policy-makers worldwide are therefore struggling to develop a framework that is conducive to innovation while protecting important public interests. Innovation is a dynamic learning process in which new products, services, designs, business models and organizational forms emerge from a process of trial and error.

Experimentation is therefore critical for innovation to unfold freely, and public policy can help support it. In the ICT ecosystem, upper layers and lower layers of the ecosystem are in a complementary relation to each other, each enabling (and potentially constraining) the innovative opportunities of players in the complementary layer. In other words, innovation in network infrastructure is stimulated by innovation in devices, applications and services, but network innovation, in turn, also stimulates innovation in devices, applications and services. Regulators therefore need to maintain a delicate balance that allows innovation and experimentation in all layers.

Some market segments, often network infrastructure and local access markets, are more concentrated than others and entry barriers may be high. A first critical task of public policy is therefore to make sure such bottlenecks are mitigated with appropriate tools, whether regulation or competition policy. The complementarity of innovation needs to be considered when designing a response. Several countries and regions, including the United States, the European Union and Chile, have adopted network neutrality principles with the goal of supporting edge innovations, including innovations in IoT. While this discussion is ongoing, this policy may impose barriers to the development of applications in IoT that require deterministic service quality, for example in vehicle-to-vehicle communications (Knieps, 2016). A better approach would be to allow network and quality of service differentiation by network operators while preventing discrimination and sabotage, either by forms of *ex post* regulation or competition policy. Such policies will also need to ensure that players in higher layers of the ecosystem are provided with relatively open and standardized interconnection to network and computing resources. If competition and the marketplace do not generate such conditions, policy intervention may be required.

In addition to eliminating barriers and mitigating the potentially negative effects of bottlenecks, public policy has an important role to play in establishing conditions that facilitate innovation. Given the importance of wireless communications on the edges of IoT, it is important that sufficient allocations of licensed and unlicensed bands are available. Licensed bands have the advantage

that they provide control over quality of service and therefore protect investment better than unlicensed bands. The latter allow entrepreneurs to experiment more freely without the need to go through lengthy processes to obtain a licence. Models in which public authorities and network operators collaborate to roll out open platforms for third-party developers are promising steps to overcoming these challenges.

Policy-makers also need to adopt policies that promote trust in IoT and other trends. This includes measures to enhance and safeguard privacy and security. The proliferation of devices has created considerable vulnerability in IoT, as demonstrated by recent cyberattacks. Measures to help reduce such risks necessitate both supply-side and demand-side measures. On the supplier side, vendors need to face stronger incentives or liabilities to improve the security of devices. Security-aware design and development, as well as certification programmes, can go a long way in this direction. On the user side, increased awareness needs to be generated. Such capacity building is a difficult undertaking, as users often do not take advantage of opportunities to learn more about security. Nonetheless, several governments offer educational initiatives.

Moreover, countries need to review their innovation policies in general and to facilitate programmes that develop the skills needed to take advantage of IoT, big data and artificial intelligence. This requires building a stronger base of professionals with computer science and data science skills. It also requires support in the private and public sectors to develop new business models that take full advantage of the opportunities offered by digital technology. Due to the unique economic characteristic of information markets, such as high economies of scale and scope, upfront costs, but also very low or zero incremental costs,<sup>32</sup> a high pace of innovation, low entry barriers for second and third movers, and the high plasticity of digital technology, sustainable business models are challenging to design. Most information businesses operate in multi-sided platform markets in which differentiated products and services are offered to an increasingly finely structured set of consumers (Evans and Schmalensee, 2016; Hagiu and Wright, 2015; Parker et al., 2016; Rogers, 2016). Digital technology requires efforts to find new ways of interacting with customers to build strong

and loyal relationships. Operating in multi-sided markets requires a rethinking of pricing policies and a reassessment of competitor relations. It is no surprise that in many countries ICT industries have made more progress toward adopting such practices than agriculture, manufacturing or utilities. Essentially, countries need to develop analogue complements (skills, knowledge and practices) to the digital economy (World Bank, 2016).

Because of the high plasticity of digital innovation, many of the benefits of the emerging technologies can be realized with innovative solutions that can thrive even within a constrained infrastructure. One response by network operators and other ecosystem players is to make concerted efforts to improve digital connectivity by rolling out mobile and fixed broadband networks. After initial deployments in 2009, many countries launched LTE services. On a global scale, for the foreseeable future, most subscribers will be served by high-speed networks (Ericsson, 2016b, p. 4). Network operators also deploy platforms that provide connectivity for IoT and they regularly collaborate with public partners such as cities to deploy connectivity.<sup>33</sup>

To take full advantage of the technological opportunities offered by IoT, big data, cloud computing and artificial intelligence for achieving the SDGs, six major components of the broader ecosystem need to be aligned: connectivity providers, device infrastructure providers, content and platform service providers, application developers, policy arrangements, and user skills and needs. Digital technology reduces the barriers to participation in these sectors faced by lower-income countries. Moreover, as the experience with earlier communication technologies demonstrates, such projects are most successful if they respond to local user needs, the unique local economic and technological conditions, and the specific historical and cultural context (Heeks, 2008; Toyama, 2015; Unwin, 2017). In the past, a main hurdle for reaping the benefits of technological change was the design and implementation of a policy framework conducive to innovation. IoT can help to create such a framework, as it will increase transparency and reduce practices, such as corruption, that may create uncertainty and stand in the way of beneficial reforms (Bhattacharya and Suri, 2017).

While advanced ICTs have considerable upsides, they also raise broader societal challenges. The risk to open next-generation digital divides that would reduce some of the gains from earlier forms of fixed and mobile connectivity and Internet use have already been mentioned. This is but the latest iteration of the relentless cycle of inclusion and exclusion that can be observed in the history of ICTs over the past century. A second concern relates to the potential consequences of advanced ICTs, especially artificial intelligence and robotics, on employment. Historically, job losses from technological change were absorbed by other occupations, although often with considerable transitional hardships. While it is not entirely clear whether the new employment opportunities will suffice to absorb freed workers, it is understood that many of these emerging activities will require retraining of the workforce and other social support systems to mitigate transitions (Garcia-Murillo et al., 2015). Moreover, the entire education system will have to be adapted to prepare individuals for the new work environment of the future. A third concern is the effects of ICTs on income inequality. There is mounting evidence that increased connectivity is associated with, even if not necessarily a cause of, reduced inequality of average national incomes, but that it coincides with increased income inequality within many nations. Bauer (2017) explains this bifurcated and ambiguous pattern with the specific dynamics of advanced ICTs. Again, public policy may be required to include mitigating measures. A fourth concern is the major security problems associated with IoT and increased connectivity in general. Finally, advanced ICTs can be technologies of freedom or they can be abused as technologies of repression. Enlightened policy will be needed to develop workable and satisfactory responses to these potential problems, or the benefits of advanced ICTs may not be realized.

While these general principles that should govern policy hold across countries and regions, the best response is contingent on the local and national circumstances. Because the four key technologies and their applications are evolving at a fast pace, and the entire sector is in a phase of experimentation whose outcomes are not fully visible, the best practices are those that support such experimentation. The different world regions offer examples of good practices, but also illustrate the challenges that need to be overcome.

## 4.5 Improving measurements of the four trends

The four trends identified in this chapter will play increasingly important roles as core services and applications of the advanced information society. Harnessing their potential for society and the SDGs requires creating an environment that supports beneficial innovation and provides safeguards against potential undesirable effects. Better policies are contingent on better measurement. Current data collection efforts capture important parts of the emergent activities well, especially at the network level, where data collection has been standardized for a while. However, they do not allow a complete picture of the emerging trends and their effects to be assembled. A growing number of stakeholders – including private businesses, business associations, research arms of consulting firms, non-profit groups and academic researchers – have filled this void. Depending on how an activity such as IoT or artificial intelligence is delineated, how activities are measured, and what projections are used to forecast future developments, wildly different numbers result.<sup>34</sup> Given the relatively early stage of development, this high degree of uncertainty will only gradually be reduced as more actual observations become available and more standardized methods of measurement are used. To some extent, big data approaches can help overcome these measurement issues, as important metrics can be mined from the digital infrastructure. An example is the innovative use of data from mobile networks to improve transportation modelling and planning.<sup>35</sup>

As discussed in previous sections, IoT, big data analytics, cloud computing and artificial intelligence are contingent on the presence of complementary assets, skills and institutional arrangements. To facilitate an assessment of the state of the advanced information society and to assist public and private decision-making, a comprehensive system of metrics should address these interrelated aspects. Existing efforts to collect information, and several new initiatives, can be built upon to generate this data, most importantly information collected by ITU but also complementary indicators assembled by the World Bank and the Inter-agency and Expert Group on SDG Indicators established by the United Nations Statistical Commission in the context of the implementation of the SDGs.

However, documenting the new developments requires building on this existing agenda and broadening it to include additional aspects. A range of direct and indirect indicators is available or can be designed (see Table 4.6). Some of these metrics can be expressed in units (e.g. number of robots) or shares (e.g. percentage of businesses using big data), and others are better expressed as monetary values (e.g. revenues of artificial intelligence providers). Either can be stated in absolute numbers and relative to meaningful benchmarks (e.g. percentage of the population or percentage of gross national income). Indicators referring to the policy conditions will most likely be of a qualitative nature. Direct indicators fall into three groups: hardware, basic services and software, and intermediate applications and services. Indirect indicators reflect complementary conditions such as the coverage with and quality of advanced fixed and wireless connectivity, human capital and policy conditions. In addition to direct and indirect measures, proxies are often available that help in assessing how well a location, region or nation is positioned to take advantage of the emergent trends.

Collecting such a set of indicators will require collaboration among various stakeholders and novel approaches to harvest information from the digital infrastructures and applications directly. In this process, the role of government agencies and ITU will often be to orchestrate processes to mine appropriate data, to work with private sector organizations to allow access to data, and to curate data; it may be less focused on collecting the data in the first place. However, this will require sustained efforts by public and private sector organizations. International organizations such as ITU can take a leadership role in putting such a broader framework in place. ITU and its Member States have the most direct role and control over data related to connectivity and data documenting the policy framework, two of the enabling conditions. Here an amendment of the data collection framework would probably suffice, with Member States called upon to collect the information. Collaboration with other United Nations agencies could help generate data on human capital, also one of the preconditions. The most challenging area will be collection of data related to hardware. Except for IoT, much of the new technology is beyond the traditional realm of telecommunications in the upper layers of the new ICT ecosystem. Thus, collaboration

Table 4.6: Measuring emerging ICTs (selected metrics)

	IoT	Big data analytics	Cloud computing	Artificial intelligence
<i>Direct measures</i>				
Hardware	Number of connected devices; Revenues in IoT device markets	Percentage of data centre capacity dedicated to big data analytics; Investment in data analysis centres	Number of data centres; information processing capacity of data centres; Investment in cloud facilities	Number of cognitive computing/deep learning installations; Number of robots; Revenue of artificial intelligence chip manufacturers
Basic services and software	Number of M2M subscriptions	Revenues for big data analysis software	Revenues for IaaS, SaaS, PaaS	Share of small, medium and large businesses using cognitive computing
Intermediate applications and services	Number of smart homes; Number of smart city applications; Revenues generated by IoT applications and services	Percentage of businesses and government organizations using big data analytics; Revenues generated by data analytics services	Percentage of businesses and government organizations using cloud computing; Revenues generated from cloud computing applications	Percentage of businesses and organizations using artificial intelligence applications; Revenues generated by artificial intelligence applications
<i>Enabling conditions</i>				
Connectivity	Percentage of population covered by mobile broadband; Percentage of population covered by fixed broadband; Available bandwidth; Quality of connectivity; Access to cloud resources; Adoption of broadband; Share of small, medium and large businesses using cloud resources; Percentage of population using cloud resources			
Human capital	Number of data scientists; Number of computer scientists; Percentage of schools with broadband connectivity			
Policy arrangements	Flexible spectrum policy; Policies toward bottlenecks and market power; Interoperability requirements; Standardization; Promotion of experimentation and innovation; Open data policies			
<i>Effects on SDGs, welfare and well-being</i>				
Welfare effects	Efficiency gains; Improvements in service quality; Better service/price relationship; Improvements in health, education, safety, care of elderly, empowerment, environmental stewardship, etc.			

Source: ITU.

with private sector organizations collecting such information, including consulting firms and industry associations, may be the most effective way forward.

In the context of the SDGs, it would also be desirable to formulate a general framework for evaluating the contribution of ICTs to welfare and well-being. Innovative research is under way, both in the private sector and in academia, aiming at the development of methods to make such assessments. As many new applications can be introduced at a smaller, local scale, evaluations can use randomized control trials to identify specific treatment effects of IoT and artificial intelligence projects. This novel approach to identify and test the role of ICTs has been applied to agricultural outcomes, food safety, mobile money and other effects of ICTs (Aker and Ksoll, 2016; Blumenstock et al., 2015; Nakasone et al., 2014; Torero and von Braun, 2006). Another approach enabled by the

increasing availability of data at a more aggregated level is reliance on panel data analyses.

McKinsey and Company (2015) has generated a detailed assessment of the potential contribution of IoT (broadly interpreted) to global GDP, differentiated by sectors. In a more recent study, Accenture and Frontier Economics have generated estimates for the potential productivity improvements supported by the wide deployment of artificial intelligence (Purdy and Daugherty, 2016). One challenge of these and other studies is the quasi-public good character of many of the effects of advanced ICTs. While some of these effects, such as company productivity increases and the efficiency increases achieved in smart homes, are private goods, other aspects come with strong spillover effects and externalities whose benefits are widely diffused and potentially difficult to measure. For example, increased air quality management in a smart city will have

measurable benefits for health, but it will also have broader and often intangible benefits for well-being in general. Capturing these effects in full will require methods that go beyond traditional approaches and will necessitate integrative measurement. Such initiatives can take inspiration from earlier work in the context of improving gross national income measurements (Cui and Taylor, 2012). Moreover, they can greatly benefit from big data analytics, provided that public and private data are made available for detailed examination.

## 4.6 Summary and conclusion

Advances in ICTs are enabling innovations that will fundamentally transform business, government and society. Four interrelated technological trends that will unfold their full impact in the coming years are IoT, cloud computing, big data analytics and artificial intelligence. These developments are enabled by exponential performance improvements and associated cost decreases in components, networking and the ubiquitous availability of connectivity and computing resources. In the virtuous cycle of the new ICT ecosystem, lower cost of connectivity, services and devices, and their continuous improvement, are going hand in hand with a proliferation of commercial and user-generated content.

Fully harnessing the economic and social benefits of these developments requires efficient and affordable physical infrastructures, generic services (connectivity, computing resources and storage), and appropriate institutional arrangements and user skills. Despite great advances, the nations and regions of the world differ widely in terms of where they stand in meeting these prerequisites. Among the six ITU regions, Asia and the Pacific, the Americas and Europe are currently best positioned to take advantage of these technologies, followed by the CIS region, the Arab States and Africa. LDCs face additional challenges due to the compounding of infrastructure challenges with weaknesses in their policy and regulatory systems, and shortcomings in capacity building and ICT education. However, within each of the world's six regions, and among the LDCs, considerable divergences exist between best and worst performers. Regional comparisons must be interpreted with caution.

While at first glance the four trends seem to widen the digital divide once more (Hilbert, 2016), they also offer rays of hope. For one, while their benefits are enhanced if deployed in an internationally networked environment, digital technologies can be deployed locally and in response to specific local conditions and challenges. Many innovative applications and services require only limited start-up capital, keeping the barriers to entry low for entrepreneurs. Likewise, as software and hardware become more efficient, some limited data analytical methods may be carried out in ways that are not contingent on the availability of massive data centres and computing resources. This may offer a limited path for weaker-performing nations towards participation in some of the potentially huge benefits of advanced ICTs. Nonetheless, for some time to come, more ambitious and more sophisticated big data analytical tasks as well as artificial intelligence applications will require high-capacity fixed and mobile connectivity and access to ubiquitous computing power.

Policy-makers contribute in important ways to overcoming these challenges and harnessing the benefits of the digital economy. Effective policy will require different policy-makers and stakeholders to work on joint solutions. Ideally, policy would create conditions that support entrepreneurship and experimentation with innovative services and solutions. Telecommunication regulation will be most effective if it supports the roll-out and continuous upgrade of mobile and fixed network infrastructure. Also, it will be important to make sufficient licensed and unlicensed spectrum available to accommodate the new increasing communication demands of smart cities, precision agriculture, education or health care applications. Safeguarding information security and privacy will be important preconditions for the building of trust and the adoption of advanced services and applications. This implies that education policy will need to prepare individuals to make better use of the opportunities of a digital future. Finally, it will be important to develop a framework of metrics that allows better tracking of the four trends. This will be an important precondition to develop supportive policy frameworks and to fully harness the tremendous power of IoT, big data analytics, cloud computing and artificial intelligence.

## Endnotes

- <sup>1</sup> Numerous books and overarching visions seek to come to grips with the opportunities and risks of the next waves of digital transformation. For additional overviews of the opportunities and challenges, see Vermesan and Friess (2016), Toyama (2015) and Unwin (2017).
- <sup>2</sup> One area in which the accuracy of artificial intelligence already exceeds the average performance of humans is cancer diagnostics from digital images.
- <sup>3</sup> Moore's Law refers to the observed doubling every two years in the number of transistors in a dense integrated circuit (or electronic chip). The ability to cram more components per electronic chip has contributed to the consistent increase in computing power.
- <sup>4</sup> Cooper's Law of Spectral Efficiency refers to the observed uniform increase in the ability to transmit different radio communications simultaneously in the same place since the first radio transmission more than a century past.
- <sup>5</sup> Cloud computing is only the latest development in the evolution of computing architectures. The locus of computational resources is influenced by the relative costs of communications and computing, as well as the transaction costs of coordinating resources. Earlier stages and related concepts include time-sharing, client-server models, grid computing and utility computing.
- <sup>6</sup> According to Google, about 300 years of video are uploaded daily to YouTube.
- <sup>7</sup> Sandvine traffic data documents that in 2016 about two-thirds of North American fixed network traffic was for real-time entertainment (mainly video). In Africa, the share of video traffic in total traffic was less than 25 per cent. On mobile networks, the share of video traffic was more than one-third of traffic in North America, while it was below 10 per cent in Africa.
- <sup>8</sup> The ITU Telecommunication Standardization Sector (ITU-T) has defined IoT as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies". See Recommendation ITU-T Y.2060, available at: <https://www.itu.int/rec/T-REC-Y.2060-201206-I>. See also (ITU, 2015).
- <sup>9</sup> Cisco's prediction of 50 billion connected devices in the "Internet of Everything" by 2020 is widely seen as inflated. In contrast, a report by Berg Insight on IoT platforms and services estimates the number of connected devices by 2020 to just below 7 billion. See chapter 5 in ITU (2015) for a more thorough analysis of the different predictions and the main differences among them.
- <sup>10</sup> Encryption of communications will potentially reduce the amount of data that can be mined but it will allow continued collection of metadata that can be analysed.
- <sup>11</sup> An example is Google's effort to predict flu epidemics based on search data. The company examined 450 million alternative models to make such forecasts. For a while, the predictive accuracy was high, but over time the characteristics of the process changed and the accuracy of the real-time forecasts increasingly declined. See, for example, Lazer et al. (2014a, 2014b).
- <sup>12</sup> In contrast to forecasts, which are typically a quantitative method of predicting future outcomes from past observations, foresight methods encompass quantitative and qualitative tools to explore potential futures.
- <sup>13</sup> Examples include water service management solutions provided by TaKaDu in Europe, Latin America, Asia and the Middle East, in partnership with local utilities and technology companies; energy management services provided by Opower to clients worldwide; educational initiatives in India; and precision agriculture in Colombia. See Hilbert et al. (2016) for numerous additional examples.
- <sup>14</sup> The complexity of some types of services may undermine this potential for efficiency gains if clients hold spare capacity in the cloud or if transaction costs create frictions that limit flexibility. See Harris (2015), for a critical analysis.
- <sup>15</sup> This perspective raises complicated problems of attribution. As artificial intelligence builds on IoT and big data, the Accenture estimate of potential productivity gains likely also includes the productivity increase attributable to these technologies.
- <sup>16</sup> One zettabyte (ZB) equals 1,000 exabytes (EB) equals 1,000 petabytes (PB) equals 1,000 terabytes (TB) equals 1,000 gigabytes (GB).
- <sup>17</sup> Ericsson (2016a) developed a scenario of IoT communications in a dense urban setting and concludes that one NB-IoT carrier can fulfil the communication needs of the deployed metering and monitoring devices.
- <sup>18</sup> For example, between 2014 and 2015, smartphone ownership in Turkey increased by 42 per cent, 34 per cent in Malaysia, and 26 per cent in Chile and Brazil (Poushter, 2016, p. 6).
- <sup>19</sup> See GfK (n.d.). Smartphone unit shipments worldwide from 2013 to 2016 (in million units), by region. In *Statista - The Statistics Portal*. Retrieved June 2, 2017, from <https://www-statista-com.proxy1.cl.msu.edu/statistics/412108/global-smartphone-shipments-global-region/>.

- <sup>20</sup> See Berg Insight (n.d.). Number of cellular M2M subscribers worldwide by region from 2013 to 2016 (in millions). In *Statista - The Statistics Portal*. Retrieved June 2, 2017, from <https://www-statista-com.proxy1.cl.msu.edu/statistics/626241/cellular-m2m-subscribers-by-region/>.
- <sup>21</sup> Data documenting cloud use by individuals are rather incomplete and need to be interpreted with caution.
- <sup>22</sup> See <https://www.statista.com/statistics/254266/global-big-data-market-forecast/> for global market revenue forecasts, and “Middle East and Africa Big Data Market 2015 – 2020”, accessed 18 July 2017 at [http://www.bizjournals.com/prnewswire/press\\_releases/2016/05/26/BR09779](http://www.bizjournals.com/prnewswire/press_releases/2016/05/26/BR09779), for an estimate of the market share of the African and Middle Eastern region.
- <sup>23</sup> International comparisons of broad-based indices differ in the main analytical interest motivating the design of an index. Thus, there are deviations between them, and the rankings do not always yield consistent findings (Bauer, 2010a).
- <sup>24</sup> Patent statistics are often used as a source of information on innovation activity. They are not always a good proxy for actual innovation activity, as many patents are taken out for competitive strategy reasons.
- <sup>25</sup> See M. Meeker, Internet Trends 2017. Code Conference, 31 May 2017, slides 232-287, available at <https://www.recode.net/2017/5/31/15693686/mary-meeker-kleiner-perkins-kpcb-slides-internet-trends-code-2017>.
- <sup>26</sup> Microsoft opened an office in 2006 and Cloudflare announced in March 2017 that it would open a data centre there. See <https://blog.cloudflare.com/yerevan-armenia-cloudflare-data-center-103>.
- <sup>27</sup> See Digital Economy and Society Index, accessed 9 July 2017 at <https://ec.europa.eu/digital-single-market/en/desi>.
- <sup>28</sup> For example, Akamai (2017, pp. 17–21) reports average connection speeds in states in the United States with the best connectivity rival those of global leaders in Asia (Republic of Korea and Singapore) and the Nordic countries (Norway and Sweden).
- <sup>29</sup> See IDATE Digiworld (2016, p. 126).
- <sup>30</sup> See <https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-connectivity-visualization.jsp>, retrieved 20 July 2017. See also Akamai (2017).
- <sup>31</sup> Speed data retrieved from Akamai (<https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-connectivity-visualization.jsp>) and author’s own calculations.
- <sup>32</sup> The level of upfront costs may vary from extremely high (e.g. putting together a generic search database and infrastructure, producing a commercial digital movie) to very low for a mobile or web app that can be launched freely on the Internet. However, even digital innovations with low upfront costs have the peculiar cost structure that the upfront costs are typically much higher than the incremental costs of providing the service. While the latter group of projects poses lower entry barriers, it goes hand in hand with easier imitation and more intense competition, making it more difficult to find a sustainable revenue model.
- <sup>33</sup> In 2016, the Netherlands became the first country with a national IoT platform. KPN rolled out a Low-Power, Long-Range Wide Area Network starting in 2015, first offering services in Rotterdam and The Hague (see <http://www.zdnet.com/article/dutch-telco-kpn-deploys-lora-iot-network-across-netherlands>). Other models are structured as partnerships between businesses, for example, the collaboration of Actility with Inmarsat, Cisco and Softbank. Yet others take the form of public–private partnerships, for example, the collaborative effort between Kigali, Rwanda and Actility and Inmarsat or the collaboration between the City of Los Angeles and Philips to deploy smart street lighting.
- <sup>34</sup> An early case in point is Cisco’s widely cited number of 50 billion connected devices in IoT by 2020. More recent estimates, based on a longer record of actual evidence, typically provide lower numbers. But similar discrepancies continue to plague outlooks such as valuations of the artificial intelligence market. For example, Forrester Research anticipates that the global market for cognitive computing technologies will be about USD 1.2 trillion by 2020, but Tractica Research anticipates a much lower volume of USD 38.6 billion by 2025.
- <sup>35</sup> See the earlier examples reported in Hilbert (2016), Hilbert et al. (2016) and ITU (2015). The United Nations Global Pulse programme (<http://www.unglobalpulse.org>) has supported a range of projects that demonstrate the potential of big data analytics in overcoming lack of available statistics. In South Asia, LIRNEasia has done pioneering work.



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# Annex 1. ICT Development Index methodology

This annex outlines the methodology used to compute the ICT Development Index (IDI) and provides additional details on various elements and steps involved, such as the indicators included in the Index and their definition, the imputation of missing data, the normalization procedure, the weights applied to the indicators and sub-indices, and the results of the sensitivity analysis.

## 1. Indicators included in the IDI

The selection of indicators was based on certain criteria, including relevance for the Index objectives, data availability and the results of various statistical analyses such as the principal component analysis (PCA).<sup>1</sup> The following 11 indicators are included in the IDI (grouped by the three sub-indices: access, usage and skills).

### a) ICT infrastructure and access indicators

Indicators included in this group provide an indication of the available ICT infrastructure and individuals' access to basic ICTs. Data for all these indicators are collected by ITU.<sup>2</sup>

#### 1. Fixed-telephone subscriptions per 100 inhabitants

The term “fixed-telephone subscriptions” refers to the sum of active analogue fixed-telephone lines, voice-over-Internet Protocol (VoIP) subscriptions, fixed wireless local loop subscriptions, Integrated Services Digital Network voice-channel equivalents and fixed public payphones. It includes all accesses over fixed infrastructure supporting voice telephony using copper wire, voice services using Internet Protocol (IP) delivered over fixed (wired)-broadband infrastructure (e.g. digital subscriber line (DSL), fibre optic), and voice services provided over coaxial-cable television networks (cable modem). It also includes fixed wireless local loop connections, defined as services provided by licensed fixed-line telephone operators that provide last-mile access to the subscriber using radio technology, where the call is then routed over a fixed-line telephone network (not a mobile-

cellular network). VoIP refers to subscriptions that offer the ability to place and receive calls at any time and do not require a computer. VoIP is also known as voice-over-broadband (VoB), and includes subscriptions through fixed-wireless, DSL, cable, fibre optic and other fixed-broadband platforms that provide fixed telephony using IP.

#### 2. Mobile-cellular telephone subscriptions per 100 inhabitants

The term “mobile-cellular telephone subscriptions” refers to the number of subscriptions to a public mobile-telephone service providing access to the public switched telephone network using cellular technology. It includes both the number of postpaid subscriptions and the number of active prepaid accounts (i.e. accounts that have been active during the previous three months). It includes all mobile-cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging, machine-to-machine (M2M) and telemetry services.

#### 3. International Internet bandwidth (bit/s) per Internet user

The term “international Internet bandwidth” refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbit/s). Used international Internet bandwidth refers to the average usage of all international links, including fibre optic cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). All international links used by all types of operators – namely fixed, mobile and satellite operators – are taken into account. The average is calculated over the 12-month period of the reference year. For each individual international link, if the traffic is asymmetric, i.e. incoming traffic is not equal to outgoing traffic, then the higher value of the two is provided. The combined average usage of all international links can be reported as the sum of the average usage of each individual link. *International Internet bandwidth (bit/s) per Internet*

*user* is calculated by converting to bits per second and dividing by the total number of Internet users.

#### 4. Percentage of households with a computer

The term “computer” refers to a desktop computer, laptop (portable) computer, tablet or similar handheld computer. It does not include equipment with some embedded computing abilities, such as smart television sets, or devices with telephony as a main function, such as mobile phones or smartphones.

*Household with a computer* means that the computer is available for use by all members of the household at any time. The computer may or may not be owned by the household, but should be considered a household asset.

Data are obtained by countries through national household surveys and are either provided directly to ITU by national statistical offices (NSOs) or obtained by ITU through its own research, for example, from NSO websites. There are certain data-related limits to this indicator, insofar as estimates have to be calculated for many developing countries that do not yet collect ICT household statistics. Over time, as more data become available, the quality of the indicator will improve.

#### 5. Percentage of households with Internet access

The Internet is a worldwide public computer network. It provides access to a number of communication services, including the World Wide Web, and carries e-mail, news, entertainment and data files, irrespective of the device used (not assumed to be only a computer; it may also be a mobile telephone, tablet, PDA, games machine, digital television, etc.). Access can be via a fixed or mobile network. *Household with Internet access* means that the Internet is available for use by all members of the household at any time.

Data are obtained by countries through national household surveys and are either provided directly to ITU by NSOs or obtained by ITU through its own research, for example from NSO websites. There are certain data-related limits to this indicator, insofar as estimates have to be calculated for many developing countries which do not yet collect ICT household statistics. Over time, as more data

become available, the quality of the indicator will improve.

#### b) ICT usage indicators

The indicators included in this group capture ICT intensity and usage. Data for all these indicators are collected by ITU.<sup>3</sup>

##### 1. Percentage of individuals using the Internet

The term “individuals using the Internet” refers to people who used the Internet from any location and for any purpose, irrespective of the device and network used, in the previous three months. Usage can be via a computer (i.e. desktop computer, laptop computer, tablet or similar handheld computer), mobile phone, games machine, digital television, etc.). Access can be via a fixed or mobile network.

Data are obtained by countries through national household surveys and are either provided directly to ITU by NSOs or obtained by ITU through its own research, for example, from NSO websites. There are certain data-related limits to this indicator, insofar as estimates have to be calculated for many developing countries which do not yet collect ICT household statistics. Over time, as more data become available, the quality of the indicator will improve.

##### 2. Fixed-broadband subscriptions per 100 inhabitants

The term “fixed-broadband subscriptions” refers to fixed subscriptions for high-speed access to the public Internet (a Transmission Control Protocol (TCP)/IP connection) at downstream speeds equal to or higher than 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. The total is measured irrespective of the method of payment. It excludes subscriptions that have access to data communications (including the Internet) via mobile-cellular networks. It includes fixed WiMAX and any other fixed wireless technologies, and both residential subscriptions and subscriptions for organizations.

### 3. Active mobile-broadband subscriptions per 100 inhabitants

The term “active mobile-broadband subscriptions” refers to the sum of data and voice mobile-broadband subscriptions and data-only mobile-broadband subscriptions to the public Internet. It covers subscriptions actually used to access the Internet at broadband speeds, not subscriptions with potential access, even though the latter may have broadband-enabled handsets. Subscriptions must include a recurring subscription fee to access the Internet or pass a usage requirement – users must have accessed the Internet in the previous three months. It includes subscriptions to mobile-broadband networks that provide download speeds of at least 256 kbit/s (e.g. WCDMA, HSPA, CDMA2000 1x EV-DO, WiMAX IEEE 802.16e and LTE), and excludes subscriptions that only have access to GPRS, EDGE and CDMA 1xRTT.

- The term “data and voice mobile-broadband subscriptions” refers to subscriptions to mobile-broadband services that allow access to the open Internet via HTTP in which data services are contracted together with voice services (mobile voice and data plans) or as an add-on package to a voice plan. These are typically smartphone-based subscriptions with voice and data services used in the same terminal. Data and voice mobile-broadband subscriptions with specific recurring subscription fees for Internet access are included regardless of actual use. Prepaid and pay-per-use data and voice mobile-broadband subscriptions are only counted if they have been used to access the Internet in the previous three months. M2M subscriptions are excluded. The indicator includes subscriptions to mobile networks that provide download speeds of at least 256 kbit/s (e.g. WCDMA, HSPA, CDMA2000 1x EV-DO, WiMAX IEEE 802.16e and LTE), and excludes lower-speed technologies such as GPRS, EDGE and CDMA 1xRTT.
- The term “data-only mobile-broadband subscriptions” refers to subscriptions to mobile-broadband services that allow access to the open Internet via HTTP and that do not include voice services, i.e. subscriptions that offer mobile broadband as a standalone service, such as mobile-broadband subscriptions for datacards, modem/dongle

and tablets. Data-only mobile-broadband subscriptions with recurring subscription fees are included regardless of actual use. Prepaid and pay-per-use data-only mobile-broadband subscriptions are only counted if they have been used to access the Internet in the previous three months. M2M subscriptions are excluded. The indicator includes subscriptions to mobile networks that provide download speeds of at least 256 kbit/s (e.g. WCDMA, HSPA, CDMA2000 1x EV-DO, WiMAX IEEE 802.16e and LTE), and excludes lower-speed technologies such as GPRS, EDGE and CDMA 1xRTT. It excludes data subscriptions that are contracted together with mobile voice services.

### c) ICT skills indicators

Data on gross secondary and tertiary enrolment ratios are collected by the United Nations Educational, Scientific and Cultural Organization Institute for Statistics (UIS).

#### 1. Mean years of schooling

The term “mean years of schooling” is the average number of completed years of education of a country’s population, excluding years spent repeating individual grades. It is estimated using the distribution of the population by age group and the highest level of education attained in a given year, and time series data on the official duration of each level of education.<sup>4</sup>

#### 2. Gross enrolment ratio (secondary and tertiary level)

According to the UIS, the gross enrolment ratio is “the total enrolment in a specific level of education, regardless of age, expressed as a percentage of the eligible official school-age population corresponding to the same level of education in a given school-year.”

#### 2. Imputation of missing data

A critical step in the construction of the Index is to create a complete data set, without missing values. A number of imputation techniques can be applied to estimate missing data.<sup>5</sup> Each of the imputation

techniques, like any other method employed in the process, has its own strengths and weaknesses. The most important consideration is to ensure that the imputed data will reflect a country's actual level of ICT access, usage and skills.

Imputation of missing data for access and use of ICTs by households and individuals were made by applying multiple imputation models based on multiple regression techniques using actual data from more than 100 countries. The approach took into consideration many explanatory variables of ICT development, such as national income, fixed and mobile-broadband penetration, geographic affiliation, population distribution and the proportion of the population living in urban areas, and the level of 3G and LTE population coverage. However, given that ICT access and usage are both highly correlated with national income, gross national income per capita was the most determinant variable for imputing access and use of ICTs by households and individuals. The availability of relevant data from other sources was also taken into account during the imputation process.

For example, the proportion of individuals using the Internet was estimated based on all available information on Internet use in the country from household surveys, and if no historical information was available, explanatory variables to estimate the level of Internet use were used. The estimates obtained from the regression analysis were benchmarked against estimates from other models, and against other countries in the region with similar characteristics, as well as against other key variables and data sources.

### 3. Normalization of data

Data normalization is necessary before any aggregation can take place, to ensure that the data set uses the same unit of measurement. Regarding the indicators selected to construct the IDI, the values must be converted into the same unit of measurement, since some values are expressed as a percentage of the population/total households, where the maximum value is 100, while other indicators can have values exceeding 100, such as mobile-cellular and active mobile-broadband penetration or international Internet bandwidth (expressed as bit/s per user).

Certain particularities need to be taken into consideration in selecting the normalization method for the IDI. For example, to identify the digital divide, it is important to measure the *relative* performance of countries (i.e. the divide among countries). Secondly, the normalization procedure should produce Index results that allow countries to track progress in their evolution towards an information society over time.

A further important criterion in selecting the normalization method is replicability by countries, as some countries have shown a strong interest in applying the Index methodology at the national or regional level. Certain methods therefore cannot be applied, for example, those that rely on the values of other countries, which might not be available to users.

For the IDI, the *distance to a reference measure* was used as the normalization method. The reference measure is the *ideal value* that could be reached for each variable (similar to a "goalpost"). For all the indicators chosen, this will be 100, except in regard to the following five indicators:

- International Internet bandwidth per Internet user, which in 2016 ranged from 0 (bit/s/user) to almost 8 397 884: Values for this indicator vary significantly between countries. To diminish the effect of the enormous dispersion of values, the data were first converted to a logarithmic (log) scale. Outliers were then identified using a cut-off value calculated by adding two standard deviations to the mean of the rescaled values, resulting in a log value of 6.33.
- Mobile-cellular subscriptions, which in 2016 ranged from 7.3 to 332.1 per 100 inhabitants: The reference value for mobile-cellular subscriptions was 120, a value derived by examining the distribution of countries based on their value for mobile-cellular subscriptions per 100 inhabitants in 2013. For countries where postpaid is the predominant mode of subscription, 120 is the maximum value attained, while in countries where prepaid is dominant (57 per cent of all countries included in the IDI have more than 80 per cent prepaid subscriptions), 120 is also the maximum value attained in a majority of countries. It was therefore concluded that 120 is the ideal value that a country could attain, irrespective of

the predominant type of mobile subscription. Although the distribution of 2016 values may differ slightly from that of previous years' values, the ideal value of 120 was used to calculate this year's IDI, in the interest of consistency with the value used in previous years.

- Fixed-telephone subscriptions per 100 inhabitants, which ranged from zero to 120.7 in 2016: The reference value was calculated by adding two standard deviations to the mean, resulting in a value of 53 per 100 inhabitants. In the interest of consistency with the value used in previous years, the reference value of 60 per 100 inhabitants was used to calculate this year's IDI.
- Fixed-broadband subscriptions per 100 inhabitants: Values ranged from zero to 48.2 per 100 inhabitants in 2016. In line with fixed-

telephone subscriptions, the ideal value was defined as 60 per 100 inhabitants.

- Mean years of schooling: Values ranged from 1.4 to 13.4 in 2016. The ideal value of 15 is used for this indicator, which refers to the projected maximum number of years of schooling by 2025.<sup>6</sup>

After normalizing the data, the individual series were all rescaled to identical ranges, from 1 to 10. This was necessary to compare the values of the indicators and the sub-indices.

#### 4. Weighting and aggregation

The indicators and sub-indices included in the IDI were weighted on the basis of the PCA results obtained when the Index was first computed.<sup>7</sup>

**Annex Table 1.1: Weights used for the indicators and sub-indices included in the IDI**

	Weights (indicators)	Weights (sub-indices)
<b>ICT access</b>		0.40
Fixed-telephone subscriptions per 100 inhabitants	0.20	
Mobile-cellular telephone subscriptions per 100 inhabitants	0.20	
International Internet bandwidth per Internet user	0.20	
Percentage of households with a computer	0.20	
Percentage of households with Internet access	0.20	
<b>ICT usage</b>		0.40
Percentage of individuals using the Internet	0.33	
Fixed-broadband Internet subscriptions per 100 inhabitants	0.33	
Active mobile-broadband subscriptions per 100 inhabitants	0.33	
<b>ICT skills</b>		0.20
Mean years of schooling	0.33	
Secondary gross enrolment ratio	0.33	
Tertiary gross enrolment ratio	0.33	

Source: ITU.

## 5. Calculating the IDI

Sub-indices were computed by summation of the weighted values of the indicators included in the respective subgroup:

- *ICT access* is measured by fixed-telephone subscriptions per 100 inhabitants, mobile-cellular subscriptions per 100 inhabitants, international Internet bandwidth per Internet user, the percentage of households with a computer and the percentage of households with Internet access.
- *ICT usage* is measured by the percentage of individuals using the Internet, fixed-broadband Internet subscriptions per 100 inhabitants and active mobile-broadband subscriptions per 100 inhabitants.
- *ICT skills* are approximated by mean years of schooling, secondary gross enrolment ratio and tertiary gross enrolment ratio.

The values of the sub-indices were calculated first by normalizing the indicators included in each sub-index in order to obtain the same unit of measurement. The *reference values* applied in the normalization process were discussed above. The sub-index value was calculated by taking the simple average (using equal weighting) of the normalized indicator values.

For computation of the final Index, the ICT access and ICT usage sub-indices were each given a 40 per cent weighting, and the skills sub-index (because it is based on proxy indicators) a 20 per cent weighting. The final Index value was then computed by summation of the weighted sub-indices. Annex Box 1.1 illustrates the process of computing the IDI for Iceland (which tops the IDI 2017).

## 6. Sensitivity analysis

Sensitivity analysis was carried out to investigate the robustness of the Index results in terms of the relative position in the overall ranking, using different combinations of methods and techniques to compute the Index.

Potential sources of variation or uncertainty can be attributed to different processes employed in the computation of the Index, including the selection of individual indicators, the imputation of missing values and the normalization, weighting and aggregation of the data.

Each of the processes or combination of processes affects the IDI value. A number of tests were carried out to examine the robustness of the IDI results (rather than the actual values). The tests computed the possible Index values and country rankings for different combinations of the processes mentioned above. Results show that, while the computed Index values change, the message remains the same. The IDI was found to be extremely robust with regard to different methodologies, with the exception of certain countries, including in particular those in the “high” group.

The relative position of countries included in the “high” group (see Chapter 2) can change depending on the methodology used. Caution should therefore be exercised in drawing conclusions based on these countries’ rankings. However, the relative position of countries included in the “low” group is in no way affected by the methods or techniques used, and the countries in this group ranked low in all Index computations using different methodologies. This confirms the results conveyed by the IDI.

## Annex Box 1.1: Example of how to calculate the IDI value

Iceland			
Indicators			2016
<b>ICT access</b>			
		<b>Ideal value*</b>	
a	Fixed-telephone subscriptions per 100 inhabitants	60	48.4
b	Mobile-cellular telephone subscriptions per 100 inhabitants	120	118.0
c	International Internet bandwidth per Internet user**	2,158,212	997,830
d	Percentage of households with a computer	100	98.5
e	Percentage of households with Internet access	100	97.0
<b>ICT use</b>			
f	Percentage of individuals using the Internet	100	98.2
g	Fixed-broadband Internet subscriptions per 100 inhabitants	60	37.6
h	Active mobile-broadband subscriptions per 100 inhabitants	100	104.0
<b>ICT skills</b>			
i	Mean years of schooling	15	12.2
j	Secondary gross enrolment ratio	100	118.6
k	Tertiary gross enrolment ratio	100	81.3
<b>Normalized values</b>		<b>Formula</b>	<b>Weight</b>
<b>ICT access</b>			
z1	Fixed-telephone subscriptions per 100 inhabitants	a/60	0.20
z2	Mobile-cellular telephone subscriptions per 100 inhabitants	b/120	0.20
z3	International Internet bandwidth per Internet user	log(c)/6.33	0.20
z4	Percentage of households with a computer	d/100	0.20
z5	Percentage of households with Internet access	e/100	0.20
<b>ICT use</b>			
z6	Percentage of individuals using the Internet	f/100	0.33
z7	Fixed-broadband Internet subscriptions per 100 inhabitants	g/60	0.33
z8	Active mobile-broadband subscriptions per 100 inhabitants	h/100	0.33
<b>ICT skills</b>			
z9	Mean years of schooling	i/15	0.33
z10	Secondary gross enrolment ratio	j/100	0.33
z11	Tertiary gross enrolment ratio	k/100	0.33
<b>Sub-indices</b>		<b>Formula</b>	<b>Weight</b>
<b>ICT access sub-index (L)</b>		<b>y1+y2+y3+y4+y5</b>	<b>0.40</b>
y1	Fixed-telephone subscriptions per 100 inhabitants	z1*.20	0.16
y2	Mobile-cellular telephone subscriptions per 100 inhabitants	z2*.20	0.20
y3	International Internet bandwidth per Internet user	z3*.20	0.19
y4	Percentage of households with a computer	z4*.20	0.20
y5	Percentage of households with Internet access	z5*.20	0.19
<b>ICT use sub-index (M)</b>		<b>y6+y7+y8</b>	<b>0.40</b>
y6	Percentage of individuals using the Internet	z6*.33	0.33
y7	Fixed-broadband Internet subscriptions per 100 inhabitants	z7*.33	0.21
y8	Active mobile-broadband subscriptions per 100 inhabitants	z8*.33	0.33
<b>ICT skills sub-index (N)</b>		<b>y9+y10+y11</b>	<b>0.20</b>
y9	Mean years of schooling	z9*.33	0.27
y10	Secondary gross enrolment ratio	z10*.33	0.33
y11	Tertiary gross enrolment ratio	z11*.33	0.27
<b>IDI</b>	<b>ICT Development Index</b>	<b>((L*.40)+(M*.40)+(N*.20))*10</b>	<b>8.98</b>

\*The ideal value for indicators a, b, c and g was computed by adding two standard deviations to the mean value of the indicator.

\*\*To diminish the effect of the large number of outliers at the high end of the value scale, the data were first transformed to a logarithmic (log) scale. The ideal value of 2'158'212 bit/s per Internet user is equivalent to 6.33 if transformed to a log scale.

## Endnotes

- <sup>1</sup> PCA was used to examine the underlying nature of the data. A more detailed description of the analysis is available in Annex 1 to the 2009 report *Measuring the Information Society – The ICT Development Index* (ITU, 2009).
- <sup>2</sup> More information about the indicators is available in the ITU *Handbook for the collection of administrative data on telecommunications/ICT* (ITU, 2011) and the ITU *Manual for Measuring ICT Access and Use by Households and Individuals* (ITU, 2014).
- <sup>3</sup> See endnote 2.
- <sup>4</sup> See <http://www.uis.unesco.org/Education/Documents/Mean-years-schooling-indicator-methodology-en.pdf>. Data used in the calculation of the Index were based from the United Nations Development Programme Human Development Index 2016, available from <http://hdr.undp.org/en/2016-report>.
- <sup>5</sup> See OECD and European Commission (2008).
- <sup>6</sup> See Human Development Report 2015, Technical Notes, available at [http://hdr.undp.org/sites/default/files/hdr2015\\_technical\\_notes.pdf](http://hdr.undp.org/sites/default/files/hdr2015_technical_notes.pdf).
- <sup>7</sup> For more details, see Annex 1 to ITU (2009).

## Annex 2. Statistical tables of indicators used to compute the IDI

## Access indicators

Rank	Economy	Fixed-telephone subscriptions per 100 inhabitants		Mobile-cellular subscriptions per 100 inhabitants		International Internet bandwidth Bit/s per Internet user		Percentage of households with computer		Percentage of households with Internet	
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
		1	Afghanistan	0.3	0.3	61.6	66.0	14,124	11,967	2.9	3.4
2	Albania	7.1	7.6	106.4	105.1	43,232	56,964	25.7	27.7	35.5	37.0
3	Algeria	8.0 <sup>1</sup>	8.2 <sup>1</sup>	106.4 <sup>1</sup>	117.0 <sup>1</sup>	30,119	40,015	37.0	38.4	31.9	34.7
4	Andorra	48.0	47.4	88.1	87.2	82,857	106,390	85.6	85.1	83.6	83.3
5	Angola	1.2	1.3	60.8	55.3	6,518	8,796	11.1	10.5	10.2	10.0
6	Antigua & Barbuda	21.8	24.3	191.7	194.1	77,790	88,622	57.6	59.1	56.3	58.6
7	Argentina	23.9 <sup>2</sup>	23.4	146.7 <sup>2</sup>	150.7	35,925	41,130	67.0	67.6	62.0	63.8
8	Armenia	18.4	17.8	115.9	114.8	66,892	59,860	61.9	64.7	57.8	60.5
9	Australia	35.5 <sup>3</sup>	33.8 <sup>2</sup>	107.7 <sup>3</sup>	109.6 <sup>2</sup>	77,766	88,304	83.0	85.9	85.9	88.5
10	Austria	42.2 <sup>4</sup>	41.5 <sup>3</sup>	157.4	166.1	130,957	149,988	82.1	83.2	82.4	85.1
11	Azerbaijan	18.7	17.5	111.3	106.3	35,127	34,255	62.4	64.3	76.7	77.4
12	Bahamas	31.2	30.9	80.3	91.8 <sup>3</sup>	225,877	198,447	69.2	70.7	61.1	66.0
13	Bahrain	20.6	20.8	185.3	216.9	89,425	112,770	94.8	94.8	88.7	98.0
14	Bangladesh	0.5	0.5 <sup>4</sup>	81.9	77.9 <sup>4</sup>	8,736 <sup>1</sup>	9,154	8.2	9.6	10.1	14.5
15	Barbados	52.0	48.4	116.5	115.0	247,474	284,571	70.8	71.7	62.9	67.7
16	Belarus	49.0	49.0	123.6	124.2	128,875	168,518	63.1	67.0	59.1	62.5
17	Belgium	40.1	39.0	114.2	111.0	159,436	189,254	82.1	82.2	81.8	84.8
18	Belize	6.8 <sup>5</sup>	6.5	61.0 <sup>4</sup>	63.9	38,654	44,633	34.0	36.0	25.6	30.2
19	Benin	1.8	1.1	85.6	79.6	1,811	1,656	5.1	5.8	5.4	6.6
20	Bhutan	2.8 <sup>6</sup>	2.7 <sup>5</sup>	87.0 <sup>5</sup>	88.8 <sup>5</sup>	11,220 <sup>2</sup>	18,077	24.6	26.0	31.7	33.0
21	Bolivia	8.0	7.7	92.2	90.7	24,950	36,347	29.7	33.9	23.8	26.6
22	Bosnia and Herzegovina	20.2	19.5	90.2	89.2	82,289	98,452	47.1	49.2	53.6	57.1
23	Botswana	7.8 <sup>7</sup>	6.9 <sup>6</sup>	169.0	158.5	8,387	7,880	25.3	28.5	41.7	43.7
24	Brazil	21.4	20.4	126.6	118.9	44,196	66,181	49.6	51.0	50.9	52.4
25	Brunei Darussalam	17.7 <sup>8</sup>	17.1 <sup>7</sup>	108.1	120.7	69,907	76,226	92.5	93.0	74.0	75.0
26	Bulgaria	23.3	21.0 <sup>8</sup>	129.3	127.2 <sup>6</sup>	153,312	175,869	59.0	60.2	59.1	63.5
27	Burkina Faso	0.4	0.3	80.6	83.6	3,191	2,810	5.2	5.8	7.5	10.6
28	Burundi	0.2	0.2 <sup>9</sup>	46.2	48.0 <sup>7</sup>	5,702	6,083	2.0	3.4	2.0	3.5
29	Cambodia	1.6 <sup>9</sup>	1.4	133.0	124.9 <sup>8</sup>	17,792	23,573	9.8 <sup>1</sup>	10.5	21.0	26.0
30	Cameroon	4.5 <sup>10</sup>	4.4 <sup>10</sup>	71.8 <sup>6</sup>	68.1 <sup>9</sup>	992	2,549	12.7	13.7	8.6	10.5
31	Canada	43.5 <sup>11</sup>	41.4	83.0	84.1 <sup>10</sup>	112,039	141,885	85.1	86.8	86.6	89.2
32	Cape Verde	11.5	11.6	118.6	122.0	15,382	23,357	34.2	37.4	58.4	62.0
33	Central African Rep.	0.0	0.0 <sup>11</sup>	25.9	25.5	121	1,695	2.8	2.9	2.9	3.1
34	Chad	0.1	0.1	40.2	44.5	1,987	3,762	3.1	3.3	3.1	3.5
35	Chile	19.2	19.2	129.5	127.1	129,825	175,556	61.9	63.9	59.7	61.1
36	China	16.5	14.7	92.2	96.9	6,530	14,699	49.6	52.5	54.2	55.5
37	Colombia	14.4 <sup>12</sup>	14.2 <sup>12</sup>	115.7 <sup>7</sup>	117.1 <sup>11</sup>	105,050	150,871	45.5	45.2	41.8	45.8
38	Comoros	1.9	1.7	55.2	57.7	12,187	12,729	8.1	8.7	4.7	5.1
39	Congo (Dem. Rep.)	0.0	0.0	53.0	39.5	369	770	2.3	2.7	2.4	2.8
40	Costa Rica	17.2 <sup>13</sup>	16.3	150.7 <sup>8</sup>	159.2	61,746	68,449	53.2 <sup>2</sup>	51.7	60.2	64.8
41	Côte d'Ivoire	1.3	1.3	119.3	126.0	4,984	6,825	8.8	10.4	17.2	22.7
42	Croatia	34.7	33.9	103.8	104.1	57,038	118,953	76.8	79.5	76.7	77.2
43	Cuba	11.5	11.8	29.7	35.5	571	1,152	13.0	15.1	5.6	7.5
44	Cyprus	38.4	38.0	131.8	134.5	159,145	188,904	71.5	71.8	71.2	74.4
45	Czech Republic	17.7	15.6 <sup>13</sup>	115.6 <sup>9</sup>	115.5 <sup>12</sup>	161,342	180,697	73.1	75.6	73.1	76.1

Economy	Fixed-telephone subscriptions per 100 inhabitants		Mobile-cellular subscriptions per 100 inhabitants		International Internet bandwidth Bit/s per Internet user		Percentage of households with computer		Percentage of households with Internet		
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	
	46	Denmark	30.0	27.4	125.0	122.9	199,293	239,874	92.3	95.0	91.7
47	Djibouti	2.5	2.7	34.9	37.8	10,255	15,228	19.1	20.3	8.1	9.1
48	Dominica	28.3	18.3	106.3	107.4	201,092	176,449	52.2	54.0	58.4	60.0
49	Dominican Rep.	12.3 <sup>14</sup>	12.5 <sup>14</sup>	82.6	80.8	18,024	22,061	30.1	32.0	23.6	26.2
50	Ecuador	15.5 <sup>15</sup>	14.8 <sup>15</sup>	79.8 <sup>10</sup>	84.3 <sup>13</sup>	43,717	43,677	40.8	42.3	32.8	36.0
51	Egypt	7.4	7.1	111.0	113.7	10,743	17,194	50.9	53.1	42.3	43.3
52	El Salvador	14.7	14.4 <sup>16</sup>	145.3	140.7 <sup>14</sup>	62,219	63,622	20.1	20.8	14.0	16.9
53	Equatorial Guinea	1.4	1.2	66.7	65.9	2,130	2,397	14.6	16.0	8.9	9.4
54	Eritrea	1.0	1.0	7.0	7.3	2,629	3,601	2.8	3.3	1.7	1.9
55	Estonia	30.3	29.0	148.7 <sup>11</sup>	148.7 <sup>15</sup>	173,936	210,798	87.9	89.6	87.7	86.2
56	Ethiopia	0.9	1.1	42.8 <sup>12</sup>	50.5	1,959	2,242	4.4	5.0	14.4	15.4
57	Fiji	8.1	8.3	108.2	103.3	29,868	23,726	39.2	41.7	31.3	33.6
58	Finland	9.8	8.3	135.4 <sup>13</sup>	134.5 <sup>16</sup>	187,722	216,391	82.1	84.5	82.2	84.6
59	France	59.9	59.7	102.6	103.5	84,255	97,653	81.5	81.8	82.6	85.9
60	Gabon	1.1	1.1	161.1	144.2	4,511	4,844	29.2	31.0	29.3	34.4
61	Gambia	2.3	1.9	137.8	139.6	13,843	13,297	8.9	9.3	8.6	11.2
62	Georgia	22.1	19.4	129.0	129.1	96,324	92,145	49.7	52.5	45.1	49.8
63	Germany	54.9 <sup>16</sup>	53.7	116.7 <sup>14</sup>	114.5	91,443	107,489	91.0	91.4	90.3	90.8
64	Ghana	1.0	0.9	129.7	139.1	7,461	9,851	18.5	20.8	28.6	32.5
65	Greece	47.3	46.1	113.0	112.8	74,346	68,698	68.6	71.7	68.1	69.1
66	Grenada	25.3	25.0	112.3	111.1	191,597	229,948	48.1	52.4	42.8	44.7
67	Guatemala	10.6	10.1	111.5 <sup>15</sup>	115.3	23,215	24,022	22.2	23.4	17.4	20.5
68	Guinea	0.0	0.0	87.2	85.3	384	589	2.6	2.8	6.4	7.7
69	Guinea-Bissau	0.0	0.0 <sup>17</sup>	69.3 <sup>16</sup>	70.3 <sup>17</sup>	4,013	4,707	2.7	2.8	2.1	2.2
70	Guyana	19.1	18.9	67.2	66.4	28,770	34,675	29.1	31.2	26.1	28.2
71	Haiti	0.1	0.1	68.8	60.5	2,375	2,337	9.4	10.1	4.4	4.7
72	Honduras	5.9	5.2	95.5	91.2	17,497	33,443	23.0	23.5	22.8	24.6
73	Hong Kong, China	59.2	58.7	228.7	234.0	4,741,239	4,906,023	80.4	81.0	79.0	82.0
74	Hungary	31.2	31.5	118.9	119.1	134,830	154,765	75.0	76.4	75.6	78.6
75	Iceland	49.9	48.4	114.0	118.0	725,806	997,830	98.5	98.5	96.5	97.0
76	India	2.0 <sup>17</sup>	1.9 <sup>18</sup>	78.1 <sup>17</sup>	87.0 <sup>18</sup>	5,725 <sup>3</sup>	15,956	14.1	15.2	20.0	22.6
77	Indonesia	4.1 <sup>18</sup>	4.0	132.6	149.1	26,988	24,947	18.7	19.1	38.4	47.2
78	Iran (I.R.)	38.3	38.3	93.4	100.1	8,267	15,238	57.4	61.4	55.5	62.2
79	Ireland	40.9 <sup>19</sup>	39.7 <sup>19</sup>	103.7	103.6	188,191	183,943	83.5	84.1	85.0	87.0
80	Israel	43.1 <sup>20</sup>	41.6 <sup>20</sup>	133.5 <sup>18</sup>	131.7 <sup>19</sup>	143,150	158,696	80.3	81.1	74.3	75.7
81	Italy	33.1 <sup>21</sup>	33.1 <sup>21</sup>	143.4 <sup>19</sup>	140.4 <sup>20</sup>	70,546	82,335	63.9	64.7	66.2	69.2
82	Jamaica	9.0	11.0	111.5	115.6	36,639	47,949	36.5	39.1	34.6	36.7
83	Japan	50.2	50.6 <sup>22</sup>	126.5 <sup>20</sup>	129.8 <sup>21</sup>	64,180 <sup>4</sup>	83,010 <sup>1</sup>	79.7	81.0	97.2	97.2
84	Jordan	4.8	4.6	179.4	196.3	24,450	8,229	50.6	53.1	75.9	79.0
85	Kazakhstan	24.7	23.2	156.9	150.0	69,583	87,235	74.2	76.2	82.2	84.4
86	Kenya	0.2 <sup>22</sup>	0.2 <sup>23</sup>	80.7	81.3	87,046	69,014	13.1	14.8	19.6	22.3
87	Kiribati	1.4	0.9	38.8	51.3	2,916	4,426	6.7	7.3	6.3	6.9
88	Korea (Rep.)	58.1	56.1	118.5	122.7	46,894	54,252	77.1	75.3	98.8	99.2
89	Kuwait	13.4	11.0	163.2	146.6	77,395	69,516	82.0	83.5	76.9	77.7
90	Kyrgyzstan	7.1	6.6	132.8	131.4	44,790	65,377	19.5	21.4	16.5	18.8
91	Lao P.D.R.	13.7 <sup>23</sup>	17.7 <sup>24</sup>	53.1 <sup>21</sup>	55.4 <sup>22</sup>	16,795 <sup>5</sup>	17,487	11.4	12.3	13.4	18.7
92	Latvia	17.5 <sup>24</sup>	18.2 <sup>25</sup>	127.5 <sup>22</sup>	131.2 <sup>23</sup>	213,210	246,666	76.1	78.0	76.0	77.3
93	Lebanon	20.0	21.0	92.2	96.4	40,913	55,086	76.5	78.1	75.7	77.7
94	Lesotho	1.9	1.9	100.9	106.6	3,311	4,484	7.8	8.2	25.4	27.9
95	Libya	16.8	21.5	154.3	119.8	5,133	5,286	22.0	23.5	20.4	22.0

	Economy	Fixed-telephone subscriptions per 100 inhabitants		Mobile-cellular subscriptions per 100 inhabitants		International Internet bandwidth Bit/s per Internet user		Percentage of households with computer		Percentage of households with Internet	
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
		96	Lithuania	18.7	17.8	139.5	140.7	138,946	198,564	67.6	70.5
97	Luxembourg	51.0 <sup>25</sup>	50.9	148.5	147.8	7,186,378	8,397,884	95.3	95.9	96.8	96.4
98	Macao, China	25.0 <sup>26</sup>	23.9	324.4	332.1 <sup>24</sup>	111,931	252,868	79.0	77.9	86.3	88.6
99	Madagascar	1.0	0.6	44.1	41.8	12,420	14,258	5.3	6.2	5.8	7.0
100	Malawi	0.1 <sup>27</sup>	0.1	37.9 <sup>23</sup>	40.3	1,631 <sup>6</sup>	4,201	5.8	6.4	9.1	11.5
101	Malaysia	14.6	14.5	143.9	141.2	34,119	42,627	67.6	72.2	70.1	76.9
102	Maldives	6.1	5.8	206.7	223.0	48,147	59,669	68.5	71.1	49.6	54.7
103	Mali	1.0	1.2	139.6	120.3	344	598	3.3	3.2	8.2	8.9
104	Malta	53.4	54.2	121.5	124.8	1,220,570	1,596,254	81.1	81.6	81.9	81.1
105	Mauritania	1.3	1.3	89.3 <sup>24</sup>	86.5 <sup>25</sup>	3,785	4,477	4.7	5.0	7.7	11.2
106	Mauritius	30.3	30.7 <sup>26</sup>	140.6 <sup>25</sup>	144.2 <sup>26</sup>	33,896	63,491	57.0	61.2	60.0	63.8
107	Mexico	15.4	15.5 <sup>27</sup>	86.0	88.2 <sup>27</sup>	29,775	37,598	44.9	45.6	39.2	47.0
108	Moldova	35.0	34.3	108.0 <sup>26</sup>	111.0 <sup>28</sup>	153,430	144,087	68.0 <sup>3</sup>	71.0 <sup>1</sup>	68.0 <sup>1</sup>	76.0 <sup>1</sup>
109	Monaco	128.1	120.7	88.8	86.3	64,287	95,232	84.0	84.1	76.6	78.3
110	Mongolia	8.7	7.6	105.0	113.6	162,429	166,056	42.6	23.6	24.5	23.6
111	Montenegro	24.8	23.8	162.2	167.5	96,835	202,876	56.0	58.2	67.5	69.8
112	Morocco	6.5	6.0	126.9	120.7	18,316	25,702	54.8	54.9	66.5	68.5
113	Mozambique	0.3	0.3	74.2	66.3 <sup>29</sup>	1,519	1,115	6.1	6.5	13.2	16.2
114	Myanmar	1.0	0.9	75.7	89.3	5,214	6,426	11.3	13.6	19.7	24.4
115	Namibia	7.6	7.7	106.6	109.2	19,579	15,915	17.7	20.0	24.5	29.5
116	Nepal	3.0 <sup>28</sup>	3.0 <sup>28</sup>	96.7 <sup>27</sup>	111.7 <sup>30</sup>	3,200	3,886	8.9	11.2	12.0	15.0
117	Netherlands	41.3	40.3 <sup>29</sup>	123.5	130.0 <sup>31</sup>	177,467	196,105	88.3 <sup>4</sup>	89.6 <sup>2</sup>	90.9 <sup>2</sup>	92.2 <sup>2</sup>
118	New Zealand	40.2	39.2 <sup>30</sup>	121.8	125.0 <sup>32</sup>	63,624	109,601	82.3	86.6	82.8	85.7
119	Nicaragua	5.7 <sup>29</sup>	5.8 <sup>31</sup>	116.1 <sup>28</sup>	122.1 <sup>33</sup>	23,871	29,161	11.8	13.1	14.0	16.2
120	Nigeria	0.1	0.1 <sup>32</sup>	82.2	81.8	5,783	11,257	9.8	10.6	12.5	15.2 <sup>3</sup>
121	Norway	18.4	16.6 <sup>33</sup>	111.1	110.1 <sup>34</sup>	206,668	268,953	96.5	97.6	96.6	97.1
122	Oman	10.5	9.8 <sup>34</sup>	159.9	159.2	67,052	66,071	87.5	87.5	84.0	86.1
123	Pakistan	1.9 <sup>30</sup>	1.6 <sup>35</sup>	66.9 <sup>29</sup>	71.4 <sup>35</sup>	15,309 <sup>7</sup>	16,636	15.2	16.1	19.0	22.1
124	Palestine*	8.9	9.3	77.6	76.8	0	0	66.7	70.4	52.4	56.5
125	Panama	15.6 <sup>31</sup>	15.8 <sup>36</sup>	174.2 <sup>30</sup>	172.3 <sup>36</sup>	38,193	55,072	39.6	42.5	52.7	53.9
126	Paraguay	5.5	5.1	105.4	104.8 <sup>37</sup>	16,421	21,015	29.0	30.3	22.7	26.0
127	Peru	9.3	9.7 <sup>37</sup>	109.9 <sup>31</sup>	117.1 <sup>38</sup>	31,297	33,315	32.6	33.5	23.2	26.4
128	Philippines	3.2	3.7	115.8	109.2 <sup>39</sup>	28,353	43,440	32.5	34.0	36.1	39.1
129	Poland	23.7 <sup>32</sup>	24.5	142.7	146.2	78,216	83,299	77.9	80.1	75.8	80.4
130	Portugal	44.1	45.1	110.4 <sup>32</sup>	109.1 <sup>40</sup>	148,747	177,808	71.1	72.7	70.2	74.1
131	Qatar	17.6	19.3	159.1	147.1	71,566	86,950	88.3	89.0	95.8	95.8
132	Romania	19.8	19.1 <sup>38</sup>	107.1 <sup>33</sup>	106.4 <sup>41</sup>	146,012 <sup>8</sup>	155,516 <sup>2</sup>	68.7	74.0	67.7	72.4
133	Russian Federation	25.0	22.8	160.0	163.3	26,845	51,888	72.5	74.3 <sup>3</sup>	72.1	74.8 <sup>4</sup>
134	Rwanda	0.1 <sup>33</sup>	0.1 <sup>39</sup>	70.5	69.9	5,661	7,455	4.0	4.5	6.7	9.3
135	S. Tomé & Príncipe	3.2	2.8 <sup>40</sup>	91.2	85.3 <sup>42</sup>	20,627	37,317	14.9	16.8	16.6	20.0
136	Samoa	5.9 <sup>34</sup>	3.7 <sup>41</sup>	62.4 <sup>34</sup>	69.2 <sup>43</sup>	7,842 <sup>9</sup>	13,159	22.6	24.0	25.5	29.1
137	Saudi Arabia	12.5	12.0	176.6	157.6	88,669	78,163	67.0	69.0	94.0	94.6
138	Senegal	2.0	1.9	99.9	98.7	5,338	4,977	12.9	15.1	15.7	19.9
139	Serbia	36.5	36.0	120.5	120.6	23,693	26,292	64.4	65.8	63.8	64.7
140	Seychelles	22.8	22.1	158.1	161.2	41,126 <sup>10</sup>	52,433 <sup>3</sup>	54.6	56.7	52.4	55.2
141	Singapore	35.9	35.0 <sup>42</sup>	146.5 <sup>35</sup>	146.9 <sup>44</sup>	765,829	982,923	87.0	86.6	88.2	91.1
142	Slovakia	15.9	15.1	122.3	128.0	41,269	52,351	80.5	80.9	79.5	80.5
143	Slovenia	36.2	35.1	113.2	114.6	186,317	239,168	77.8	78.1 <sup>4</sup>	77.6	78.4
144	Solomon Islands	1.3	1.2	72.7	69.9	7,100	11,971	6.7	7.4	6.3	8.5

Economy	Fixed-telephone subscriptions per 100 inhabitants		Mobile-cellular subscriptions per 100 inhabitants		International Internet bandwidth Bit/s per Internet user		Percentage of households with computer		Percentage of households with Internet		
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	
	145	South Africa	7.7	6.6	164.5 <sup>36</sup>	142.4 <sup>45</sup>	147,630	263,030	20.1	24.4	50.0
146	Spain	41.5	41.3	108.2	109.7	87,791	112,997	75.9	77.1	78.7	81.9
147	Sri Lanka	15.2 <sup>35</sup>	11.4 <sup>43</sup>	110.6	118.5	15,815	22,038	24.2	25.4	18.1	21.1
148	St. Kitts and Nevis	35.7	31.2	131.8	136.9	131,203	165,372	70.8	71.7	70.5	72.6
149	St. Lucia	18.9	18.8	101.5	94.8	7,704	7,558	41.1	43.7	39.7	43.1
150	St. Vincent and the Grenadines	22.7	18.8	103.7	103.0	158,187	188,740	61.8	63.9	49.4	51.0
151	Sudan	0.3 <sup>36</sup>	0.3	70.5	68.6	2,189	2,035	17.1	18.0	32.3	33.6
152	Suriname	16.8	16.1	136.8	145.9	3,884	66,533	45.2	46.4	39.1	42.4
153	Sweden	36.7	34.1 <sup>44</sup>	130.4	126.7 <sup>46</sup>	421,237	505,650	88.3	88.5	91.0	92.0
154	Switzerland	50.3 <sup>37</sup>	48.4 <sup>45</sup>	136.5 <sup>37</sup>	135.6 <sup>47</sup>	233,990	269,222	88.4	89.3	84.7	86.8
155	Syria	15.9	15.2	64.3	54.2	7,125	12,813	49.9	49.9	42.3	43.6
156	Tanzania	0.3	0.2	75.9	74.4	2,199	1,741	3.9	3.9	5.1	8.5
157	TFYR Macedonia	17.6	17.4 <sup>46</sup>	98.8	100.7 <sup>48</sup>	91,492	109,004	68.4	69.8	69.4	70.4
158	Thailand	7.9 <sup>38</sup>	7.0	152.7 <sup>38</sup>	172.6	55,020	49,244	29.5 <sup>5</sup>	28.4	52.2	59.8
159	Timor-Leste	0.2	0.2	117.4	125.0	2,010	1,888	14.8	16.2	21.8	23.9
160	Togo	0.7 <sup>39</sup>	0.5 <sup>47</sup>	67.7	74.9	7,310	4,490	6.1	6.8	4.1	7.7
161	Tonga	12.4	10.3	69.1	74.7	17,025 <sup>11</sup>	33,947	37.1	38.8	39.5	42.6
162	Trinidad & Tobago	20.1	20.2	157.7	160.6	122,703	182,808	67.9	71.4	65.0	70.9
163	Tunisia	8.4	8.6	129.9	125.8	22,013	31,167	34.5	37.0	30.7	33.0
164	Turkey	15.0	14.3	96.0	96.9	59,034	68,058	55.6	58.0	69.5	76.3
165	Uganda	0.8 <sup>40</sup>	0.9 <sup>48</sup>	50.4 <sup>39</sup>	55.1 <sup>49</sup>	4,993 <sup>12</sup>	5,510	6.7	7.6	7.2	8.9
166	Ukraine	21.6	19.8	144.0	132.6	73,425	79,885	59.2	65.1	50.2	54.8
167	United Arab Emirates	23.6	23.4	187.3	204.0	108,791 <sup>13</sup>	133,749 <sup>4</sup>	89.3	91.0	95.4	94.3
168	United Kingdom	52.0	52.2	124.1	122.3	374,554	449,137	89.9	89.8	91.3	91.3
169	United States	38.4 <sup>41</sup>	37.1 <sup>49</sup>	117.6 <sup>40</sup>	127.2 <sup>50</sup>	99,011	126,545	86.8	87.0	81.5	84.0
170	Uruguay	32.3	32.4	150.6 <sup>41</sup>	148.7 <sup>51</sup>	73,151 <sup>14</sup>	96,707 <sup>5</sup>	68.0	69.5	59.7	61.8
171	Uzbekistan	9.5	11.3	73.3	77.3	2,075	5,683	43.2	43.9	75.4	75.4
172	Vanuatu	1.8	1.6	66.2	71.3	35,468	21,921	21.0	22.6	27.4	29.5
173	Venezuela	24.9 <sup>42</sup>	24.4 <sup>50</sup>	93.0 <sup>42</sup>	87.0 <sup>52</sup>	16,310	18,937	44.1	42.7	34.7	34.0
174	Viet Nam	7.8	5.9	128.8	128.0	41,300	91,252	22.0	23.5	24.1	25.9
175	Zambia	0.7	0.6	74.5	74.9	3,187	3,925	7.1	8.1	12.7	14.3
176	Zimbabwe	2.2	2.0	84.8	83.2	4,590	9,119	11.8	12.9	21.6	22.1

Note: Data in italics are ITU estimates. \*Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (Rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU World Telecommunication/ICT Indicators database.

## Use indicators

Economy	Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile-broadband subscriptions per 100 inhabitants	
	2015	2016	2015	2016	2015	2016
1 Afghanistan	8.3	10.6	0.0	0.0	6.0	14.3
2 Albania	63.3	66.4	7.6	8.2	40.6	52.6
3 Algeria	38.2	42.9	5.6 <sup>1</sup>	6.9	40.2 <sup>1</sup>	46.8
4 Andorra	96.9	97.9	37.9	39.8	42.1	47.8
5 Angola	12.4	13.0	0.7	0.5 <sup>1</sup>	19.3	17.1
6 Antigua & Barbuda	70.0	73.0	10.9	10.0	33.8	44.2
7 Argentina	68.0	70.2	16.3	16.9	78.4 <sup>2</sup>	80.5
8 Armenia	59.1	62.0	9.6	10.1	40.3	53.9
9 Australia	84.6 <sup>1</sup>	88.2	28.5 <sup>2</sup>	30.4 <sup>2</sup>	126.5 <sup>3</sup>	130.2 <sup>1</sup>
10 Austria	83.9 <sup>2</sup>	84.3	28.7	29.4	70.5	88.3
11 Azerbaijan	77.0 <sup>3</sup>	78.2	19.8	18.6	60.9	57.4
12 Bahamas	78.0	80.0	20.9	22.0 <sup>3</sup>	47.1	51.2
13 Bahrain	93.5 <sup>4</sup>	98.0	18.6	16.8	131.8	162.1
14 Bangladesh	14.4	18.2	3.1	3.8 <sup>4</sup>	15.7	17.8 <sup>2</sup>
15 Barbados	76.1	79.5	27.2	30.1	54.9	59.3
16 Belarus	67.3 <sup>5</sup>	71.1	31.4	33.3	61.8	69.5
17 Belgium	85.1 <sup>6</sup>	86.5 <sup>1</sup>	36.8	38.0	62.1	66.7
18 Belize	41.6	44.6	5.0 <sup>3</sup>	6.2	12.1 <sup>4</sup>	13.8
19 Benin	11.3	12.0	0.7	0.8	4.2	5.6
20 Bhutan	39.8	41.8	3.6	3.9 <sup>5</sup>	46.7 <sup>5</sup>	47.9 <sup>3</sup>
21 Bolivia	35.6	39.7	1.6	2.6	33.8 <sup>6</sup>	57.6 <sup>4</sup>
22 Bosnia and Herzegovina	65.1	69.3	16.6	17.4	33.5	37.4
23 Botswana	37.3	39.4	1.8	2.8 <sup>6</sup>	67.6	67.9 <sup>5</sup>
24 Brazil	58.3	59.7	12.2 <sup>4</sup>	13.0	88.6	89.5
25 Brunei Darussalam	71.2	75.0	8.0	8.3	94.9	116.6
26 Bulgaria	56.7 <sup>7</sup>	59.8	22.7 <sup>5</sup>	23.3 <sup>7</sup>	81.3	88.4 <sup>6</sup>
27 Burkina Faso	11.4	14.0	0.0	0.0 <sup>8</sup>	15.3	19.9
28 Burundi	4.9	5.2	0.0	0.0 <sup>8</sup>	7.6	8.3 <sup>7</sup>
29 Cambodia	19.0	25.6	0.5	0.6	42.8	50.2
30 Cameroon	20.7	25.0	0.1	0.2 <sup>9</sup>	4.3	9.6
31 Canada	88.5	89.8	36.3	37.3	61.4	66.1 <sup>8</sup>
32 Cape Verde	48.0	48.2	3.3	3.0	69.6	70.0
33 Central African Rep.	3.8	4.0	0.0	0.0	2.6 <sup>7</sup>	3.3
34 Chad	3.5	5.0	0.1 <sup>6</sup>	0.1	1.4 <sup>8</sup>	9.5
35 Chile	64.3	66.0	15.2	16.0	56.1	69.0
36 China	50.3 <sup>8</sup>	53.2	19.8	22.9	55.5	66.8
37 Colombia	55.9 <sup>9</sup>	58.1	11.2 <sup>7</sup>	11.8 <sup>10</sup>	41.0 <sup>9</sup>	45.5 <sup>9</sup>
38 Comoros	7.5	7.9	0.3	0.4	0.0	0.0
39 Congo (Dem. Rep.)	3.8	6.2	0.0	0.0	8.5	14.2
40 Costa Rica	59.8 <sup>10</sup>	66.0	11.2	11.6	97.2	109.5
41 Côte d'Ivoire	21.9	26.5	0.5	0.6	40.4	47.5
42 Croatia	69.8 <sup>11</sup>	72.7	23.2	24.6	73.1	79.7
43 Cuba	37.3 <sup>12</sup>	38.8	0.1	0.1	0.0	0.0
44 Cyprus	71.7 <sup>13</sup>	75.9	30.9	33.0	75.7	97.5
45 Czech Republic	75.7 <sup>14</sup>	76.5 <sup>2</sup>	27.3 <sup>8</sup>	27.7 <sup>11</sup>	72.0	76.0 <sup>10</sup>

Economy		Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile-broadband subscriptions per 100 inhabitants	
		2015	2016	2015	2016	2015	2016
46	Denmark	96.3 <sup>15</sup>	97.0	42.5 <sup>9</sup>	42.8 <sup>12</sup>	117.6	124.2
47	Djibouti	11.9	13.1	2.7	3.0	5.6	11.6
48	Dominica	65.0	67.0	20.9	21.2	42.2	41.0
49	Dominican Rep.	54.2 <sup>16</sup>	61.3	6.4	6.5	39.6	49.2
50	Ecuador	48.9 <sup>17</sup>	54.1	9.7 <sup>10</sup>	9.7	35.1	47.2
51	Egypt	37.8 <sup>18</sup>	39.2	4.5	5.2	50.7	52.6
52	El Salvador	26.8	29.0	5.5	6.0 <sup>13</sup>	19.9	28.5
53	Equatorial Guinea	21.3	23.8	0.5	0.5	0.0 <sup>10</sup>	0.1
54	Eritrea	1.1	1.2	0.0	0.0	0.0	0.0
55	Estonia	88.4 <sup>19</sup>	87.2	30.0	31.1	112.9	125.0
56	Ethiopia	11.6	15.4	0.5	0.6	3.7 <sup>11</sup>	5.3
57	Fiji	42.5	46.5	1.4	1.4	48.2	54.3
58	Finland	86.4 <sup>20</sup>	87.7 <sup>3</sup>	31.7	31.2	144.0	153.0
59	France	84.7 <sup>21</sup>	85.6	41.3	42.4	74.7	81.7
60	Gabon	45.8	48.1	0.6	0.7	36.3	66.1
61	Gambia	16.5	18.5	0.2	0.2	13.5	21.3
62	Georgia	47.6 <sup>22</sup>	50.0	14.7	15.8	50.5 <sup>12</sup>	57.7
63	Germany	87.6 <sup>23</sup>	89.6	37.2	38.1 <sup>14</sup>	70.8	80.2
64	Ghana	31.4	34.7	0.3	0.3	66.8	71.3
65	Greece	66.8 <sup>24</sup>	69.1	30.9 <sup>11</sup>	32.5	45.6	51.3
66	Grenada	53.8	55.9	18.5	19.4	28.8	32.9
67	Guatemala	28.8	34.5	2.8	3.0	10.1 <sup>13</sup>	13.9
68	Guinea	8.2	9.8	0.0	0.0	13.9	15.0
69	Guinea-Bissau	3.5	3.8	0.1 <sup>12</sup>	0.0 <sup>15</sup>	0.0	6.9
70	Guyana	34.0	35.7	6.6	7.6	0.2	0.2
71	Haiti	12.2	12.2	0.0	0.0	0.2	10.3
72	Honduras	27.6	30.0	2.3	2.6	17.2 <sup>14</sup>	22.5 <sup>11</sup>
73	Hong Kong, China	84.9 <sup>25</sup>	87.3	32.1	35.5	107.2	105.9
74	Hungary	72.8 <sup>26</sup>	79.3	27.4	28.5	39.8	44.5
75	Iceland	98.2	98.2	37.0	37.6	93.4	104.0
76	India	26.0	29.5	1.3 <sup>13</sup>	1.4 <sup>16</sup>	9.4 <sup>15</sup>	16.8 <sup>12</sup>
77	Indonesia	22.0 <sup>27</sup>	25.4	1.6	1.9	42.0	67.3
78	Iran (I.R.)	45.3 <sup>28</sup>	53.2	10.9	11.6	20.0	33.8
79	Ireland	80.1 <sup>29</sup>	82.2 <sup>4</sup>	27.7	28.5	95.0 <sup>16</sup>	98.2 <sup>13</sup>
80	Israel	77.4 <sup>30</sup>	79.8	27.4 <sup>14</sup>	28.1 <sup>17</sup>	84.6	93.4 <sup>14</sup>
81	Italy	58.1 <sup>31</sup>	61.3 <sup>5</sup>	24.4 <sup>15</sup>	25.4 <sup>18</sup>	82.1 <sup>17</sup>	86.7 <sup>15</sup>
82	Jamaica	42.2 <sup>32</sup>	45.0	8.1	10.1	53.5	56.2
83	Japan	91.1	92.0	30.7	31.5 <sup>19</sup>	128.3 <sup>18</sup>	131.9 <sup>16</sup>
84	Jordan	60.1	62.3	4.2	5.8	98.4	118.8
85	Kazakhstan	72.9 <sup>33</sup>	76.8	13.7	13.7 <sup>20</sup>	73.1	71.0
86	Kenya	21.0	26.0	0.3	0.3	15.5	26.2
87	Kiribati	13.0	13.7	0.1	0.1	0.3	0.9
88	Korea (Rep.)	89.6 <sup>34</sup>	92.7	40.2	41.1	109.7	111.5
89	Kuwait	77.5	78.4	1.5	2.8	52.5	66.8
90	Kyrgyzstan	30.2	34.5	3.7	4.1	31.0	46.1
91	Lao P.D.R.	18.2	21.9	0.5 <sup>16</sup>	0.3 <sup>21</sup>	14.2 <sup>19</sup>	34.7 <sup>17</sup>
92	Latvia	79.2 <sup>35</sup>	79.9	24.8 <sup>17</sup>	25.6 <sup>22</sup>	67.0 <sup>20</sup>	77.0 <sup>18</sup>

Economy	Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile-broadband subscriptions per 100 inhabitants	
	2015	2016	2015	2016	2015	2016
93 Lebanon	74.0	76.1	25.4	25.6	57.7	67.2
94 Lesotho	25.0	27.4	0.1	0.1	39.2	36.9
95 Libya	19.0	20.3	1.0	2.6	31.8	34.9
96 Lithuania	71.4 <sup>36</sup>	74.4	27.8 <sup>18</sup>	28.7 <sup>23</sup>	67.6	76.8 <sup>19</sup>
97 Luxembourg	97.3 <sup>37</sup>	97.5	35.9 <sup>19</sup>	36.7	87.8	90.2
98 Macao, China	77.6 <sup>38</sup>	81.6	29.1	30.0 <sup>24</sup>	324.4	332.1 <sup>20</sup>
99 Madagascar	4.2	4.7	0.1	0.1	13.2	10.5
100 Malawi	9.3	9.6	0.0	0.0	16.2	18.5
101 Malaysia	71.1 <sup>39</sup>	78.8	10.0	8.7	90.6 <sup>21</sup>	91.7
102 Maldives	54.5	59.1	6.5	7.2	63.6 <sup>22</sup>	72.7 <sup>21</sup>
103 Mali	10.3	11.1	0.0	0.0	18.8 <sup>23</sup>	24.4
104 Malta	76.2 <sup>40</sup>	77.3	37.8	39.6	62.6	71.4
105 Mauritania	15.2	18.0	0.2	0.3	23.1	30.2 <sup>22</sup>
106 Mauritius	50.1 <sup>41</sup>	53.2	15.7 <sup>20</sup>	16.9 <sup>25</sup>	37.0 <sup>24</sup>	51.7 <sup>23</sup>
107 Mexico	57.4 <sup>42</sup>	59.5	11.8	12.7 <sup>26</sup>	51.0	58.8 <sup>24</sup>
108 Moldova	63.3	71.0	15.5	16.3	51.9	55.5
109 Monaco	93.4	95.2	47.9	48.2	67.1 <sup>25</sup>	64.8 <sup>25</sup>
110 Mongolia	21.4 <sup>43</sup>	22.3	7.1	7.6	76.0	82.0
111 Montenegro	68.1 <sup>44</sup>	69.9	18.1	18.5	58.2	60.7
112 Morocco	57.1 <sup>45</sup>	58.3	3.4	3.7	39.3	46.0
113 Mozambique	16.9	17.5	0.2	0.1 <sup>27</sup>	44.9 <sup>26</sup>	49.5
114 Myanmar	21.7	25.1	0.1	0.1	33.5 <sup>27</sup>	47.6
115 Namibia	25.7	31.0	1.9	2.2	35.8	66.1
116 Nepal	17.6	19.7	1.1 <sup>21</sup>	0.8 <sup>28</sup>	26.4 <sup>28</sup>	30.8
117 Netherlands	91.7 <sup>46</sup>	90.4 <sup>6</sup>	41.7	42.2 <sup>29</sup>	81.6	87.8 <sup>26</sup>
118 New Zealand	88.2	88.5	31.6 <sup>22</sup>	32.4 <sup>30</sup>	114.2	101.3 <sup>27</sup>
119 Nicaragua	19.7	24.6	1.9 <sup>23</sup>	2.8 <sup>31</sup>	7.2	22.8
120 Nigeria	24.5	25.7	0.0	0.0	21.0	21.8
121 Norway	96.8 <sup>47</sup>	97.3	39.7	40.4 <sup>32</sup>	100.2	101.8 <sup>28</sup>
122 Oman	66.1	69.8	5.6 <sup>24</sup>	6.2	78.3	91.3
123 Pakistan	14.0	15.5	1.0 <sup>25</sup>	0.9 <sup>33</sup>	13.0 <sup>29</sup>	20.1 <sup>29</sup>
124 Palestine*	57.4	61.2	6.0	6.9	0.0	0.0
125 Panama	51.2 <sup>48</sup>	54.0	7.9 <sup>26</sup>	9.5 <sup>34</sup>	32.7	29.7
126 Paraguay	48.4 <sup>49</sup>	51.3	3.1 <sup>27</sup>	3.4 <sup>35</sup>	39.2 <sup>30</sup>	41.7 <sup>30</sup>
127 Peru	40.9 <sup>50</sup>	45.5	6.4	6.7	55.0 <sup>31</sup>	62.0 <sup>31</sup>
128 Philippines	53.7	55.5	4.8 <sup>28</sup>	5.5	41.6	46.3
129 Poland	68.0 <sup>51</sup>	73.3 <sup>7</sup>	19.0 <sup>29</sup>	19.2	57.4 <sup>32</sup>	58.9
130 Portugal	68.6 <sup>52</sup>	70.4	29.6	31.8	52.0	61.1
131 Qatar	92.9 <sup>53</sup>	94.3	10.1	10.8	120.5	129.2
132 Romania	55.8 <sup>54</sup>	59.5	19.8 <sup>30</sup>	20.7 <sup>36</sup>	63.7 <sup>33</sup>	73.7 <sup>32</sup>
133 Russian Federation	73.4 <sup>55</sup>	76.4 <sup>8</sup>	18.9	19.5	71.2	75.0
134 Rwanda	18.0	20.0	0.2	0.2	25.9	27.0
135 S. Tomé & Príncipe	25.8	28.0	0.6	0.7 <sup>37</sup>	17.7	24.0 <sup>33</sup>
136 Samoa	25.4	29.4	1.1 <sup>31</sup>	1.2 <sup>38</sup>	9.6 <sup>34</sup>	26.6 <sup>34</sup>
137 Saudi Arabia	69.6 <sup>56</sup>	73.8	11.9 <sup>32</sup>	10.8	111.7	78.5
138 Senegal	21.7	25.7	0.7	0.6	26.4	26.1
139 Serbia	65.3 <sup>57</sup>	67.1	17.4	18.9	66.9	67.4

Economy	Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Active mobile-broadband subscriptions per 100 inhabitants	
	2015	2016	2015	2016	2015	2016
140 Seychelles	54.3	56.5	14.3	14.9	19.1	22.6
141 Singapore	79.0	81.0	26.5	25.4 <sup>39</sup>	143.2 <sup>35</sup>	144.6 <sup>35</sup>
142 Slovakia	77.6 <sup>58</sup>	80.5 <sup>9</sup>	23.3	24.5	67.5	78.7
143 Slovenia	73.1 <sup>59</sup>	75.5	27.4	28.3	52.0	62.3
144 Solomon Islands	10.0	11.0	0.2	0.2	11.4 <sup>36</sup>	12.9
145 South Africa	51.9	54.0	2.6	2.8	59.5	58.6
146 Spain	78.7 <sup>60</sup>	80.6	28.7	29.5	82.7	87.3
147 Sri Lanka	30.0	32.1	2.9	4.1	15.8	18.3
148 St. Kitts and Nevis	75.7	76.8	29.6	29.3	71.0	77.1
149 St. Lucia	42.5	46.7	15.4	15.9	33.6	37.0
150 St. Vincent and the Grenadines	51.8	55.6	15.5	20.0	39.0	49.4
151 Sudan	26.6	28.0	0.1	0.1	29.4	25.2
152 Suriname	42.8	45.4	9.6	12.9	66.6	69.6
153 Sweden	90.6 <sup>61</sup>	91.5	36.1	36.3 <sup>40</sup>	122.1	125.2 <sup>36</sup>
154 Switzerland	87.5 <sup>62</sup>	89.4	45.1 <sup>33</sup>	46.3 <sup>41</sup>	102.0 <sup>37</sup>	103.7 <sup>37</sup>
155 Syria	30.0	31.9	3.1	4.0	10.5	10.4
156 Tanzania	10.0	13.0	0.2	0.3	9.0	9.2
157 TFYR Macedonia	70.4 <sup>63</sup>	72.2	17.2	17.9 <sup>42</sup>	53.5	59.0 <sup>38</sup>
158 Thailand	39.3 <sup>64</sup>	47.5	9.2 <sup>34</sup>	10.7	88.6 <sup>38</sup>	94.7
159 Timor-Leste	23.0	25.2	0.1	0.1	37.5	64.6
160 Togo	7.1	11.3	0.9 <sup>35</sup>	0.6 <sup>43</sup>	6.0	19.6
161 Tonga	38.7	40.0	2.3	2.8	50.0	56.0
162 Trinidad & Tobago	69.2	73.3	20.0	18.9	32.9	47.3
163 Tunisia	48.5	50.9	5.1	5.6	61.9	63.0
164 Turkey	53.7 <sup>65</sup>	58.3	12.4	13.6	50.9	66.8
165 Uganda	17.8	21.9	0.2 <sup>36</sup>	0.3 <sup>44</sup>	18.3 <sup>39</sup>	33.7 <sup>39</sup>
166 Ukraine	48.9 <sup>66</sup>	52.5	11.8	12.0	8.1	22.6
167 United Arab Emirates	90.5	90.6 <sup>10</sup>	12.9	13.3	130.9 <sup>40</sup>	156.7
168 United Kingdom	92.0 <sup>67</sup>	94.8	38.6	39.2	87.5 <sup>41</sup>	91.4
169 United States	74.6 <sup>68</sup>	76.2	31.4 <sup>37</sup>	32.4 <sup>45</sup>	115.5 <sup>42</sup>	120.0 <sup>40</sup>
170 Uruguay	64.6 <sup>69</sup>	66.4	26.3 <sup>38</sup>	26.8	77.7 <sup>43</sup>	102.0 <sup>41</sup>
171 Uzbekistan	42.8	46.8	6.0	9.1	44.0	55.9
172 Vanuatu	22.4	24.0	1.6 <sup>39</sup>	1.6	18.9 <sup>44</sup>	22.3 <sup>42</sup>
173 Venezuela	61.9	60.0	8.2 <sup>40</sup>	8.2 <sup>46</sup>	43.0 <sup>45</sup>	44.6 <sup>43</sup>
174 Viet Nam	43.5	46.5	8.2	9.9	38.3	46.6
175 Zambia	21.0	25.5	0.2 <sup>41</sup>	0.2	13.8	32.2
176 Zimbabwe	22.7	23.1	1.1	1.1	39.0	38.1

Note: Data in italics are ITU estimates. \*Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (Rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: ITU World Telecommunication/ICT Indicators database.

## Skills indicators

Economy	Gross enrolment ratio				Mean years of schooling		
	Secondary		Tertiary		2015	2016	
	2015	2016	2015	2016			
1	Afghanistan	54.3	55.6	3.7	8.7	3.2	3.6
2	Albania	96.4	95.8	62.7	58.1	9.3	9.6
3	Algeria	97.6	99.9	34.6	36.9	7.6	7.8
4	Andorra	130.8	130.8	84.6	84.6	10.3	10.3
5	Angola	31.5	28.9	9.9	9.9	4.7	5.0
6	Antigua & Barbuda	102.3	102.7	23.5	23.5	9.2	9.2
7	Argentina	106.3	106.8	80.0	82.9	9.8	9.9
8	Armenia	95.9	88.5	46.6	44.3	10.9	11.3
9	Australia	137.6	137.6	86.6	90.3	13.0	13.2
10	Austria	99.3	100.0	80.0	81.5	10.8	11.3
11	Azerbaijan	102.8	102.8	23.2	25.5	10.6	11.2
12	Bahamas	92.9	92.6	57.1	57.1	10.9	10.9
13	Bahrain	95.5	99.4	36.8	37.4	9.4	9.4
14	Bangladesh	58.3	63.5	13.2	13.4	5.1	5.2
15	Barbados	109.2	109.2	60.8	65.4	10.5	10.5
16	Belarus	107.0	107.1	88.9	87.9	12.0	12.0
17	Belgium	163.1	164.8	72.3	73.3	11.4	11.4
18	Belize	80.2	80.8	24.2	23.3	10.5	10.5
19	Benin	54.4	56.8	15.4	15.4	3.3	3.5
20	Bhutan	84.2	84.2	10.9	10.9	3.0	3.1
21	Bolivia	84.7	86.4	37.7	37.7	8.2	8.2
22	Bosnia and Herzegovina	89.3	89.3	37.7	37.7	9.2	9.0
23	Botswana	83.9	81.4	27.5	27.5	8.9	9.2
24	Brazil	105.8	102.0	25.6	49.3	7.7	7.8
25	Brunei Darussalam	99.1	96.1	31.7	30.8	8.8	9.0
26	Bulgaria	100.9	99.0	70.8	73.9	10.6	10.8
27	Burkina Faso	30.3	33.7	4.8	4.8	1.4	1.4
28	Burundi	37.9	42.5	4.4	4.4	2.7	3.0
29	Cambodia	45.0	45.1	15.8	13.1	4.4	4.7
30	Cameroon	56.4	58.1	11.9	17.5	6.0	6.1
31	Canada	103.4	109.9	66.6	66.6	13.0	13.1
32	Cape Verde	92.6	92.9	23.0	21.7	4.7	4.8
33	Central African Rep.	17.4	17.4	2.8	2.8	4.2	4.2
34	Chad	22.8	22.4	3.4	3.4	1.9	2.3
35	Chile	100.5	100.6	83.8	88.6	9.8	9.9
36	China	96.2	94.3	30.2	43.4	7.5	7.6
37	Colombia	93.0	98.1	51.3	55.6	7.3	7.6
38	Comoros	59.3	60.4	8.7	8.9	4.8	4.8
39	Congo (Dem. Rep.)	43.5	43.5	6.6	6.6	6.0	6.1
40	Costa Rica	120.3	123.1	53.0	53.6	8.7	8.7
41	Côte d'Ivoire	40.1	43.9	8.7	9.2	4.3	5.0
42	Croatia	98.4	99.0	61.6	69.5	11.0	11.2
43	Cuba	99.7	100.4	41.0	36.3	11.5	11.8
44	Cyprus	99.4	99.8	53.1	60.1	11.7	11.7
45	Czech Republic	104.4	105.1	65.4	66.0	12.3	12.3
46	Denmark	129.8	129.9	81.2	81.5	12.7	12.7

Economy	Gross enrolment ratio				Mean years of schooling		
	Secondary		Tertiary		2015	2016	
	2015	2016	2015	2016			
47	Djibouti	47.1	48.3	4.9	5.0	3.8	4.1
48	Dominica	96.7	100.5	34.2	34.2	7.9	7.9
49	Dominican Rep.	78.4	77.8	47.5	47.5	7.7	7.7
50	Ecuador	104.2	107.2	40.5	40.5	7.6	8.3
51	Egypt	86.0	86.1	30.3	36.2	6.6	7.1
52	El Salvador	78.1	81.1	29.2	28.9	6.5	6.5
53	Equatorial Guinea	28.2	27.4	3.3	3.2	5.5	5.5
54	Eritrea	34.8	30.5	2.3	2.6	3.9	3.9
55	Estonia	108.6	115.2	72.9	69.6	12.5	12.5
56	Ethiopia	28.9	37.7	6.3	8.1	2.4	2.6
57	Fiji	88.3	88.7	16.1	16.1	9.9	10.5
58	Finland	143.2	149.5	91.1	87.3	10.3	11.2
59	France	110.9	110.6	62.1	64.4	11.4	11.6
60	Gabon	53.9	53.3	8.5	8.4	7.8	8.1
61	Gambia	57.5	57.5	3.4	3.1	2.8	3.3
62	Georgia	99.4	103.7	39.2	43.4	12.3	12.2
63	Germany	102.5	102.7	61.1	68.3	13.5	13.2
64	Ghana	71.0	71.0	15.6	15.9	7.0	6.9
65	Greece	108.2	106.5	110.2	113.9	10.5	10.5
66	Grenada	101.1	99.2	52.8	91.1	8.6	8.6
67	Guatemala	63.5	63.5	18.3	18.3	7.0	6.3
68	Guinea	38.8	38.8	10.8	10.8	2.4	2.6
69	Guinea-Bissau	34.5	32.6	2.6	2.5	2.8	2.9
70	Guyana	101.0	89.3	12.9	12.5	8.5	8.4
71	Haiti	29.4	29.4	6.5	6.5	5.1	5.2
72	Honduras	68.4	70.8	21.2	21.2	6.2	6.2
73	Hong Kong, China	100.6	100.8	68.8	68.5	11.2	11.6
74	Hungary	108.2	105.2	57.0	50.9	11.6	12.0
75	Iceland	112.0	118.6	81.4	81.3	10.6	12.2
76	India	68.9	74.3	23.9	25.5	5.4	6.3
77	Indonesia	82.5	82.5	31.3	31.1	7.6	7.9
78	Iran (I.R.)	88.4	89.2	66.0	71.9	8.2	8.8
79	Ireland	126.5	127.2	73.2	77.6	12.2	12.3
80	Israel	101.5	101.9	66.3	66.2	12.8	12.8
81	Italy	102.4	102.6	63.5	63.1	10.1	10.9
82	Jamaica	83.0	82.1	27.4	27.2	9.7	9.6
83	Japan	101.9	101.7	62.4	63.4	11.5	12.5
84	Jordan	87.8	82.4	46.6	44.9	9.9	10.1
85	Kazakhstan	109.1	112.0	46.0	46.3	11.4	11.7
86	Kenya	67.0	67.6	4.0	4.0	6.3	6.3
87	Kiribati	86.4	87.1	17.0	17.0	7.8	7.8
88	Korea (Rep.)	97.7	97.7	95.3	95.3	11.9	12.2
89	Kuwait	92.5	95.0	27.0	27.0	7.2	7.3
90	Kyrgyzstan	90.8	90.8	47.3	45.9	10.6	10.8
91	Lao P.D.R.	57.2	61.7	17.3	16.9	5.0	5.2
92	Latvia	110.5	115.4	67.0	67.0	11.5	11.7
93	Lebanon	68.2	61.2	42.8	38.5	7.9	8.6
94	Lesotho	52.2	53.8	9.8	9.8	5.9	6.1

Economy	Gross enrolment ratio				Mean years of schooling		
	Secondary		Tertiary		2015	2016	
	2015	2016	2015	2016			
95	Libya	101.6	101.6	61.1	61.1	7.3	7.3
96	Lithuania	105.4	106.8	72.0	68.5	12.7	12.7
97	Luxembourg	102.4	102.3	19.7	19.4	11.7	12.0
98	Macao, China	96.1	96.5	69.4	75.6	7.5	9.8
99	Madagascar	38.4	38.4	4.2	4.8	6.0	6.1
100	Malawi	39.5	43.4	0.8	0.8	4.3	4.4
101	Malaysia	71.1	77.6	38.5	26.1	10.0	10.1
102	Maldives	72.3	69.8	13.2	16.2	5.8	6.2
103	Mali	43.5	41.3	7.5	6.9	2.0	2.3
104	Malta	85.5	85.8	45.1	47.0	11.3	11.3
105	Mauritania	29.9	30.6	5.5	5.3	3.8	4.3
106	Mauritius	97.9	95.7	38.7	36.7	8.5	9.1
107	Mexico	87.0	90.5	29.2	29.9	8.4	8.6
108	Moldova	88.3	86.1	41.3	41.2	11.9	11.9
109	Monaco	109.7	109.7	54.9	54.9	11.4	11.4
110	Mongolia	90.7	91.5	64.3	68.6	9.3	9.8
111	Montenegro	90.3	90.3	55.5	55.3	11.2	11.3
112	Morocco	68.9	69.1	24.6	28.1	4.4	5.0
113	Mozambique	24.5	32.4	6.0	6.0	3.2	3.5
114	Myanmar	51.3	51.3	13.4	13.5	4.1	4.7
115	Namibia	64.8	64.8	9.3	9.3	6.2	6.7
116	Nepal	67.2	69.6	15.8	14.9	3.3	4.1
117	Netherlands	130.7	132.3	77.3	78.5	11.9	11.9
118	New Zealand	117.2	117.5	79.7	80.9	12.5	12.5
119	Nicaragua	68.9	74.2	17.9	17.7	6.0	6.5
120	Nigeria	43.8	55.7	10.4	10.1	5.9	6.0
121	Norway	113.0	113.0	76.1	76.7	12.8	12.7
122	Oman	93.5	104.2	28.1	28.1	8.0	8.1
123	Pakistan	41.6	44.5	10.4	9.9	4.7	5.1
124	Palestine*	82.2	83.0	44.0	44.3	8.9	8.9
125	Panama	75.5	75.5	38.7	38.7	9.3	9.9
126	Paraguay	69.6	76.6	34.5	35.1	8.1	8.1
127	Peru	95.6	95.7	42.6	40.5	9.0	9.0
128	Philippines	88.4	88.4	35.8	35.8	8.9	9.3
129	Poland	108.7	108.7	71.2	71.2	11.9	11.9
130	Portugal	119.7	116.4	66.2	65.6	8.9	8.9
131	Qatar	111.6	109.4	15.8	17.2	9.8	9.8
132	Romania	97.9	92.3	52.2	53.2	10.6	10.8
133	Russian Federation	98.8	100.6	78.0	78.7	12.0	12.0
134	Rwanda	40.2	39.1	7.5	7.5	3.7	3.8
135	S. Tomé & Príncipe	84.9	86.2	9.8	13.4	5.3	5.3
136	Samoa	86.9	85.0	7.5	7.6	10.3	10.3
137	Saudi Arabia	108.3	108.3	61.1	63.1	8.7	9.6
138	Senegal	41.0	49.6	7.6	10.4	2.5	2.8
139	Serbia	94.3	96.7	58.1	58.3	10.8	10.8
140	Seychelles	74.6	81.6	6.5	14.3	9.4	9.4
141	Singapore	97.2	97.2	43.8	69.8	11.6	11.6
142	Slovakia	91.8	91.9	54.4	52.9	12.1	12.2

Economy	Gross enrolment ratio				Mean years of schooling		
	Secondary		Tertiary		2015	2016	
	2015	2016	2015	2016			
143	Slovenia	110.9	110.7	85.2	82.9	12.1	12.1
144	Solomon Islands	48.4	48.4	16.2	16.2	5.0	5.3
145	South Africa	98.2	92.0	19.7	19.4	10.3	10.3
146	Spain	131.1	129.8	87.1	89.7	9.8	9.8
147	Sri Lanka	99.7	99.7	20.7	19.8	10.8	10.9
148	St. Kitts and Nevis	91.5	90.4	79.1	79.6	8.4	8.4
149	St. Lucia	86.5	85.1	16.9	16.8	9.3	9.3
150	St. Vincent and the Grenadines	104.7	106.4	18.2	18.2	8.6	8.6
151	Sudan	40.7	42.7	16.9	16.3	3.1	3.5
152	Suriname	78.5	81.1	12.1	12.7	7.7	8.3
153	Sweden	128.5	132.9	63.4	62.4	12.3	12.3
154	Switzerland	96.3	99.8	56.3	57.2	13.8	13.4
155	Syria	50.5	50.5	34.5	44.0	6.3	5.1
156	Tanzania	32.3	32.3	3.6	3.6	5.1	5.8
157	TFYR Macedonia	82.8	78.6	39.4	39.6	9.3	9.4
158	Thailand	86.2	129.0	51.4	48.9	7.3	7.9
159	Timor-Leste	73.1	76.8	17.7	18.1	4.4	4.4
160	Togo	54.9	54.7	10.1	10.6	4.5	4.7
161	Tonga	90.6	90.1	6.3	6.3	10.7	11.1
162	Trinidad & Tobago	85.5	85.5	12.0	12.0	10.9	10.9
163	Tunisia	90.1	88.2	34.6	34.6	6.8	7.1
164	Turkey	114.6	100.3	79.0	86.3	7.9	7.9
165	Uganda	27.6	26.1	9.1	4.5	5.4	5.7
166	Ukraine	99.2	99.2	82.3	82.3	11.3	11.3
167	United Arab Emirates	83.6	83.6	22.0	22.0	9.5	9.5
168	United Kingdom	124.4	127.8	56.9	56.5	13.3	13.3
169	United States	95.9	97.6	88.8	85.8	13.6	13.2
170	Uruguay	90.3	95.1	63.2	63.1	8.6	8.6
171	Uzbekistan	105.2	95.9	8.9	9.1	10.9	12.0
172	Vanuatu	59.5	54.0	4.7	4.7	6.8	6.8
173	Venezuela	91.6	89.7	78.1	77.0	8.9	9.4
174	Viet Nam	77.2	77.2	30.5	28.8	7.5	8.0
175	Zambia	45.5	45.5	2.4	2.2	6.6	6.9
176	Zimbabwe	47.2	47.6	5.9	8.4	7.3	7.7

Note: Note: \*Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

Source: Gross enrolment ratio refer to latest available data from UIS. Mean years of schooling data are from UNDP HDR and UIS.

## Notes

The notes are presented here as submitted by countries to ITU.

### Access indicators

#### Fixed-telephone subscriptions per 100 inhabitants, 2015

1) Incl. 254132 WLL subscriptions. Source: ARPT/Algérie Télécom. 2) Preliminary. 3) As of June 2016. Source: Australian Communications and Media Authority, 2016, Communications report 2015-16, ACMA, Sydney, p. 7. Change in data source in 2016 to ACCC retail and resale data collected from the providers stated in the Division 12 Record Keeping Rules. 2015 data has been revised to be consistent with the 2016 data collection method and differs from data reported in the previous Communications report. 4) Incl. ISDN channels measured in ISDN B channel equivalents. 5) Incl. PSTN and CDMA fixed base. 6) Bhutan Telecom is the only service provider for fixed-lines in Bhutan. 7) December 2015. 8) Including bundled packages. 9) Decrease due to the reduction of FWLL services which contributes to 78 per cent of total fixed-telephone subscriptions. 10) Sept. 11) Total retail access lines. 12) Source: Sistema de Información Integral Colombia TIC. 13) Preliminary. 14) Incl. IP lines. 15) Incl. public payphones. 16) Including ISDN voice-channel equivalents. Data based on estimates. 17) December 2015. 18) Decrease was due to consumer preference in using mobile phones instead of fixed phones since proliferation of fixed telephone lines (infrastructure) has also decreased, and main priority is in rolling out fiber optic networks for broadband. 19) Incl. PSTN lines, ISDN paths, FWA subscriptions, public payphones and VOIP. 20) Incl. PRI access lines. 21) Source: AGCOM. 22) The major fixed network provider shut down its fixed wireless network and migrated the subscribers to its GSM network. 23) Data from 4 main operators, LTC, BEELINE, UNITEL, ETL. 24) Data on 11.08.2016, source- Public Utilities Commission. 25) Incl. digital lines. Without including separate ISDN channels (fixed-telephone subscriptions). 26) Excl. ISDN channels and fixed wireless subscriptions. 27) 2014 subs included CDMA subscribers however fixed subs only were 18,963. 28) December 2015. Source: January 2016 Management Information System Report. 29) Estimate. 30) Figures are as on 31st December, 2015 based on data received from Fixed Line Operators. 31) Estimate. 32) All fixed subscribers, public payphones and VoIP subscribers. 33) Inactive fixed telephones were disconnected. 34) Refers to Bluesky and Digicel, the two main operators. 35) Ninety day period has been taken into consideration for active fixed telephone subscriptions. 36) Strong decrease due to the disconnection of inactive subscriptions. 37) Estimate. 38) NBTC. 39) Only includes fixed subscriptions (WLL and ISDN) but excludes CDMA. 40) December. 41) Data as of June 30, 2015. 42) Preliminary.

#### Fixed-telephone subscriptions per 100 inhabitants, 2016

1) Incl. 229950 WLL subscriptions. 2) As at June 2016. Source: Australian Communications and Media Authority, 2016, Communications report 2015-16, ACMA, Sydney, p. 7. Change in data source in 2016 to ACCC retail and resale data collected from the providers stated in the Division 12 Record Keeping Rules. 3) Incl. ISDN channels measured in ISDN B channel equivalents. 4) December 2016. 5) Bhutan Telecom is the only service provider for fixed-lines in Bhutan. 6) 42705 7) Incl. bundled packages. 8) Preliminary data. 9) Agence de Régulation et de Contrôle des Télécommunications. 10) 30/06/2016 11) Q3 2016 12) Source: Colombia TIC. 13) The figure for 2016 is based on provisional data and therefore represents an estimate. 14) Incl. IP lines. 15) Incl. public payphones. 16) Data as of 30 September 2016. 17) Fixed network in operation since 2010. 18) December 2016. 19) Incl. PSTN lines, ISDN paths, FWA subscriptions, public payphones and VOIP. 20) Incl. PRI access lines. 21) Source: AGCOM. 22) The number of fixed public payphones is as of March 2016. (This data is reported by carriers every March.) 23) This includes fixed lines and fixed wireless subscriptions. During the year, an operator introduced fixed wireless however the subscriptions are low. 24) Data from 4 main operators, LTC, BEELINE, UNITEL, ETL. 25) Source - Public Utilities Commission. 26) Information and Communication Technologies Authority of Mauritius. 27) Preliminary- December 2016. 28) Based on NTA January 2016 Management Information System Report. 29) Data Q3 2016 30) Estimated fixed lines with a voice service. 31) Estimate. 32) Decrease was due to the migration of one operator subscribers to GSM network. 33) First half 2016. 34) The total fixed telephone subscriptions has declined due to the technical adjustments in the calculation by the service providers as per ITU definitions. 35) Figures are as on 31st December, 2016. 36) Estimate. 37) Incl. public telephone lines. 38) Provisional data. 39) The number of fixed telephones have continued to decrease. 40) Used mostly for public services. 41) Bluesky Samoa Limited, only fixed line service provider in Samoa. 42) Data as of Dec 2016. 43) Ninety day period has been taken into consideration for active fixed telephone subscriptions. 44) As per 30 June 2016. No data yet available for 31 December 2016. 45) Estimates. 46) Value in the third quarter of 2016. 47) Only includes fixed subscriptions (WLL and ISDN) but excludes CDMA. 48) December. 49) FCC trend-based estimate using recent historical data. 50) Preliminary.

#### Mobile-cellular subscriptions per 100 inhabitants, 2015

1) Source: ARPT. 2) Preliminary. 3) As at June 2015. Source: Australian Communications and Media Authority, 2016, Communications report 2015-16, ACMA, Sydney, p. 7; Bureau of Communications and Arts Research Calculations. 4) Incl.

mobile GSM mobile base. 5) Bhutan Telecom and Tashi Cell combined. 6) Sept. 7) Source: Sistema de Información Integral Colombia TIC. 8) Preliminary. 9) Excl. M2M services. 10) Operators cleaned inactive lines. Incl. public mobile telephony. 11) Excl. 2 351 881 prepaid cards that are used to provide Travel SIM/WorldMobile service. 12) There was a Telecom Expansion Project (TEP) ongoing which results in about 12 Million new subscriber than the previous year. 13) Excl. data-only subscriptions. 14) Excl. data-only SIM cards and M2M cards. 15) No tax was applied, therefore the number of subscriptions experienced growth. 16) Data correspond to two operators (Orange et MTN). The third operator (Guinétel) is no longer operative. 17) December 2015. Including cellular and fixed wireless local loop. 18) Estimate. 19) Source: AGCOM. 20) Incl. PHS and data cards, cannot be separated. 21) Data from 4 main operators: LTC, BEELINE, UNITEL, ETL. 22) Source- Public Utilities Commission. 23) Data from 4 operators including 2 CDMA providers. 24) Active subscriptions. 25) Information and Communication Technologies Authority of Mauritius. 26) Active subscriptions (85.88per cent of the total). 27) December 2015 Source: NTA Management Information System Report. 28) Incl. inactive. 29) Figure is reported after bio-metric re-verification of SIMs in 2015 by all Cellular Mobile Operators. 30) Estimate. 31) Excl. data-only subscriptions. 32) Excl. 492.761 M2M subscriptions. 33) Includes active (in the last 6 months) prepaid accounts. 34) Refers to Bluesky and Digicel, the two main operators. 35) Data as at end Mar 2016. 36) This number is different from the one provided during short questionnaire because we had a good response rate from licensees. 37) Estimates. 38) NBTC. 39) December. 40) UBS Investment Research Data as of 6/30/15 as reported in the FCC's Eighteenth Mobile Wireless Competition Report. 41) Excl. subscriptions via data cards or USB modems. 42) Preliminary.

### Mobile-cellular subscriptions per 100 inhabitants, 2016

1) Source: ARPT. 2) As of June 2016. Source: Australian Communications and Media Authority, 2016, Communications report 2015-16, ACMA, Sydney, p. 7; Bureau of Communications and Arts Research Calculations. 3) Annual report 2016. 4) December 2016. Including cellular and fixed wireless local loop. 5) Bhutan Telecom and Tashi Cell combined. 6) Preliminary. 7) Agence de Régulation et de Contrôle des Télécommunications. 8) Decrease was due to enforcement on sim cards that have no Identity document. 9) December 2016. 10) These figures are based on quarterly data and will be revised in the long form survey with annual data. 11) Source: Colombia TIC. 12) SIM cards for internet access service without voice services (subscriptions via data cards or USB modems) and M2M SIM cards were not included. The figure for 2016 is based on provisional data and therefore represents an estimate. 13) Incl. public payphones. 14) Data as of 30 September 2016. 15) Excl. 320 502 prepaid cards that are used to provide Travel SIM. 16) Excl. data-only subscriptions. 17) Data correspond to two operators (Orange et MTN). The third operator is not operative since 2010. 18) December 2016. Including cellular and fixed wireless local loop. 19) Estimate. 20) Source: AGCOM. 21) Incl. PHS and data cards, cannot be separated. 22) Data from 4 main operators: LTC, BEELINE, UNITEL, ETL. 23) Source- Public Utilities Commission. 24) CTT website. 25) Active subscriptions. 26) Information and Communication Technologies Authority of Mauritius. 27) Preliminary- December 2016. 28) Active subscriptions (85.5 per cent). 29) SIMs that are not registered are suspended. 30) NTA MIS January. 31) Data Q3 2016. 32) Estimated active in last 90 days. 33) Incl. inactive. 34) First half 2016. 35) Data as of 31st December 2016. 36) Estimate. 37) December 2016. 38) Excl. data-only subscriptions. 39) Estimate of active subscriptions. 40) Excl. 758.680 M2M subscriptions. 41) Provisional data. Incl. active (in the last 6 months) prepaid accounts. 42) Active subscriptions. 43) Figures from Bluesky Samoa and Digicel Samoa Ltd. 44) Data as of Dec 2016. 45) One operator lost around 29 per cent of its subscriptions. 46) As per 30 June 2016. 47) Estimate. 48) As of Q3 2016. 49) December. 50) UBS Data. 51) Excl. subscriptions via data cards or USB modems. 52) Preliminary.

### International Internet bandwidth per Internet user, 2015

1) December 2015. 2) 2867.2 Mbit/s for Bhutan Telecom and 600 Mbit/s for TashiCell. 3) Source: TRAI. 4) ITU research based on Telegeography's website. 5) Ref. LTC&UNITEL. 6) Four operators only. 7) As per data received from PTCL and TWA. 8) Contracted capacity. 9) Figures obtained from Bluesky and Digicel 10) Downlink capacity. 11) Tonga Cable Limited. 12) December. 13) Incl. UAEs Yahsat & Thuraya 14) Installed capacity.

### International Internet bandwidth per Internet user, 2016

1) ITU research based on Telegeography's website. 2) Contracted capacity 3) Downlink capacity. 4) Incl. UAEs Yahsat & Thuraya. 5) Installed capacity.

### Percentage of households with a computer, 2015

1) Estimate. 2) As of 2015, incl. tablets. 3) According to the Analytical Survey report "Citizens' perception, uptake and support for the e- Transformation of Governance in the Republic of Moldova" – 2015, the share of households that own at least one computers is 68 per cent. 4) Households with population 12+. 5) Incl. desktop, notebook and tablet, and excl. PDA and smartphone.

## Percentage of households with a computer, 2016

1) According to the Analytical Survey report "Citizens" perception, uptake and support for the e-Transformation of Governance in the Republic of Moldova" – 2016, the share of households that own at least one computers is 71 per cent. 2) Households with population 12+. 3) Private households, observation units- individuals aged from 15 to 72 (members of these households). 4) ITU estimate based on the 2015 data from Statistical Office of Slovenia.

## Percentage of households with Internet, 2015

1) According to the Analytical Survey report "Citizens" perception, uptake and support for the e- Transformation of Governance in the Republic of Moldova" – 2015, the share of households with computers connected to the Internet is 68 per cent. 2) Households with population 12+.

## Percentage of households with Internet, 2016

1) According to the Analytical Survey report "Citizens" perception, uptake and support for the e- Transformation of Governance in the Republic of Moldova" – 2016, the share of households with computers connected to the Internet is 76 per cent. 2) Households with population 12+. 3) Estimate based on the results from the 2015-2016 General Household Survey. 4) Private households, observation units- individuals aged from 15 to 72 (members of these households).

## Use indicators

### Percentage of individuals using the Internet, 2015

1) Population age 15+. 2) Population age 16-74. 3) Population age 7+. 4) Population age 15+. 5) Break in series. Population age 6-72. 6) Population age 16-74. Last three months. 7) Population age 16-74. 8) Permanent residents at the age of 6 or above. In the last 6 months. 9) Population age 5+. 10) Population age 5+ in the last three months. 11) Population age 16-74. 12) Population age 6+. 13) Population age 16-74. 14) Population age 16+. 15) Population age 16-74. 16) Population age 12+. 17) Population age 5+. 18) Population age 6+. 19) Population age 16-74. 20) Population aged 16-89. 21) Population age 16-74. 22) Population age 6+. Break in comparability, reference period in the last 3 months. 23) Population age 16-74. 24) Population age 16-74. 25) Population age 10+. 26) Population age 16-74. 27) Population age 5+. 28) Country estimate. 29) Population age 16-74. Last three months. 30) Population age 20+. 31) Population age 6+. 32) Country estimate. 33) Population age 6-74. 34) Population age 16-74. 35) Population age 16-74. 36) Population age 16-74. 37) Population age 16-74. 38) Population age 3+. 39) Population age 15+. 40) Population age 16-74. 41) Population age 5+. 42) Population age 6+. Break in comparability: as of 2015 the respondent of ICT use questions is a self-respondent randomly selected and the survey is a stand-alone ICT survey. Before the ICT survey was a module attached to a main survey and respondent was an informed person of the household who responded about self and the other members of the household. 43) All population. 44) Population age 16-74. 45) Population age 5+ using Internet in the last 3 months. 46) Population age 12+. 47) Population age 16-74. 48) Population age 10+ 49) Population age 10+. 50) Population age 6+. 51) Population age 16-74. Last three months. 52) Population age 16-74. 53) "Mainstream" population age 15+ living in households. 54) Population age 16-74. 55) Percentage of population aged 15-72 years who used the Internet in the last 12 months. 56) Population age 12-65 over total population 57) Population age 16-74. 58) Population 16-74. Last three months. 59) Population age 16-74. 60) Population age 16-74. 61) Population age 16-74. 62) In the last 6 months. Population age 14+. 63) Population age 16-74. 64) Population age 6+. 65) Population age 16-74. 66) All population. 67) Population age 16-74. 68) Population age 3+. 69) Population age 6+.

### Percentage of individuals using the Internet, 2016

1) Population age 16-74. Last three months. 2) Population age 16+. 3) Population aged 16-89. 4) Population age 16-74. Last three months. 5) Population age 6+. 6) Population age 12+. 7) Population age 16-74. Last three months. 8) Percentage of population aged 15-72 years who used the Internet in the last 12 months. 9) Population 16-74. Last three months. 10) Population age 15-74 in the last 3 months.

### Fixed-broadband subscriptions per 100 inhabitants, 2015

1) A few subscriptions between 128 and 256 kbps are still included. 2) Internet activity survey December 2015. 3) Incl. Ded Inet, HSI & EVDO. 4) Estimate. 5) Information provided by 92.3 per cent of all ISPs. 6) ADSL, ADSL+, CDMA. 7) Source: Colombia TIC. 8) Incl. WiFi subscriptions (not WiFi hotspots). Estimates. 9) Incl. 144 kbit/s to less than 256 kbit/s. Excl. subscriptions with unspecified download capacity. 10) Updated data. 11) There are 63.267 lines that are not classified by the

operators to indicated speed categories. 12) Fixed Wimax. Incl. 861 subscriptions at speeds of 128-255 kbps 13) December 2015. Subscriptions with download speeds of at least 512 Kbps. 14) Dec. 2015- Inc. DSL and cable. 15) Source: AGCOM. 16) There are Ref.no from 4 main operators, LTC, BEELINE, UNITEL, ETL. 17) Source- Public Utilities Commission. 18) Wimax included to the mobile. 19) Incl. non-residential customers (ca 49'000). 20) Information and Communication Technologies Authority of Mauritius. 21) December 2015. Source: Management Information System. 22) As of June 2015. 23) Estimate. 24) Incl. less than 40 subscriptions below 256 Kbps. 25) Figure is based on data received from Broadband Operators. 26) Estimate. 27) Estimate. 28) Incl. fixed wireless. 29) Speeds equal to or greater than 144 kbit/s. 30) Incl. subscriptions at downstream speeds equal to or greater than 144 kbit/s (the number of subscriptions that are included in the 144-256 range is insignificant). SIM based fixed connections are included. 31) Refers to Bluesky and Digicel, the two main operators. 32) Incl. subscriptions to fixed LTE. 33) Estimates. 34) NBTC. 35) ADSL, dedicated internet line, Wimax, Ev-Do. 36) December. 37) Please note that FCC collects information about broadband Internet access subscriptions in service that have downstream bandwidths exceeding 200 kbps, rather than 256 kbps. 38) Incl. ADSL and FTTH + LMDS. 39) Incl. xDSL, fixed wireless data subscription and fixed broadband internet subscribers. Numbers are believed to have dropped as some subscribers have preferred to switch to mobile broadband alternatives as prices for these services have fallen and quality has increased. 40) Preliminary. 41) ISP subscriptions with Internet speed of at least 256 kbps.

### Fixed-broadband subscriptions per 100 inhabitants, 2016

1) Decrease due to companies that closed. 2) Source: Australian Bureau of Statistics, 2017, Internet Activity, Australia, December 2016, cat. No. 8153.0 (Table 1), ABS, Canberra; Bureau of Communications and Arts Research Calculations. 3) Annual report 2016. 4) December 2016. 5) Data only for one operator (Bhutan Telecom). 6) 01/12/2016 7) Preliminary data. 8) Agence de Régulation et de Contrôle des Télécommunications. 9) Adsl, fttx and LS. 10) Source: Colombia TIC. 11) Incl. WIFI subscriptions (not WIFI hotspots). The figure for 2016 is based on provisional data and therefore represents an estimate. 12) Incl. 144 kbit/s to less than 256 kbit/s. Excl. subscriptions with unspecified download capacity. 13) Data as of 30 September 2016. 14) Data as of 30/06/2016. 15) Speeds > 128 and ≤ 256Kbps = 721 (Fixed Wimax) - Operator Orange only. 16) December 2016. Subscriptions with download speeds of at least 512 Kbps. 17) Dec. 2016- Inc. DSL and cable. 18) Source: AGCOM. 19) December 2016. 20) Incl. fixed wired and fixed wireless broadband subscriptions. 21) There are Ref.no from 4 main operators, LTC, BEELINE, UNITEL, ETL. 22) Source- Public Utilities Commission. 23) Wimax included to the mobile. 24) CTT website. 25) Information and Communication Technologies Authority of Mauritius. 26) Preliminary- December 2016. 27) The number of subscribers are from TDM, Teledata, IS and TVCabo. Most of the subscriptions are related to connection and from that link there are more users. 28) NTA MIS January report. DSL, fibre and cable modem. 29) Data Q3 2016. 30) As at June 2016 and as provided to OECD. 31) Estimate connections. 32) Source: Statistics Norway. 33) Figures are as of 31st December 2016. 34) Estimate. 35) Estimate as of December 2016. 36) Provisional data. Incl. subscriptions at downstream speeds equal to or greater than 144 kbit/s (the number of subscriptions that are included in the 144-256 range is insignificant). SIM based fixed connections are included. 37) Mostly used for public services. 38) Figures obtained from Bluesky, CSL and Digicel Samoa. 39) Data as of December 2016. 40) As per 30 June 2016. No data yet available for 31 December 2016. 41) Estimate. 42) Value as of Q3 2016. 43) ADSL, dedicated internet line, Wimax, Ev-Do. 44) December. 45) FCC trend-based estimate using recent historical data. Please note that FCC collects information about broadband Internet access subscriptions in service that have downstream bandwidths exceeding 200 kbps, rather than 256 kbps. 46) Preliminary.

### Active mobile-broadband subscriptions per 100 inhabitants, 2015

1) Source: ARPT. 2) Preliminary. 3) Source: Australian Bureau of Statistics, 2017, Internet Activity, Australia, December 2016, cat. No. 8153.0, ABS, Canberra; Bureau of Communications and Arts Research Calculations. 4) GPRS/EDGE and LTE. 5) Combined number for two operators. The increase is due to increased growth of smart phones and increase in 3G network. 6) Activity criteria: data communication in the last month. 7) Number of subscriptions from the operators offering 3G services. 8) December 2015. 9) Source: Colombia TIC. 10) Only postpaid mobile-broadband subscriptions. 11) Data screening was made and the previous years data is found to include GPRS and EDGE internet users. 12) Before 2014, Mobitel offered only 2G. In 2015 it received an LTE license and launched the service. 13) Does not incl. prepaid smartphones. 14) Speeds equal or greater than 1 Mbit/s. 15) December 2015. Subscriptions with download speeds of at least 256 kbit/s. 16) Users who have made a transaction in the last 90 days via a handset, dongle/USB modem or other mobile Internet device, whereby they accessed advanced data services such as web/Internet content, online multiplayer gaming content, VoD or other equivalent data services (excluding SMS and MMS). 17) Source: AGCOM. 18) Incl. standard and dedicated mobile broadband Wimax. 19) There are Ref.no from 4 main operators, LTC, BEELINE, UNITEL, ETL. 20) Source- Public Utilities Commission. 21) The increase was due to the attractive price offered in postpaid and prepaid packages; pay per use subscriptions and the introduction of LTE package. 22) Equal to dedicated mobile broadband subs as CAM does not report on standard mobile broadband pay-as-you-go subscriptions. 23) Incl. both Orange and Sotelma customers. 24) Information and Communication Technologies Authority of Mauritius. 25) Estimation DCE. 26) Big increase due to the entrance of a new operator. 27) Active MPT and Telenor subscriptions. 28) Estimate. Activity period: 6 months. 29) Figures are as on 31st December, 2015 based on data received from cellular mobile Operators. 30) Estimate. Activity period: 6 months. 31) Incl. handset-based mobile broadband. 32) Speeds equal to or greater than 144 kbit/s. 33) includes active subs (in the last 6 months), by 3G and higher

technologies. SIM based fixed connections are excluded. 34) Figures obtained from Bluesky Samoa Digicel Samoa and Lesa Telephone Service. 35) Data as of end Mar 2016. 36) Slight drop due to upgrades on data services network by the two operators in April, Sept, Dec. 37) Estimate. Activity period: 6 months. 38) NBTC. 39) December. 40) Revised data received from Sector. 41) Excl. M2M subscriptions. 42) Based on data from Ovum. 43) Incl. subscriptions with potential access. 44) TRR estimates for active subscriptions. The number of subscriptions with theoretical ability to use mobile broadband is 78216. 45) Preliminary.

## Active mobile-broadband subscriptions per 100 inhabitants, 2016

1) Source: Australian Bureau of Statistics, 2017, Internet Activity, Australia, December 2016, cat. No. 8153.0, ABS, (Table 1: Mobile wireless and Table 5: No of mobile handset subscribers) Canberra; Bureau of Communications and Arts Research Calculations. 2) December 2016. 3) Only for one operator (Bhutan Telecom) The increase is due to increased growth of smart phones and increase in 3G network and introduction of LTE. 4) Activity criteria: data communication in the last month. 5) 01/12/2016 6) Preliminary data. 7) Agence de Régulation et de Contrôle des Télécommunications. 8) These figures are based on quarterly data and will be revised in the long form survey with annual data. 9) Source: Colombia TIC. 10) The figure for 2016 is based on provisional data and therefore represents an estimate. 11) Speeds equal or greater than 1 Mbit/s. 12) December 2016. Subscriptions with download speeds of at least 512 kbit/s. 13) Users who have made a transaction in the last 90 days via a handset, dongle/USB. 14) Estimate. 15) Source: AGCOM 16) December 2016, incl. standard and dedicated mobile broadband Wimax 17) Increase due to wider coverage- all township can access to 3G and LTE network. 18) Source - Public Utilities Commission. 19) Data as of July 2016. 20) CTT website. 21) Equal to dedicated mobile broadband subs as CAM does not report on standard mobile broadband pay-as-you-go subscriptions. 22) Active subscriptions. 23) Information and Communication Technologies Authority of Mauritius. 24) Preliminary- December 2016. 25) Estimation DCE. 26) Data Q3 2016. 27) As reported to the OECD. 28) First half 2016. 29) Figures are as on 31st December, 2016. 30) Data as of June 2016. 31) Incl. handset-based mobile broadband. 32) Provisional data. Incl. active subs (in the last 6 months), by 3G and higher technologies. SIM based. 33) New services and tariffs at low costs. 34) Figures obtained from Bluesky and Digicel Samoa. 35) Data as of December 2016 36) As per 30 June 2016. No data yet available for 31 December 2016. 37) Estimates. 38) Value in the third quarter of 2016. 39) December. 40) Based on data from Ovum. Data as of June 30, 2016. 41) Incl. subscriptions with potential access. 42) TRR estimates for active subscriptions. The number of subscriptions with theoretical ability to use mobile broadband is 101,438. 43) Preliminary.



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# Measuring the Information Society Report 2017

Volume 2. ICT country profiles





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The country profiles presented in this second volume of the *Measuring the Information Society Report 2017* represent a comprehensive effort by ITU to provide a snapshot of the status of the information and communication technology (ICT) markets in 192 economies, including significant infrastructure developments, and government policy and initiatives to improve the access and use of ICTs for households and individuals. Each profile is structured around three key areas: mobile services, fixed services, and government policy. The profiles are supported by a table showing key indicators of mobile and fixed subscription penetration rates, prices of ICT services, and data on access and use of ICTs by households and individuals. The tables present 2016 ITU data that were collected in the spring of 2017 through the short World Telecommunication/ICT Indicators (WTI) questionnaire and the short questionnaire on ICT Access and Use by Households and Individuals. The data on ICT prices were collected in the last quarter of 2016 by means of the ICT Price Basket Questionnaire. The tables also include regional and global averages as references. The indicator definitions are presented in Annex 1.

The qualitative information provided in the country profiles is based on research conducted during May-June 2017. The research took into consideration information provided in official documents and other information provided on websites of relevant ministries, regulatory authorities, national statistical offices, and telecommunication operators. The country profiles also include information provided in reports published by international organizations and news announcements reported through reputable telecommunication media sources. The draft country profiles were shared with the official country statistical focal points for final verification in October 2017. It is, however, important to recognize the rapid developments that often take place in the ICT sector. This being the case, new information may have become available during the final stages of the production cycle of this report, and more recent ICT developments can therefore be reflected only in future editions.

The second volume of the *Measuring the Information Society Report 2017* was prepared by the ICT Data and Statistics Division within the Telecommunication Development Bureau of ITU. The following consultants to ITU provided substantive contributions to the country profiles: Abdelfattah Abuqayyas (Arab States), Lisa Kreuzenbeck (Europe), Michael Minges (Africa, Asia and the Pacific), Chelsea Mori Clark (the Americas) and Ihar Shchetko (CIS). Insightful comments on the country profiles were also made by colleagues from the ITU Regional Offices. ITU also appreciates the cooperation of countries for providing data and information included in this volume.



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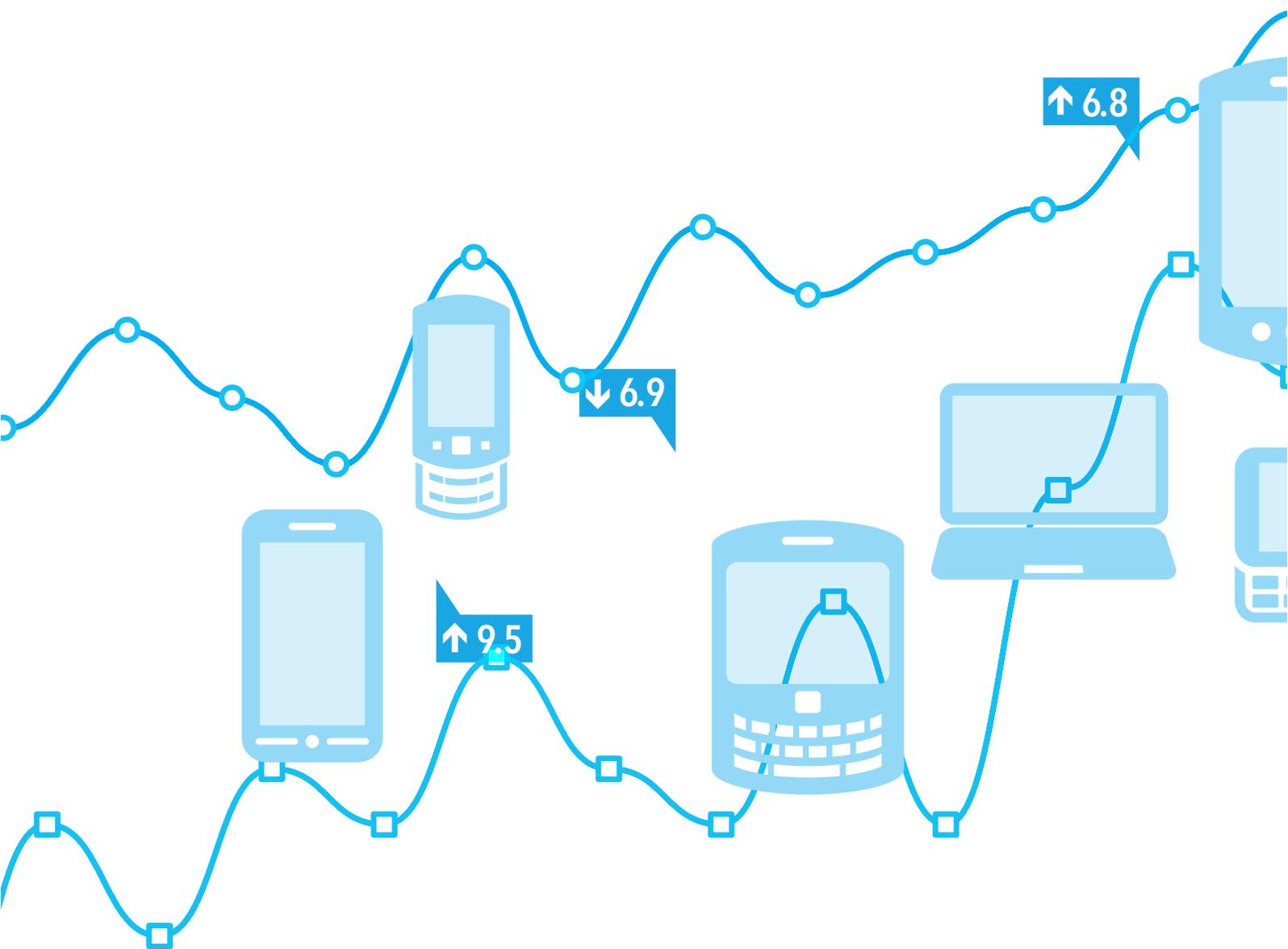
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\*Note: Palestine is not an ITU member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.



## Volume 2. ICT country profiles



## Afghanistan

**Despite a challenging economic, social, geographic and security environment, Afghanistan has a competitive mobile market with a relatively high level of GSM coverage.**

**Mobile services:** The mobile market is highly competitive, with five operators. The country's first mobile operator was the Afghan Wireless Communication Company launched in 2002. A second operator, Roshan, majority owned by the Aga Khan Fund for Economic Development, was launched in 2003. The two companies were awarded exclusivity for a period of three years. In 2006, a third operator, Areeba, entered the marketplace and was subsequently purchased by the South Africa-based MTN Group. United Arab Emirates-based Etisalat became the country's fourth mobile operator in 2007. Afghan Telecom (AFTEL), the incumbent state-owned fixed-line operator, was awarded a mobile licence and launched its mobile service in 2014 under the Salaam brand. This steady increase in competition has boosted mobile access with 87 per cent of Afghan homes had a mobile phone (94 per cent in urban areas and 85 per cent in rural locations).<sup>1</sup> 3G mobile broadband was launched in March 2012 and uptake has been growing. Some of the operators have piloted LTE, and frequency allocations are expected in the near future.

**Fixed services:** AFTEL was established under presidential decree in 2005 and awarded a 25-year operating licence. Landline telephones are limited and most investment, particularly in rural areas, has been in fixed wireless CDMA. Afghan Telecom is the main fixed-line provider, while Wasel Telecom, backed by UAE-based investors, was launched in 2008 to provide wireless fixed lines in several northern provinces. There are few broadband fixed subscriptions owing to limited availability and high costs. ADSL is offered in urban areas as well as fixed wireless broadband provided by Afghan Telecom, Wasel and several Wi-Max providers.

Construction of a national fibre-optic backbone began in 2007. Afghanistan is landlocked, so international connectivity relies on terrestrial systems, with cross-border links to the Islamic Republic of Iran, Pakistan, Tajikistan, Turkmenistan and Uzbekistan.

Key indicators for Afghanistan (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	0.3	10.0	13.6
Mobile-cellular sub. per 100 inhab.	66.0	98.9	101.5
Fixed-broadband sub. per 100 inhab.	0.0	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	14.3	47.4	52.2
3G coverage (% of population)	40.0	87.6	85.0
LTE/WiMAX coverage (% of population)	0.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	9.4	3.2	5.2
Fixed-broadband prices (% GNI pc)	29.0	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	10.1	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	10.1	5.4	6.8
Percentage of households with computer	3.4	37.8	46.6
Percentage of households with Internet access	4.8	45.5	51.5
Percentage of individuals using the Internet	10.6	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	12.0	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The *Telecommunications Services Regulation Act* became law in 2005, resulting in the formation of the Afghan Telecommunications Regulatory Authority (ATRA) in 2006. The Ministry of Communications and Information Technology (MCIT) is responsible for policy making and implementing the *ICT Policy (2015-2024)*. The policy is aligned with the country's Vision 2024 and has four high-level goals: i) maximizing penetration and diffusion of ICT; ii) developing and promoting ICT as an enabler of increased efficiency and productivity in all economic and social sectors and industry domains; iii) optimizing use of ICT for management of government operations and as a tool for enhanced efficiency, effectiveness and transparency in public governance, and in service delivery; and iv) encouraging and promoting the ICT sector in the country as an important contributor to the national economy and as a venue for employment.

**Conclusion:** Despite security, economic and geographical challenges, Afghanistan has made notable progress in extending access to the population, primarily through mobile communications, which have spread rapidly owing to a vibrant and competitive market.

## Albania

***This small market of just under three million inhabitants has a competitive mobile market with a high mobile-cellular penetration rate. Fixed services are less commonplace in Albania and fixed-broadband is scarcely available, especially in rural areas of the country.***

**Mobile services:** AMC, the former state-owned mobile operator was privatized in 2000. Vodafone Albania entered the market in 2001, followed by ALBTelecom subsidiary Eagle Mobile in 2008.<sup>2,3</sup> When Mobile 4 Al became operational in 2010 under the brand name Plus communications, Albania became the first country in the Balkans with four mobile operators. Three of the four mobile operators are offering mobile-broadband services. Vodafone Albania was the first operator to introduce 3G services in 2010, followed by AMC (since July 2015, named Telekom Albania), which was granted an authorization in 2011 (ITU, 2012), and Eagle Mobile started 3G services in 2013.<sup>4</sup> The number of active mobile-broadband subscribers, however, remains below the European average. While 3G coverage is almost complete in terms of population, LTE coverage is significantly lower.

**Fixed services:** Albania fixed-telephone and fixed-broadband penetration is low for the region, and also at a global level. The *Digital Agenda Strategy 2015-2020* and the *National Broadband Plan* identified the development of ICT infrastructure as a strategic objective. Furthermore the development of ICT infrastructure is identified as an important priority in the Business and Investment Development Strategy for 2014-2020 (Republic of Albania, Ministry of Economic Development, Trade & Entrepreneurship, 2014). Fixed infrastructure is relatively good around urban centres, but much less so in rural areas. The pattern is similar in terms of soft infrastructure including training and incubation programmes, which public and private players are developing in and around the capital Tirana. A 2016 ITU country review of Albania found that “while availability is sporadic, usage is strong where available, leading to a point (...) that distribution is a major issue in terms of infrastructure” (ITU, 2016).

**Government policy:** In 2003, the country published its first National ICT Policy Strategy, recognizing the potential of ICTs to enhance economic and social development. The strategy

Key indicators for Albania (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	7.8	37.7	13.6
Mobile-cellular sub. per 100 inhab.	105.1	118.0	101.5
Fixed-broadband sub. per 100 inhab.	8.3	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	52.6	80.1	52.2
3G coverage (% of population)	99.0	98.5	85.0
LTE/WiMAX coverage (% of population)	80.2	92.2	66.5
Mobile-cellular prices (% GNI pc)	1.8	1.0	5.2
Fixed-broadband prices (% GNI pc)	2.7	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.2	0.6	6.8
Percentage of households with computer	27.7	79.6	46.6
Percentage of households with Internet access	37.0	82.5	51.5
Percentage of individuals using the Internet	66.4	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	57.0	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

focused on improving access to ICT services but also stimulating demand for ICTs. This was continued with the 2009-2015 National Strategy on Information Society (NSIS) and the Digital Agenda of Albania 2015-2020, which puts ICTs at the heart of Albania development. The Albania digital agenda aims at increasing investments in ICT infrastructure and boosting policies to provide new digital services. Furthermore, the government is working to improve ICT education and support to outside actors in the ICT sector. In 2016, an ITU-D report examined the dynamics of the ICT centric innovation ecosystem in Albania and made recommendations to strengthen Albania’s ability to integrate ICT innovation in its national development agenda, and leverage the economic and social opportunities provided by innovative technologies (ITU, 2016).

**Conclusion:** Albania’s ICT ecosystem has seen a positive development over the past decade. Innovation strategies brought forward by the government and the European Union (EU) enlargement process have fostered policy reform, in particular in the ICT sector (European Commission, 2014). Access to and use of ICTs have grown due to the government strategic vision and liberalization of the ICT market. While ICT infrastructure is well developed in urban centres, rural connectivity remains a challenge. In some, especially rural, regions costs can be high and penetration low. The lack of rural connectivity is “one of the major gaps” and hampers growth in the country (ITU, 2016).

## Algeria

**Algeria has been witnessing widespread change and development in its Internet and telecommunication markets. With three competing operators, Algeria offers affordable prices for fixed and fixed-broadband services and lower than the average prices in the region.**

**Mobile services:** The Algeria cellular and mobile-broadband markets are served by three operators, Algerie Telecom Mobile (Mobilis), launched in 1999, and was the first cellular operator to start its services in the Algeria market; Optimum Telecom Algérie (OTA, trading as Djezzy) entered the telecommunication market in 2002; and Ooredoo (formerly Nedjma) followed in 2004. The fixed telecommunication and Internet market is served by Algerie Telecom. The deployment of 3G and LTE services by all operators increased the level of competition between mobile operators, which increased the mobile-cellular and mobile-broadband penetration. In 2013, Algerian Telecoms and Post Regulator (ARPT) issued 3G concessions to Mobilis, Ooredoo, and Djezzy in the 1900 and 2100 MHz bands. Initially and in a transitional phase, the ARPT imposed a 3G dual numbering license on mobile operators. This dual numbering system required that every citizen wishing to benefit from a 3G service have two separate 2G and 3G phone numbers. Today, this method has been abandoned since the use of both 2G and 3G networks is possible by means of the same telephone number. In September 2016, ARPT awarded the executive decrees authorizing the deployment of LTE networks in the 1800 MHz band to Mobilis, Djezzy, and Ooredoo Algeria.

**Fixed services:** With a fixed-line penetration of around 8 per cent, Algeria has one of the highest penetration levels in the Middle East. The infrastructure in Algeria includes a national fibre backbone and one of Africa's first FttP deployments. Algerie Telecom has invested in expanding and upgrading its ADSL, WiMAX, and fixed LTE networks. Algerie Telecom is investing in the expansion of its national fibre infrastructure, while the operator has also become a major shareholder in a four-company national fibre project. By the end of 2016, Algerie Telecom had laid more than 76 500 km of fibre.

**Government policy:** ARPT was created as part of the liberalization of the postal and

Key indicators for Algeria (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	8.2	7.7	13.6
Mobile-cellular sub. per 100 inhab.	113.9	107.1	101.5
Fixed-broadband sub. per 100 inhab.	6.9	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	64.6	45.2	52.2
3G coverage (% of population)	83.4	81.9	85.0
LTE/WiMAX coverage (% of population)	3.6	33.8	66.5
Mobile-cellular prices (% GNI pc)	2.5	4.3	5.2
Fixed-broadband prices (% GNI pc)	3.6	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.6	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.4	5.5	6.8
Percentage of households with computer	38.4	43.3	46.6
Percentage of households with Internet access	34.7	45.3	51.5
Percentage of individuals using the Internet	42.9	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	40.0	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

telecommunication market. The main tasks and mission of the ARPT include ensuring effective competition and regulating the framework in the telecommunication and postal market. Furthermore the regulator guarantees the sharing of telecommunication infrastructure, and oversees the planning, management, assignment and control of the band frequencies. The Algeria Government passed a new telecommunication law in 2017, the Code of Posts and Electronic Communications, which includes an obligation for fixed line incumbent Algerie Telecom to open its local loops to alternative operators, in addition to granting extra powers to telecommunication operators to undertake widespread monitoring of all international phone calls. The Council of Ministers has endorsed: (a) to strengthen the regulatory authority for postal and electronic communications in order to enable it to fulfil its tasks in the commercial field in order to ensure the effective exercise of fair competition; (b) to put the spectrum management regulation and planning as a high priority of the National Radio Frequency Agency.

**Conclusion:** The efforts made by the Government of Algeria over the past 15 years, and in particular during the last 5 years, have resulted in high levels of mobile penetration, indicating how wide mobile-broadband and fibre optic network coverage is in the country, and how well mobile operators and Algerie Telecom have managed to roll this out. Algeria has a fast growth in term of infrastructures deployment, not only at national level but also as a regional actor that could insure connectivity within remote areas of neighbouring countries.

## Andorra

**Andorra Telecom is the only telecommunication service provider in the Principality of Andorra. The country stands out as a forerunner of optical fibre deployments, having achieved complete optical fibre coverage in 2012 and switched off its copper network in 2016.**<sup>5</sup>

**Mobile services:** Andorra Telecom is the only mobile operator offering services in the country. 3G services were launched in 2005 and 3G population coverage is almost complete. LTE services were launched in 2014 and LTE coverage has significantly increased in the country since its launch, reaching 90 per cent of the population in 2017.<sup>6</sup> Moreover, LTE remains an important area of investment for Andorra Telecom.<sup>7</sup> Mobile-cellular and mobile-broadband subscription rates are below the European average.

**Fixed services:** The country has very high fixed-telephone and fixed-broadband penetration rates which are well above the European average. In 2006, Andorra Telecom started the implementation of its strategy to provide all households in the Principality with optical fibre broadband access. Complete optical fibre coverage was achieved in 2012, ADSL services were switched off in 2014 and fixed-telephone over copper wire was discontinued in 2016. Thus, copper-wire connections have been phased out in favour of fibre.<sup>8</sup> Today, all fixed Internet connections in Andorra are at speeds equal or above 10 Mbit/s. Furthermore, Andorra Telecom is investing in the replacement of the active equipment of the optical fibre network, which should be finalized by the end 2017. This will allow broadband speeds to be upgraded from 100 Mbit/s symmetric to 300 Mbit/s symmetric. International connectivity is ensured by eight cross-border cables with a capacity of 10 Gbit/s each connecting the country with Spain and France.

**Government policy:** Andorra Telecom holds a monopoly in the telecommunication market. The operator is 100 per cent government-owned and the head of the operator acts as the head of the regulator. The public operator implements directly Andorra ICT policies, such as, for instance, the decision to provide universal access to optical fibre broadband. Andorra Telecom has the legal obligation to provide optical fibre access at 100

Key indicators for Andorra (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	47.4	37.7	13.6
Mobile-cellular sub. per 100 inhab.	87.2	118.0	101.5
Fixed-broadband sub. per 100 inhab.	39.8	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	47.8	80.1	52.2
3G coverage (% of population)	97.0	98.5	85.0
LTE/WiMAX coverage (% of population)	50.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.9	1.0	5.2
Fixed-broadband prices (% GNI pc)	0.5	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.5	0.6	6.8
Percentage of households with computer	85.1	79.6	46.6
Percentage of households with Internet access	83.3	82.5	51.5
Percentage of individuals using the Internet	97.9	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	106.4	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Mbit/s to all households at the same price, and retail prices are regulated by the government.<sup>9</sup>

**Conclusion:** Despite its mountainous geography, Andorra is a highly connected country with optical fibre cables to all households. Government policy implemented by Andorra Telecom ensures universal access to telecommunication services. The country has completed a very ambitious roll-out of fibre infrastructure and continues to invest in ICT infrastructure.

## Angola

***This oil-rich country is aiming to shift from ICTs led by economic growth to ICTs being a leading engine of the economy.***

**Mobile services:** The market is a duopoly between UNITEL and MOVICEL. UNITEL is 25 per cent owned by Angolan investors, 50 per cent by State-run oil company SONANGOL and 25 per cent by Oi of Brazil. MOVICEL was originally a subsidiary of the State-owned incumbent Angola Telecom. In 2010, a majority of shares were sold to several Angolan companies, with Angola Telecom retaining a small share. One factor that affected the competitiveness of the mobile market is the fact that MOVICEL'S network was based on Code Division Multiple Access (CDMA) technology, while UNITEL has used Global System for Mobile Communications (GSM) from the start. In 2010, MOVICEL shifted to GSM. Despite Angola's above-average per capita income in the region, only around two-thirds of households (63 per cent) had mobile phones with a wide variation between urban (83 per cent) and rural areas (31 per cent).<sup>10</sup> Operators have been moving to widen access and deploy mobile-broadband. MOVICEL introduced 3G in 2010, when it converted its network, some two years after the introduction of the technology by UNITEL. Both operators introduced LTE in 2012, one of the earliest launches of this mobile-broadband technology in sub-Saharan Africa.

**Fixed services:** Angola Telecom is the State-owned incumbent. Unlike most other countries in sub-Saharan Africa, there are more fixed-telephone operators (four) than mobile operators (two). Nevertheless, Angola Telecom dominates the market. All of the fixed-telephone operators also compete in the fixed-broadband market, along with several fixed wireless Internet service providers (ISPs). Fixed technologies in use include ADSL, optical fibre and cable modem. Angola Telecom has been building out the national fibre backbone and it now reaches all provincial capitals. Angola is well provisioned with undersea fibre-optic cables. It was one of the original countries in sub-Saharan Africa to have a submarine cable link when it connected to SAT-3 in 2002. However, it was not until the arrival of the Africa Coast to Europe (ACE) and, in particular, the West African Cable System (WACS) a decade later that international bandwidth prices were significantly lowered. WACS is owned by Angola Cables, a

Key indicators for Angola (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	1.3	1.0	13.6
Mobile-cellular sub. per 100 inhab.	55.3	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.5	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	17.1	22.9	52.2
3G coverage (% of population)	62.0	59.3	85.0
LTE/WiMAX coverage (% of population)	8.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	3.2	14.2	5.2
Fixed-broadband prices (% GNI pc)	8.6	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.2	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	6.1	17.7	6.8
Percentage of households with computer	10.5	9.6	46.6
Percentage of households with Internet access	10.0	16.3	51.5
Percentage of individuals using the Internet	13.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	8.8	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

consortium of the country's telecom operators. Angola Cables also manages the ANGNIX Internet exchange point (IXP). The country's first satellite, Angosat1, is slated for launch in 2017.

**Government policy:** The Ministry of Telecommunications and Information Technology is the authority for electronic communications in Angola, and is responsible for defining the sector's development policies. The National Plan for the Information Society 2013–2017 is aligned with Angola's national development plan and sector strategies. It aims at bridging current gaps by strengthening the impact of ICTs on economic and social development to promote an inclusive country whose citizens are linked to the world, and have access to education and health and opportunities to develop their personal and professional ideas and skills. The Angolan Institute for Communications, created in 1999, is the sector regulator responsible for telecommunications and posts.

**Conclusion:** ICT growth has largely been driven by economic growth from the country's large oil reserves. There is now a push to widen and deepen access, infrastructure, human resources, content and e-services, so that ICT plays a major role in the country's economic development strategies.

## Antigua and Barbuda

**Antigua and Barbuda has made substantial progress in the market for ICT services. Increased competition has fostered both the expansion of services provision and viable pricing when compared not only with the regional levels but also worldwide, resulting in a high share of the population regularly using the Internet.**

**Mobile services:** The country's mobile-cellular penetration rates surpass both regional and worldwide levels. This sector's segment hosts three operators: LIME, Digicel and the Antigua Public Utilities Authority, provider of the national telecommunications infrastructure.<sup>11</sup> Competition was first introduced in 1997, and the partially competitive environment has experienced extensive growth during the beginning of the twenty-first century, expanding more than 90 per cent between 2005 and 2010.<sup>12</sup> Mobile-broadband penetration levels, however, have failed to keep the regional pace despite prices being considerably lower than the regional and global averages. Unlike the mobile-cellular segment, mobile-broadband is a fully competitive market and has considerable potential for expansion as almost the entire population is currently covered by long-term evolution (LTE)-based services, a long way from the introduction of 2G networks, introduced in 1992.<sup>13</sup> The LTE market was introduced in 2014 as part of LIME's strategy to upgrade the service offering in the country, investing EC\$ 37 million in the process.<sup>14</sup>

**Fixed services:** The fixed-broadband market has been partially competitive since 2000 and not only is pricing lower than the world's average, but bandwidth per Internet user is largely above it, being on par with the region's average. Whereas international gateways have experienced a partially competitive environment since 2000, the domestic and international long distance, as well as the local fixed-line services, remain under monopoly.

**Government policy:** The national ICT regulatory body is the Ministry of Telecommunications, Science and Technology, which is responsible for the sector's policy and legislation, although it is not autonomous in its decision-making, and the entirety of its budget stems from government appropriation. Public consultation opened in August 2016 for a new Telecommunications Bill,

Key indicators for Antigua and Barbuda (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	24.3	24.4	13.6
Mobile-cellular sub. per 100 inhab.	194.1	114.2	101.5
Fixed-broadband sub. per 100 inhab.	10.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	44.2	82.7	52.2
3G coverage (% of population)	99.0	93.6	85.0
LTE/WiMAX coverage (% of population)	100.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.7	3.6	5.2
Fixed-broadband prices (% GNI pc)	4.8	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.3	5.7	6.8
Percentage of households with computer	59.1	64.9	46.6
Percentage of households with Internet access	58.6	63.3	51.5
Percentage of individuals using the Internet	73.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	88.6	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

which aims to restructure the telecommunications industry, moving the sector towards liberalization, bringing the regulation up to date, including measures on consumer protection.<sup>15,16,17</sup> Efforts are being made by the Government to further develop the nation's telecommunications sector by partnering with the Eastern Caribbean Telecommunications Authority (ECTEL), with a principal objective of increasing liberalization. Furthermore, the Government has focused for over a decade on increasing ICT accessibility, particularly regarding ICT in education, through the Connect Antigua and Barbuda Initiative, launched in 2006.<sup>18</sup> The all-encompassing programme promotes computer literacy from early childhood education through to higher education, also focusing on technology for empowerment. These efforts to bridge the digital divide are also pronounced in other initiatives, for instance the Government-Assisted Technology Endeavour, which aims at improving connectivity and increasing the availability of ICT training facilities.

**Conclusion:** Antigua and Barbuda's steps towards industry development have resulted in remarkable progress over the years, noteworthy both with respect to service take-up and its competitive pricing levels and Internet speed.

## Argentina

**Argentina fosters one of the most dynamic mobile markets in the Americas, with above-average penetration rates and competitive pricing, not only at the regional level, but globally. The country has advanced telecommunications infrastructure and boasts a higher-than-average ratio of individuals using the Internet. Its current challenges revolve around improving broadband speed and extending the service reach to the more remote areas.**

**Mobile services:** The Argentine mobile-cellular market has shown exponential growth in the past 20 years. The mobile-cellular services are under full competition and there are three main operators: Claro (America Móvil), Personal (Telecom Argentina) and Movistar (Telefónica). A fourth player, Nextel Argentina, from Grupo Clarin, is gaining strength and entering the market by leveraging a varied service offering that stems from broadband and cable television.<sup>19</sup> The recent resolution 38/2016 of the Argentine Ministry of Communications is expected to increase competition levels even further by enabling mobile virtual network operators (MVNOs) to access the market. The mobile-broadband penetration is close to the regional average and noticeably ahead of the global level. In 2007, 3G technology was launched, and LTE became available in 2014.<sup>20</sup> Argentina's LTE adoption rates were the fastest growing in Latin America during the first six months after the launch, with approximately six new users per minute. Mobile operators alone generate close to 1 per cent of the country's GDP, and the mobile market in its entirety contributed with more than 3.5 per cent. Spectrum auctions are expected to take place in the short term after the recent auction of the 700 MHz and 1 700–2 100MHz bands.<sup>21</sup>

**Fixed services:** The national fixed-telephone penetration rates are similar to the regional average and higher than the global average. As it stands, long distance services benefit from a competitive market, whereas the same cannot be said about local telephony.<sup>22</sup> Telefónica de Argentina and Telecom Argentina hold approximately 68 per cent of the DSL market share, the remainder being divided among several smaller operators.<sup>23</sup> Recently, a third significant market player, FiberTel, was able to gain market

Key indicators for Argentina (2016)	The Americas		World
Fixed-telephone sub. per 100 inhab.	23.4	24.4	13.6
Mobile-cellular sub. per 100 inhab.	149.9	114.2	101.5
Fixed-broadband sub. per 100 inhab.	17.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	80.5	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	85.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.0	3.6	5.2
Fixed-broadband prices (% GNI pc)	3.3	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.0	5.7	6.8
Percentage of households with computer	67.6	64.9	46.6
Percentage of households with Internet access	63.8	63.3	51.5
Percentage of individuals using the Internet	70.2	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	41.1	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

access. In terms of fixed-broadband penetration, the Argentine market is yet to attain the regional rate. Progress is also sought in terms of speed, since it demonstrates significant lower bandwidth than regional and worldwide levels.

**Government policy:** The *Ministerio de Modernización* is the independent regulator in charge of telecommunications.<sup>24</sup> At the end of the 1990s, the Government of Argentina liberalized its telecommunications market and the country currently has one of the most advanced telecommunications infrastructures in Latin America.<sup>25</sup> The State-owned infrastructure operator, ARSAT (*Empresa Argentina de Soluciones Satelitales S.A.*), has announced considerable investment to increase the broadband reach to the rural areas. Within the same scope, that of the national plan *Argentina Conectada*, the Government aims to supply free digital television to the most remote and underserved regions. ARSAT is also responsible for deploying the national broadband plan, which aims to connect 1 200 remote locations and provide universal broadband access. Another ICT programme, the *Plan País Digital*, administered by the *Ministerio de Modernización*, also aims at developing ICT infrastructure, bridging the digital gap and supplying public Wi-Fi in more than 1 000 municipalities across the country.<sup>26</sup>

**Conclusion:** Argentina's approach to the telecommunications sector is multifaceted, employing national plans that focus on both infrastructure development and computer literacy, but also allowing for and incentivizing competition in the different market segments.

## Armenia

**Armenia was one of the first countries to launch LTE in the CIS region. It has a high level of mobile-broadband coverage: 3G is available for almost 100 per cent of the population, LTE coverage is above the CIS region average.**

**Mobile services:** There are three mobile-cellular telecommunication operators in Armenia: Vivacell-MTS, Ucom, and Beeline/Armentel. 3G-services have been provided since 2008. The first commercial LTE network was launched in 2011, and since 2016, all mobile-cellular operators provide LTE services.<sup>27</sup> Mobile number portability was introduced in 2014. As of the end of 2016, 3.4 per cent of localities were covered by one operator, 16.3 per cent by two, and 80.3 per cent by all three operators and. It is estimated that 80 per cent will be covered by LTE in 2017. In 2016, the number of broadband Internet subscribers is increasing steadily, with 84 per cent accessing the Internet via mobile networks.<sup>28</sup>

**Fixed services:** Operators continue modernization of fixed-telephone networks in Armenia. By the end of 2016 around 89 per cent of fixed-telephone networks were digital. At the same time, the number of fixed-broadband connections increases annually. Regulation authorities facilitate regional infrastructure development by imposing obligations on telecommunication operators. According to the last licensing requirements, Armentel shall provide 440 remote localities with broadband access in 2017.<sup>29</sup> Besides Armentel, Ucom, and GNC-Alfa companies are also among the largest fixed-broadband market players. The majority of users have ADSL-Internet access, although their number is decreasing while FTTx networks are being actively deployed.<sup>30</sup> The number of FTTx subscribers increased by 14 per cent from 2015 to 2017.<sup>31</sup> In remote areas, fixed-telephone and Internet access services are offered with CDMA networks.<sup>32</sup> In order to attract subscribers, operators bundle services together. Some services bundles contain both fixed and mobile services.

**Government policy:** The Ministry of Transport, Communication and Information Technologies is in charge for the policy making in ICT and telecommunications.<sup>33</sup> The government policy is stated in the “Concept paper on IT development for 2008-2018”. It focuses on ICT-

Key indicators for Armenia (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	17.8	20.7	13.6
Mobile-cellular sub. per 100 inhab.	114.8	141.2	101.5
Fixed-broadband sub. per 100 inhab.	10.0	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	51.7	59.7	52.2
3G coverage (% of population)	100.0	77.1	85.0
LTE/WiMAX coverage (% of population)	52.5	45.9	66.5
Mobile-cellular prices (% GNI pc)	0.9	1.7	5.2
Fixed-broadband prices (% GNI pc)	2.6	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.6	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.3	3.1	6.8
Percentage of households with computer	64.7	67.4	46.6
Percentage of households with Internet access	60.5	68.0	51.5
Percentage of individuals using the Internet	62.0	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	59.9	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

infrastructure and e-government development, ICT-education quality improvement, financial tools implementation to stimulate start-ups in the IT sphere, etc. According to this strategy Armenia aims to supply 70 per cent of households and 100 per cent of educational and governmental establishments with computers, and provide Internet access to 90 per cent of households by 2018.<sup>34</sup> Regulation authorities maintain a competitive environment in the telecommunication sector. One of the first steps to market liberalization was to end the international Internet gateway monopoly of ArmenTel in 2007.<sup>35</sup> The monopoly on VoIP (voice over IP) services was cancelled in the same year.<sup>36</sup> Although, there is an obligation to use ‘digital dividend’ frequencies of 800 MHz band for wireless-broadband services, in the majority of cases, telecommunication operators are able to use their radio-frequency resources with no limitations on offered services or implemented technology.<sup>37</sup> Some operators compete with each other both in fixed and mobile market segments.<sup>38</sup> Dominant telecommunication operators shall provide interconnection capabilities to small operators.<sup>39</sup> Armenian legislation provides for mechanisms to access the infrastructure of dominant operators, non-discriminatory terms of telecommunication operators' networks interconnection and consumer protection measures including tariff regulation.<sup>40</sup>

**Conclusion:** In its policy, the Armenia Government incentivizes ICT-infrastructure development for further introduction of e-government. ICT-related activities penetrated into many sectoral programme documents. Armenia is heading

towards affordable, secure access to e-government services across the country.

## Australia

**Australia has achieved a high level of mobile and Internet access. Government emphasis is on steps to promote the widespread availability of universal high-speed fixed broadband access through a wholesale/retail model.**

**Mobile services:** The market consists of three facilities-based operators: the incumbent Telstra; Optus, a subsidiary of Singapore Telecom; and Vodafone, a subsidiary of the United Kingdom mobile group of the same name. There are also a number of mobile virtual network operators (MVNOs). Mobile services are increasingly higher speed and 2G networks will be shut down by the end of 2017.<sup>41</sup> In June 2016, an estimated 14 million adults (76 per cent of the total) used a smartphone.<sup>42</sup> LTE networks were launched in 2011 and now cover most of the population. A fourth operator TPG has purchased spectrum and announced plans for building a network. The commercial rollout of 5G mobile networks is expected to commence in 2020.

**Fixed services:** Fixed-line broadband is dominated by ADSL, followed by cable modem and high speed connections such as fiber. There are four major fixed-line broadband and retail providers. The incumbent, Telstra, was fully privatised in 2011. Telstra supplies services over its legacy copper networks and over HFC and fiber networks. The other three major providers TPG, Optus and Vocus, supply services on Telstra's copper network and on their own networks. In major capital cities, TPG has deployed a fiber-to-the-basement network whilst Optus has deployed its own HFC network. A number of small fiber providers also service new developments. Some carriers also operate fixed wireless networks. Most of these are small scale and localized, but several cover multiple states. The federal government is rolling out the National Broadband Network (NBN), where NBN Co (a Government owned wholesaler) is rolling out high speed broadband to every premises in Australia. The rollout of the NBN aims to foster productivity and provide a platform for innovation in order to deliver economic and social benefits for all Australians. The NBN is being designed to provide peak wholesale download data rates of at least 25 megabits per second to all premises, and at least 50 megabits per second to 90 percent of the fixed line premises. The flexible rollout approach has meant that by October 2017 there were 6 million

Key indicators for Australia (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	33.8	10.0	13.6
Mobile-cellular sub. per 100 inhab.	109.6	98.9	101.5
Fixed-broadband sub. per 100 inhab.	30.4	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	130.2	47.4	52.2
3G coverage (% of population)	98.8	87.6	85.0
LTE/WiMAX coverage (% of population)	98.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.3	3.2	5.2
Fixed-broadband prices (% GNI pc)	1.1	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.4	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.2	5.4	6.8
Percentage of households with computer	85.9	37.8	46.6
Percentage of households with Internet access	88.5	45.5	51.5
Percentage of individuals using the Internet	88.2	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	88.3	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

premises that were able to order a service over the NBN (out of a total 11.6 million premises). The network is on track to be completed by 2020. All major fixed-line broadband providers, and many smaller providers, offer services on the NBN. Australia has eight international submarine cables which are built in response to commercial activities. Several more planned in the coming years. There are over a dozen Internet Exchange Points, all in major cities. Exchange Points are located in all but one of the eight state or territory capital cities.

**Government policy:** The Department of Communications and the Arts is the ministry responsible for industry policy covering broadcasting, telecommunications and postal services. Its *2017-18 Corporate Plan* outlines strategic priorities: consumer; advancing the sector; and content and culture. The Australian Communications and Media Authority (ACMA) is responsible for technical regulation of telecommunications and broadcasting guided by the *Telecommunications Act* of 1997. The Australian Competition and Consumer Commission (ACCC) is responsible for economic regulation including telecommunications and the NBN, broadcasting and content. The ACMA and ACCC share responsibility for consumer protection.

**Conclusion:** Australia has achieved a high level of ICT access that is typical of a developed nation. The Government is now promoting the availability of affordable high-speed infrastructure to every premises in the nation to support a knowledge-based, innovative economy.

## Austria

***Austria has a competitive telecommunication market with high penetration rates for fixed and mobile services and relatively affordable prices.***

**Mobile services:** A1 Telekom Austria, the incumbent operator, leads the Austria mobile market. The incumbent is however facing increased competition from the two other mobile network operators, Hutchinson and T-Mobile, as well as from several mobile virtual network operators (MVNOs). Hutchinson's takeover of Orange in 2013 allowed the operator to close in on its rival T-Mobile. At the end of 2015, T-Mobile (28 per cent) and Hutchinson/3 Austria (27.9 per cent) were separated by just 0.1 percentage points in terms of market share (RTR, 2015). Since the market consolidation, more and more MVNOs have entered the market and contributed to building competitive pressure in the sector. Numerous discount brands continue to stir up the market with highly attracted offers. Part of this increase in the MVNO sector has been driven by a regulatory concession imposed on 3 Austria following the Orange takeover to provide a third of its network capacity to up to 16 MVNOs. This high level of competition in the mobile market leads to very low prices for mobile services as well as relatively low ARPU levels for operators (RTR, 2015). Heavy competition in the mobile sector as well as an obligation to provide complete mobile-broadband coverage as part of the multiband auction in 2013 prompted operators to invest in their networks even in rural areas of the country. Furthermore, operators were allowed to refarm existing 2G and 3G spectrum for LTE, and spectrum in the 700 MHz band – once it is released from broadcasters - has been earmarked for mobile broadband. As a result, LTE networks are available to almost the entire population.

**Fixed services:** Austria has a very high fixed-telephone penetration that is even above the European average. Fixed-broadband penetration is close to the European average and very affordable in international comparison. The incumbent A1 holds the largest market share in the fixed telecommunication sector and is the only Austrian operator with a nationwide network infrastructure. A1 continues to restructure its access networks and is rolling out FTTx as well as implementing VDSL vectoring technology in

Key indicators for Austria (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	41.5	37.7	13.6
Mobile-cellular sub. per 100 inhab.	166.1	118.0	101.5
Fixed-broadband sub. per 100 inhab.	29.4	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	88.3	80.1	52.2
3G coverage (% of population)	98.0	98.5	85.0
LTE/WiMAX coverage (% of population)	98.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.2	1.0	5.2
Fixed-broadband prices (% GNI pc)	0.6	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.1	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.1	0.6	6.8
Percentage of households with computer	83.2	79.6	46.6
Percentage of households with Internet access	85.1	82.5	51.5
Percentage of individuals using the Internet	84.3	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	150.0	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

order to provide higher broadband speeds to its customers.<sup>43</sup>

**Government policy:** The liberalization of Austria's telecommunication market was triggered by the accession to the European Economic Area (EEA) in 1993 and European Union (EU) in 1995. ICT development is considered a national priority by the Austrian government. In 2010, the Austria Government founded the *Kompetenzzentrum Internetgesellschaft*, an Internet competence centre. The centre coordinates measures to strengthen the information society in Austria (OECD, 2012). The Austria national broadband strategy for 2020 was adopted in 2012 and aims at achieving 70 per cent coverage of broadband at speeds of 100 Mbit/s in metropolitan areas by 2018 and 99 per cent coverage of all households by 2020. The government follows a market-based approach, and only steps in to provide access in areas underserved by private operators.<sup>44</sup>

**Conclusion:** Austria is among the leading countries for ICT development. The government prioritizes ICT development and has created the framework to support roll-out driven by private players.

## Azerbaijan

**For mobile-broadband penetration and coverage Azerbaijan is among the leaders in the CIS region. The penetration rate in the fixed-broadband market is also above the CIS average. The prices for mobile and fixed telecommunication services are relatively low and continue to decline.**

**Mobile services:** The mobile-cellular market of Azerbaijan is represented by three telecommunication operators: Bakcell, Azercell and Azerfon. The companies started to provide commercial services in 1994, 1996, and 2007 correspondingly.<sup>45,46,47</sup> Azercell is the largest mobile telecommunication operator in the country with more than four million subscribers.<sup>48</sup> The first 3G network was deployed in 2009 by Azerfon.<sup>49</sup> This was followed by years of rapid development of mobile broadband networks. LTE was launched in 2015.<sup>50</sup> The IMEI code registration system was introduced in 2011, while mobile number portability (MNP) was introduced in the beginning of 2014.

**Fixed services:** From 1993 to 2003, telephone networks were actively deployed, Azerbaijan was connected to the Trans-Asia-Europe (TAE) international fibre-optic cable line and Internet access services became available all over the country. Nowadays, more than 90 per cent of regional centres are connected to high-speed fibre-optic cable lines.<sup>51</sup> By 2008, all of the settlements were provided by fixed telephone services. By 2010, analogue private branch exchanges (PBX) were replaced by digital systems. CDMA technology is heavily used in wireless local loop (WLL) systems. The largest national telecommunication operator Aztelecom covers 80 per cent of the population with CDMA networks. Commercial broadband Internet services have been offered to the population since 2006. Today, there are about 40 Internet providers in Azerbaijan. Three of them (Aztelekomnet, Bakinternet, and Azdatakom) are state owned.<sup>52</sup> Under the Public Wi-Fi project, free Wi-Fi hotspots are being deployed in the capital of Azerbaijan since May 2017.<sup>53</sup> Two private companies provide international Internet connections.<sup>54</sup>

**Government policy:** Two programmes in ICT were implemented under the National ICT Strategy 2003-2012 in recent years. The first

Key indicators for Azerbaijan (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	17.5	20.7	13.6
Mobile-cellular sub. per 100 inhab.	105.0	141.2	101.5
Fixed-broadband sub. per 100 inhab.	18.6	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	56.3	59.7	52.2
3G coverage (% of population)	95.5	77.1	85.0
LTE/WiMAX coverage (% of population)	41.0	45.9	66.5
Mobile-cellular prices (% GNI pc)	0.9	1.7	5.2
Fixed-broadband prices (% GNI pc)	1.1	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.5	3.1	6.8
Percentage of households with computer	64.3	67.4	46.6
Percentage of households with Internet access	77.4	68.0	51.5
Percentage of individuals using the Internet	78.2	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	34.3	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

project, e-Azerbaijan, focused on modern telecommunication infrastructure construction. The second aimed at information society development and ICT use. The strategy pursued development of information society legal framework, creation of favourable conditions for information distribution, e-government and e-trade development, ICT-infrastructure deployment, new ICT-services launch, etc. As a result, in 2003-2009 around 500 ICT related companies emerged. In 2010-2015, fixed-telephone network penetration increased by 45 per cent, and mobile-cellular network penetration increased by 38 per cent. In 2008, the government of Azerbaijan approved a national programme aimed at developing a space industry and launched its first telecommunication satellite and earth observation satellite in 2013. It plans to launch the second telecommunication satellite in 2018. In 2008, Azerbaijan initiated the Trans-Eurasian Information Super Highway (TASIM) project that is a major regional initiative aimed at creation of transnational fibre-optic backbone targeting primarily the countries of Eurasia from Western Europe to Eastern Asia.<sup>55</sup> Another significant infrastructural project is "AzDATACOM" implemented in partnership with the United Nations Development Programme (UNDP). The "AzDATACOM" project is a network infrastructure for data transmission covering almost all regions of the country.<sup>56</sup> In 2014, the government adopted a national programme based on The National Strategy of Information Society Development in the Republic of Azerbaijan 2014-2020.<sup>57</sup> The strategy targets the following issues: renovation of ICT-infrastructure, effective regulation, creation of competitive ICT-products, e-government enhancement, ICT-education, information security,

etc. In 2016, the government adopted the State Program to use this National Strategy.

**Conclusion:** The ICT sector in the country is one of the most developed in the CIS region. The Azerbaijan Government has a clear understanding of ICT policy significance in the development process. According to national plans, the focus will be on high-speed optical fibre and wireless access network construction, deployment of an IMS (IP multimedia subsystem)<sup>58</sup>, increasing transit capacity, and the development of data-centres and satellite communications.<sup>59</sup>

## Bahamas

***Notwithstanding the late introduction of competition in the mobile segment, the penetration rates in Bahamas are not far from the average in the region. The country stands out in regard to its higher percentage of individuals using the Internet as well as its mobile-broadband coverage, relative to the other countries in the region.***

**Mobile services:** There is a strong presence of both the partially government-owned operator (49 per cent of the company's shares), the Bahamas Telecommunications Company (BTC), which has majority market shares in fixed telephony and mobile services, and Cable Bahamas Limited (CBL) a 100 per cent locally owned operator with majority market shares in cable television and fixed broadband services, and a controlling interest in the second mobile operator, Be Aliv Limited (Aliv). The Bahamian mobile market was a monopoly of BTC until October 2016, when Aliv entered the market with a fully LTE network covering more than 75 per cent of the population, having received its licence in July 2016. Aliv's licences require its network to cover all populated islands of The Bahamas within two years. Mobile is the segment with the highest penetration level in Bahamas, though overall mobile voice penetration is lower than regional and global averages. In 2016, BTC was in the process of rolling out LTE.<sup>60</sup> Both mobile-cellular and mobile-broadband prices are well below the regional average in terms of GNI per capita.

**Fixed services:** Fixed-telephone services are provided by BTC and Cable Bahamas Limited (CBL).<sup>61</sup> In an effort to enhance the array of choices to the consumer, the national telecommunications regulator introduced fixed number portability in 2013. Bahamas has a higher penetration rate for fixed services, both telephony and fixed broadband, than the regional and global average.

**Government policy:** The telecommunications sector is regulated by the Utilities Regulation and Competition Authority (URCA), a separate and independent regulator created in 2009. Among URCA's main objectives are the promotion of sustainable competition, investment and optimal usage of resources.<sup>62</sup> While mobile number portability is currently being implemented by the regulator (with expected launch in April 2017), and

Key indicators for Bahamas (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	30.9	24.4	13.6
Mobile-cellular sub. per 100 inhab.	91.8	114.2	101.5
Fixed-broadband sub. per 100 inhab.	22.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	51.2	82.7	52.2
3G coverage (% of population)	98.0	93.6	85.0
LTE/WiMAX coverage (% of population)	95.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.1	3.6	5.2
Fixed-broadband prices (% GNI pc)	1.7	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.6	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.6	5.7	6.8
Percentage of households with computer	70.7	64.9	46.6
Percentage of households with Internet access	66.0	63.3	51.5
Percentage of individuals using the Internet	80.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	198.4	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

work to implement price caps is in train, various other measures to regulate the operators with significant market power (SMP) have already been put in place (for instance regulated interconnect offers, national roaming, and additional regulatory obligations).<sup>64</sup> URCA determined that BTC has SMP in fixed-voice services, mobile voice and mobile data services and fixed broadband services (BTC's SMP in fixed broadband is limited to Geographic Market 2, which comprises all but the four most heavily populated populous islands); CBL, on the other hand, has SMP in paid television services and fixed broadband services (CBL has SMP in fixed broadband services in Geographic Market 1 which comprises the most heavily populated islands of New Providence, Grand Bahama, Abaco and Eleuthera). Still within the scope of fostering competition, the regulator commenced net neutrality discussions in 2016 but has not yet finalized any regulatory intervention.

**Conclusion:** As with many small countries, the Bahamas' various telecommunications segments are susceptible to a concentrated market but the regulator is committed to adopting the various measures necessary to move towards broader market liberalization. The country's infrastructure already allows for a more intense usage uptake of the various telecommunications services.

## Bahrain

***Bahrain has a vibrant and advanced market for ICT services, with low prices and high usage of fixed and mobile-broadband services. With three competing mobile operators and 14 Internet operators, the country offers some of the lowest prices of fixed and mobile-broadband services in the Arab States region.***

**Mobile services:** Mobile-cellular penetration is well above the average penetration in Arab States region and globally. The same applies to mobile-broadband penetration, which has grown fast and is three times as high as the global and regional averages. This can be attributed to the strong competition between its three telecommunication operators. The Bahrain Telecommunications Company (Batelco), the partially private incumbent operator, began facing competition when Zain (MTC-Vodafone prior to 2007) that was granted the second licence in the country. At the end of 2003, Bahrain was the first country in the Arab States to launch commercial 3G services. In 2009, the third licence was granted to Viva in an effort to reduce prices for consumers. Spectrum licences were granted in 2013 in the 900MHz/1800MHz/2100MHz bands to the three mobile operators to increase the capacities of mobile networks, and commercial services were launched the same year based on LTE networks. Today, 100 per cent of the population is covered by LTE networks.

**Fixed services:** Bahrain has also the highest penetration of fixed-broadband among the Arab States countries with speeds exceeding 2 Mbit/s for the majority of its subscribers. Full competition was introduced in fixed domestic and international, international gateways, satellite and Internet services in 2004. Number portability for fixed and mobile services was introduced in 2011, and investors face no restrictions to foreign ownership in ICTs. Additionally, fixed-wireless broadband is popular in Bahrain representing 43 per cent of all fixed-broadband subscriptions.

**Government policy:** The independent Telecommunications Regulatory Authority (TRA) was established in 2002 through the adoption of the Telecommunications Law of 2002 and the first Telecommunication National Plan released in 2003, as part of the reform process launched by the government that focused on measures

Key indicators for Bahrain (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	20.3	7.7	13.6
Mobile-cellular sub. per 100 inhab.	216.9	107.1	101.5
Fixed-broadband sub. per 100 inhab.	16.8	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	162.4	45.2	52.2
3G coverage (% of population)	100.0	81.9	85.0
LTE/WiMAX coverage (% of population)	100.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.6	4.3	5.2
Fixed-broadband prices (% GNI pc)	0.8	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.0	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.6	5.5	6.8
Percentage of households with computer	94.8	43.3	46.6
Percentage of households with Internet access	98.0	45.3	51.5
Percentage of individuals using the Internet	98.0	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	112.8	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

to introduce and foster competition as well as protect the interests of consumers. The second National Telecommunication Plan released in 2008, recognized the need to nurture competition, to create an environment conducive to investment and to enhance the use of broadband and Internet services. The third National Telecommunication Plan, released in 2012, identifies measures to strengthen ICT competitiveness and readiness to support the fast-growing digital economy. In 2016, the fourth National Telecommunication Plan for the coming three years was approved. The plan aims to develop high-speed optical fibre networks across the country with a downstream data rate of at least 100 Mbit/s for households and 1 Gbit/s for businesses, in an effort to strengthen Bahrain as a leading regional hub for Internet businesses, content and applications.

**Conclusion:** The efforts made by the Government of Bahrain over the past 15 years have resulted in making Bahrain one of the world's most connected countries. Nearly all of its households have Internet access and most of its citizens use the Internet on a regular basis. Recent plans to further develop countrywide high-speed networks reinforce its high ambition to maintain and further strengthen Bahrain as a global high-tech hub.

## Bangladesh

**Bangladesh has achieved widespread telecommunications coverage through wireless solutions and is now moving towards greater mobile-broadband coverage.**

**Mobile services:** There are five mobile operators, the top three controls 90 per cent of the market. GRAMEENPHONE, a subsidiary of the Telenor Norwegian mobile group, is the largest. The other two are BANGLALINK a subsidiary of the Global Telecom Holding and ROBI, a subsidiary of the Malaysian mobile group AXIATA. Currently, the 2G population coverage is more than 99 per cent. Mobile broadband using 3G technologies was deployed in 2013 and with government active initiatives the 3G network expanded countrywide very rapidly which impacted the mobile broadband subscriptions (28.7 million 3G data users in December, 2016). The government is in the process to award spectrum for mobile LTE with tech neutrality. Existing Broadband Wireless Access (BWA) or WiMAX operators BANGLALION, BIEL and QUBEE are in process to deploy LTE technology.

**Fixed services:** Bangladesh Telecommunications Company Limited (BTCL) is the incumbent, state-owned fixed telephone service operator, tracing its roots back to the formation of the Posts and Telegraph Department in 1853. Besides the incumbent, there are few fixed line operators but their penetration is very low like the world trend. Fixed broadband Internet penetration is also low comparing to mobile broadband Internet service. Various fixed Internet services like ADSL, FTTH etc. are available. There is an extensive network of Union Digital Centers (UDC) which is around 4500 throughout the country. To provide seamless telecommunication services, the Government has issued Nationwide Telecommunication Transmission Network (NTTN) license in 2009 to lay optical fiber throughout the country. At present, around 79,000 km optical fiber has been laid by the two private NTTN operators (Fiber @ home Ltd. and Summit Communications Ltd) and three incumbent NTTN operators (BTCL, Power Grid Company of Bangladesh and Bangladesh Railway). Bangladesh is connected with two submarine cables: SEA-ME-WE-4 in 2005 and SEA-ME-WE-5 is going to start its commercial operation in 2017. It has also Six (06) International Terrestrial Cable (ITC) operators which are linked to India.

Key indicators for Bangladesh (2016)	Asia & Pacific		World
Fixed-telephone sub. per 100 inhab.	0.5	10.0	13.6
Mobile-cellular sub. per 100 inhab.	83.8	98.9	101.5
Fixed-broadband sub. per 100 inhab.	4.1	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	27.2	47.4	52.2
3G coverage (% of population)	91.4	87.6	85.0
LTE/WiMAX coverage (% of population)	65.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	1.8	3.2	5.2
Fixed-broadband prices (% GNI pc)	4.4	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.3	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.2	5.4	6.8
Percentage of households with computer	9.6	37.8	46.6
Percentage of households with Internet access	14.5	45.5	51.5
Percentage of individuals using the Internet	18.2	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	9.2	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Besides this, two National Internet Exchanges (NIX) are in operation to provide local peering.

**Government policy:** Bangladesh Telecommunication Regulatory Commission (BTRC) was established in 2002, under the *Bangladesh Telecommunication Regulation Act 2001* as telecom regulator. BTRC works independently. However, there are certain areas where BTRC performs its function under the supervision of the Ministry of Posts, Telecommunications and Information Technology (MoPTIT). The *National Broadband Policy* was formulated in 2009. The policy called for ensuring the availability of affordable, advanced and secure broadband services with a target of 30 per cent broadband penetration by 2015. 'Digital Bangladesh' is the ICT vision set out by the present Government of Bangladesh in its 2008 election manifesto. Its goal is to turn the country into a fully digitized nation by 2021. The spirit of Digital Bangladesh has been enshrined in the country's *Seventh Five Year Plan* (FY2016 – FY2020), which devotes an entire chapter to ICT. The plan features detailed strategies for applying ICT across ten areas: i) Economic growth; ii) Education; iii) Youth empowerment; iv) Equity; v) Governance; vi) Civil service; vii) Judiciary; viii) Law enforcement; ix) Parliament and x) Environment.

**Conclusion:** Bangladesh has witnessed rapid expansion of 3G networks which is significantly impacting the growth of mobile-broadband users and it is looking forward to introduce LTE technology. However, fixed Internet penetration is increasing day by day as several initiatives and policies have been formulated and implemented

by the Government of Bangladesh to successfully achieve the vision of 'Digital Bangladesh'.

## Barbados

**Barbados has made considerable progress since the end of the operator LIME's monopoly in the early 2000s, both in terms of infrastructure and service pricing. Within the first five years, both the wireless and long distance segments of the market were competitive. The Government has also made efforts to train and educate its population for capacity building and technology transfer. The National Strategic Plan of Barbados 2005–2025 recognizes in multiple instances the positive impact brought by ICT development in all areas of the society.**

**Mobile services:** Following the merger of LIME and FLOW, two of the mobile operators present in the market, there are now three main players competing for market share, the other two being Digicel and Sunbeach.<sup>65</sup> The mobile market has been in the process of liberalization since 2003, when the first Reference Interconnection Offer was issued, and in 2015 Barbados surpassed the Americas' regional mobile-cellular penetration levels. Mobile-broadband has been steadily spreading in recent years and the operators are committed to heavily investing in LTE, first launched by Digicel towards the end of 2016. The incumbent, Flow, has also made LTE available and plans to continue investments in order to increase the service availability.<sup>66</sup>

**Fixed services:** Competition was first introduced to the national market for fixed-telephony in the early 2000s, its penetration rates being above the regional and global levels and maintaining an upward trend, whereas there is a decline in the percentage of users for this service regionally and globally. Fixed-broadband penetration is higher than average for Barbados, and since the establishment of the Barbados Internet Exchange in 2015, the service quality and network capacity are expected to increase while also anticipating lower costs.<sup>67</sup>

**Government policy:** The Ministry for Telecommunications is responsible for management and regulation of the telecommunications sector, especially concerning licensing and legislation. It delegates certain regulatory functions to Barbados' telecommunications regulatory body, the Fair Trading Commission, in accordance with the Telecommunications Act of 2001, the Fair Trading

Key indicators for Barbados (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	48.4	24.4	13.6
Mobile-cellular sub. per 100 inhab.	115.0	114.2	101.5
Fixed-broadband sub. per 100 inhab.	30.1	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	44.7	82.7	52.2
3G coverage (% of population)	100.0	93.6	85.0
LTE/WiMAX coverage (% of population)	20.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.3	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.7	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.7	5.7	6.8
Percentage of households with computer	71.7	64.9	46.6
Percentage of households with Internet access	67.7	63.3	51.5
Percentage of individuals using the Internet	79.5	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	284.6	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Commission Act and the Utilities Regulation Act. The Commission is responsible for standards of service, tariff control and implementing the policies established by the Telecommunications Unit; this arm of the Ministry is also responsible for licensing in the industry.<sup>68</sup> The regulator issued its first price cap in 2005 with respect to the national incumbent, and has kept this practice over the years, more recently imposing a ban on price increases of more than 3 per cent on non-competitive services until 2019.<sup>69</sup> The Commission also reviews and publishes annual reports on the standards of customer service, first released in 2006.

**Conclusion:** The national Government considers the telecommunications sector to be paramount for the country's development, along with regional integration, the latter a constant subject for the Caribbean in order to leverage the resources of the different islands. The Telecommunications Unit has recently embarked on a series of projects, namely the National Computer Incident Response Team, the revision of the Telecommunications Act and the preparation for the introduction of IPv6.<sup>70</sup>

## Belarus

**Belarus systematically develops ICT infrastructure and makes it affordable for the population, which creates a favorable environment for new ICT-services and ICT-usage growth. As a result Belarus is one of the regional leaders in ICT development.**

**Mobile services:** Mobile-broadband penetration in Belarus is one of the highest in the CIS region. The first commercial mobile services were launched in 1993. GSM telecommunication operators received their licences in 1999, 2002 and 2005.<sup>71,72</sup> Government and foreign investment in the mobile cellular market resulted in fast infrastructure development and competition growth in the following years. In the beginning of 2012 mobile number portability was launched.<sup>73</sup> The first 3G licence was issued in 2009 in 2100 MHz frequency band.<sup>74</sup> In the beginning of 2016, as a result of spectrum refarming, UMTS-900 was introduced.<sup>75</sup> This technology aims to increase mobile broadband coverage and enhance signal quality. In the end of 2015, LTE-A was launched in 1800 MHz frequency band.<sup>76</sup> It is also planned to use 2600 MHz band in the future. Today, there are three telecommunication operators offering mobile services to the population: Velcom, MTS, and BeST/Life. Each of them has its own 2G/3G network. However, LTE-A network is currently being deployed by a separate state owned infrastructure operator beCloud, which was created in 2012 to facilitate infrastructure deployment on a national scale.<sup>77,78</sup> Recently, it provides fixed and mobile infrastructure for other telecommunication operators and government bodies across the country. It is also in charge for the republican data-center development to support the national e-services platform.<sup>79</sup> Mobile telecommunication operators are able to provide their services over the LTE-A network, but cannot build their own. In the beginning of 2017, two mobile telecommunication operators (MTS and BeST/Life) offered their services over the LTE-A infrastructure. It is planned to provide LTE coverage for all of the regional centers by the end of 2017.<sup>80</sup>

**Fixed services:** Belarus has the highest penetration of fixed-broadband services in the region. At the beginning of 2016, download speeds of 2-10 Mbit/s were provided for more than 70 per cent of subscribers. Sixty per cent of subscribers

Key indicators for Belarus (2016)		CIS	World
Fixed-telephone sub. per 100 inhab.	49.0	20.7	13.6
Mobile-cellular sub. per 100 inhab.	124.2	141.2	101.5
Fixed-broadband sub. per 100 inhab.	33.3	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	69.5	59.7	52.2
3G coverage (% of population)	98.7	77.1	85.0
LTE/WiMAX coverage (% of population)	41.5	45.9	66.5
Mobile-cellular prices (% GNI pc)	1.1	1.7	5.2
Fixed-broadband prices (% GNI pc)	1.2	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.6	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.1	3.1	6.8
Percentage of households with computer	67.0	67.4	46.6
Percentage of households with Internet access	62.5	68.0	51.5
Percentage of individuals using the Internet	71.1	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	168.5	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

connected to the Internet via xDSL, and over 15 per cent of them use fibre-optics.<sup>81</sup> Belarus has a high level of local competition among telecommunication operators. More than 150 of them have licences to provide data transmission services.<sup>82</sup> Over 75 per cent of subscribers are clients of the national operator Beltelecom.<sup>83</sup> Along with beCloud, Beltelecom is responsible for many national ICT development activities. It deploys GPON access networks and public Wi-Fi, extends core network and gateway capacity, and develops IMS-based services.<sup>84</sup>

**Government policy:** The Ministry of Communications and Informatization is responsible for the national development programmes.<sup>85</sup> The previous national programme covered 2011 to 2015.<sup>86</sup> It aimed at developing broadband infrastructure to maximize the population coverage and introduce modern e-services. The National programme of digital economy and information society development 2016-2020 is in action now.<sup>87</sup> It focuses on further enhancements of fibre-optic networks, 3G/LTE coverage, satellite communications, digital television, and cloud-based technologies.

**Conclusion:** Efforts made in ICT development on a national scale resulted in the high level of mobile and fixed services penetration. Implementation of existing plans allows the country to steadily enhance people's quality of life through e-services integration into various spheres of society.

## Belgium

**Belgium's mobile market, which is served by three MNOs, has gone through numerous mergers and acquisitions in recent years. The fixed network is very advanced and widely available. Penetration rates for both fixed and mobile services are high and prices very affordable.**

**Mobile services:** Three licensed mobile network operators provide services in Belgium: Proximus, Orange and BASE. Proximus leads the mobile market with a postpaid market share of close to 50 per cent.<sup>88</sup> In addition, there are an ever growing number of mobile virtual network operators active in the market. The Belgium market has witnessed numerous mergers and acquisitions. Most notably, the third largest operator BASE was bought by Telenet in 2016.<sup>89</sup> Mobile-broadband services are offered by all three MNOs and almost complete population coverage has been reached for 3G and LTE signals thanks to extensive investment made by the Belgian operators. Mobile offers, in particular for prepaid and postpaid mobile-broadband services, are very affordable.

**Fixed services:** Belgium has a very well developed fixed infrastructure and fixed-broadband penetration is high. Virtually all households in Belgium, including in rural areas, have access to fixed broadband. Moreover, broadband connections over next-generation access (NGA) networks with speeds over 30 Mbit/s are commonplace and 99 per cent of all households in the country are covered. Cable networks continue to be most popular and fibre connections only make up a very small percentage of connections.<sup>90</sup> Fixed-telephony continues to have penetration rates higher than the European average, but is declining in line with the global trend towards fixed-to-mobile substitution.

**Government policy:** In April 2015, the Belgium Federal Government launched "Digital Belgium" a policy strategy that aims at achieving faster connectivity and improved digital skills. The government takes a market-based approach to ICT development and aims to increase broadband connectivity by promoting investments in NGA and non-NGA connections by private operators. To support this development, the government is committed to reducing administrative burdens and infrastructure deployment costs as well as

Key indicators for Belgium (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	39.0	37.7 13.6
Mobile-cellular sub. per 100 inhab.	111.8	118.0 101.5
Fixed-broadband sub. per 100 inhab.	38.1	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	66.7	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	100.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.8	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.8	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	0.6 6.8
Percentage of households with computer	82.2	79.6 46.6
Percentage of households with Internet access	84.8	82.5 51.5
Percentage of individuals using the Internet	86.5	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	189.3	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

providing a stable, reliable regulatory regime. Belgium incumbent operator Proximus announced plans to roll out FTTC in the coming decade and operator Telenet continues to invest in its cable network.<sup>91</sup>

**Conclusion:** Belgium developed into an advanced ICT market with a high ICT household penetration and proportion of the population that is online. The government supports technology-neutral, market-based broadband development and aims to provide the appropriate framework for investments by private players.

## Belize

***Belize was one of the pioneers in privatizing the incumbent among Latin American countries. Following its privatization in the late 1980s, Belize Telecommunications Ltd. (BTL) was granted a monopoly concession that lasted for 15 years for both mobile and fixed services.<sup>92</sup> The lack of a competitive environment caused underinvestment in the industry, but this is beginning to change as new service providers enter the market, in particular over-the-top players, and triggering a switch in the existing operators' strategy, involving more investment and better pricing.<sup>93</sup>***

**Mobile services:** Mobile-cellular penetration is below the regional and global levels, which can be attributed to the concentrated market dominated by the two main players: Digicel, owned by BLT, and SMART.<sup>94</sup> Similarly, mobile-broadband uptake has been lagging behind the regional average, the operators having launched LTE coverage during 2016. The mobile segment, however, accounts for more than 90 per cent of all subscriptions and therefore holds the potential for more significant development and impact.<sup>95</sup>

**Fixed services:** Despite the liberalization over a decade ago, BTL remains the dominant operator for fixed-telephony and broadband. With penetration levels for both segments well under the regional and global averages, the Government of Belize has been working on introducing more competition and facilitating access by other providers: for example, in 2013, the obligatory opening of its networks to VoIP services.

**Government policy:** The Telecommunications Act of 2002 made the Public Utilities Commission the telecommunications industry's regulator. The Commission oversees the industry's licensing, and is in charge of stimulating the national industry and promoting investment and innovation.<sup>96</sup> The privatization of the incumbent, BTL, was reverted in 2009, when the Government regained the stakes in the company.<sup>97</sup> Progress is being made on the Internet service front, as the first Internet exchange point was launched in 2016 and is expected to decrease the costs for local Internet service providers and improve reliability.<sup>98</sup>

**Conclusion:** Belize is in the process to overcome a variety of hurdles within its ICT market in order to

Key indicators for Belize (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	6.5	24.4	13.6
Mobile-cellular sub. per 100 inhab.	63.9	114.2	101.5
Fixed-broadband sub. per 100 inhab.	6.2	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	13.8	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	46.9	77.4	66.5
Mobile-cellular prices (% GNI pc)	7.4	3.6	5.2
Fixed-broadband prices (% GNI pc)	3.3	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.0	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.3	5.7	6.8
Percentage of households with computer	36.0	64.9	46.6
Percentage of households with Internet access	30.2	63.3	51.5
Percentage of individuals using the Internet	44.6	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	44.6	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

reach the market development levels of the region. The Government's efforts to liberalise the market and the roll-out of LTE networks are expected to increase the uptake of ICT services.

## Benin

**This West African country looks forward to higher ICT uptake with the arrival of a new undersea fibre-optic cable. The Government aims to leverage this to develop a digital economy.**

**Mobile services:** There are four mobile operators in the country: MTN, a subsidiary of the South African mobile group; MOOV, a subsidiary of Maroc Telecom; GLO, a subsidiary of the Nigerian mobile company Globalcom; and Benin Telecoms, the State-owned incumbent operating under the brand LIBERCOM. The first two account for around 90 per cent of the market and have been at the forefront of introducing new services such as mobile-broadband and mobile money. In 2013, 78 per cent of households had mobile phones, 86 per cent in urban areas and 69 per cent in rural locations.<sup>99</sup> Following the award of universal licenses, MTN launched 3G in 2012, followed by MOOV in 2014. MTN launched LTE using 1 800 MHz in 2016.

**Fixed services:** Benin Telecoms, the State-owned incumbent operator, is the only fixed line telephone provider using both copper wire and wireless local loop lines. Fixed-broadband offered by Benin Telecoms includes CDMA, WiMAX and LTE fixed wireless, as well as fixed ADSL and fibre-optic connections for businesses. The maximum speed on offer for ADSL is 2 Mbit/s. In addition to the mobile-broadband operators, there are ten fixed wireless ISPs. Benin Telecoms' infrastructure manages the national backbone. The five-year project to develop telecommunications and ICT infrastructure, financed by a Chinese loan, will significantly extend the backbone, including fibre-optic links to all of the country's 77 communes. The country has been connected to the SAT-3 undersea fibre-optic cable since 2002, with Benin Telecoms (then called OPT) owning the landing rights for Benin. However, it was only with the arrival of ACE cable over a decade later that there was a substantial increase in international bandwidth with lower prices. A joint venture of local mobile operators and ISPs called Benin ACE GIE manages the ACE connection. Benin-IX (Benin Internet eXchange Point), launched in 2013, has six participants.

**Government policy:** The strategy of the sector is elaborated by the *Conseil du Numérique* chaired by the President of the Republic, with

Key indicators for Benin (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	1.1	1.0	13.6
Mobile-cellular sub. per 100 inhab.	79.6	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.2	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	7.9	22.9	52.2
3G coverage (% of population)	45.0	59.3	85.0
LTE/WiMAX coverage (% of population)	23.9	25.7	66.5
Mobile-cellular prices (% GNI pc)	11.6	14.2	5.2
Fixed-broadband prices (% GNI pc)	36.1	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	9.6	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	16.9	17.7	6.8
Percentage of households with computer	5.8	9.6	46.6
Percentage of households with Internet access	6.6	16.3	51.5
Percentage of individuals using the Internet	12.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	1.7	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

as executive arm *l'Agence d'Exécution du Numérique* (ADN). Supervision for the sector is the responsibility of the Ministry of Digital Economy and Communications. This includes oversight over Benin Telecoms and the national posts and radio and television services. It also oversees the universal service agency and ICT agency, and is responsible for e-government. The government has adopted a Sector Policy Declaration (DPS 2016 -2021) whose strategic orientations for 2021 are: "Transforming Benin into West Africa's digital services platform for the acceleration of growth and social inclusion". The six flagship projects identified in the DPS are the deployment of high- and very high-speed Internet throughout the territory; the transition to Digital Terrestrial Television (DTT); the implementation of intelligent administration (Smart Gov); the widespread use of e-commerce; the widespread use of digital technology through education and training; and the promotion and development of digital content.

**Conclusion:** The arrival of a second undersea cable ended the monopoly the incumbent had on international fibre Internet bandwidth, resulting in greatly expanded capacity at much lower prices. The Government now aims to seize on this by more tightly integrating ICTs into the country's social and economic development strategies.

## Bhutan

**Despite being remote, landlocked and a least developed country, the mountain Kingdom has achieved a high level of ICT access. Mobile population coverage is high and the fibre-optic backbone reaches most parts of the country.**

**Mobile services:** There are two mobile operators. The state-owned incumbent Bhutan Telecom Limited launched its GSM network in 2003, operating under the brand B-Mobile. Tashi InfoComm Limited, operating under the brand, TashiCell, a locally owned company, entered the market in 2008. Population coverage by 2G mobile is extensive and by 2012, 93 per cent of households had a mobile phone, with a slight difference in coverage between urban (97 per cent) and rural (91 per cent) areas.<sup>100</sup> Mobile broadband has become popular since the introduction of 3G by Bhutan Telecom in 2008 and by TashiCell in 2013. Growth in mobile broadband coverage has been aided by the deployment of 3G using 850 MHz and 700 MHz, which has a long wider signal range. Bhutan Telecom launched LTE in 2013, with TashiCell following in 2016. LTE services are now available in all 20 districts.

**Fixed services:** Bhutan Telecom is the sole provider of fixed-line telephone services. The number of fixed line subscriptions has been declining owing to the popularity of mobile services. Bhutan Telecom and DrukCom use ADSL and FTTH/FTTC to provide fixed broadband access for premises in selected areas. There are several other ISPs offering fixed wireless broadband. The country has an extensive fibre-optic backbone. The National Broadband Master Plan Implementation Project (NBMP) led to the connection of all *Dzongkhags* (second level administrative unit in Bhutan equivalent to a district) and 201 out of 205 *Gewogs* (blocks of villages). The Government owns the network spanning some 3 300 kilometres and leases fibre to telecommunication operators and ISPs free of charge. The network extends to the Indian border, where Bhutan's Internet traffic is routed to undersea fibre-optic cables. There are plans to establish an Internet Exchange Point.

**Government policy:** The Ministry of Information and Communications (MIS) is the policy maker. The 2015 *ICT Roadmap* guides policy for the sector with the vision of “An ICT-Enabled, Knowledge Society as a Foundation for Gross

Key indicators for Bhutan (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	2.7	10.0	13.6
Mobile-cellular sub. per 100 inhab.	88.8	98.9	101.5
Fixed-broadband sub. per 100 inhab.	2.1	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	69.4	47.4	52.2
3G coverage (% of population)	85.0	87.6	85.0
LTE/WiMAX coverage (% of population)	53.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	1.3	3.2	5.2
Fixed-broadband prices (% GNI pc)	3.9	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.8	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.4	5.4	6.8
Percentage of households with computer	26.0	37.8	46.6
Percentage of households with Internet access	33.0	45.5	51.5
Percentage of individuals using the Internet	41.8	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	18.1	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

National Happiness.” The Roadmap identifies 15 specific strategies to achieve the three main outcomes: ICT for Good Governance; ICT for a Shared National Consciousness; and ICT as a Key Enabler for Sustainable Economic Development. The *Bhutan Telecommunications and Broadband Policy* was adopted in 2014 with the chief aims of connectivity for all, bolstering the regulatory environment, creating an enabling environment for private investment, and competition resulting in affordable broadband services. The Bhutan InfoComm and Media Authority (BICMA) is the independent agency established in 2007 to promote and regulate the telecommunications, media and broadcasting sectors. The *Bhutan Information, Communications and Media Act 2006* is the key regulatory legislation for the sector. In 2010, Thimphu TechPark was inaugurated in the capital. It houses the government data centre and offices for companies providing ICT-enabled services.

**Conclusion:** The country has witnessed impressive progress in ICT in the past decade, with high mobile cellular coverage and growing Internet usage. Forward-thinking policies and strategies, including a predictable regulatory environment and a reasonable level of competition for a country of Bhutan's size, have facilitated this progress.

## Bolivia (Plurinational State of)

**The Bolivia's ICT industry has been slow to flourish, with the services' uptake at a moderate rate when compared with the regional and global levels. The operator Entel was privatized in 1995, only to be renationalized in 2007. Since then, it is a state-owned company.**

**Mobile services:** The predominance of mobile over fixed services is evident in the Plurinational State of Bolivia, with mobile phones accounting for more than ten times the amount of fixed lines. There are three mobile operators in the country: Entel, Telecel and NuevaTel. In 2015, Entel's market share represented more than 40 per cent of the mobile subscriptions, with the other two companies sharing the rest of the market. All companies offer mobile-broadband services and have had increasing success, especially given the poor quality and lack of availability of fixed broadband. During the last eleven years, more than 11000 radio base stations have been deployed allowing 3G and LTE technologies to sharply increase their coverage. Moreover, the three mobile network operators have recently made efforts in LTE technology roll-out, amounting to close to US\$ 500 million for 2015.<sup>101</sup> In 2017, the Government will implement mobile number portability, which aims at increasing the dynamics and competition in the mobile market.<sup>102</sup>

**Fixed services:** The Plurinational State of Bolivia's fixed-telephone penetration levels have remained stable over recent years, despite being at a much lower level than those of its neighbouring countries. The Bolivian local fixed services are supplied by multiple telecom cooperatives that are controlled by their users. In many cases, those cooperatives also offer broadband services. The non-profit character of such cooperatives could also explain the low uptake in the fixed services, as there are few competitive related incentives to improve the service quality. Entel offers long distance services as well as DSL. Entel's broadband prices are influenced by the fact that the Plurinational State of Bolivia is a landlocked country with no direct access to submarine cable networks. Nevertheless, the country has made remarkable progress in terms of fixed infrastructure. In 2013, there were 3500 km of optical fibre and only three International Internet links; today, there are 18000 km of optical fibre

Key indicators for Bolivia (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	7.7	24.4	13.6
Mobile-cellular sub. per 100 inhab.	90.2	114.2	101.5
Fixed-broadband sub. per 100 inhab.	2.6	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	55.0	82.7	52.2
3G coverage (% of population)	74.5	93.6	85.0
LTE/WiMAX coverage (% of population)	60.7	77.4	66.5
Mobile-cellular prices (% GNI pc)	4.1	3.6	5.2
Fixed-broadband prices (% GNI pc)	5.7	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.3	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.9	5.7	6.8
Percentage of households with computer	33.9	64.9	46.6
Percentage of households with Internet access	26.6	63.3	51.5
Percentage of individuals using the Internet	39.7	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	36.3	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

and nine international links to the Internet with a bandwidth of 200 Gbit/s.

**Government policy:** The body responsible for regulating the Plurinational State of Bolivia's telecommunication sector, *Autoridad de Regulación y Fiscalización de Telecomunicaciones y Transportes* (ATT), was created in 2009. The regulator recognizes the importance of telecommunications for national social and economic development, further stating that, by itself, the sector contributed to 6 per cent of the country's GDP. The Plurinational State of Bolivia's Central Bank announced in 2015 that mobile money transactions grew by more than 900 per cent in volume compared with the previous year, one more example of the strong presence of the mobile segment in the country.<sup>103</sup> Mobile operators have also joined forces with GSMA and ATT within the scope of "We Care Bolivia", a campaign committed to leveraging mobile communications to increase online safety and data protection.<sup>104</sup> In recent years, the Government has implemented policies on digital signature, broadband planning, free software development, digital terrestrial television and electronic government, among others.

**Conclusion:** The Bolivia's mobile services uptake has great potential, as the penetration rates continue to grow. Government incentives along with operators' investment and strategic partnerships, such as the one for "We Care Bolivia", have been paramount to the industry's growth.

## Bosnia and Herzegovina

***The telecommunication market in Bosnia and Herzegovina is dominated by three incumbent operators that provide fixed services mainly in their respective regions of the country, and mobile services in the whole country. Penetration rates for both fixed and mobile services are low in comparison to both Europe and global level, but also in relation to most of its neighbouring countries.***

**Mobile services:** The incumbent fixed-line operators each have mobile divisions that are leading the mobile market as well.<sup>105</sup> The Telekom Srpske mobile phone subsidiary, m:tel, has been growing its market share both in the Republika Srpska as well as at the national level. BH Mobile (BH Telecom subsidiary) and HT Mostar's Eronet (Hrvatske Telekomunikacije subsidiary) are market leaders in the Federation of Bosnia and Herzegovina. Licences to provide 3G services were issued in 2009 by the regulator Communications Regulatory Agency (CRA) to the three MNOs.<sup>105</sup> GSM and UMTS licences oblige dominant operators to develop their mobile networks throughout the whole country. While 3G coverage is almost complete in terms of population, mobile-broadband penetration is below the European and global average. This can be explained by a relatively low level of competition within each respective regional market as well as relatively high prices for mobile-broadband services. LTE mobile-broadband is not yet available.

**Fixed services:** As many aspects of Bosnian society, telecom operators have formed along regional lines following independence in 1992. The fixed market is dominated by Bosnia and Herzegovina incumbent operators, namely: BH Telecom (based in Sarajevo), Telekom Srpske (based in Banja Luka) and Hrvatske Telekomunikacije (based in Mostar), which provide services in their respective regions of the country.<sup>106</sup> In 2006, the fixed market was liberalized, leading to the emergence of alternative fixed telephony service providers. The Government of the Federation of Bosnia and Herzegovina still owns controlling shares in BH Telecom and Hrvatske Telekomunikacije. Telekom Srpske was sold to Telekom Srbija (which is partly owned by the Serbia Government) in 2006.<sup>107</sup> Fixed penetration, for both fixed-broadband and fixed-telephone services is below the European average.

Key indicators for Bosnia and Herzegovina (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	19.5	37.7	13.6
Mobile-cellular sub. per 100 inhab.	89.2	118.0	101.5
Fixed-broadband sub. per 100 inhab.	17.4	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	37.4	80.1	52.2
3G coverage (% of population)	96.0	98.5	85.0
LTE/WiMAX coverage (% of population)	0.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	2.4	1.0	5.2
Fixed-broadband prices (% GNI pc)	1.7	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.5	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.7	0.6	6.8
Percentage of households with computer	49.2	79.6	46.6
Percentage of households with Internet access	57.1	82.5	51.5
Percentage of individuals using the Internet	69.3	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	98.5	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** Bosnia and Herzegovina is not a member of the European Union, but has a potential candidate country status and has undertaken many steps towards integration into the Union. This is also notable in the telecommunication sector, which has been liberalized and a regulatory framework based on the EU regulatory framework for communications has been created. Most notably, fixed and mobile number portability have been introduced and interconnection tariffs were reduced. Furthermore, service providers without licensed spectrum were allowed into the market in order to increase competition.

**Conclusion:** Competition in the telecommunication market as well as pro-growth regulatory measures have been progressively introduced in Bosnia and Herzegovina. With growing competition on a national scale and the modernization of services, the Bosnia and Herzegovina telecommunication market has a potential for growth.

## Botswana

***This landlocked country is noted for its progressive policy and regulatory regimes. Recently it moved to a new licensing framework which has allowed for various players to enter the ICT market, leading to new services offerings, lower prices and increased competition.***

**Mobile services:** There are three mobile operators in Botswana: MASCOM, the market leader, majority-owned by institutional investors; Orange, 74 per cent owned by Orange France; and beMOBILE, 51 per cent owned by the government and 45 per cent by citizen investors (shareholders). The last is the mobile division of incumbent Botswana Telecommunications Corporation Limited (BTCL). This relatively high level of competition for a small population has paid off. In 2014, 94 per cent of households had a mobile phone.<sup>108</sup> Mobile-broadband has grown significantly since the launch of 3G in 2009. Both MASCOM and Orange commercially deployed LTE networks in 2015.

**Fixed services:** In 2013, the Government of Botswana separated incumbent BTCL into a services company (which continues to be called BTCL) and an infrastructure company called Botswana Fibre Networks (BOFINET). The latter is a wholesaler, rolling out the national fibre network, making the Government's investments in international capacity and some other infrastructure available to third parties. BTCL was listed on the local stock exchange in 2015. Although the market is open, fixed-telephone subscriptions are solely offered by BTCL. Penetration is relatively high for sub-Saharan Africa. Fixed-broadband has been limited to two technologies: ADSL provided by BTCL and fixed wireless provided by Orange. Since December 2015, BOFINET has been offering wholesale fibre to the premises to enable resellers connect businesses and households, with speeds ranging from 2 to 50 Mbit/s. There is a 2 000 km nationwide fibre-optic backbone ring with connections to all urban centres, major villages and key border crossings. This ensures that, though landlocked, Botswana has ample cross-border access to submarine cables in neighbouring nations. The Botswana IXP was launched in 2005 and hosts 12 peers.

Key indicators for Botswana (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	6.9	1.0 13.6
Mobile-cellular sub. per 100 inhab.	158.5	74.6 101.5
Fixed-broadband sub. per 100 inhab.	2.8	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	67.9	22.9 52.2
3G coverage (% of population)	84.0	59.3 85.0
LTE/WiMAX coverage (% of population)	64.0	25.7 66.5
Mobile-cellular prices (% GNI pc)	1.3	14.2 5.2
Fixed-broadband prices (% GNI pc)	4.9	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	5.1	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	11.5	17.7 6.8
Percentage of households with computer	28.5	9.6 46.6
Percentage of households with Internet access	43.7	16.3 51.5
Percentage of individuals using the Internet	39.4	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	7.9	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Ministry of Transport and Communications is responsible for policy for the development and utilization of ICTs and integrated transport services. The Botswana Communications Regulatory Authority is a converged regulator responsible for telecommunications, posts, Internet and broadcasting. It emerged from the Botswana Telecommunication Authority, established in 1997. The Authority, through its special purpose vehicle of the Universal Access and Service Fund, has supported a project to provide Wi-Fi hot spots in more than 30 strategic locations (e.g. shopping malls, bus stops, hospitals, etc.) across the country. The Wi-Fi hotspots are deployed by the wholesale service provider and retailers can access their network infrastructure on equal terms. The hotspots offer free access to the Government website and a complementary 10 minutes per device of Internet access daily.

**Conclusion:** Botswana has an advanced ICT market and regulatory framework. The Government has opted for a wholesale backbone model to facilitate open access and cost-based pricing in order to lower prices.

## Brazil

**Brazil is one of the major telecommunication markets in the Americas region. All segments of the sector are under full competition in major cities and there are currently several infrastructure development projects in place. Both the Government and the operators invest in telecom and ICT, being the private sector the major player. The quality of the services as well as the coverage are expected to significantly improve over the next few years. For this, Brazil is relying upon additional submarine cables as well as new satellites to assist areas where the vegetation does not allow for fibre optic infrastructure expansion.**<sup>109</sup>

**Mobile services:** Mobile-cellular and mobile-broadband penetration rates are ahead of both regional and global levels. The market is evenly divided among the four biggest market players – Vivo, TIM, Claro and Oi – all of which have profited from the large demand for data services, having access to the 2.5 GHz band and expecting also to have access to the 700 MHz band later in 2017. The Government of Brazil has recently signed a Memorandum of Understanding with the European Union to work together on the development of 5G technology.<sup>110</sup>

**Fixed services:** The evolution of the national fixed-telephone market has stagnated over the years as mobile and VoIP services have become increasingly popular, the latter continuing to be unregulated at the national level.<sup>111</sup> Brazil's bandwidth is in line with regional and global levels, but is expected to grow considerably in the short term as new cable systems will come into service within the scope of the Atlantic Cable System, linking Brazil with the Americas, Europe and Africa. The main providers of broadband are Claro, Telefônica and Oi. The latter two use hybrid fibre–coaxial cable and FttC architecture respectively.<sup>112</sup>

**Government policy:** The regulatory body, the *Agência Nacional de Telecomunicações* (ANATEL), was created in 1997 and aims at expanding and developing the telecommunications sector in the country, which accounts for approximately 4 per cent of the national GDP (Anatel, 2017). At its inception, the body had to oversee the privatization of the national incumbent, Telebras, and ensure the creation of a level playing field for the market entrants. New challenges have

Key indicators for Brazil (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	20.4	24.4	13.6
Mobile-cellular sub. per 100 inhab.	118.9	114.2	101.5
Fixed-broadband sub. per 100 inhab.	13.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	89.5	82.7	52.2
3G coverage (% of population)	96.9	93.6	85.0
LTE/WiMAX coverage (% of population)	79.6	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.7	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.1	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.0	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.3	5.7	6.8
Percentage of households with computer	51.0	64.9	46.6
Percentage of households with Internet access	52.4	63.3	51.5
Percentage of individuals using the Internet	59.7	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	66.2	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

surfaced since then, for example, the regional and social class disparities in terms of service usage (almost all of the wealthier households have access to the Internet, whereas the situation is the opposite for the poorer, with the great majority being disconnected). The agency currently follows its 2015–2024 Strategic Plan, which is premised on four main goals surrounding universal access, fair pricing, promotion of a competitive and sustainable sector, and consumer protection.<sup>113</sup> In addition, the National Broadband Plan, the *Plano Nacional de Banda Larga*, launched in 2010, aims at universal broadband access and better infrastructure, working closely with the reinstated Telebras on the expansion of the national fibre backbone among other public policy projects.<sup>114</sup>

**Conclusion:** Brazil possesses a dynamic and competitive telecom market that is still under expansion. Developing telecommunications services coverage and uptake within the country has its own hurdles, geographically and socially speaking, relating to both the landscape of the country and the income disparities respectively.

## Brunei Darussalam

**Brunei Darussalam has a high level of ICT access in relation to the South-East Asia region and a growing telecommunications sector.**

**Mobile services:** There are two mobile services provider in Brunei Darussalam: DST Communications and Progresif Cellular. Among two mobile service providers in the country, DST Communications dominates the market as the incumbent since 1993, whereas Progresif Cellular entered the market, with a much more innovative approach when Darussalam Assets acquired and rebranded B-Mobile in 2014. Mobile-cellular penetration is high, and in 2016, 97 per cent of the total number of subscriptions were actively accessing mobile broadband over 3G or LTE services throughout the country.

**Fixed services:** Telekom Brunei Berhad (TelBru), a corporatized incumbent entity, previously known as Department of Telecommunication (JTB), is the fixed line and broadband services provider of the country. TelBru offers ADSL and fiber to the home (FTTH) high speed broadband services with speeds up to 300 Mbps. It also caters leased line services for local and international businesses. The proportion of individuals using the Internet has increased steadily over the past five years and reached 75 per cent in 2016. Of equal importance in the country's expanding fibre optic network are Brunei's international connections with the rest of the world via submarine cables managed by Brunei International Gateway (BIG). Brunei Darussalam is currently served by three cable systems, with the newer Southeast Asia Japan Cable (SJC) inaugurated in June 2013. The Asian-America Gateway (AAG) which was commissioned in 2009 connects the Sultanate with Malaysia, Singapore, Thailand, Vietnam, Hong Kong, Guam and the US, with a capacity of 1.93 Tbps. The third, and original cable, the SEA-ME-WE 3, connects Brunei Darussalam with other networks at 39 international landing points in Southeast Asia, Africa, the Middle East and Western Europe tops out at a speed of 655 Mbps across its 39,000km.

**Government policy:** The government of Brunei Darussalam has identified its strategic vision, *Wawasan Brunei 2035*, or *Vision 2035*, which set a course towards a society of a highly skilled labour force in a country with dynamic and sustainable economic growth. The Ministry of

Key indicators for Brunei Darussalam (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	17.1	10.0	13.6
Mobile-cellular sub. per 100 inhab.	120.7	98.9	101.5
Fixed-broadband sub. per 100 inhab.	8.3	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	116.6	47.4	52.2
3G coverage (% of population)	92.5	87.6	85.0
LTE/WiMAX coverage (% of population)	89.6	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.3	3.2	5.2
Fixed-broadband prices (% GNI pc)	0.6	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.2	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	5.4	6.8
Percentage of households with computer	93.0	37.8	46.6
Percentage of households with Internet access	75.0	45.5	51.5
Percentage of individuals using the Internet	75.0	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	76.2	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Communications as the sector policy maker, aligning to *Vision 2035*, gives emphasis in narrowing the digital divide and ensuring the development of Telecommunication Infrastructure as one of the major key enablers in realizing the vision. The *National Broadband Policy*, covering the period of 2014-2017, addresses access, affordability, quality, usage and content development. It also seeks to create employment opportunities from broadband opportunities. In an effort to establish a more independent oversight body and create a more conducive environment for the development of the telecommunications and ICT industry, the Authority for Information Communications Technology Industry (AITI) was established in 2003. AITI functions as a statutory body to regulate telecommunications systems and services, and to efficiently manage the national radio frequency spectrum, as well as to develop the ICT industry.

**Conclusion:** Strong investment in Brunei Darussalam's mobile and fixed telecoms infrastructure is providing a durable, capable and efficient backbone that will serve as a solid foundation to build upon for future public and private ICT growth opportunities. With virtually all households having a mobile phone and around half with fixed broadband, the demand for data and increased speeds continues to grow. There is ample Internet bandwidth from multiple submarine cables and last mile optical fibre connections is growing rapidly.

## Bulgaria

***Bulgaria has a competitive mobile market with high penetration rates, in particular for mobile-broadband services.***

**Mobile services:** Bulgaria has very high mobile-cellular and mobile-broadband penetration rates, both exceeding the European averages. Competition in the mobile market continues to develop between Mobiltel (Mtel), the incumbent operator and market leader in the voice segment, and its competitors Telenor, Vivacom (owned by the Bulgarian fixed-line incumbent and operating under its mobile brand Vivatel until September 2009) and Bulsatcom. As of mid-2017, Vivacom had the largest market share in the mobile-broadband market, followed by Telenor, Mtel and Bulsatcom. All four operators are offering LTE services, which were first introduced in Bulgaria in 2014. The share of LTE users represented 35 per cent of mobile Internet users in the country in mid-2017.

**Fixed services:** The monopoly in the fixed voice market held by the Bulgarian Telecommunications Company (BTC), which now operates under the brand Vivacom, was ended in 2003. BTC was partly privatized and the market was opened to competition (Republic of Bulgaria, Ministry of Transport, Information Technology and Communications, 2004). At present, BTC is a private company holding the largest market share in terms of fixed-telephone subscriptions, but it faces significant competition with as many as 20 competitors providing retail fixed-telephone services. The fixed-broadband market has shown a very positive development. There is strong technology-based competition and operators are investing in fibre and cable networks (European Commission, 2017). The incumbent operator is still the leader in the retail broadband market, followed closely by Mtel, whose acquisition of the broadband provider Blizoo in 2015 reinforced its position in the fixed Internet sector. While Bulgaria holds one of the top positions in Europe in terms of Internet speeds achieved in major cities, Internet services at high speeds are less available in Bulgaria's smaller cities and remote or scarcely-populated areas.<sup>115</sup>

**Government policy:** Bulgaria became a member of the European Union in 2007. Accession to the EU had an important impact on the telecommunication sector. In line with EU

Key indicators for Bulgaria (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	21.0	37.7 13.6
Mobile-cellular sub. per 100 inhab.	127.2	118.0 101.5
Fixed-broadband sub. per 100 inhab.	24.1	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	88.3	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	86.8	92.2 66.5
Mobile-cellular prices (% GNI pc)	4.1	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.6	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.7	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.9	0.6 6.8
Percentage of households with computer	60.2	79.6 46.6
Percentage of households with Internet access	63.5	82.5 51.5
Percentage of individuals using the Internet	59.8	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	175.9	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

policies, the sector was liberalized and regulatory measures to increase competition continue to be implemented. Bulgaria is an integral part of the European Digital Market and has thus set a number of ambitious goals in order to advance connectivity and the use of digital services. Bulgaria's National Strategy for the Development of Broadband Access was first approved in 2009 and updated in 2012. The strategy was followed in 2014 by the National Broadband Infrastructure Plan for Next Generation Access, which aims to achieve 100 per cent broadband coverage with at least 30 Mbit/s by 2020 and 50 per cent take-up rate for 100 Mbit/s. Special emphasis is placed on connecting remote and sparsely populated areas of Bulgaria. In order to achieve these goals, EU funds as well as private and state investments are being secured. Regulatory measures such as increased competition, simplified authorization procedures and rules by which the broadband market operates are being implemented as well.<sup>116</sup>

**Conclusion:** With the liberalization of its telecommunication market and the advancements made in the sector, Bulgaria is becoming an increasingly connected country. Bulgaria's ambitious goals for broadband access and usage underline its ambitions to further this development.

## Burkina Faso

***The explosion of submarine cables on Africa's West Coast and the build-out of its national fibre backbone have diversified options for this landlocked country, increased bandwidth and lowered costs.***

**Mobile services:** There are three mobile operators in Burkina Faso: TELMOB, the mobile arm of the fixed line incumbent ONATEL (National Office of Telecommunications), which is partially owned by Morocco Telecom; Orange Burkina Faso SA (owned by Orange Middle East & Africa (OMEA) and Orange Côte d'Ivoire Participation); and TELECEL FASO SA (owned by a local group, Planor Afrique). The market has been competitive since 2000. Mobile access is relatively high, with 86 per cent of households owning a portable telephone, of which 97 per cent are in urban areas and 82 per cent in rural areas.<sup>117</sup> Licenses for 3G were issued in 2012 and mobile-broadband has since been growing rapidly. Operators have also launched mobile money services since 2013.

**Fixed services:** Although the fixed-telephone market is open and all operators have global licenses, ONATEL is the only provider of fixed-telephone services. It uses both copper wire and CDMA wireless local loop. ONATEL also provides ADSL fixed-broadband services. In 2005, 1 000 km of fibre-optic cable were laid from the capital to the Malian, Togolese and Cote d'Ivoire borders for transmission of traffic onward to the SAT3 undersea cable land points of the coastal countries and in 2012, 195 km of fibre-optic to connect the Niger border. The Government has embarked on the development of a full nationwide backbone with links to all provincial capitals and key border crossings. The Government has also adopted a licensing regime that ensures non-discriminatory access to infrastructure, with plans to develop a public-private partnership consortium to manage the national backbone. A link to Ghana became operational in 2016 enabling access to the international undersea cables. Since its recent market entry, Orange and ONATEL have developed a metro fibre ring around the capital Ouagadougou. In addition, Orange developed a 197-km fibre connection to Ghana. Burkina Faso's IXP was launched in 2015 and has eight members, including all of the leading operators.

Key indicators for Burkina Faso (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.4	1.0	13.6
Mobile-cellular sub. per 100 inhab.	83.6	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	19.9	22.9	52.2
3G coverage (% of population)	23.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	18.2	14.2	5.2
Fixed-broadband prices (% GNI pc)	69.6	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	9.5	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	13.3	17.7	6.8
Percentage of households with computer	5.8	9.6	46.6
Percentage of households with Internet access	10.6	16.3	51.5
Percentage of individuals using the Internet	14.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.8	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Ministry of Digital Economy and Posts is in charge of ICT policy. There is an independent Regulatory Authority of Electronic Communications and Posts, and an ICT agency now in charge of the main ICT projects of the Government. The National Plan for Economic and Social Development 2016–2020 (PNDES) focuses on three main challenges translated into the following strategic directions: (a) institutional reforms and modernization of the administration; (b) development of human capital; and (c) stimulation of high-potential sectors to foster economic development and job creation. ICT is part of the PNDES and is seen as a key enabler and high-potential sector for the country's development. Commitments concerning ICTs include (a) connecting all public agencies, schools and healthcare facilities; (b) setting up a unique digital identification for each citizen and company; (c) improving education, health and rural development by developing and deploying e-services; and (d) developing a local digital industry, through investments in incubation, innovation and research and development.

**Conclusion:** Two decades of telecom sector reforms have resulted in notable improvements in Burkina Faso's ICT sector. The country has created a relatively competitive environment for telecommunication services and has been one of the leading countries in the region in terms of adopting Economic Community of West African States (ECOWAS) ICT policies.

## Burundi

***This small landlocked East African country has a competitive mobile market and more recently adopted an open access approach to its backbone market. This should enhance affordability and triggering greater access and use of ICT services and applications.***

**Mobile services:** Following industry consolidation, there are now four operators in Burundi's mobile market: the State-owned incumbent, ONATEL; VIETTEL, a subsidiary of the Vietnamese mobile group; LACELL, owned by Kenyan and Russian investors; and ECONET LEO, a subsidiary of a South African-headquartered mobile group. While ONATEL has only a 2G network, the other operators have launched 3G and VIETTEL, and ECONET has launched LTE. Mobile-broadband is by far the most prevalent method of Internet access in the country.

**Fixed services:** ONATEL offers copper line telephone service, while VIETTEL and LACELL provide fixed wireless telephone service. There has been little growth in the market, with around the same fixed-telephone subscriptions as before the launch of mobile services. There are around a half dozen ISPs competing alongside ONATEL in the fixed-broadband market. Technologies are mainly fixed wireless, including one fixed LTE operator, with some ADSL and fibre-optic connections. Fixed-broadband penetration is extremely low. The Burundi Backbone System (BBS) is a joint venture between the Government of Burundi and several telecom operators on an open access basis. BBS manages the Burundi backbone and ensures connection to the landing stations of submarine fibre-optic cables in Tanzania and Kenya, passing through Rwanda and Uganda. The Burundi IXP was launched in 2014 and is managed by an association whose members include the telecommunication operators and ISPs in the country.

**Government policy:** The Ministry of Posts, Information Technology, Communication and Media is responsible for oversight of the sector. The National ICT Policy – featuring several strategic axes such as infrastructure development, education and universal access – guides the Ministry. There was a national broadband strategy covering the period through 2015. The Agency for Regulation and Control of Telecommunications became operational in 1998. The legal framework

Key indicators for Burundi (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	0.2	1.0 13.6
Mobile-cellular sub. per 100 inhab.	48.0	74.6 101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	8.3	22.9 52.2
3G coverage (% of population)	40.0	59.3 85.0
LTE/WiMAX coverage (% of population)	0.0	25.7 66.5
Mobile-cellular prices (% GNI pc)	35.0	14.2 5.2
Fixed-broadband prices (% GNI pc)	362.6	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	22.3	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	27.9	17.7 6.8
Percentage of households with computer	3.4	9.6 46.6
Percentage of households with Internet access	3.5	16.3 51.5
Percentage of individuals using the Internet	5.2	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	6.1	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

of the sector is framed by a telecommunication law supplemented by a number of regulations.

**Conclusion:** Burundi has taken steps to spur greater competition in the sector and lower prices through new mobile licenses, a public-private partnership backbone and an IXP. It could further leverage Internet access in urban areas to encourage operators to make greater investments in rural areas.

## Cambodia

### ***Cambodia has a competitive mobile market deploying the latest LTE technologies.***

**Mobile services:** Cambodia has been one of the more competitive markets in the region, and one characterized by ongoing mergers and acquisitions. There are presently six active operators. The largest is SMART, which is majority-owned by the Malaysian AXIATA group. VIETTEL, the Vietnamese mobile group, is the second largest. Operating under the METFONE brand, it was launched in 2008 and purchased the mobile operator Beeline in 2015. CAMGSM, operating under the brand CELLCARD, is one of the oldest operators. It has been in service since 1996 and is 100 per cent locally owned. Three smaller companies also operate in the market. GSM mobile coverage is high, with subscription penetration passing the 100 per cent mark in 2011. Availability of mobile phones is high for a least developed country, and stands at 87 per cent overall (96 per cent in urban areas and 86 per cent in rural ones).<sup>118</sup> Mobile broadband has developed rapidly owing to the scarcity of fixed infrastructure, and the first 3G network was launched in 2007. In 2014, SMART became the first operator to launch LTE, which is now available across 25 provinces covering over half the population. The other leading operators launched LTE in 2015. Most Internet access is via mobile phones, and almost half the population (48 per cent) had a smartphone in 2016.<sup>119</sup>

**Fixed services:** State-owned Telecom Cambodia is the main fixed telephone service provider. In addition, there are seven other licensed operators using a mixture of copper PSTN lines and wireless local loop technologies. Owing to the popularity of mobile, fixed telephone subscriptions have been in decline since 2012. Fixed broadband is provided through a mixture of technologies including ADSL, fixed wireless, cable modem and fibre. The country has an extensive national backbone, with fibre-optic networks operated by three companies. The largest is owned by VIETTEL, while the Cambodia Fibre-optic Communication Network was launched in 2006 with the backing of Chinese shareholders. Telecom Cambodia also operates some fibre-optic backbone routes. Two submarine cables land in Sihanoukville on the Gulf of Thailand. There are two Internet Exchange Points - the Cambodian Network Exchange that began in 2008 and the

Key indicators for Cambodia (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	1.4	10.0	13.6
Mobile-cellular sub. per 100 inhab.	124.9	98.9	101.5
Fixed-broadband sub. per 100 inhab.	0.6	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	50.2	47.4	52.2
3G coverage (% of population)	80.0	87.6	85.0
LTE/WiMAX coverage (% of population)	50.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	7.7	3.2	5.2
Fixed-broadband prices (% GNI pc)	13.5	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.1	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.2	5.4	6.8
Percentage of households with computer	10.5	37.8	46.6
Percentage of households with Internet access	26.0	45.5	51.5
Percentage of individuals using the Internet	25.6	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	23.6	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

HTN-Cambodia Internet Exchange established in 2013.

**Government Policy:** The Ministry of Post and Telecommunications (MPT) is responsible for the sector. The *Law on Telecommunications* adopted in 2015 formally established the Telecommunication Regulator of Cambodia. The main objective of the Telecommunication Regulator of Cambodia (TRC) is to formulate regulations relating to the operation and provision of telecommunications networks and services. The *Telecom/ICT Development Policy 2020* was adopted in 2016. The policy established a number of targets to be achieved by 2020, such as 100 per cent broadband coverage in urban areas and 70 per cent in rural ones. It also targets an 80 per cent Internet penetration rate. There are three key objectives: i) to improve and expand telecommunication infrastructure and usage; ii) to develop ICT human capacity; and iii) to diversify the ICT industry and promote ICT applications.

**Conclusion:** With a highly competitive mobile market, Cambodia has achieved a very high rate of mobile access with the cheapest mobile-broadband prices in the region.

## Cameroon

### *The Government is aiming to make Cameroon a digital hub for the Central African region.*

**Mobile services:** There are three operators in Cameroon: MTN, a subsidiary of the South African mobile group; Orange, a subsidiary of Orange France; and VIETTEL, operating under the brand name NEXTTEL, a subsidiary of the Vietnamese mobile group. VIETTEL won the country's third mobile license in 2012 and launched in 2014. In 2014, 81 per cent of households had mobile phones, with a notable divide between urban (95 per cent) and rural (66 per cent) homes.<sup>120</sup> Mobile-broadband services began in 2015 after the entry into operation of Viettel and the renewal of MTN and Orange licenses, which allowed the latter two operators to provide 3G and LTE services, as well as to deploy fibre-optic networks. Orange and Viettel both launched 3G services in 2015, while MTN deployed LTE the same year.

**Fixed services:** Cameroon Telecommunication (CAMTEL) is the State-owned operator and main provider of fixed-telephone services, using both copper wire and wireless local loop. CAMTEL offers fixed-broadband over ADSL and over CDMA EV/DO fixed wireless. Other ISPs provide WiMAX and LTE fixed wireless services. There is a national backbone of more than 8 000 km of fibre-optic cable reaching the ten regional capitals and is in a third phase of deployment, with the objective of reaching a network of more than 20 000 km. Cameroon has been connected to the SAT-3/WASC since 2002, followed over a decade later by WACS. It is also connected to Nigeria via the Nigeria Cameroon Submarine Cable System, with another cable under construction to Equatorial Guinea.

**Government policy:** The Ministry of Posts and Telecommunications is the principal government institution responsible for ICT in the country. This includes developing the ICT sector strategy. The strategy ending in 2015 called for (a) building and updating the legal, regulatory and institutional framework; (b) increasing the quantity, quality and affordability of ICT services; and (c) increasing the use of ICT by industry. The Telecommunication Regulatory Board is the sector regulator. The main sector legislation is outlined in the 2010 Law Governing Electronic Communications and substantiated by 2015 legislation. The National Information Technology and Communications

Key indicators for Cameroon (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	4.4	1.0 13.6
Mobile-cellular sub. per 100 inhab.	68.1	74.6 101.5
Fixed-broadband sub. per 100 inhab.	0.2	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	9.6	22.9 52.2
3G coverage (% of population)	65.0	59.3 85.0
LTE/WiMAX coverage (% of population)	64.1	25.7 66.5
Mobile-cellular prices (% GNI pc)	12.2	14.2 5.2
Fixed-broadband prices (% GNI pc)	22.8	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	3.1	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	6.1	17.7 6.8
Percentage of households with computer	13.7	9.6 46.6
Percentage of households with Internet access	10.5	16.3 51.5
Percentage of individuals using the Internet	25.0	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.5	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Agency is responsible for promoting ICTs, managing country code top-level domain names, and cybersecurity.

**Conclusion:** The ongoing expansion of the national backbone, connectivity to new submarine cables and recent deployment of mobile-broadband networks have set the stage for a more accelerated take-up of broadband services. These initiatives could be further strengthened by updated strategies and plans to leverage high-speed Internet for supporting national development goals.

## Canada

**Canada's telecommunications sector is well served by a variety of operators that coexist in a competitive environment. The five main telecommunication services providers – Bell, Québecor, Rogers, Shaw and TELUS – are responsible for more than 80 per cent of the market revenues.**

**Mobile services:** Wireless services represent an increasing part of the telecommunications sector in Canada, totalling 52 per cent of the industry's revenues (with regard to retail services) in 2016. There are three main operators – Roger, TELUS and Bell – accounting for approximately 90 per cent of the market share.<sup>121</sup> Smaller service providers who compete in regional markets, however, are becoming more competitive and prompting the main players to improve services and pricing. The Government organized spectrum auctions in 2014 and 2015, for the 700 MHz and 1 755–1 780 MHz bands. Following the 700 MHz spectrum auction in 2014, the authorities also released 50 MHz in the bands of 1 755–1 780 MHz. This increase in spectrum availability encouraged an investment of more than US\$ 2 billion in 2015 by the operators. The competitive environment for mobile services, along with government action and operators' investment, has meant that almost the entirety of the population is covered by mobile-broadband. Providers have been investing in next generation LTE-advanced technology, which is now available to 83 per cent of the population.

**Fixed services:** The fixed broadband market is also under intense competition between service providers that offer cable, DSL and fibre technologies. Cable modem and DSL are available to 85 and 77 per cent of the households respectively, whereas fibre is available to 28 per cent. Bandwidth is fast in Canada, with providers now investing heavily in advanced FTTH and DOCSIS 3.1 technologies. The biggest discrepancy lies on the Internet speed available to the rural parts of the country: whereas 87 per cent of the rural households have access to 5 Mbps, only 6 per cent have access to speeds of 100 Mbps and above.

**Government policy:** The sector regulator is the Canadian Radio-television and Telecommunications Commission, which actively engages in multiple facets of the sector. Recently

Key indicators for Canada (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	41.8	24.4	13.6
Mobile-cellular sub. per 100 inhab.	84.9	114.2	101.5
Fixed-broadband sub. per 100 inhab.	37.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	68.9	82.7	52.2
3G coverage (% of population)	99.4	93.6	85.0
LTE/WiMAX coverage (% of population)	98.5	77.4	66.5
Mobile-cellular prices (% GNI pc)	0.7	3.6	5.2
Fixed-broadband prices (% GNI pc)	1.4	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.4	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.0	5.7	6.8
Percentage of households with computer	86.8	64.9	46.6
Percentage of households with Internet access	89.2	63.3	51.5
Percentage of individuals using the Internet	89.8	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	141.9	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

the Commission updated a framework to enforce net neutrality, enabling a more competitive market and instigating further service quality improvements based on the fact that data usage cannot be treated differently based on its content.<sup>122</sup> To further foster competition in the market, the Commission published a new policy regulating rates for wholesale roaming in 2015. DSL, Cable, and, more recently, FTTH infrastructure must be shared with non-affiliated ISPs. In 2016, the Commission published a new universal service objective: Canadians, in urban areas as well as in rural and remote areas, have access to voice services and broadband Internet access services, on both fixed and mobile wireless networks.<sup>123</sup> The Commission also improved its wireless code of conduct.<sup>124</sup>

**Conclusion:** The Canadian telecommunications sector is well developed, covering almost the entirety of the population at competitive prices. The regulator is very active in the promotion of a competitive and innovative environment, which is reflected in the quality of services and on the steady growth of service penetration across all segments except fixed telephony.

## Cape Verde

***The West African island group has made notable progress in ICT access, particularly since the introduction of competition in the mobile market. Connection to a second submarine cable should spur the broadband market.***

**Mobile services:** The two mobile operators are CV Móvel, the mobile arm of the incumbent CV Telecom, and UNITEL, owned by the Angolan mobile operator, which also has operations in São Tomé and Príncipe. Both operators have launched 3G services. Following a public consultation on the provision of LTE services, it is expected that the 800 MHz band will be made available for LTE services, even though the analogue-to-digital switchover of the television broadcasting is not complete, because only one channel is currently in use by the national television broadcaster.

**Fixed services:** The fixed provider is CV Telecom, a subsidiary of Portugal Telecom (PT). The Brazilian operator Oi was a 40 per cent shareholder in CV Telecom but in September 2016 announced it would be selling its shares to PT. The CV Telecom group provides fixed telephony and Internet services as well as IPTV. Fixed-broadband connections are mainly via ADSL. There is a small ISP, Cabocom, providing Wi-Fi service on the Island of Sal. CV Telecom operates an inter-island fibre-optic submarine cable providing a ring interconnecting all the islands. Atlantis-II was Cape Verde's first undersea fibre-optic connection, a 12 000 km cable initiated by Brazil's Embratel in 2000 to link Brazil with Europe via Portugal, and passing Senegal, Cape Verde and the Canary Islands. More recently, CV Telecom has invested in WACS, which began operations in May 2012, linking 14 countries along the West Coast of Africa to Portugal and the United Kingdom.

**Government policy:** ANAC, the National Communications Agency, is the regulator responsible for telecommunications, Internet services and broadcasting. The telecommunication sector was liberalized in 2005 and a series of initiatives to improve the enabling policy and regulatory environment for ICTs has been undertaken since then. In 2012, ANAC determined that CV Telecom had significant market power and imposed a number of obligations on the operator, in particular to provide wholesale services at regulated prices, and to grant access to its facilities

Key indicators for Cape Verde (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	12.6	13.6
Mobile-cellular sub. per 100 inhab.	117.4	101.5
Fixed-broadband sub. per 100 inhab.	3.0	12.4
Active mobile-broadband sub. per 100 inhab.	70.0	52.2
3G coverage (% of population)	87.6	85.0
LTE/WiMAX coverage (% of population)	0.0	66.5
Mobile-cellular prices (% GNI pc)	8.7	5.2
Fixed-broadband prices (% GNI pc)	3.6	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.8	6.8
Percentage of households with computer	37.4	46.6
Percentage of households with Internet access	62.0	51.5
Percentage of individuals using the Internet	48.2	45.9
Int. Internet bandwidth per Internet user (kbit/s)	23.4	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

to other operators. In November 2015, the National Broadband Strategy was approved by the Council of Ministers. The Strategy aims to increase the availability of connectivity, promote public-private partnerships and focus resources on the strategic sectors of the country's transformation agenda (sea, aero navigation, financial services and ICTs), along with expanding digital learning programmes. The Strategy envisions the creation of an entity to monitor progress, and a cross-sector coordination mechanism to maximize synergies. The broadband programme has a set time-frame for implementation and will close at the end of 2018.

**Conclusion:** Cape Verde's Government has made consistent and forward-looking efforts to improve the country's connectivity and use of ICTs, efforts that are paying off given the relatively high levels of broadband adoption, widespread use of ICTs by Government and increased availability of local online services.

## Central African Republic

***The landlocked Central African Republic's recent uncertain institutional situation has constrained investment in broadband networks and access to cross-border submarine cables. Mobile, however, remains a bright spot, with a reasonable level of competition, given the challenges.***

**Mobile services:** There are four mobile operators in the country; MOOV, which launched in 2005 and is a subsidiary of Morocco Telecom; TELECEL, the oldest operator in the market, having launched in 1996, a subsidiary of South Africa-headquartered ECONET WIRELESS; AZUR, which launched in 2004 and is owned by a private Congolese group; and Orange, the latest market entrant, launched in 2007, a subsidiary of Orange France. Despite the relatively large number of operators, penetration is low, challenged by the country's instability since 2013, which has constrained investment and coverage expansion. Orange was the first operator to launch 3G services in 2013, with coverage mainly limited to urban areas. An inadequate electricity network and national backbone infrastructure make the expansion of mobile networks challenging.

**Fixed services:** The Central African Telecommunications Society (SOCATEL) is the incumbent operator. It was partly privatized in 1990, when 40 per cent was sold to a subsidiary of France Telecom (rebranded as Orange in 2013). SOCATEL is experiencing competition from mobile operators, and is further constrained by its limited fixed-telephone subscriber base of only a few thousand subscriptions, which is concentrated in urban areas. Most broadband Internet access is through the mobile operators, although there are some fixed wireless broadband operators offering service using WiMAX technology. Development of the national backbone is imperative since, as a landlocked country, the Central African Republic does not have a direct outlet to international Internet capacity on undersea fibre-optic cables. The World Bank's Central African Backbone (CAB) project provided support for the development of a fibre-optic backbone with multiple cross-border connections. Further, the country was perceived as a potential key transit point for cables linking the East and West coasts of Africa. However, the reluctance to end SOCATEL's monopoly over international gateways, combined with an unstable institutional environment, forced this component

Key indicators for Central African Rep. (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.0	1.0	13.6
Mobile-cellular sub. per 100 inhab.	46.7	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	3.3	22.9	52.2
3G coverage (% of population)	23.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.1	25.7	66.5
Mobile-cellular prices (% GNI pc)	41.7	14.2	5.2
Fixed-broadband prices (% GNI pc)	1,772.2	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	n.a.	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	n.a.	17.7	6.8
Percentage of households with computer	2.9	9.6	46.6
Percentage of households with Internet access	3.1	16.3	51.5
Percentage of individuals using the Internet	4.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	1.7	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

of the World Bank's project to be cancelled. The country continues to rely on costly satellite connections for most of its international Internet bandwidth, constraining investment and resulting in high Internet prices.

**Government policy:** The Ministry of Posts and Telecommunications in charge of New Technologies is responsible for sector oversight. The 2007 Law on Telecommunications Regulation is the main legislation governing the sector. However, a draft Law on Electronic Communication was adopted in October 2017. The Agency for Regulation of Telecommunications is the sector regulator, charged with implementing the 2007 law. But with the adoption of the new law, this agency will be replaced by the Regulatory Authority for Electronic Communications and Post.

**Conclusion:** This landlocked country faces severe challenges, including an uncertain institutional environment. This limits the support available for constructing an open access national backbone to avail itself of cost-based capacity on undersea cables in neighbouring countries. As a result, the deployment of broadband access infrastructure and service is constrained. Despite these circumstances, it has a competitive mobile market.

## Chad

**Expansion of the national fibre-optic backbone is a top national priority for the landlocked country to access the needed international Internet capacity from neighbouring countries.**

**Mobile services:** There are three mobile operators: TIGO, a subsidiary of the Luxembourg-based MILLICOM mobile group; AIRTEL, a subsidiary of the Indian mobile group; and Salam, the mobile arm of the State-owned incumbent Telecommunications Society of Chad (SOTEL). In 2015, 59 per cent of households had mobile telephones, with a significant difference between urban (85 per cent) and rural areas (52 per cent).<sup>125</sup> One challenge is the limited coverage in rural areas. Another is the relatively high tax burden on mobile use (e.g. additional SIM card tax, daily usage tax and per call tax) that decrease affordability. Mobile-broadband has been deployed relatively recently. Both AIRTEL and TIGO launched 3G services in 2014, with TIGO simultaneously launching LTE in 2014, the first by a MILLICOM operation in Africa.

**Fixed services:** SOTEL is the sole provider of fixed-telephone services using copper lines and CDMA wireless local loop. Fixed-telephone connections have been dropping due to the popularity of mobile services. Fixed-broadband connections are very limited and most fixed-broadband connections are based on fixed wireless technologies, which are provided by several operators. As a landlocked country, Chad relies on the backbone connectivity of neighbouring countries to access undersea fibre-optic cables. A fibre-optic backbone network running along oil pipelines to Cameroon was completed in 2012, although the capacity contracted remains low. There are two other projects supported by development partners to extend fibre-optic backbones. The CAB project is sponsored by the World Bank and would link Chad to neighbouring countries. The African Development Bank is sponsoring the Trans-Sahara Optic Fibre Backbone Project, which would lay fibre-optic cable along the Trans-Sahara Highway connecting Chad to Algeria via Niger, as well as Chad to Nigeria. Meanwhile, Chad continues to rely on satellite for a substantial portion of its international Internet bandwidth.

Key indicators for Chad (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.1	1.0	13.6
Mobile-cellular sub. per 100 inhab.	44.5	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.1	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	9.5	22.9	52.2
3G coverage (% of population)	22.0	59.3	85.0
LTE/WiMAX coverage (% of population)	22.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	21.4	14.2	5.2
Fixed-broadband prices (% GNI pc)	577.2	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	11.5	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	23.0	17.7	6.8
Percentage of households with computer	3.3	9.6	46.6
Percentage of households with Internet access	3.5	16.3	51.5
Percentage of individuals using the Internet	5.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	3.8	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Ministry of Posts and New Information Technologies is responsible for the sector policy and overseeing the national agencies responsible for various aspects of ICTs. The Ministry's Action Plan for ICT Development has seven strategic axes: (a) development of infrastructure, with an emphasis on the national backbone; (b) ICT for poverty reduction; (c) reinforcing the legal and regulatory framework; (d) content development; (e) reinforcing human capacity; (f) e-Government; and (g) enhancing ICT access for vulnerable groups. The Government is also considering the privatization of SOTEL, despite several unsuccessful attempts in the past. The main sector legislation is the 2014 Law Covering Electronic Communications and Postal Activities. The Authority for Regulation of Electronic Communications and Posts replaced the former Chad Office of Telecommunications Regulation following the adoption of the new telecommunications law.

**Conclusion:** The landlocked country faces challenges to expand access to rural areas. Planned projects to build out the national backbone with multiple cross-border connections should help to increase coverage while lowering costs due to increased choices in undersea fibre-optic cables. At the same time, a reduction in telecommunication usage charges could increase affordability.

## Chile

**Chile has a well-developed telecommunications sector that fosters competition and promotes innovation and investment. Mobile services are increasingly popular and prices are well below the average. Efforts have been centred on infrastructure development, especially since the earthquake in the beginning of 2010, which revealed that there were considerable parts of the population that did not have access to mobile service.**

**Mobile services:** Almost the entire Chilean mobile market is shared between three mobile operators: Movistar, Entel and Claro.<sup>126</sup> The first two operators compete directly for the leading spot, but competition is intensifying not only because of Claro's presence but also because of smaller mobile virtual network operators (MVNOs) entering the market, for instance Falabella Movil, Virgin Mobile and Wom.<sup>127</sup> Since September 2016, the competitive environment has been facilitated not only by mobile number portability requirements, but also by intermodal portability. The mobile-broadband market is well developed and all three main operators have provided LTE services since 2014, with the percentage of the population covered by the services steadily increasing. In 2016, the Government provided the operators access to the 700 MHz band. Since then, Entel has worked on the roll-out of its 700 MHz LTE network, which was finished in the beginning of 2017 and allows for the LTE-Advanced service, a better and faster connection.<sup>128</sup> Mobile access to the Internet has helped the country to reach a high rate of Internet users.

**Fixed services:** Chile's receding fixed-line market has been making place for an increasingly successful mobile market. Fixed-broadband services are represented by a competitive market that has three main providers: Movistar, VTR and Claro. Despite being under the regional average, the country's fixed-broadband penetration rates have been continuously increasing, with speed considerably above the average, as well as being accessible at low prices.<sup>129</sup>

**Government policy:** The sector regulator, *Subsecretaria de Telecomunicaciones* (Subtel), is actively working on promoting competition, introducing, for instance, intermodal number portability towards the end of 2016.<sup>130</sup> Subtel

Key indicators for Chile (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	18.7	24.4	13.6
Mobile-cellular sub. per 100 inhab.	128.9	114.2	101.5
Fixed-broadband sub. per 100 inhab.	16.1	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	71.5	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	79.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.6	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.4	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.2	5.7	6.8
Percentage of households with computer	63.9	64.9	46.6
Percentage of households with Internet access	61.1	63.3	51.5
Percentage of individuals using the Internet	66.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	175.6	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

is also committed to increasing access to ICT technologies and bridging the digital gap, as well as fostering innovation and investment. In order to do so, Subtel follows the *Agenda Digital Imagina Chile 2013–2020*, which set out goals in terms of digital education, service take-up and accessibility.<sup>131</sup> The Government has also put in place a national plan to develop ICT infrastructure, namely the *Plan Nacional de Infraestructura*, which places greater importance on the cooperation between the public and private sector.<sup>132</sup>

**Conclusion:** Chile has a well-developed telecommunication sector that still leaves room for considerable growth, especially in terms of fixed and mobile broadband. Efforts are being made at the infrastructure level to increase service reach and quality, whereas the Government is also working on educating its population to bridge the digital divide.

## China

**China is the world's largest telecommunication market in terms of the number of mobile, fixed-telephone and fixed-broadband subscriptions, as well being as the leading exporter of ICT products.**

**Mobile services:** There are three mobile operators in the country: China Mobile, China Unicom and China Telecom. Nationwide coverage of 2G mobile networks is ubiquitous and access is high as a result of low service prices and easy availability of inexpensive handsets. By 2012, there were already 213 mobile phones per 100 urban households and 198 per 100 rural households.<sup>133</sup> 3G mobile networks were launched in 2009, each operator using a different system (CDMA2000, WCDMA and the Chinese-developed TD-SCDMA). Operators are aggressively promoting the use of LTE services, launched over the period 2013-2014. By the end of 2016, over half of all mobile subscriptions were LTE. Operators are piloting 5G mobile networks, with plans to launch commercial networks by 2020.

**Fixed services:** China Telecom and China Unicom were the incumbent fixed line telephone operator. With market liberalization, all three operators in the mobile market are also the leaders in the fixed services segment. Having each operated fixed-broadband services for a number of years, China Telecom and China Unicom have had first leader advantage, whereas China Mobile is a more recent market entrant. However, by the end of 2016, China Mobile had more fixed-broadband subscribers than China Unicom. In order to catch up it purchased the fixed line assets of China Railway Communication in 2015. The country has traditionally used DSL and cable modems for fixed broadband, but operators are now making a big push towards fibre to the premises technology. The national backbone is extensive, with almost one million kilometres of fibre-optic cable. There are more than half a dozen submarine cable landing stations on the country's east coast, with connections to more than ten existing or planned regional and intercontinental systems. There are also terrestrial connections with bordering countries. There are three Internet Exchange Points (IXPs) in operation.

**Government policy:** In 2008, the Government restructured the telecom industry through

Key indicators for China (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	14.7	10.0	13.6
Mobile-cellular sub. per 100 inhab.	96.9	98.9	101.5
Fixed-broadband sub. per 100 inhab.	22.9	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	69.1	47.4	52.2
3G coverage (% of population)	98.0	87.6	85.0
LTE/WiMAX coverage (% of population)	97.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.6	3.2	5.2
Fixed-broadband prices (% GNI pc)	2.4	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.1	5.4	6.8
Percentage of households with computer	52.5	37.8	46.6
Percentage of households with Internet access	55.5	45.5	51.5
Percentage of individuals using the Internet	53.2	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	14.7	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

mergers in order to shape three nationwide operators of comparable scale to compete effectively. All have been partly privatized and publicly listed. The Ministry of Industry and Information Technology (MIIT) is responsible for policy and regulation of the sector. Policy is guided by multiyear plans. The *Broadband China* plan was launched in 2013, covering the period up to 2020, and was instrumental in the adoption of fibre-optic standards and the licensing of LTE. The plan aims to reduce the broadband gap between China and developed countries, and between urban and rural areas. There are a number of goals to achieve by 2020, including increased coverage and speeds. Targets of 1 Gbps for large cities, 50 Mbps for other urban areas, and 12 Mbps for rural areas, have been established. The plan identifies five key tasks: i) enhancing coordinated broadband development among various areas; ii) expediting the optimization and upgrading of broadband networks; iii) increasing the level of broadband network applications; iv) promoting the continuous improvement of industrial chains; and v) reinforcing security.

**Conclusion:** A mix of government direction, private sector operation, and a large ICT manufacturing base has forged China's rapid telecommunication development, establishing it as the largest telecommunication market in the world.

## Colombia

**The ICT sector represents a considerable part of the country's GDP, reaching 7.5 per cent in 2015.<sup>134</sup> The mobile market is one of the most prosperous within the region, and still has immense potential. The Government is actively engaged in educating the population to make use of telecommunications services, investing in programmes to provide digital education. The Government is expected to sell its stake of the operator Empresa de Telecomunicaciones de Bogota (ETB) soon.<sup>135</sup>**

**Mobile services:** The mobile market is dominated by three main operators: Claro, Movistar and Tigo. There is increasing competition by new entrants, mobile virtual network operators (MVNOs), such as Uff! Móvil, ETB, Móvil Exito, Avantel and Virgin Mobile. From the entry of the MVNOs in the market in 2010, they had accumulated 6 per cent market share by 2015. Mobile use for Internet access has intensified over recent years. In 2016, 70 per cent of Internet users stated they used mobile devices to access the Internet.<sup>136</sup> There is potential for further mobile services expansion as the mobile-broadband penetration remains relatively low compared with the regional average. Additionally, mobile services are a welcome solution to the underdeveloped fixed-line infrastructure, especially in the remote areas.<sup>137</sup> Competition and service quality in this segment are expected to improve following the auction of frequencies in the 700 MHz and 1 900 MHz bands later in 2017.<sup>138</sup>

**Fixed services:** Colombia's fixed-telephony has been slower to lose ground to the mobile services than to regional and global trends. This can be partly attributed to the fact that fixed-telephony services are not subject to the value-added tax whereas mobile services are, which results in more affordable services. Fixed-broadband is mainly supplied via cable technology, with DSL representing 40 per cent of market share. Fibre-based technology remained at 5 per cent as of 2016, owing to its dependence on the development of fibre-infrastructure.<sup>139</sup>

**Government policy:** The government body in charge of overseeing the telecommunications sector, the *Comisión de Regulación de Comunicaciones*, has played an increasingly important part in the sector development. Its

Key indicators for Colombia (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	14.2	24.4	13.6
Mobile-cellular sub. per 100 inhab.	117.1	114.2	101.5
Fixed-broadband sub. per 100 inhab.	11.8	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	45.5	82.7	52.2
3G coverage (% of population)	100.0	93.6	85.0
LTE/WiMAX coverage (% of population)	92.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.1	3.6	5.2
Fixed-broadband prices (% GNI pc)	3.2	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.4	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.0	5.7	6.8
Percentage of households with computer	45.2	64.9	46.6
Percentage of households with Internet access	45.8	63.3	51.5
Percentage of individuals using the Internet	58.1	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	150.9	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

current action plan, the *Agenda Regulatoria 2017–2018*, promotes sector development through fostering competition and innovation, improving service quality and reducing prices, which at present are below the regional and global averages.<sup>140</sup> Another important programme, the *Plan Vive Digital para la Gente 2014–2018*, led by the *Ministerio de Tecnologías de la Información y las Comunicaciones*, concentrates on leveraging the ICT development to positively impact the society, in terms of job generation, poverty reduction and digital education, among others.<sup>141</sup>

**Conclusion:** Colombia's telecommunications sector has been flourishing over recent years following public and private efforts. There remains a significant need to develop infrastructure, in particular regarding fixed broadband. The numerous governmental programmes have encountered significant success with the increase of service penetration, especially within the lower socio-economic groups.

## Comoros

**Comoros has witnessed a great development in its Information and Communication Technology (ICT) sector over the last 5 years, but fixed and broadband penetration rates are still one of the lowest in the region, with high prices and low affordability. Currently with two competing operators, the ICT sector is starting to move ahead and it is expected that the prices are to go down with the launching of 3G and LTE services.**

**Mobile services:** Mobile-cellular penetration is far below the average penetration in Arab States countries and globally. The same applies to mobile-broadband penetration. This can be attributed to the absence of competition up to 2015, when the National Authority for Regulation of ICT (ANRTIC) awarded a 15 year licence to Telco SA, a consortium composed of Telma Madagascar, SOFIMA and NJJ Capital, operating under the name Telma, thus removing the long-held monopoly of incumbent Comores Telecom (CT). Comores Telecom was the mobile operator through its mobile arm Huri, which rolled out a GSM network in 2003. Telma has launched commercial mobile voice and 3G and LTE data services in Comoros. By the end of 2016, it had rolled out 50 base stations in the capital Moroni and across the country (all of which are LTE-enabled), providing coverage to more than 60 per cent of the population. A variety 3G/LTE data tariffs are on offer.

**Fixed services:** Comoros has a low level penetration and high prices of fixed-broadband among Arab States countries and globally. Similar to the mobile market, Comores Telecom was the only fixed line operator in the country until ANRTIC awarded the second licence to Telco SA. The licence is valid for 15 years and will allow Telma to provide fixed and mobile (2G, 3G, LTE) services to the public upon full payment; however, as of 2017, Telma had yet not deployed a fixed network.

**Government policy:** In 2004, the President of Comoros issued a decree to reform the telecommunication sector. The Government of Comoros announced plans to separate the telecommunication functions of the national postal and communications operator SNPT to create a new company, Comoros Telecom (Comtel). ANRTIC is the state institution created by Decree N° 065 of 2009. It is responsible for ensuring the implementation of the ICT sector policy and the

Key indicators for Comoros (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	1.7	7.7	13.6
Mobile-cellular sub. per 100 inhab.	57.7	107.1	101.5
Fixed-broadband sub. per 100 inhab.	0.4	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	0.0	45.2	52.2
3G coverage (% of population)	60.0	81.9	85.0
LTE/WiMAX coverage (% of population)	60.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	14.0	4.3	5.2
Fixed-broadband prices (% GNI pc)	51.9	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	14.5	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	18.2	5.5	6.8
Percentage of households with computer	8.7	43.3	46.6
Percentage of households with Internet access	5.1	45.3	51.5
Percentage of individuals using the Internet	7.9	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	12.7	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

law governing the sector throughout the national territory. In this respect, it aims to foster the creation of a healthy, fair and non-discriminatory competitive environment between operators, manage the frequency spectrum, control of tariff costs and quality of service, and work towards a policy of universal access and service. The move forms part of a wider plan to prepare the market for the privatisation of its national Public Telecom Operator (PTO). In January 2013, the Government of Comoros launched the privatisation of Comores Telecom via an international auction. The privatisation of the operator was one of the recommendations of the International Monetary Fund. In July 2013, an infrastructure company called Comores Cables was created by the decree N° 13-86 / PR. Comores Cables has as main role the management and marketing of international fibre optic cables EASSY and others in the future. The liberalization of the market in 2015 followed the licensing of the second telecommunication operator Telco SA. Through the Regional Communications Infrastructure Program, the World Bank is supporting Comoros' efforts to increase connectivity and lower prices for international capacity and extend the geographic reach of broadband networks.<sup>142</sup>

**Conclusion:** The efforts made by the government in the last ten years have resulted in improved ICT status in the country. Comoros, in cooperation with the World Bank, has set a development policy, and one of the main pillars is enhancing competition in the ICT sector by licensing additional operators and introducing mobile and fixed broadband services.

## Congo (Democratic Republic of the)

***There is a large untapped potential for the ICT market in this fourth most populated country in Africa. The spread of access will depend on political stability and commitment of the Government and operators to extend last mile access and backbones deeper into rural areas.***

**Mobile services:** Following industry consolidation and exits, there were four mobile operators with nationwide licenses active in the country at the end of 2016: Vodacom DRC, a subsidiary of Vodacom, the South African mobile group; Orange DRC, a subsidiary of Orange, the French telecom group (Orange purchased TIGO'S operations in 2016); AIRTEL DRC, a subsidiary of Bharti Airtel, the Indian mobile group; and AFRICELL DRC, a subsidiary of Africell Holding, a Lebanese-owned mobile group. Coverage remains somewhat limited, as reflected in access statistics. In 2014, 39 per cent of households had mobile phones, with a large gap between urban (79 per cent) and rural (21 per cent) areas.<sup>143</sup> All of the operators have launched 3G services and are waiting for the sale of LTE licenses, which is dependent on the freeing of frequencies from the transition to digital broadcasting. Mobile-broadband is by far the most prevalent form of Internet access in the country.

**Fixed services:** The State-owned Congolese Society for Posts and Telecommunications (SCPT) is the result of the reform of the Congolese Office of Posts and Telecommunications into a commercial company by law No. 08/007 of 8 July 2008. It is mainly focused on wholesale backbone and postal services, and does not offer fixed-telephone service. A few companies mainly using fixed wireless access offer broadband. Fixed broadband using optical fibre is primarily used by businesses. SCPT operates a national backbone with around 4 000 km of fibre-optic cable connecting some 45 locations across the country. Prospects for international bandwidth have improved, with connection to one undersea submarine cable, WACS. An IXP was launched in 2012, managed by the country's ISP Association. Located in Kinshasa, the IXP has 11 members.

**Government policy:** The Ministry of Posts, Telecommunications, New Information Technologies and Communications is responsible for the sector. The 2002 Law on Telecommunications is the relevant sector

Key indicators for Congo (Dem. Rep.) (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.0	1.0	13.6
Mobile-cellular sub. per 100 inhab.	39.5	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	14.2	22.9	52.2
3G coverage (% of population)	20.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	27.6	14.2	5.2
Fixed-broadband prices (% GNI pc)	n.a.	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	43.9	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	58.5	17.7	6.8
Percentage of households with computer	2.7	9.6	46.6
Percentage of households with Internet access	2.8	16.3	51.5
Percentage of individuals using the Internet	6.2	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	0.8	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

legislation. The Congolese Authority for Regulation of Posts and Telecommunications is the sector regulator.

**Conclusion:** Wireless is the prevalent method of access in this LDC. Expansion of the national backbone network, triggered by the arrival of the submarine cable, should help to improve coverage in rural areas.

## Congo (Republic of the)

**ICTs are seen as an opportunity to diversify the economy from its historical reliance on oil.**

**Mobile services:** There are three mobile operators: AIRTEL, owned by the Indian mobile group; MTN, a subsidiary of the South African mobile group; and AZUR, privately held by local investors. Penetration is relatively high for sub-Saharan Africa, with the *2014–2015 Multiple Indicator Cluster Survey* finding that 89 per cent of households had mobile phones.<sup>144</sup> In 2011, 3G was launched, and mobile broadband has grown rapidly. MTN launched an LTE network in 2016.

**Fixed services:** Congo Telecom is the State-owned incumbent operator and the sole provider of fixed-telephone services. Fixed-broadband is available via Congo Telecom's ADSL, offering as well as fixed wireless provided by several ISPs. Fibre-optic connections are mainly provided for businesses. The Government is implementing several backbone projects with Chinese assistance. The National Coverage Project aims to extend fibre-optic connectivity throughout the country with some segments using the existing fibre-optic cables of the national electricity company. As part of the World Bank's CAB project, fibre-optic routes are being extended to the borders of neighbouring countries. The Republic of the Congo connected to its first undersea submarine cable in 2012 with the arrival of WACS.

**Government policy:** The Ministry of Posts and Telecommunications is responsible for sector oversight. While there is no specific sector policy, there are a number of action plans, most relating to national backbone connectivity as well as institutional strengthening. The Agency for the Regulation of Posts and Electronic Communications is the sector regulator. The relevant sector legislation is Law 9 of 2009 on the Regulation of the Electronic Communications Sector. In addition to its sector regulator duties, ARPCE also coordinates the country code top-level domain name (.cg), the various fibre-optic backbone projects, and the establishment of an IXP.

**Conclusion:** The Central African country is looking to move beyond a relatively high level of basic mobile connectivity to more fully embrace the potential of ICTs. The landing of the country's first

Key indicators for Congo (Rep.) (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.4	1.0	13.6
Mobile-cellular sub. per 100 inhab.	113.3	74.6	101.5
Fixed-broadband sub. per 100 inhab.	n.a.	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	25.1	22.9	52.2
3G coverage (% of population)	64.5	59.3	85.0
LTE/WiMAX coverage (% of population)	5.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	5.3	14.2	5.2
Fixed-broadband prices (% GNI pc)	38.5	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	8.1	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	8.0	17.7	6.8
Percentage of households with computer	5.3	9.6	46.6
Percentage of households with Internet access	2.7	16.3	51.5
Percentage of individuals using the Internet	8.1	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	n.a.	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

submarine cable has created new opportunities for ICT high-speed services and applications.

## Costa Rica

**The Costa Rican telecommunications sector was open to competition in 2008, ending the Instituto Costarricense de Electricidad (ICE)'s monopoly, which also runs the electric power market across the country. The government-owned incumbent subsidized access to ICT services, as they have historically been considered as a fundamental part of the country's development. Since its liberalization, the market has shown impressive growth and attracted foreign investors.**

**Mobile services:** Mobile services were open to competition in 2011, operators expanded the services and coverage to the underserved areas, so mobile services quickly caught up with regional and global levels. Currently, the three main operators are ICE, Movistar and Claro, all offering broadband services. There are also two MVNOs. The introduction of new competitors in mobile services meant an increase in coverage, access, service quality and competitive prices. In July 2017, SUTEL auctioned 4 2x5 MHz blocks on the 1800 MHz band and 3 2x5 MHz blocks on the 1900/2100 MHz band. The auction ended with Telefónica winning 4 2x5 blocks and Claro winning 3 2x5 MHz blocks.

**Fixed services:** Fixed-telephony is solely provided by ICE and the current trend of substitution of such services for mobile or VoIP has created a significant decrease in this service revenue. Fixed-broadband services have witnessed a slow but steady increase in penetration, which is partially due to more affordable services since the market liberalization. HFC (fixed technology) and WiMax (wireless technology) are the most used technologies. Most of the urban areas are served, with the challenge remaining to improve the infrastructure to reach more remote areas and offer higher bandwidths.

**Government policy:** Following the market opening in 2008, the Government created the Superintendence of Telecommunications to serve as the sector regulator and competition authority to ensure a level playing field for all market players, in order to promote competition. Following the increase in competition in Costa Rica's telecommunication markets, retail fixed Internet services and some other wholesale markets were declared competitive in December 2016. In September 2017, the mobile market was

Key indicators for Costa Rica (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	16.8	24.4	13.6
Mobile-cellular sub. per 100 inhab.	164.5	114.2	101.5
Fixed-broadband sub. per 100 inhab.	12.6	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	103.6	82.7	52.2
3G coverage (% of population)	90.6	93.6	85.0
LTE/WiMAX coverage (% of population)	46.2	77.4	66.5
Mobile-cellular prices (% GNI pc)	0.5	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.1	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.9	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.5	5.7	6.8
Percentage of households with computer	51.7	64.9	46.6
Percentage of households with Internet access	64.8	63.3	51.5
Percentage of individuals using the Internet	66.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	68.4	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

declared competitive. With the goal of universal access, the Government also created the Fondo Nacional de Telecomunicaciones (FONATEL), which is financed among other sources by operator's contributions and fines. FONATEL works on various fronts, from the provision of Internet services to schools to the assistance of underprivileged persons, as well as increasing the access of services to the more remote towns. More recently, the Government launched CRDigit@I, a national programme funded by FONATEL and designed to bridge the digital divide within the country.

**Conclusion:** Costa Rica's mobile market is thriving and there is still potential for improvement in terms of LTE coverage and higher bandwidths. The fixed-broadband segment still requires infrastructure investment and further development. The Government is involved in all fronts of ICT development, from infrastructure to educating the population, through promoting and ensuring a competitive and secure environment for market players.

## Côte d'Ivoire

***This West African nation is looking to make up for years of civil strife by promoting ICTs as a key motor of the economy.***

**Mobile services:** After industry consolidation and exits, there are now three robust mobile operators, each with a different foreign strategic partner: (a) Orange (with Orange France); (b) MTN (with MTN South Africa); and (c) MOOV (with Morocco Telecom). GSM coverage is widespread and 80 per cent of households had mobile phones in 2015.<sup>145</sup> Mobile-broadband has grown in popularity following the launch of 3G in 2012 and the launch of LTE by all operators after they received their licenses in 2015. Mobile money has been quite successful, with more than 30 per cent of adults using it, the highest penetration in West Africa.

**Fixed Services:** CI-Telecom was the incumbent operator, and has been rebranded following its purchase by Orange. It offers fixed-telephone service using copper lines. MTN also provides fixed-telephone services using LTE-TDD. Orange's ADSL fixed-broadband offering has been growing since lowering prices and increasing the maximum speed to 10 Mbit/s. Orange also offers fibre-optic connections with speeds up to 150 Mbit/s. There are four other fixed-broadband ISPs offering service using fixed wireless CDMA, WiMAX, LTE and very small aperture terminal (VSAT) and fixed broadband using optical fibre. The national fibre-optic backbone project was launched in 2012 under the Nation Broadband Network project. It is partly financed by the universal service fund and is being built by Chinese and French contractors. Upon completion (forecast for 2018), the network will be extended by some 7 000 km in addition 15 000 km of fibre provided by telecom operators. The country has long been connected to the SAT-3/WASC undersea fibre-optic cable. The arrival of ACE and WACS has boosted international Internet bandwidth capacity and lowered wholesale prices. Côte d'Ivoire, with a project of landing a new cable by the end of 2017, is hoping to leverage the cables to position itself as a regional Internet hub. The Côte d'Ivoire IXP was launched in 2013 and has eight members, including all the mobile operators and leading ISPs.

**Government policy:** Sector oversight is the responsibility of the Ministry of Communication,

Key indicators for Côte d'Ivoire (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	1.3	1.0 13.6
Mobile-cellular sub. per 100 inhab.	126.0	74.6 101.5
Fixed-broadband sub. per 100 inhab.	0.6	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	47.6	22.9 52.2
3G coverage (% of population)	56.3	59.3 85.0
LTE/WiMAX coverage (% of population)	34.0	25.7 66.5
Mobile-cellular prices (% GNI pc)	11.9	14.2 5.2
Fixed-broadband prices (% GNI pc)	26.4	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	7.3	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	22.0	17.7 6.8
Percentage of households with computer	10.4	9.6 46.6
Percentage of households with Internet access	22.7	16.3 51.5
Percentage of individuals using the Internet	26.5	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	6.8	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Digital Economy and Post. The digital economy figures strongly in the National Development Plan, which has the goal of becoming an emerging country by 2020. ICT strategies include (a) adequate regulation; (b) abundant offers for broadband and services with local content; (c) massification of ICT tools and services by citizens and the public administration; (d) new activities, innovation and employment generation; and (e) development of national expertise in ICT. The strategy calls for close to 100 per cent mobile telephone services population coverage, Internet coverage of 90 per cent of the population and broadband penetration of 50 per cent, all by 2020. The regulatory framework for telecommunications in Côte d'Ivoire is guided by the 2012 Ordinance Relating to Telecommunications and Information and Communications Technology. The National Authority for Regulation of Telecommunications/ICT is the independent sector regulator responsible for posts and telecommunications, as well as managing the country code top-level domain name, security, data protection, CIRT and the IXP.

**Conclusion:** Since the end of the civil war, there has been a concerted effort by the Government to accelerate ICT development. This is partly driven by a desire for the country to regain its previous status as a leading ICT hub in the region as well as to use ICTs to help achieve national development goals.

## Croatia

**Croatia has some of the highest ICT penetration rates of all Balkan countries and around the European average. The telecommunication market was greatly influenced by Croatia's accession to European Union in 2013, which strengthened market liberalization and the creation of a regulatory framework in line with the EU framework.**

**Mobile services:** Three mobile operators offer services in Croatia. HT is the market leader (by number of subscriptions) with a market share of 47 per cent followed by Vipnet (35 per cent) and Tele2 (17 per cent) at the end of 2015.<sup>146</sup> In addition, there are a small number of mobile virtual network operators present in the market. All mobile operators have deployed LTE networks. LTE population coverage is almost complete and thus well above the European average. Mobile-cellular and mobile-broadband penetrations rates are high compared with other Balkan countries and around the European average. Mobile operators in Croatia have a relatively high margin and continue to invest in telecommunication infrastructure.<sup>147</sup>

**Fixed services:** Croatia has a generally well-developed telecommunication infrastructure. The market is dominated by incumbent operator HT, which had a market share of 58 per cent of the fixed-line market (by number of subscriptions) by end 2015.<sup>148</sup> Other fixed-line operators include Optima Telecom, Iskon Internet, Vipnet, and Metronet. HT also controls the fixed-broadband market.<sup>149</sup> HT shares were first publically traded in 2007 and in 2010 HT and Deutsche Telekom merged.<sup>150</sup> Operators are investing in telecommunication infrastructure and especially in optical fibre networks, with Vipnet and HT upgrading to optical fibre infrastructure in order to increase speeds.<sup>151</sup>

**Government policy:** "The Strategy for Broadband Development in the Republic of Croatia for 2012 – 2015" aimed at ensuring competition in the telecommunication sector, increasing broadband access and encouraging demand for services. Where broadband access was lacking, the strategy suggested deploying mobile broadband. Croatia's objectives are in line with the Digital Agenda for Europe (100 per cent coverage with 30 Mbit/s and 50 per cent take-up rate for 100 Mbit/s by 2020). To this end, the regulator HAKOM has put

Key indicators for Croatia (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	33.9	37.7 13.6
Mobile-cellular sub. per 100 inhab.	104.1	118.0 101.5
Fixed-broadband sub. per 100 inhab.	24.6	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	76.7	80.1 52.2
3G coverage (% of population)	99.1	98.5 85.0
LTE/WiMAX coverage (% of population)	96.9	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.9	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.4	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.6	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.1	0.6 6.8
Percentage of households with computer	79.5	79.6 46.6
Percentage of households with Internet access	77.2	82.5 51.5
Percentage of individuals using the Internet	72.7	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	119.0	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

in place an interactive GIS portal, which shows the availability of broadband access, as well as information on deployment and bandwidth speeds. The national government is funding a project with a budget of approximately EUR 6.5 million to bring basic broadband access to "areas of special state concern" including mountainous areas and islands. Furthermore, the "national framework programme for the development of broadband infrastructure in areas lacking commercial interest for investments" with a budget of EUR 712 million is being co-funded by the government and private operators. The EU is also investing in Croatia and has approved a project to develop broadband NGN networks under the European Regional Development Fund.

<sup>152</sup>

**Conclusion:** Croatia has a well-developed telecommunication infrastructure and state actors as well as the private sector continue to invest in its modernization. ICT household penetration is relatively high and the number of people using the Internet is increasing.

## Cuba

***Cuba's telecommunication sector has been developing positively despite the country's limited access to financing and technology. There is a national program for the development of broadband that includes the modernization and growth of capacities, which allows the provision of new services with greater coverage and scope, and improves quality standards and affordability. Basic telecommunication services in Cuba are exclusively offered by the Telecommunications Company of Cuba S. A. (ETECSA) which has an administrative concession granted by the Cuban Government by means of a Decree.***

**Mobile services:** Mobile telephony is the telecommunication service with the highest rate of development in Cuba with an annual growth of more than 800 thousand lines. Investments are being made in the modernization of mobile infrastructure to support the expected growth in numbers of users and services. For instance, the 3G network is being rolled out and 3G services are already offered in Havana and the 15 provincial capitals.<sup>153</sup>

**Fixed services:** Growth rates in the fixed-line market have been moderate but positive over the past years. Moreover, investments are being made to improve the quality of existing services, such as fixed telephony, and extend them to other areas, such as Internet access.

**Government policy:** In 2017 Cuba updated its policy for the informatization of society which reaffirms the country's willingness to move forward in capacity building and to make more affordable access to telecommunications, including the Internet, as a resource for the country's sustainable human development, its culture and the preservation, promotion and dissemination of its values.

**Conclusion:** Even if it is necessary a higher level of investment in the telecommunication sector, a growing positive trend can be seen in recent years in the development of ICT services in Cuba.

Key indicators for Cuba (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	11.8	24.4	13.6
Mobile-cellular sub. per 100 inhab.	35.5	114.2	101.5
Fixed-broadband sub. per 100 inhab.	0.1	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	0.0	82.7	52.2
3G coverage (% of population)	n.a.	93.6	85.0
LTE/WiMAX coverage (% of population)	0.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	3,4	3.6	5.2
Fixed-broadband prices (% GNI pc)	28,6	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	n.a.	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	n.a.	5.7	6.8
Percentage of households with computer	15.1	64.9	46.6
Percentage of households with Internet access	7.5	63.3	51.5
Percentage of individuals using the Internet	38.8	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	1.2	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

## Cyprus

**The Cyprus telecommunication market is largely dominated by the Cyprus Telecommunication Authority (Cyta). Mobile-cellular services are very affordable and penetration rates for mobile cellular as well as mobile broadband are above the European average.**

**Mobile services:** Cyprus has 3 MNOs and 1 MVNO. The incumbent operator Cyta holds the largest market share (around 55 per cent), MTN is the second biggest player with a market share of 35 per cent and Primetel is the third biggest player with a share of 8 per cent. Cablenet, which is an MVNO, has the smallest share with less than 1 per cent (OCECPR, 2017a). Competition was first introduced as part of the country's accession to the EU with MTN launching its services in 2004. In 2011, PrimTel started to offer services as an MVNO and since March of 2015 as a full MNO in competition with Cyta and MTN. LTE services are available since 2015 in urban centres; 3G networks are more widely available and cover almost the entire population (International Telecommunications Law, 2016).

**Fixed services:** Cyta, which offers a variety of telecommunication services from voice to data and from fixed to mobile, is the dominant player in the market with 58 per cent of the market share (OCECPR, 2017b). Fixed-broadband is very affordable, and penetration is slightly above the European average. DSL is the most popular broadband technology on the island, but providers are facing increasing competition from Cablenet, the only cable Internet provider in Cyprus (Cyta, 2011), which was sold to Malta's GO in 2016.<sup>154</sup> The company invested heavily and was able to extend its reach to cover 68 per cent of Cypriot households in 2017, reaching a market share of 20 per cent. Primetel is the third biggest player with a market share of 15 per cent and MTN is the fourth player with a share of around 6 per cent.

**Government policy:** Cyprus has been an EU member since 2004. In the course of the country's accession to the EU and since then, government policies have been aligned with the EU acquis. For the telecommunication sector this translates most notably in the liberalization of the market. Furthermore, the EU regulatory framework for telecommunications, which focuses on competition and user rights, was

Key indicators for Cyprus (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	38.0	37.7 13.6
Mobile-cellular sub. per 100 inhab.	134.5	118.0 101.5
Fixed-broadband sub. per 100 inhab.	33.0	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	97.5	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	73.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.3	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.8	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.0	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.8	0.6 6.8
Percentage of households with computer	71.8	79.6 46.6
Percentage of households with Internet access	74.4	82.5 51.5
Percentage of individuals using the Internet	75.9	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	188.9	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

adopted. The Digital Strategy for Cyprus was approved by the government in 2012. It takes a market-based approach, where the government will only intervene in case private investments cannot achieve improved access to ICTs. By providing the right regulatory incentives, the government encourages investments in FTTx and LTE technology. In 2016, the Cyprus *Broadband Plan 2016-2020* was published. The plan aims at achieving full population coverage for broadband services at 30 Mbit/s and 50 per cent household penetration for broadband speeds of 100 Mbit/s by 2020.<sup>155</sup>

**Conclusion:** The Cypriot telecommunication market underwent some important changes in the past decades in terms of its market structure and the type of services that are being offered. The national government is working on the fulfilment of its obligations by increasing competition and encouraging investments in ICT infrastructure.

## Czech Republic

**The Czech Republic has a well-developed ICT market with high penetration rates. The telecommunication market is competitive and has experienced a number of important acquisitions by pan-European as well as local actors in the past decades.**

**Mobile services:** The Czech Republic has high mobile penetration rates, for both mobile-cellular and mobile-broadband services, at around the European average. Prices are very affordable and virtually the whole population is covered by a 3G and LTE signal. After the end of communist rule, the Czech telecommunication market attracted investments from major operators. Deutsche Telekom, O2, and Vodafone are all operating in this relatively small market of just over 10 million inhabitants. In addition, a fourth licence was granted to U:fon in 2007.<sup>156</sup> In an effort to further increase competition, MVNOs were allowed to enter the market in 2012 and since 2017 have been granted LTE access.<sup>157</sup> LTE spectrum was first auctioned off in 2013, with T-Mobile, O2, and Vodafone each being awarded an equal share of the 800 MHz spectrum. The licence obliges operators to cover underserved areas and allows MVNOs to access the LTE networks.<sup>158</sup> Moreover, the auction of the 3.6-3.8 GHz band has been recently concluded and is regarded as important step towards 5G deployment.<sup>159</sup>

**Fixed services:** O2 Czech Republic, which is the market leader and incumbent operator in the fixed market, was sold to PPF Group in 2013. The acquisition marks the transition of ownership from a pan-European provider to a local investment firm. In 2015, O2 was split into two separate undertakings: O2 Czech Republic, retail service provider, and CETIN, wholesale network operator. Fixed-broadband penetration in the Czech Republic is relatively high compared to neighbouring countries and close to the European average. The Czech Republic has one of the highest shares of alternative operators in the fixed-broadband market in the EU and there is strong, infrastructure-based competition in the market. DSL connections represent about one third of total subscriptions and are on the decline. Wireless local loop and cable are the most important non-DSL broadband technologies in the country.

Key indicators for Czech Republic (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	16.3	37.7	13.6
Mobile-cellular sub. per 100 inhab.	115.5	118.0	101.5
Fixed-broadband sub. per 100 inhab.	28.4	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	78.9	80.1	52.2
3G coverage (% of population)	99.7	98.5	85.0
LTE/WiMAX coverage (% of population)	99.7	92.2	66.5
Mobile-cellular prices (% GNI pc)	1.1	1.0	5.2
Fixed-broadband prices (% GNI pc)	0.9	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.8	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.5	0.6	6.8
Percentage of households with computer	75.6	79.6	46.6
Percentage of households with Internet access	76.1	82.5	51.5
Percentage of individuals using the Internet	76.5	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	180.7	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Czech Telecommunication Office (CTU) was established in 1993, following the split of Czechoslovakia into the sovereign states of the Czech Republic and Slovakia. In 2000, the process of liberalization of the telecommunication market began. The Czech Republic joined the European Union in 2004, a step that had a tremendous impact on the ICT sector. Liberalization and competition were strengthened and regulatory measures aligned with the European framework. As part of the EU Digital Single Market, the Czech Republic has set ambitious goals for broadband development. The national broadband strategy - Digital Czech Republic v.2.0 - was adopted in 2013 and commits to providing broadband access with at least 30 Mbit/s for all households and 100 Mbit/s for 50 per cent of households until 2020. The new strategy, *Národní plan rozvoje sítí nové generace* (NPRSNG) was adopted in 2016.<sup>160</sup> The *Radio Spectrum Management Strategy* adopted by the government in June 2015 is of particular importance for the development of high-speed mobile broadband (Czech Telecommunication Office, 2015).

**Conclusion:** Internet usage is very high and the vast majority of the population are online in the Czech Republic. With its national broadband strategy, the Czech Republic underlines its ambition to further promote ICT development.

## Denmark

**Denmark has a very advanced telecommunication market that is among the most open and competitive in the world. Fixed and mobile penetration rates are high and prices very affordable.**

Mobile services: Penetration rates for both mobile-cellular and mobile-broadband services are very high. Denmark exceeds the European average for both services and has one of the highest mobile-broadband penetration rates worldwide. The Danish mobile market is extremely competitive and offers very affordable mobile-cellular and mobile-broadband plans. TDC, the incumbent operator, continues to hold the highest market share, but is in fierce competition with second place Telenor, followed by TeliaSonera and Hi3G. All four operators offer mobile-broadband services, with Telenor and TeliaSonera having entered into an agreement to share 2G, 3G, and LTE networks in order to strengthen their position against TDC.<sup>161</sup>

**Fixed services:** Denmark has a widely available and highly sophisticated fixed-broadband infrastructure. Penetration is well above the European average and prices for fixed-broadband services are very affordable. Broadband access is provided mainly through cable and DSL. Fibre and other fixed networks are expanding with the support of progressive regulatory measures. TDC is the largest fixed-broadband provider with a market share of just over 50 per cent, but declining, and numerous alternative providers are active in the market.<sup>162</sup> Denmark has seen a strong fixed-to-mobile substitution leading to a remarkable decline in the number of fixed-telephone subscriptions over the last years (ITU, 2015).

**Government policy:** Denmark opened its telecommunication market to full competition in July 1996, 18 months ahead of the 1998 deadline set by the EU Full Competition Directive, and ahead of many other EU members. The market is one of the most open with no barriers to entry or restriction on foreign companies. Thus, in combination with Denmark's early liberalization, the country attracted a high number of operators into its telecommunication market (OECD 2000). The Danish government announced that every household and business in the country should have

Key indicators for Denmark (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	27.4	37.7 13.6
Mobile-cellular sub. per 100 inhab.	122.9	118.0 101.5
Fixed-broadband sub. per 100 inhab.	43.3	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	124.2	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	100.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.7	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.7	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.1	0.6 6.8
Percentage of households with computer	95.0	79.6 46.6
Percentage of households with Internet access	94.0	82.5 51.5
Percentage of individuals using the Internet	97.0	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	239.9	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

access to a broadband connection with download speeds of at least 100 Mbit/s and upload speeds of 30 Mbit/s by 2020. The Digital Strategy 2016-2020 "A Stronger and more Secure Digital Denmark" reiterates the focus on a technology neutral approach and puts in place the conditions for broadband development and investment in order to achieve those goals. The regulator will make additional spectrum for wireless broadband available. Continued investments in high-speed infrastructure are expected to come from private operators. Public funding is available for underserved areas, for example through the broadband funding pool that is directed to associations of households, businesses and cottages with limited bandwidth.<sup>163</sup> Furthermore, in 2016 Danish authorities introduced a tax deduction regulation for private households setting up broadband access.<sup>164</sup>

**Conclusion:** Denmark continues to be at the forefront of ICT development by maintaining a competitive environment and the right incentives for investments in and use of ICTs. Most people in Denmark are Internet users and ICT-household penetration is above 90 per cent.

## Djibouti

***The Djibouti ICT sector is one of few monopolistic telecommunication sectors in the world, and has a relatively low level of penetration for telecommunication services. Despite these challenges, the country has seen important progress in the last years with the launch of LTE services.***

**Mobile services:** Djibouti is one of the few remaining countries in which the national telecommunication operator, Djibouti Telecom (DT), has a monopoly on all telecommunication services, including fixed lines, mobile, Internet, and broadband. The lack of competition has meant that the market has not lived up to its potential. Growth in the mobile and Internet markets is accelerating in line with DT investment in its mobile network. However, competition and foreign investment are both required for the telecommunication market to develop. In preparation for this, DT is forging international alliances, and has been a key investor in cable network systems including the DARE and AWE systems. Growth in the mobile and Internet sectors accelerated with the 3G launch in 2011 using the 2100 MHz band. Evatis, the mobile division of Djibouti Telecom, launched a HSPA mobile service, augmenting its existing GSM and EDGE platforms in 2012, offering subscribers access to high speed mobile broadband, voice, and SMS/MMS services. As a result of the launch, Djibouti Telecom users have access to broadband on a range of devices, including mobile phones, tablets and laptops. Djibouti Telecom started rolling out a full-blown LTE network in 2016 in the 1800 MHz band.

**Fixed services:** While domestic infrastructure remains poor, the country is one of the best connected for optical fibre international cables in the region. The Djibouti Internet Exchange is a meeting point for a number of cable systems passing between the Red Sea and Indian Ocean. Despite this connectivity, broadband services in Djibouti remain very expensive: high rates have contributed to an under-utilization of the copper network. Subscriber and line connection fees are very high, taking into account the population poverty rate, which continues to hold back the full growth potential of the sector.

Key indicators for Djibouti (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	2.7	7.7	13.6
Mobile-cellular sub. per 100 inhab.	37.8	107.1	101.5
Fixed-broadband sub. per 100 inhab.	3.0	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	11.6	45.2	52.2
3G coverage (% of population)	57.6	81.9	85.0
LTE/WiMAX coverage (% of population)	<i>n.a. 0</i>	33.8	66.5
Mobile-cellular prices (% GNI pc)	n.a.	4.3	5.2
Fixed-broadband prices (% GNI pc)	32.0	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	16.2	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	9.7	5.5	6.8
Percentage of households with computer	20.3	43.3	46.6
Percentage of households with Internet access	9.1	45.3	51.5
Percentage of individuals using the Internet	13.1	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	15.2	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** Djibouti has not yet liberalised the telecommunication market, which has affected the prices, access, and quality of mobile and fixed services. Djibouti Telecom still holds a monopoly on the national and international market, and as a result, high speed Internet access is relatively more expensive than in other countries in the region. Strengthening the ICT sector and making quality telecommunication services available at affordable prices is crucial to achieve the objectives in the Djibouti Vision 2035 and the aim to triple per capita income by 2035. Djibouti highlighted the importance of its ICT sector in its recent World Trade Policy Statement provided to the World Trade Organization in September 2014. To achieve the Djibouti Vision 2035 policy objectives, the Government set up since 2014 a specific strategy for ICT (Integrated Strategic Plan) which has for objective to develop and to generalize the access to ICT.

**Conclusion:** The effort made by the Government of Djibouti and Djibouti Telecom in the last ten years, with the launching of HSPA and LTE, and with many international alliances, has reflected positively on the sector. Growth in the mobile and Internet markets is accelerating in line with DT investment in its mobile network. However, competition and foreign investment are both required for the telecommunication market to show solid development in coming years.

## Dominica

**Dominica's telecommunications sector has shown substantial development in recent years, both in terms of infrastructure and service uptake, especially regarding broadband services. Dominica is one of the five members of the Eastern Caribbean Telecommunications Authority (ECTEL), an overarching regulatory organization that assists the national regulators on the creation and adoption of well-adapted and effective policies.**

**Mobile services:** The mobile market yields the greatest share of revenue among all telecommunications services, and continues to experience growth. Three operators compete for market share in Dominica: LIME, Digicel and Wikibuli. Mobile-broadband penetration has increased substantially in recent years, with LTE technology first available in 2014.<sup>165</sup> Mobile-broadband has received growing investments in terms of infrastructure deployment, unveiling great potential for the near future as coverage expands and the population adopts the service.

**Fixed services:** Dominica's penetration rate for fixed-broadband services is above the regional average. The fixed-broadband segment has seen its adoption rates increase and dedicated investment represented the largest part of industry's total invested funds in 2015, amounting to more than 60 per cent as the deployment of hybrid fibre-coaxial took place.

**Government policy:** A separate sector regulator, the National Telecommunications Regulatory Commission of the Commonwealth of Dominica, was created following adoption of the Telecommunications Act 31 in 2000. Since then, a universal service fund was established with the aim of encouraging ICT access and use, particularly focusing on affordability of services and bridging the digital divide within Dominica.<sup>166</sup> The Fund's current projects include supply of equipment to public entities, skills training for youth and the creation of free public Internet via Community Access Points.<sup>167</sup> The national regulator collaborates constantly with ECTEL and more recently has adopted a new Electronic Communications Bill.<sup>168</sup>

**Conclusion:** Dominica's telecommunications sector has a positive outlook, with broadband

Key indicators for Dominica (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	18.3	24.4	13.6
Mobile-cellular sub. per 100 inhab.	107.4	114.2	101.5
Fixed-broadband sub. per 100 inhab.	21.2	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	41.0	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	0.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	3.7	3.6	5.2
Fixed-broadband prices (% GNI pc)	5.7	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	3.5	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.9	5.7	6.8
Percentage of households with computer	54.0	64.9	46.6
Percentage of households with Internet access	60.0	63.3	51.5
Percentage of individuals using the Internet	67.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	176.4	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

services becoming increasingly available and investment dedicated to the deployment of related infrastructures, as well as programmes to incentivize service uptake. The partnership with other countries in the region has fomented a promising regulatory environment to assist on the development of the sector.

## Dominican Republic

**The liberalization of the Dominican Republic's telecommunications sector during the end of the 1990s was followed by an influx of national and international investments. Since then, broadband and mobile service penetration showed significant growth, but there are pressing needs in terms of infrastructure development to both improve the connection speed as well as increase service reach to more remote areas.**<sup>169</sup>

**Mobile services:** The national mobile market is dominated by Claro and Altice, together retaining approximately 90 per cent of the market share. Prepaid lines represent the majority of the subscriptions; however, the postpaid model is quickly gaining ground, with growth rates close to 10 per cent. Mobile broadband is on the whole more popular than fixed broadband, which can be seen through the adoption rates, which have been under steady and substantial growth in recent years.

**Fixed services:** Fixed-telephony is dominated by Claro, with more than 70 per cent of market share. Fixed lines, however, represent little more than 10 per cent of the total national subscriptions. Fixed-broadband is mainly provided via DSL technology; however, optical fibre technology is gaining market share. In terms of submarine connections, the Dominican Republic is well served, being connected to five international optical fibre cables. The country's regulator expects to have to complete deployment of the fibre backbone network in 2018, which shall improve connection speed and decrease service pricing.<sup>170</sup>

**Government policy:** The regulator, *Instituto Dominicano de las Telecomunicaciones* (INDOTEL), is involved in different projects in order to ensure service quality, affordability and the existence of a level playing field for all operators. INDOTEL is currently promoting regulatory changes to encourage infrastructure sharing, transparency on international roaming and Premium SMS, strengthening user rights, and a more efficient process to award concessions and licences for service operators.<sup>171</sup> There is a 2 per cent rate on all telecommunication services charges that funds both the regulator as well as Universal Service programs via the *Fondo de Desarrollo de las Telecomunicaciones*. The country's biggest

Key indicators for Dominican Rep. (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	12.5	24.4	13.6
Mobile-cellular sub. per 100 inhab.	80.8	114.2	101.5
Fixed-broadband sub. per 100 inhab.	7.1	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	49.2	82.7	52.2
3G coverage (% of population)	99.0	93.6	85.0
LTE/WiMAX coverage (% of population)	86.4	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.6	3.6	5.2
Fixed-broadband prices (% GNI pc)	5.4	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.2	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.2	5.7	6.8
Percentage of households with computer	32.0	64.9	46.6
Percentage of households with Internet access	26.2	63.3	51.5
Percentage of individuals using the Internet	61.3	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	22.1	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

achievement in ICT has been the implementation of *República Digital*, a national program created by Presidential Decree 258-16 which comprises a group of policies and actions aiming at promoting ICT inclusion in productive processes as well as in the provision of public and private services. The Program is divided into four strategic components: Education, Access/Broadband, Productivity and Employment, and Digital Government. There are two cross-cutting axes common to the four pillars, which are Cybersecurity and Social Inclusion. The latest programme, the *Plan Estratégico Sectorial para la Regulación, Desarrollo y Fomento de las Telecomunicaciones en la República Dominicana 2017–2020*, aims at the sustainable development of the sector, while also focusing on better quality of service.<sup>172</sup>

**Conclusion:** There is a clear preference for mobile technologies, seen through penetration rates, in the Dominican Republic. Despite the extended mobile-broadband coverage, the country still has challenges to expand the ICT services usage to more remote areas and to provide more affordable services.

## Ecuador

**The telecommunications sector in Ecuador is relatively concentrated in the hands of a few dominant operators. The fixed services have experienced little competition thus far, with the State-owned incumbent retaining the majority of the market share. Mobile services are under a more competitive environment, but remain limited to a few market players.**

**Mobile services:** Mobile services are mainly provided by the operators Conecel and Otecel. The operator *Corporación Nacional de Telecomunicaciones* (CNT) is a distant third market competitor with a very low market share. Prepaid services are still the main type of subscription, but the postpaid format is quickly gaining ground as the population becomes more interested in accessing the Internet. The number of subscriptions that include both voice and Internet services surpassed those of voice-only in the beginning of 2017. Mobile-broadband is widely accessible in the form of 3G technology; LTE is becoming increasingly available as the operators invest in extending their networks.<sup>173</sup>

**Fixed services:** Fixed services provision are largely dominated by CNT, the State-owned operator, which retains more than 55 per cent of the fixed-broadband subscriptions, with a variety of other smaller operators sharing the rest of the market. Despite the low penetration levels, demand for fixed-broadband has increased steadily over recent years, with the infrastructure development reaching all states by end of 2016. More than half of the connections are provided through copper, with cable modem representing 13 per cent and fibre optic at 9 per cent. The fixed-broadband market is expected to grow rapidly in the coming years.

**Government policy:** The body responsible for sector regulation in Ecuador is *Agencia de Regulación y Control de las Telecomunicaciones* (ARCOTEL). The entity responsible for Government policy in telecommunications is *Ministerio de Telecomunicaciones y Sociedad de la Información* (MINTEL), which actively engages in expanding the services availability and the development of the ICT sector through a variety of programmes. The Government recently launched the *Plan Nacional de Telecomunicaciones y Tecnologías de Información y Comunicación 2016–2021*, which

Key indicators for Ecuador (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	14.9	24.4	13.6
Mobile-cellular sub. per 100 inhab.	84.3	114.2	101.5
Fixed-broadband sub. per 100 inhab.	9.7	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	46.7	82.7	52.2
3G coverage (% of population)	87.8	93.6	85.0
LTE/WiMAX coverage (% of population)	51.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	3.5	3.6	5.2
Fixed-broadband prices (% GNI pc)	4.1	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.0	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.0	5.7	6.8
Percentage of households with computer	42.3	64.9	46.6
Percentage of households with Internet access	36.0	63.3	51.5
Percentage of individuals using the Internet	54.1	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	43.7	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

focuses on infrastructure roll-out (for instance, it established the objective of having 80 per cent LTE population coverage by 2021), increasing penetration rates (for instance, reaching 59 per cent of fixed-broadband penetration by 2021), among other universal service goals. Another programme, the *National Plan for Good Living 2013–2017*, has been focusing on democratizing access to telecommunications services and increasing digital literacy among the Ecuadorian population.<sup>174</sup> Another important initiative, the *Políticas Públicas del sector de las Telecomunicaciones y de la Sociedad de la Información 2017-2021*, seeks to strengthen and promote the deployment of telecommunication infrastructure and access to ICTs. In addition, it promotes the efficient use of new technologies and encourages the business environment, incorporating technology in micro, small and medium enterprises, as a mechanism for innovation and productivity increase.<sup>175</sup>

**Conclusion:** The telecommunications sector in Ecuador still has considerable potential for development as services penetration levels are relatively low. Operators have the opportunity to increase their reach by providing better and more widely available services. The Government, along with market players, has dedicated efforts to infrastructure development and public policies to bridge the digital divide.

## Egypt

***Egypt is one of the most developed and rapidly growing Internet markets in terms of users, international bandwidth and services offered. With four competing operators, the country offers low prices of fixed and mobile-broadband services in the Arab States region. The country is connected through local and international fibre infrastructure and some FTTH deployments.***

### Mobile services:

Mobile services play a tremendous role in Egyptians daily lives through facilitating Internet access, doing e-commerce transactions, accessing social media and others. Supported by a population of more than 90 million, Egypt has a large mobile market, with high mobile penetration levels. Orange was the first cellular operator in Egypt followed by Vodafone Egypt and Etisalat Misr, while Telecom Egypt entered the market in 2016. Egypt was among the pioneer countries in the region to launch 3G services in 2007. The development of LTE was delayed for a while. Nevertheless, the incumbent fixed-line operator, Telecom Egypt (TE) received the first unified services licence from the National Telecom Regulatory Authority (NTRA) in August 2016, which allowed TE to offer LTE services. NTRA issued four LTE licences in mid-2016, and the service was officially launched in 2017. NTRA allowed TE to act as the mobile virtual network operator (MVNO), while the mobile operators will act as fixed virtual operators (FVNO) using TE infrastructure. The wide spread of LTE technology will result in creating more applications with different types and in different fields, such as health, education, agriculture, and different services. This will bring a positive impact on the citizen and will maximize the flow and use of data and information consequently the transformation to a digital economy.

**Fixed services:** The four-player market is expected to bring greater choices for consumers on one side, and to enable Telecom Egypt to provide different data packages and bundled mobile and wireline services. The three mobile operators, Orange Egypt, Vodafone Egypt, and Etisalat Misr, are to launch fixed voice services, having acquired virtual fixed-line licenses in October 2016, so the telecommunication market is expected to witness

Key indicators for Egypt (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	7.1	7.7	13.6
Mobile-cellular sub. per 100 inhab.	113.7	107.1	101.5
Fixed-broadband sub. per 100 inhab.	5.2	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	52.6	45.2	52.2
3G coverage (% of population)	98.7	81.9	85.0
LTE/WiMAX coverage (% of population)	0.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.8	4.3	5.2
Fixed-broadband prices (% GNI pc)	1.8	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.9	5.5	6.8
Percentage of households with computer	53.1	43.3	46.6
Percentage of households with Internet access	43.3	45.3	51.5
Percentage of individuals using the Internet	39.2	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	17.2	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

four players competing head-to-head for fixed and mobile voice and data customers.

**Government policy:** MCIT strives to achieve the digital economy through the use, dissemination, and penetration of ICT tools to provide prosperity, freedom, and social equity for all. Its mission is to enable the development of a knowledge-based society and a strong digital economy relying on equitable and affordable access to knowledge; and the development of a competitive, innovative national ICT industry. Knowledge, innovation, and scientific research is one of the main pillars of Egypt's Vision 2030. The strategy highlights the importance of the ICT sector as a key driver for future sustainable economic growth. Additionally, it supports the development of the ICT industry both regionally and internationally especially after the design of new initiatives such as the electronics design and manufacturing. The ICT sector achieved unprecedented levels in contribution to the GDP of the country, which reached 3.2 per cent in 2016/2017 with the highest growth rate among the other economic sectors.

**Conclusion:** The efforts made by MCIT and NTRA over the past 20 years, and despite economic difficulties, have resulted in making Egypt one of the most connected countries in the Arab States. Egypt has seen a significant rise in Internet penetration in recent years, as a result of growing usage among the middle-class and the business community, rapidly expanding international bandwidth, as well as the accompanying lower tariffs.

## El Salvador

**Until the 1990s, telecommunications services in El Salvador were solely supplied by the Government. From the mid-1990s onwards, the sector underwent a process of privatization of the incumbent and liberalization of the market. Despite these efforts, the services penetration levels remain below par compared with regional and global averages, with the exception of the very popular mobile-cellular market.**<sup>176</sup>

**Mobile services:** In El Salvador the mobile market is more dynamic and successful than the fixed market. There are five operators competing for market share: Claro, Digicel, Intelfon, Movistar and Tigo. The mobile-broadband sector holds great potential as competition between the operators should improve service quality and increase affordability for the population, as pricing is yet to decrease to regional average levels. LTE technology is not yet available in the country, as adequate spectrum is yet to be allocated for such services to be provided.<sup>177</sup>

**Fixed services:** Fixed services account for approximately one-tenth of the telephony market and adoption levels are substantially below the regional average. El Salvador's fixed-broadband penetration levels have grown steadily over the past few years; however, it is yet to experience a fully competitive environment.<sup>178</sup> For instance, despite having a competitive cable modem market, Claro remains the sole DSL provider.

**Government policy:** Created during the late 1990s, the autonomous telecommunications regulator, *Superintendencia General de Electricidad y Telecomunicaciones*, is active in promoting sector development. A reform to the law governing the national telecommunications sector was accepted in the first half of 2016, updating the country's legislative framework to include measures related to spectrum, as well as attract foreign investment. The regulator, however, has been assisting in fostering a competitive environment for longer, for instance by fixating caps for service pricing for both mobile and fixed services, as well as determining interconnection rates. Dedicated not only to the development of a sustainable and dynamic telecommunications sector, the regulator also engages in providing the population with the tools necessary to develop digital skills. The programme *Salvadoreñas Conectadas para el*

Key indicators for El Salvador (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	14.4	24.4	13.6
Mobile-cellular sub. per 100 inhab.	149.0	114.2	101.5
Fixed-broadband sub. per 100 inhab.	6.1	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	28.5	82.7	52.2
3G coverage (% of population)	61.3	93.6	85.0
LTE/WiMAX coverage (% of population)	15.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	4.1	3.6	5.2
Fixed-broadband prices (% GNI pc)	6.5	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.3	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.0	5.7	6.8
Percentage of households with computer	20.8	64.9	46.6
Percentage of households with Internet access	16.9	63.3	51.5
Percentage of individuals using the Internet	29.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	63.6	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

*desarrollo*, for instance, focuses on bridging the digital divide within the population by capacity building for women between 2017 and 2020.<sup>179</sup>

**Conclusion:** Despite the successful adoption rates of mobile cellular, the national telecommunications market has yet to reach regional levels on broadband uptake, regarding both fixed and mobile technologies. The Government is making efforts to improve the competitive environment for additional infrastructure investments. Mobile spectrum auctions are expected to take place during 2017, which shall encourage much-needed investment and bring dynamism to the market.<sup>180</sup>

## Equatorial Guinea

***This oil-rich Central African country is aiming to boost ICT use, especially following connectivity to submarine cables.***

**Mobile services:** The State-owned incumbent, Guinea Equatorial Telecommunications Society (GETESA), which launched its GSM network in 2000, dominates the market. In 2009, Green Com, a subsidiary of a Kuwaiti-based company, launched as the second mobile operator under the Muni brand. GETESA launched 3G in 2011, followed by Green Com in 2016.

**Fixed services:** GETESA was partly privatized, with 40 per cent sold to Orange France. Following the award of a third unified license to GECOMSA, a joint venture between the Government of Equatorial Guinea and Chinese investors in 2011, Orange triggered an exit clause whereby the Government was supposed to buy back its shares. The exit clause was not honoured and Orange filed a legal claim, which is currently being adjudicated in several jurisdictions. GETESA remains the only provider of fixed-telephone services. It also offers fixed-broadband over ADSL. The ISP GUINEANET offers WiMAX broadband services in the 700 MHz frequency, with plans to migrate to fixed LTE. Fibre-optic connections are available for businesses. GETESA and Green Com have an agreement to deploy a national fibre-optic backbone. In 2011, the 287 km CEIBA-1 submarine cable linking the island of Bioko (location of the capital Malabo) to the mainland was completed. Equatorial Guinea connected to the ACE undersea fibre-optic cable in 2012. The 290 km CEIBA-2 cable linking Bioko, the mainland and Cameroon is under construction. When deployed, the submarine cable will enable Equatorial Guinea to connect to other submarine cable systems – including WACS, SAT-3 and Main One, via Cameroon – and provide redundancy for CEIBA-1. The Manager of Telecommunications Infrastructure of Equatorial Guinea (GITGE) was created by Decree 44/2011 to administer the Government's fibre-optic holdings, operating as a wholesaler. GITGE provides bandwidth capacity on an equal and non-discriminatory basis to the country's telecommunication operators and ISPs.

**Government policy:** The Ministry of Telecommunications and New Technologies is responsible for the sector. Its aims are linked to the

Key indicators for Equatorial Guinea (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	1.3	1.0 13.6
Mobile-cellular sub. per 100 inhab.	70.1	74.6 101.5
Fixed-broadband sub. per 100 inhab.	0.4	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	0.4	22.9 52.2
3G coverage (% of population)	11.0	59.3 85.0
LTE/WiMAX coverage (% of population)	0.0	25.7 66.5
Mobile-cellular prices (% GNI pc)	n.a.	14.2 5.2
Fixed-broadband prices (% GNI pc)	9.5	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	n.a.	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	n.a.	17.7 6.8
Percentage of households with computer	16.0	9.6 46.6
Percentage of households with Internet access	9.4	16.3 51.5
Percentage of individuals using the Internet	23.8	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.4	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Government's Horizon 2020 national development strategy and include enhancing international capacity, improving quality of services, making prices more affordable, ensuring competition between operators, extending coverage across the country, strengthening regulations, improving ICT training, and promoting the development and take-up of new applications and services within different sectors of the economy. The General Law of Telecommunications of 2005 is the relevant legislation for the sector and, since its enactment, fixed line, mobile and Internet services have been open to competition. The Telecommunications Regulator Organ came into being after adoption of the law to regulate the sector.

**Conclusion:** The deployments of submarine cables that link the country's main island to the mainland and the country to the world have been a major connectivity boost to the sector. Limited competition is, however, holding back the potential to enhance access and promote the ICT sector as a new economic sector to diversify the country's reliance on oil.

## Estonia

***With affordable prices for telecommunication services and a population quick to adapt to new technologies, Estonia is at the forefront of ICT development in particular with regard to mobile-broadband services.***

**Mobile services:** Estonia has a very active user base of mobile services and penetration rates for both mobile-cellular and mobile-broadband services are well above the European average. The mobile market, which is served by three mobile network operators, is very competitive and prices for mobile services very affordable. Telia holds the lead, but is closely followed by its competitors Elisa and Tele2. Estonia is covered with a nationwide 3G and LTE network that reaches 100 per cent of the population.<sup>181</sup> LTE services were first launched in 2012 and the development of LTE networks from 2014-2015 enabled speeds of up to 450 Mbit/s. In 2016, mobile Internet with speeds of at least 30 Mbit/s were available almost throughout the entire country and 37 per cent of households in Estonia were covered by speeds of at least 100 Mbit/s (Republic of Estonia, 2016).

**Fixed services:** The Estonia fixed market is very advanced with high penetration rates for fixed-telephone and fixed-broadband services. There is a clear trend toward fixed-to-mobile substitution, with fixed telephony on the decline since 2007 (Republic of Estonia, 2016). Elion is the incumbent operator and market leader in both fixed-telephony and fixed-broadband with market shares of more than 50 per cent. Its main competitor Starman was bought by Elisa in 2017, which is expected to boost competition in the market.<sup>182</sup> Estonia's fixed-broadband infrastructure is well developed and the percentage of NGA lines (of total broadband lines) is above the EU average.<sup>183</sup>

**Government policy:** Estonia telecommunication policy aims "to ensure competition and openness in the sector". The sector was fully liberalized in January 2001, ending the monopoly of the Estonian Telephone Company.<sup>184</sup> The entry into the European Union in 2004 had an important impact on the sector and further promoted competitiveness. Today, EU policies as well as efforts by the national government in the area of ICTs focus on broadband development. In this context, Estonia's Digital Agenda 2020 was adopted in 2013 (Ministry of Economic Affairs and

Key indicators for Estonia (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	29.0	37.7	13.6
Mobile-cellular sub. per 100 inhab.	148.7	118.0	101.5
Fixed-broadband sub. per 100 inhab.	31.1	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	125.0	80.1	52.2
3G coverage (% of population)	99.0	98.5	85.0
LTE/WiMAX coverage (% of population)	99.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.2	1.0	5.2
Fixed-broadband prices (% GNI pc)	1.2	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.1	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.5	0.6	6.8
Percentage of households with computer	89.6	79.6	46.6
Percentage of households with Internet access	86.2	82.5	51.5
Percentage of individuals using the Internet	87.2	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	210.8	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Communications, 2013). One of the major drivers of broadband roll-out is the Estwin project, which was launched in 2009 by the Estonia Government and eight private operators. Their goal is to build a fibre network that covers 98 per cent of households and thus bring broadband to rural areas.<sup>185</sup>

**Conclusion:** The efforts made by the Estonia Government have transformed Estonia into one of the most connected countries in Europe and the world. Internet use and household ICT connectivity are very high. ICT development is expected to continue, with the government committed to providing the best conditions for private operators to invest in next generation networks.

## Ethiopia

***The country is the most populated landlocked nation in the world, which presents a challenge for ICT deployment. The ICT sector is State-run, with the Government dedicating significant resources to its development.***

**Mobile services:** Government-owned Ethio Telecom is the sole provider of telecommunication services in the country. The Government considers that this arrangement best ensures ICT development in line with national goals. The GSM mobile network was launched in 1999. In 2014, just under half the households (49 per cent) in the country had mobile phones with a wide spread between urban (84 per cent) and rural areas (40 per cent).<sup>186</sup> Ethio Telecom deployed 3G services in January 2009 and LTE in Addis Ababa in March 2015.

**Fixed services:** Ethio Telecom offers fixed-telephone service through copper landlines and CDMA wireless local loop. Fixed broadband is offered via ADSL2+ and fibre-optic technologies, and generally used in urban areas. Fixed wireless broadband is provided through CDMA EVDO. The nationwide fibre-optic backbone network essentially reaches all main towns and key border crossings in the North, East and South. Traffic in other areas is backhauled via microwave and satellite technology. Though landlocked, Ethiopia has diverse access to capacity on several international undersea cables through three border crossings: (a) via three submarine cables landing in Djibouti; (b) on two cables landing in Sudan; and (c) on two cables landing in Kenya. There is also a fibre link to Somaliland in Somalia.

**Government policy:** The Growth and Transformation Plan II (GTP II) (2015/16-2019/20) is the guiding national policy instrument for development in Ethiopia. GTP II has the overall objective of Ethiopia becoming a lower-middle-income country by 2025. ICT is recognized as a vital economic infrastructure in GTP II. The plan calls for (a) enhancing the role of the sector in socio-economic activities to enable the country to grow rapidly; (b) expanding ICT coverage in all parts of the country; (c) providing competitive ICT services in terms of cost and quality; and (d) creating a conducive environment for the private sector to use ICT. The Ministry of Communication and Information Technology is responsible for the

Key indicators for Ethiopia (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	1.1	13.6
Mobile-cellular sub. per 100 inhab.	50.5	101.5
Fixed-broadband sub. per 100 inhab.	0.6	12.4
Active mobile-broadband sub. per 100 inhab.	5.3	52.2
3G coverage (% of population)	85.0	85.0
LTE/WiMAX coverage (% of population)	10.0	66.5
Mobile-cellular prices (% GNI pc)	6.5	5.2
Fixed-broadband prices (% GNI pc)	25.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	8.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	16.7	6.8
Percentage of households with computer	5.0	46.6
Percentage of households with Internet access	15.4	51.5
Percentage of individuals using the Internet	15.4	45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.2	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

sector, including regulatory supervision as well as e-government infrastructure deployment and e-services coordination. The Ministry is drafting a new ICT policy and broadband strategy to reflect the goals of the GTP. The Telecommunications Proclamation of 1996 and its 2002 amendment are the relevant laws guiding the sector. An IT Park called EthioICT-Village is being developed in the outskirts of the capital, Addis Ababa. With a state-of-the-art infrastructure including fibre-optic connectivity and data centre, EthioICT-Village will serve as the headquarters of both Ethio Telecom and the Ministry with the aim of becoming a leading ICT hub in Africa.

**Conclusion:** Despite the challenges in deploying ICTs in this large, landlocked and mainly rural nation, the Government has devoted substantial resources recently to boost infrastructure, including last mile access, to achieve the ambitious targets in the country's national development plan.

## Fiji

***The small island developing state is a hub for international fibre-optic connectivity in the South Pacific.***

**Mobile services:** A GSM service was launched in July 1994 by Vodafone Fiji Limited, which at the time was co-owned by Vodafone UK (49 per cent) and Fijian Amalgamated Telecom Holdings (ATH) (51 per cent), a Fijian group. In 2014, Fiji's National Provident Fund purchased Vodafone UK's shareholding, making Vodafone fully locally owned. Until 2008 the company was the nation's only mobile operator. With the ending of Vodafone's exclusivity, Digicel Fiji Limited, a subsidiary of a privately held mobile group with operations in the Caribbean and the Pacific, entered the market. The year after Digicel launched, mobile penetration passed the 100 per cent mark. However actual mobile phone ownership is lower, with 76 per cent of the population aged 15 and older owning one and another 10 per cent reporting they used someone else's mobile.<sup>187</sup> Vodafone deployed a 3G network in November 2008 and has since then converted all base stations to support high-speed mobile technology, a feat accomplished in five years, compared to the 16 years needed to reach the same level of coverage for GSM. Vodafone launched an LTE network in December 2013 and coverage stood at 65 per cent of the population in 2016. Digicel deployed its 3G network in July 2011 and its LTE network in August 2014.

**Fixed services:** Telecom Fiji Limited (TFL), the incumbent owned by ATH, accounts for most fixed telephone lines in the country. Fixed telephone penetration is relatively high for a developing nation. Fixed broadband subscriptions are low and mainly limited to urban areas using ADSL or fibre. Fixed wireless penetration is higher and is being stimulated by the use of LTE for stationary Internet access as well as WiMAX. Telecom Fiji uses fibre-optic cable and microwave for its backbone network and is progressively converting to all-fibre. Digicel primarily uses microwave for its backbone network. Fiji became the first South Pacific nation to get access to an undersea fibre-optic cable when it connected to Southern Cross in November 2000. Access to Southern Cross Cable Network, which runs from Australia to the United States, has been a big attraction for other countries in the region, and Fiji has emerged as a regional hub for fibre connectivity. Submarine

Key indicators for Fiji (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	8.3	10.0	13.6
Mobile-cellular sub. per 100 inhab.	116.3	98.9	101.5
Fixed-broadband sub. per 100 inhab.	1.4	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	131.8	47.4	52.2
3G coverage (% of population)	96.0	87.6	85.0
LTE/WiMAX coverage (% of population)	90.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	4.3	3.2	5.2
Fixed-broadband prices (% GNI pc)	3.9	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.8	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.8	5.4	6.8
Percentage of households with computer	41.7	37.8	46.6
Percentage of households with Internet access	33.6	45.5	51.5
Percentage of individuals using the Internet	46.5	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	23.7	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

cables from Tonga and Vanuatu land in the country for onward transmission onto Southern Cross, with the Tui-Samoa cable under construction between Fiji and Samoa and slated for deployment in March 2018.

**Government policy:** The 2008 *Telecommunications Promulgation* led to the end of exclusivities in the telecommunication sector. The whole market was opened to competition from October 2008. Operators are now granted 15-year unified licences allowing them to provide any service. The Telecommunications Promulgation also called for the establishment of an independent regulator, the Telecommunications Authority of Fiji (TAF). The Fiji Competition and Consumer Commission (FCCC) is responsible for monitoring unfair trade practices and introducing price controls when necessary. Responsibility for the ICT sector policy lies with the Ministry of Communications. The five-year National Broadband Policy was launched in 2011, the first in a Pacific Island developing nation. It aims to achieve 95 per cent population coverage with minimum Internet speeds of 2 Mb/s by 2016. The policy is part of the Government's intent to develop the ICT sector and strengthen its position as a regional hub.

**Conclusion:** Connection to the Southern Cross Cable Network has provided progressively cheaper and higher-speed international backbone capacity for development of the Internet. Introduction of competition in the mobile market has boosted penetration, brought down prices, expanded coverage and driven wireless broadband services.

## Finland

**Finland has a very mature and highly innovative telecommunication market with high penetration rates for both fixed and mobile services.**

**Mobile services:** Finland has a highly-developed and innovative mobile market with very high penetration rates for both mobile-cellular and mobile-broadband services. Prices for mobile services are very affordable in this highly competitive market served by three mobile network operators.<sup>188</sup> According to a survey by the regulator FICORA, “mobile Internet is becoming more common and is sufficient as the only connection for most of the Finns”.<sup>189</sup> The amount of data transferred over mobile networks, although already at very high levels, continues to grow. In the first half of 2017, the average use of data per month rose to 22 GB.<sup>190</sup>

**Fixed services:** Fixed-broadband penetration in Finland is above the European average and prices are very affordable. While the number of subscriptions is increasing at a relatively low growth rate typical for fixed services, new broadband technologies (FTTH in particular) are spreading and subscriptions are becoming faster (Viestintävirasto, 2016). By end June 2017, 30 per cent of all fixed-broadband subscriptions achieved speeds of over 100 Mbit/s.<sup>191</sup> The fixed market is very competitive with a large number of companies offering fixed-telephone and broadband services. Elisa, Telia and DNA as well as the companies of the Finnet Group are the most important players in the market. The fixed-broadband and fixed-telephone markets are led by Elisa after the acquisition of one major local network.<sup>192</sup> Mobile services have largely substituted fixed telephony, which has seen a decline in penetration over the past years to reach a single digit penetration rate already in 2015.

**Government policy:** The Finland Government is putting an emphasis on ICT development and in particular broadband roll-out. Finland aims to achieve 99 per cent of all permanent residences and offices to be located within 2 km of an optical fibre network or cable network that enables connections of 100 Mbit/s. In order to make high-speed Internet widely available, the government promotes fibre-based networks and provides funds for underserved areas. Local municipalities

Key indicators for Finland (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	8.3	37.7	13.6
Mobile-cellular sub. per 100 inhab.	134.5	118.0	101.5
Fixed-broadband sub. per 100 inhab.	31.3	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	153.0	80.1	52.2
3G coverage (% of population)	99.9	98.5	85.0
LTE/WiMAX coverage (% of population)	99.9	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.3	1.0	5.2
Fixed-broadband prices (% GNI pc)	0.8	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.2	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	0.6	6.8
Percentage of households with computer	84.5	79.6	46.6
Percentage of households with Internet access	84.6	82.5	51.5
Percentage of individuals using the Internet	87.7	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	216.4	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

and cooperatives are considered important players in broadband roll-out and enabled by the government to set up joint ventures with other municipalities or private operators for the deployment of NGA. Furthermore, the government promotes the shared construction and use of network infrastructure.<sup>193</sup>

**Conclusion:** Finland has evolved to be one of the most advanced digital economy in Europe, with high penetration rates for fixed and mobile services as well as ICT household connectivity. The country has proven to be a forerunner in embracing new technologies: it was the first worldwide to launch a tender for 3G licences in 1999, and continues to assume this role by being among the first countries to issue licences for 5G trials.<sup>194,195</sup>

## France

**France has one of the largest telecommunication markets in Europe that is characterized by fierce competition between four main operators. Penetration rates are high for fixed and mobile services and prices very affordable.**

**Mobile services:** France’s mobile market is one of the largest in Europe in terms of subscriptions and also among the most competitive. Orange, a major international player with operations across Europe, the Arab States region, and Africa is leading the market. The entry of mobile operator Free in early 2012 had a disruptive effect on the market. What followed was described as “one of Europe’s most brutal telecoms price wars”.<sup>196</sup> The three “incumbent” operators Orange, SFR, and Bouygues increased their investments in LTE infrastructure in order to stay competitive and satisfy customer demands for higher speeds. LTE plans were first launched in late 2012. Mobile-broadband penetration is above the European average and prices for both prepaid and postpaid mobile-broadband services are very affordable (ARCEP, 2014).

**Fixed services:** The fixed telecommunication market in France is very advanced and subscription numbers are high. Fixed-telephone penetration is still above 50 per cent. Fixed-broadband penetration is among the highest in the world and prices for fixed-broadband services very affordable. Almost all fixed-broadband subscriptions are bundled with at least one telephony service and 69 per cent were even triple or quadruple play and bundled with a TV service in 2016 (European Commission, 2017). DSL subscriptions are still prevalent, while fibre connections have seen the strongest growth in recent years. Private operators as well as public entities are investing heavily in the roll-out of FTTH networks as well as in the modernization of copper lines in order to update to VDSL (ARCEP, 2014). Incumbent operator Orange holds the highest market share, but is facing competition from the same players as in the mobile market namely Free, Bouygues, and SFR.

**Government policy:** The focus of the government is on the development of broadband networks. France’s broadband target exceeds (albeit with a longer time frame) that of the Digital Agenda for Europe and aims to achieve 100 per cent coverage

Key indicators for France (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	59.7	37.7 13.6
Mobile-cellular sub. per 100 inhab.	103.5	118.0 101.5
Fixed-broadband sub. per 100 inhab.	42.4	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	81.7	80.1 52.2
3G coverage (% of population)	99.0	98.5 85.0
LTE/WiMAX coverage (% of population)	90.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	1.0	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.7	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.3	0.6 6.8
Percentage of households with computer	81.8	79.6 46.6
Percentage of households with Internet access	85.9	82.5 51.5
Percentage of individuals using the Internet	85.6	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	97.7	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

with 30 Mbit/s by 2020. The goal is to be achieved primarily through the roll-out of FTTH. *France Très Haut Débit*, the national broadband plan, which was adopted by the government in 2013, sets forth the conditions for the roll-out. The implementation of the strategy will require up to EUR 20 billion in private and public investments. The Fund for the Digital Society, which was set up by the France Government, provides funds to support the roll-out of superfast broadband.<sup>197</sup>

**Conclusion:** France is a highly connected country with high ICT penetration rates and a large percentage of the population online. Efforts by private operators and the government underline the ambition to remain one of the major ICT hubs in the world.

## Gabon

***This thinly populated oil-rich country is tapping ICTs as a strategic lever to diversify its economy.***

**Mobile services:** Gabon Telecom, the incumbent operator, is the market leader competing with AIRTEL, part of the Indian mobile group, and AZUR, owned by a Congolese group. Gabon Telecom acquired the fourth operator, MOOV, in 2016. This acquisition granted access to the incumbent's 3G and LTE network to the data subscribers of MOOV, who could previously only access 2G services. GSM coverage is high and 90 per cent of households had mobile phones in 2013.<sup>198</sup> Both Gabon Telecom and AIRTEL have launched 3G and LTE, with the former also deploying LTE-Advanced with theoretical download speeds of up to 300 Mbit/s.

**Fixed services:** Gabon Telecom was partly privatized through the sale of 51 per cent of its shares to Morocco Telecom in 2006. Although the basic fixed services market has been open since 2005, Gabon Telecom remains the only operator. There are other operators in the Internet market, including the mobile operators and some small ISPs providing fixed wireless access. Gabon Telecom offers ADSL as well as fibre-optic Internet access. Both fixed-telephone and fixed-broadband penetration is low. A Chinese firm is constructing a fibre-optic backbone that will extend some 1 000 km in the South-east and to the Congolese border. The backbone forms part of the World Bank's CAB project. Gabon is connected to two international undersea fibre-optic cables: SAT-3 in 2002 and ACE a decade later. In addition, an undersea fibre-optic cable connects the capital Libreville and second largest city, Port-Gentil.

**Government policy:** The sector policy-maker is the Ministry of Digital Economy, Communications, Culture and Arts. The Government's Emerging Gabon Strategic Plan aims to diversify the economy and make Gabon a leading emerging country by 2025. The strategy targets ICT-enabled services as an important part of its digital economy vision. The Government is currently preparing a broadband plan to implement the high-speed requirements in support of the national strategic plan. The regulator is the Agency for Regulation of Electronic Communications and Posts, created in 2012 and reporting to the sector Ministry as well as to the Ministry of Economy and

Key indicators for Gabon (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	1.1	1.0 13.6
Mobile-cellular sub. per 100 inhab.	165.4	74.6 101.5
Fixed-broadband sub. per 100 inhab.	1.1	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	92.1	22.9 52.2
3G coverage (% of population)	92.0	59.3 85.0
LTE/WiMAX coverage (% of population)	83.0	25.7 66.5
Mobile-cellular prices (% GNI pc)	2.2	14.2 5.2
Fixed-broadband prices (% GNI pc)	3.1	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.1	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.1	17.7 6.8
Percentage of households with computer	31.0	9.6 46.6
Percentage of households with Internet access	34.4	16.3 51.5
Percentage of individuals using the Internet	48.1	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	4.8	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Finance. The 2016 Communications Code guides the regulatory framework in Gabon.

**Conclusion:** The Government has embraced ICTs as a way to diversify the economy. The potential for development of an ICT-enabled services sector has increased, following access to a second submarine cable and deployment of the latest mobile-broadband technologies and fibre-optic cable.

## Gambia

***A competitive mobile market has resulted in a high level of access in this small West African nation. The arrival of the ACE cable has created an enabling platform for enhancing broadband access.***

**Mobile services:** There are four mobile networks operating in the country. The market leader is AFRICELL, a subsidiary of a Lebanese mobile group, which entered the market in 2001. Other operators include COMIUM, part of a Lebanese mobile group, which started operations in 2007; QCELL launched in 2009 and is privately held by Gambian investors; and GAMCEL, the mobile operator of the incumbent State-owned operator Gambia Telecommunications Ltd. (GAMTEL), which launched GSM in 2001. Mobile penetration is high, reflecting the competitiveness and straightforwardness of extending coverage in one of sub-Saharan Africa's smallest countries with a relatively high population density. In 2013, 91 per cent of households had mobile phones, with a small difference between urban (93 per cent) and rural areas (87 per cent).<sup>199</sup> QCELL was the only 3G operator from 2009 until AFRICELL launched its 3G network in 2012. This has spurred competition in the mobile-broadband market segment. QCELL launched LTE in 2017.

**Fixed services:** GAMTEL is the main provider of fixed-telephone services. It offers fixed-broadband service over ADSL, fixed wireless broadband and, for businesses, optical fibre. Several fixed wireless ISPs offer Internet access using WiMAX, fixed LTE and VSAT. The Government procured a loan from the Islamic Development Bank in 2001 to develop a fibre-optic backbone within the ECOWAS Regional Backbone initiative. GAMTEL has been deploying the backbone through a ring architecture to enhance redundancy. The arrival of the ACE submarine cable in 2011 has dramatically boosted the country's international Internet capacity. The Gambia Submarine Cable Company (GSC) manages the link. GSC is a consortium, with membership comprising all licensed telecommunication operators as well as some ISPs. The Serekunda IXP launched in 2014.

**Government policy:** The Ministry of Information and Communication Infrastructure is responsible for sector policy. Strategies for the ICT sector need updating to reflect the new broadband

Key indicators for Gambia (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	1.9	1.0	13.6
Mobile-cellular sub. per 100 inhab.	139.6	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.2	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	21.3	22.9	52.2
3G coverage (% of population)	86.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	15.8	14.2	5.2
Fixed-broadband prices (% GNI pc)	98.1	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	12.7	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	163.4	17.7	6.8
Percentage of households with computer	9.3	9.6	46.6
Percentage of households with Internet access	11.2	16.3	51.5
Percentage of individuals using the Internet	18.5	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	13.3	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

environment. The Public Utilities Regulatory Authority, created in 2001, is the multi-sector regulator responsible for telecommunications as well as other utilities. The 2009 Information and Communications Act guide the Authority's telecommunication activities.

**Conclusion:** The competitive mobile market has resulted in a high level of basic access. The landing of the country's first submarine cable has provided a platform for expanding broadband throughout Gambia. Opening up of the international gateway will improve international access even further.

## Georgia

**Georgia has a developed mobile-broadband market. 3G and LTE technologies cover the majority of the population, and LTE coverage continues high-tempo growth. Mobile and fixed service prices have recently reduced considerably.**

**Mobile services:** There are four mobile-cellular operators in Georgia: Magticom, Geocell, Mobitel, and Silknet. Three of them (Magticom, Geocell, and Mobitel) share more than 99 per cent of subscribers. Since mobile number portability (MNP) introduction in 2011, almost 600 000 numbers have used the service (54 per cent of them in 2013 and 2014). Companies offer services in a broad range of technologies including LTE, CDMA, Wi-Fi and Canopy.

**Fixed services:** There are around 150 companies providing Internet services over fixed networks. By August 2017, two main operators (Magticom and Silknet) shared 78 per cent of subscribers. Optical fibre cable connections have been increasing steadily over recent years. The number of xDSL connections started to reduce gradually in 2014. In the first quarter of 2017 FTTx technology covered 2.7 times more subscribers, and in the second quarter 3.2 times more subscribers than xDSL. Fixed number portability (FNP) was launched in 2011. Almost 7 000 numbers were ported by the end of 2016, although fixed number portability reached its peak popularity in 2012.<sup>200</sup>

**Government policy:** The Georgian National Communication Commission (GNCC) is the regulatory authority.<sup>201</sup> The Ministry of Economy and Sustainable development is the policy maker. Functions of these authorities are clearly differentiated and ensure open and fair competition. The Georgia Government implements a range of activities that facilitate infrastructure and favourable market environment development. One of them is the State Program on Broadband Infrastructure Development in Georgia.<sup>202</sup> Following its implementation, Georgia will be fully covered by optical fibre highways designed to promote retail networks and provide Internet to subscribers via local operators. The target area of financial support component are those settlements located in “white zones” whose populations exceed 200 residents and where operators do not plan to construct broadband

Key indicators for Georgia* (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	19.5	20.7	13.6
Mobile-cellular sub. per 100 inhab.	129.1	141.2	101.5
Fixed-broadband sub. per 100 inhab.	16.1	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	58.6	59.7	52.2
3G coverage (% of population)	99.9	77.1	85.0
LTE/WiMAX coverage (% of population)	92.0	45.9	66.5
Mobile-cellular prices (% GNI pc)	1.4	1.7	5.2
Fixed-broadband prices (% GNI pc)	3.2	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.4	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.2	3.1	6.8
Percentage of households with computer	52.5	67.4	46.6
Percentage of households with Internet access	49.8	68.0	51.5
Percentage of individuals using the Internet	50.0	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	92.1	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).  
\* Georgia exited CIS on 18 August 2009 but is included in the ITU BDT administrative region for the CIS countries.

infrastructure for three years after the launch of the program.

**Conclusion:** The authorities have succeeded in their efforts to liberalize the telecommunication market, and make it open and competitive. Clearly allocated responsibilities between policy maker and regulator ensure predictability of governing processes in the ICT sector, which is favourably influencing the economy. As a result, ICT infrastructure is developing steadily and citizens have access to high-quality telecommunication services that increase their participation in the country’s social-economic life.

## Germany

**Germany is the European Union's most populous country and has the largest telecommunication market in the region. Fixed and mobile penetration rates are high in this mature market that has been characterized by market consolidation in recent years.**

**Mobile services:** The three mobile network operators present in Germany's mature mobile market have relatively balanced market shares. With the acquisition of E-Plus (formerly the third largest MNO) in 2014, Telefonica was able to take the market lead from the incumbent operator Deutsche Telekom. Vodafone is the second largest operator in the German market, which is also home to an increasing number of MVNOs. Penetration rate for mobile-broadband services remain slightly below the European average. Population coverage of 3G and LTE networks, which were launched in 2004 and 2010 respectively, is almost complete. Operators continue to invest in the roll-out of LTE networks and data volumes are ever increasing. In 2016, a total of almost 1 billion GB were transferred through the mobile network, which is three times as much as in 2013 (Bundesnetzagentur, 2016).

**Fixed services:** Germany has a very advanced fixed market with high penetration rates for fixed-telephone and fixed-broadband services. The market was liberalized in 1998, opening up to competition for the former state-owned operator Deutsche Telekom. In recent years, the fixed market was shaped by a number of acquisitions, most notably the acquisition of Kabel Deutschland by Vodafone in 2014, which made Vodafone the main competitor of the incumbent operator. xDSL remains the dominant fixed-broadband technology in Germany and made up 75 per cent of all fixed-broadband connections in 2016. Broadband speeds and data usage have been increasing rapidly in recent years. In 2016, the majority of connections offered speeds between 10-30 Mbit/s and the average monthly consumption per user was 60 GB, which represents twice the 2013 volume (Bundesnetzagentur, 2016).

**Government policy:** Germany, a founding member of the European Union, liberalized its telecommunication market in line with the 1998 deadline set forth by the EU Full Competition Directive. In recent years, broadband roll-out has

Key indicators for Germany (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	53.5	37.7 13.6
Mobile-cellular sub. per 100 inhab.	125.5	118.0 101.5
Fixed-broadband sub. per 100 inhab.	38.8	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	76.5	80.1 52.2
3G coverage (% of population)	96.2	98.5 85.0
LTE/WiMAX coverage (% of population)	96.2	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.3	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.0	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.3	0.6 6.8
Percentage of households with computer	91.4	79.6 46.6
Percentage of households with Internet access	90.8	82.5 51.5
Percentage of individuals using the Internet	89.6	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	107.5	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

become the focus of EU and national ICT policy. Germany's broadband strategy was adopted in 2009 and is part of the country's Digital Agenda 2014-2017. Its objective is to connect all households with broadband speeds of at least 50 Mbit/s by 2018, by providing a market-friendly frequency policy and regulatory framework. In addition, Germany's Digital Strategy 2025 focuses on stimulating broadband take-up and use. The 2012 revision of the Telecommunications Act strengthens competition in the market by promoting the shared use of alternative infrastructures (such as energy networks) and cost-effective measures like micro-trenching to increasing broadband coverage.<sup>203</sup>

**Conclusion:** Germany is among the world's top ICT countries, with a well-developed ICT infrastructure and high ICT household penetration. The government is putting in place policies and financial funds to further stimulate broadband roll-out and usage.

## Ghana

***With access to five submarine cables, an extensive national backbone and the latest fixed and mobile-broadband technologies, the West African nation is emerging as an attractive ICT hub in the region.***

**Mobile services:** There are six mobile operators in the country. MTN, a subsidiary of the South African mobile group is the market leader, accounting for half the market in December 2016. Other operators include Vodafone, owned by the country's incumbent operator; TIGO, a subsidiary of the Luxembourg-based Millicom group; AIRTEL, a subsidiary of the Indian mobile group; Glo Mobile, a subsidiary of a Nigerian mobile operator; and Expresso, a CDMA operator that was owned by Sudan's SUDATEL and sold in 2016. In 2014, 85 per cent of households had mobile telephones, including 92 per cent in urban areas and 76 per cent in rural homes.<sup>204</sup> All of the operators have 3G networks, while MTN and Vodafone have launched LTE, as have several fixed wireless broadband operators.

**Fixed services:** Incumbent Ghana Telecom was privatized in 2008, when 70 per cent of its shares were sold to the United Kingdom mobile group Vodafone and rebranded with the same name. Vodafone Ghana leads in the fixed-telephone market, providing postpaid and prepaid landlines. AIRTEL also offers fixed-telephone services. Vodafone Ghana offers metered ADSL and optical fibre to businesses; it recently launched a fibre-to-the-home service. Four wireless broadband providers also operate in the Internet market, while MTN offers fibre-optic Internet. There are ten national fibre operators. The most extensive backbone is the one belonging to Vodafone Ghana Wholesale. It consists of redundant ring network of both underground and buried fibre-optic cables to the North and South of the country and key border points. The Government has also invested in fibre-optic infrastructure for connecting offices throughout the country. It has installed fibre in several cities and offers wholesale Wi-Fi and fibre. Although Ghana has had access to submarine cable via the SAT-3/WASC system since 2002, it was only with the arrival of four new cables since 2010 (Glo-1, Main One, ACE and WACS) that international bandwidth has skyrocketed while prices have dropped dramatically. This is enabling Ghana to increasingly becoming a hub of choice for other

Key indicators for Ghana (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.9	1.0	13.6
Mobile-cellular sub. per 100 inhab.	139.1	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.3	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	71.3	22.9	52.2
3G coverage (% of population)	80.0	59.3	85.0
LTE/WiMAX coverage (% of population)	34.9	25.7	66.5
Mobile-cellular prices (% GNI pc)	2.4	14.2	5.2
Fixed-broadband prices (% GNI pc)	19.0	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.5	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	4.5	17.7	6.8
Percentage of households with computer	20.8	9.6	46.6
Percentage of households with Internet access	32.5	16.3	51.5
Percentage of individuals using the Internet	34.7	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	9.9	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

countries in West Africa, particularly landlocked ones. The Ghana Internet Exchange (GIX), launched in 2005 in Accra, has 19 members.

**Government policy:** The Ministry of Communications is responsible for policy in the ICT sector. The 2012 National Broadband Policy and Implementation Strategy lays out Ghana's high-speed Internet direction. The policy has five goals: (a) to incorporate broadband into Universal Access/Service policy; (b) to facilitate affordable access to broadband to businesses; (c) to ensure last mile connectivity to communities and homes by 2020; (d) to promote uptake of broadband via suitable content and applications; and (e) to plan towards converged infrastructure and services delivery to stimulate supply and demand. The National Communications Authority is the sector regulator. The Electronic Communications Act enacted in 2008 guides the Authority in its activities.

**Conclusion:** Ghana has one of the most competitive telecommunication markets in Africa. The spread of national fibre backbones, access to several submarine cables, deployment of the latest mobile-broadband technologies and rising availability of fibre to the premises have transformed the ICT landscape.

## Greece

**Greece has a well-developed telecommunication market with high mobile and particularly fixed penetration rates. The ICT sector has been affected by the financial crisis that shook Greece's economy. The incumbent operator OTE continues to play a dominant role in the market, despite market liberalization. The Greek regulator EETT is further promoting competition and privatization in the market, which was mandated under the bailout programme.**

**Mobile services:** Greece has a high mobile-cellular penetration and very affordable prices for prepaid offers. Mobile-broadband penetration is however somewhat lower compared with other European countries (European Commission, 2017), but the recent growth rate is promising. The country has a well-developed and competitive mobile market, which has been hit by the financial crisis in recent years. Cosmote, a subsidiary of the incumbent operator OTE, is dominating the market, followed by Vodafone and Wind Hellas (EETT, 2015).<sup>205</sup> Cypriot-owned Cyta Hellas launched services in 2014 offering broadband, IPTV, fixed telephone as well as mobile services, which it operates as an MVNO. LTE was launched in 2015 and operators are continuing to invest in network infrastructure. 3G population coverage is almost complete and LTE coverage is expanding rapidly.

**Fixed services:** Fixed-broadband and in particular fixed-telephone penetrations are very high in Greece. Incumbent operator OTE, unlike the trend in other European countries, continued the strategy of developing the public switched telephone network instead of investing in more sophisticated telecommunication networks throughout the 1990s (OECD, 2001a). OTE, which started the process of privatization in 1996, is still the dominant fixed and mobile operator in Greece. It holds a market share of well over 50 per cent of the fixed-telephone market, although its share is on the decline (EETT, 2015). OTE is also the dominant operator in the fixed-broadband market, although since Vodafone's acquisition of the fixed-line provider Hellas On Line in 2014, all three MNOs have a fixed-line footprint.<sup>205</sup> xDSL is by far the dominant technology (more than 99 per cent of all fixed-broadband subscriptions are xDSL) and the incumbent is the only operator to have deployed VDSL networks so far. Leveraging on this competitive advantage, OTE is increasing

Key indicators for Greece (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	46.8	37.7 13.6
Mobile-cellular sub. per 100 inhab.	112.8	118.0 101.5
Fixed-broadband sub. per 100 inhab.	32.5	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	51.3	80.1 52.2
3G coverage (% of population)	99.4	98.5 85.0
LTE/WiMAX coverage (% of population)	93.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.4	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.2	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.9	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.0	0.6 6.8
Percentage of households with computer	71.7	79.6 46.6
Percentage of households with Internet access	69.1	82.5 51.5
Percentage of individuals using the Internet	69.1	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	68.7	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

its market share above 40 per cent. Despite the challenging geography, 99 per cent of Greek households are covered by basic fixed-broadband infrastructure. However, NGA network household coverage is more limited, at 44 per cent (European Commission, 2017). Since the beginning of 2017, OTE, Vodafone and WIND have started deploying NGA networks using technologies and architectures that offer rates of 100 Mbit/s or more. According to their business plans, almost 60 per cent of the subscribers will have access to these rates by the third quarter of 2019.

**Government policy:** The liberalization of the telecommunication market and the promotion of competition between operators was fostered by Greece's accession to the European Union. Increased access to and usage of broadband networks has been the focus of EU policy-makers as well as the Greece Government in more recent years as a necessary condition for the development of the digital economy. The private sector is expected to cover the largest part of the required investments. Greece's *Next Generation National Broadband Plan* thus aims at providing a favourable environment for private investments from within and outside the country to develop NGA infrastructure.<sup>206</sup>

**Conclusion:** Greece has a very well-developed fixed and mobile infrastructure. In recent years, the financial crisis, from which Greece is yet to recover, hit the country and its telecommunication market hard and Greece risks falling behind in terms of ICT development. Despite the financial crisis, significant investments in NGA networks are anticipated in the next 3-year period.

## Grenada

***The telecommunications sector represents an important part of Grenada's economy, accounting for 7 per cent of the national GDP in 2015. Mobile services, following the regional trend, account for the greatest part of the industry's revenue and is, on the whole, the most common service among the population.***

**Mobile services:** The great majority of mobile subscriptions in Grenada are of the prepaid type. Mobile broadband has become increasingly available in the past few years, employing mainly HSPA+ technology, following heavy investments on the part of operators in terms of network upgrade (accounting for more than 90 per cent of the sector investments in 2015). In efforts to foster a competitive environment in the mobile sector, the overarching regional telecommunications regulator banned anticompetitive actions from operators such as blocking over-the-top services, working towards net neutrality.<sup>207</sup> The agency has also actively promoted implementation of mobile number portability within its member States.<sup>208</sup>

**Fixed services:** Despite being well behind mobile broadband in terms of service uptake, fixed broadband was the segment with the most substantial revenue growth in 2015. Penetration levels for this segment are in line with regional averages, which means that there remains great untapped potential for market development.

**Government policy:** Grenada's sector regulator, the National Telecommunications Regulatory Commission (NTRC), was created in 2000 following market liberalization.<sup>209</sup> Grenada is part of a group of Caribbean countries that collaborates with an overarching regulatory authority, the Eastern Caribbean Telecommunications Authority (ECTEL), which provides guidelines and represents interests of the regional governments. Together, the two bodies work to create a competitive environment that fosters investment and innovation within the sector. A new and updated telecommunications bill has recently been approved by all member States of ECTEL, focusing on infrastructure access, consumer protection and promoting market competition.<sup>210</sup> The NTRC also actively engages in programmes with universal access objectives, creating, in 2013, the Broadband to Remote Areas Project, within the scope of the universal service fund.

Key indicators for Grenada (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	25.0	24.4	13.6
Mobile-cellular sub. per 100 inhab.	111.1	114.2	101.5
Fixed-broadband sub. per 100 inhab.	19.4	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	32.9	82.7	52.2
3G coverage (% of population)	81.9	93.6	85.0
LTE/WiMAX coverage (% of population)	n.a.	77.4	66.5
Mobile-cellular prices (% GNI pc)	3.0	3.6	5.2
Fixed-broadband prices (% GNI pc)	4.1	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.4	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.4	5.7	6.8
Percentage of households with computer	52.4	64.9	46.6
Percentage of households with Internet access	44.7	63.3	51.5
Percentage of individuals using the Internet	55.9	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	229.9	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Conclusion:** Grenada's telecommunication sector has been producing steady growth over the past few years. Infrastructure development is a key element to be able to expand services to more remote areas. Nonetheless, importance should also be given to digital education for the population to reap the benefits of the increasingly available and affordable telecommunications services offered.

## Guatemala

**Following the trend of its neighbouring countries, Guatemala's mobile segment has witnessed substantial growth over the past decade as a form of substitution for poorly performing fixed lines. The telecommunications sector in Guatemala has had competition since 1996, but has lacked investment to further develop dynamic and advanced services.**<sup>211</sup>

**Mobile services:** Mobile-cellular penetration is on par with the regional average, which reflects a highly competitive market. Service pricing remains considerably above expected for the region. Mobile-broadband development has been held up by slow spectrum allocation, and whereas 3G is widely available to the population, LTE technology coverage is still not complete. LTE was launched in the country by Tigo in 2014, following the operator's three-year modernization investment plan. Claro and Movistar have also launched LTE.<sup>212</sup>

**Fixed services:** The market for fixed telephony is concentrated in the hands of the operator Claro and the lack of competitiveness, among other factors, such as poor infrastructure, has been paramount to the underdevelopment of the segment. Both fixed-telephony and fixed-broadband services are not extensively adopted by the population, with the former being in decline since 2009.

**Government policy:** The body in charge of regulating the telecommunications sector in Guatemala is the *Superintendencia de Telecomunicaciones*.<sup>213</sup> The regulator works under the sector Ministry and its responsibilities surround the enforcement of sector legislation and administration of the spectrum allocation, and ensure a level playing field for market players. The regulator has recently invited operators to register for a new round of spectrum auction, offering two 900 MHz bands under the condition that coverage is supplied nationwide.<sup>214</sup>

**Conclusion:** Telecommunications investment has been largely financed by the private sector, including regarding ICT education. Development programmes for the population, including digital inclusion programmes, such as the creation of Early Childhood Development Centres, have been put in place through the collaboration between operator Tigo and the ALAS Foundation. The

Key indicators for Guatemala (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	14.7	24.4	13.6
Mobile-cellular sub. per 100 inhab.	109.7	114.2	101.5
Fixed-broadband sub. per 100 inhab.	3.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	13.9	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	40.4	77.4	66.5
Mobile-cellular prices (% GNI pc)	10.2	3.6	5.2
Fixed-broadband prices (% GNI pc)	6.6	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.4	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	8.8	5.7	6.8
Percentage of households with computer	23.4	64.9	46.6
Percentage of households with Internet access	20.5	63.3	51.5
Percentage of individuals using the Internet	34.5	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	24.0	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

nation's telecommunications sector is expected to undergo further developments in the coming years, as more investments dedicated to infrastructure roll-out are put in place.<sup>215</sup>

## Guinea

**Access to electronic communications in this West African country is practically all through wireless networks. The arrival of a submarine cable should result in better quality and lower prices to widen access.**

**Mobile services:** There are four mobile operators: MTN, the South African mobile group MTN operating under the brand AREEBA; Orange, a subsidiary of Senegal's SONATEL; INTERCEL, launched in 1993 as TELECEL, which is now a subsidiary of the incumbent operator in Sudan SUDATEL; and CELLCOM, a U.S. telecommunications firm. Orange and MTN dominate the market and both have launched 3G mobile broadband along with CELLCOM.

**Fixed services:** There is no fixed-line operator, voice communications is through mobile networks. SOTELGUI, the incumbent operator, was partly privatized in 1995, when 60 per cent was sold to Telekom Malaysia. The Government in 2008 repurchased the shares, but SOTELGUI was declared bankrupt in 2013 and, since then, there have been a number of attempts to restore its operations, but to no avail. Fixed broadband is available through fixed-broadband wireless networks and optical fibre provided by mobile operators to businesses in urban areas. The Government has obtained a loan from China for the construction of a national fibre-optic backbone that will cover around 4 000 km. The ACE submarine cable landed in the country in 2011. However, it was not until 2014 that capacity on the cable began to be used. Access to ACE is managed by GUILAB, a public-private partnership between the Government and telecommunications operators in the country. It ensures open access and cost-based pricing.

**Government policy:** The Ministry of Posts, Telecommunications and Digital Economy defines the sector policy. A National Strategy for the Development of ICTs and the Digital Economy is being developed. The Authority for Regulation of Posts and Telecommunications is the sector regulator, guided by the 2015 Law on Telecommunications and Information Technologies.

**Conclusion:** With the demise of SOTELGUI, Guinea is essentially a wireless nation, with most

Key indicators for Guinea (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.0	1.0	13.6
Mobile-cellular sub. per 100 inhab.	85.3	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	15.0	22.9	52.2
3G coverage (% of population)	39.1	59.3	85.0
LTE/WiMAX coverage (% of population)	10.3	25.7	66.5
Mobile-cellular prices (% GNI pc)	13.3	14.2	5.2
Fixed-broadband prices (% GNI pc)	22.5	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	9.0	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	22.5	17.7	6.8
Percentage of households with computer	2.8	9.6	46.6
Percentage of households with Internet access	7.7	16.3	51.5
Percentage of individuals using the Internet	9.8	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	0.6	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

ICT services provided through mobile networks. The arrival of the ACE cable and the adoption of open access and cost based pricing approaches for international Internet connectivity should stimulate demand and widen access.

## Guinea-Bissau

***This West African nation is hoping to overcome its lack of connection to undersea fibre-optic cable, driven by realization of the importance of ICT for achieving its new national development goals.***

**Mobile services:** There are two GSM mobile operators: MTN, a subsidiary of the South African mobile group, which deployed its network in 2003; and Orange, a subsidiary of Senegal's SONATEL, which launched in 2007. The market is almost evenly split between the two. There was a third mobile operator, Guinetel, belonging to the incumbent, but it has ceased operations. One result of having operators backed by technically and financially strong mobile groups and the virtual absence of fixed-telephone communications is a high level of access. In 2014, 91 per cent of households had mobile telephones, one of the highest rates among LDCs, as well as within sub-Saharan Africa.<sup>216</sup> This includes 96 per cent in urban areas and 86 per cent in rural areas. Mobile-broadband has only recently been introduced. MTN launched 3G in 2015, with Orange launching both 3G and LTE the same year.

**Fixed services:** The incumbent operator is the Telecommunications Company of Guinea-Bissau (Guine Telecom). It was partly privatized in 1989, when 40 per cent was sold to Portugal Telecom. The Government retook control of the company in 2008, which is technically bankrupt and ceased operating in 2014. There is essentially no fixed line telephone network. Internet access is available through mobile-broadband or fixed wireless broadband using WiMAX. The mobile operators operate the limited national backbone. Orange has an advantage through its cross-border terrestrial fibre connection to Senegal to access SONATEL's undersea cables. Orange also has a microwave connection to Guinea to access the ACE cable. MTN relies on microwave and satellite connectivity. This resulted in duplicate infrastructure and the lack of open access to cost-based international fibre connectivity, leading to high costs and lower affordability. Guinea-Bissau did not take the opportunity to connect to several new submarine cables deployed along the coast of West Africa. Guinea-Bissau and Eritrea are the only two sea-facing sub-Saharan African countries not to have a submarine cable landing station. There is an opportunity for Guinea to participate in

Key indicators for Guinea-Bissau (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.0	1.0	13.6
Mobile-cellular sub. per 100 inhab.	70.3	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	6.9	22.9	52.2
3G coverage (% of population)	8.2	59.3	85.0
LTE/WiMAX coverage (% of population)	21.4	25.7	66.5
Mobile-cellular prices (% GNI pc)	34.5	14.2	5.2
Fixed-broadband prices (% GNI pc)	240.1	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	102.9	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	102.9	17.7	6.8
Percentage of households with computer	2.8	9.6	46.6
Percentage of households with Internet access	2.2	16.3	51.5
Percentage of individuals using the Internet	3.8	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	4.7	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

the ACE Consortium with the revival of the World Bank's West Africa Regional Communications Infrastructure Program (WARCIP). This includes constructing a domestic landing station and deploying a domestic fibre-optic network.

**Government policy:** The country's national strategy, Terra Ranka (2014), identifies digital services as a catalytic sector for national economic development. It calls for elaborating a Digital Economy Plan in collaboration with the private operators to define coverage, access international connectivity, enhance the legal and regulatory framework to adjust to sector evolution, attract investment, develop broadband and create a safe digital environment. It also calls for privatizing the incumbent and strengthening the regulator. The Ministry of Transport, Communications and ICT is charged with implementing the digital economy goals of the Terra Rank strategy. The National Regulatory Authority for Information and Communication Technologies replaced the Institute of Communications of Guinea-Bissau following the adoption of the 2010 Telecommunication Law.

**Conclusion:** Whereas Guinea Bissau has one of the highest rates of household mobile penetration in sub-Saharan Africa, Internet access and affordability remain a concern given the lack of access to undersea fibre-optic cable. It is now hoping to make up for that, driven by the importance of ICTs for achieving its Terra Ranka development goals.

## Guyana

***Guyana's telecommunications sector has low levels of local competition and a monopoly on international voice and data communication. Guyana is undergoing an extensive reform of its telecommunications sector, with the introduction of a new legislation, which provides for the creation of a new regulatory body and liberalization of the telecommunication sector. The Government of Guyana is also in negotiations with the incumbent operator, which has approximately 13 years left on its exclusivity on international connectivity, to end the monopoly.***

**Mobile services:** The mobile market is a duopoly, with operators Guyana Telephone and Telegraph Company Ltd. (GTT) and U-Mobile (Cellular) Inc. (Digicel Guyana), competing for market shares. 3G technology was introduced in 2016, when the two operators were assigned additional spectrum.<sup>217</sup> An LTE Government network was built in 2014 mainly to provide services to Government institutions. Utilization of this network is currently being ramped up with free Internet access also being provided to schools, post offices and community ICT hubs (94 educational institutions).

**Fixed services:** Fixed telephony is supplied solely by GTT, which is also the only supplier of DSL technology in the market. Fibre to the home using GPON technology is currently being rolled out by GTT. Unlike the general regional trends, fixed-broadband uptake has encountered more success than its mobile counterpart, having grown considerably since 2010 with the opening of the SG-SCS submarine cable.<sup>218</sup>

**Government policy:** Regulation of the telecommunications sector is currently done by the Public Utilities Commission (PUC) and the National Frequency Management Unit (NFMU). To modernise and liberalize the telecommunication sector, a new legislation, which was in development for many years, was passed in the National Assembly in July 2016. The bill provides for the creation of a new regulator, the Telecommunications Agency, as well as the complete liberalization of the telecommunications sector, the extension of services and the building of infrastructure to remote regions.<sup>219</sup> The *Telecommunications Act 2016* also provides for the functions of the NFMU to be transferred

Key indicators for Guyana (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	17.5	24.4	13.6
Mobile-cellular sub. per 100 inhab.	72.1	114.2	101.5
Fixed-broadband sub. per 100 inhab.	7.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	0.2	82.7	52.2
3G coverage (% of population)	93.0	93.6	85.0
LTE/WiMAX coverage (% of population)	n.a.	77.4	66.5
Mobile-cellular prices (% GNI pc)	3.9	3.6	5.2
Fixed-broadband prices (% GNI pc)	8.5	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.4	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	4.7	5.7	6.8
Percentage of households with computer	31.2	64.9	46.6
Percentage of households with Internet access	28.2	63.3	51.5
Percentage of individuals using the Internet	35.7	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	34.7	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

to the Telecommunications Agency on a date specified by the Minister (commencement date). The Government of the Cooperative Republic of Guyana is seeking to develop a knowledge-based and educated society which is globally competitive and productive, and giving rise to the strategic placement of Guyana as the ICT hub within the region.

**Conclusion:** Guyana is making progress to transform its ICT sector to allow its population to have affordable access to the different means of communication. The ICT sector has significant potential for growth as Guyana pursues important sector reforms that will encompass significant changes to ensure the development of the ICT environment, promote competition, facilitate service uptake, and boost social and economic development.

## Haiti

**Haiti's telecommunications sector has suffered from a series of natural disasters over the past decade with existing infrastructure suffering from substantial damages. Recent efforts, notably the privatization of the incumbent as well as introduction of competition in the market, have been paramount to the development of the sector.**<sup>220</sup>

**Mobile services:** The mobile market is controlled by two operators, Digicel and Natcom, the first possessing almost three quarters of market share. Similarly to its neighbouring countries, Haiti's fixed-line infrastructure is underdeveloped and the mobile market has had more room to flourish. Both operators are interested in expanding their services' coverage, especially with the popularization of mobile banking and other data services. Concerning LTE, concessions were granted in mid-2016 to the operators, as they run trials in preparation for the auctions.<sup>221</sup> The regulator is currently working on implementation of number portability requirements, which should increase competitiveness in the segment and improve quality of service.<sup>222,223</sup>

**Fixed services:** Fixed services have suffered from lack of infrastructure and investment in Haiti. The partial privatization of State-owned TELECO in 2010, which then became Natcom, has had a number of positive effects since, with increased investments and network roll-out. As a result, fixed-broadband has become more widely available in the country, and Natcom also acts on the wholesale side, making its infrastructure available for a number of other Internet service providers.<sup>224</sup>

**Government policy:** The telecommunications regulator, *Conseil National des Telecommunications* (CONATEL) is responsible for overlooking the sector development, including frequency assignment and service licensing. The expansion and adoption of ICT services, however, also has to take into account the political and economic challenges, with income and education inequalities remaining key obstacles. To overcome these challenges, starting in 2011, the Government imposed a tax on international calls to finance an education programme.

Key indicators for Haiti (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	0.1	24.4	13.6
Mobile-cellular sub. per 100 inhab.	60.5	114.2	101.5
Fixed-broadband sub. per 100 inhab.	0.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	10.3	82.7	52.2
3G coverage (% of population)	57.0	93.6	85.0
LTE/WiMAX coverage (% of population)	0.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	11.6	3.6	5.2
Fixed-broadband prices (% GNI pc)	70.9	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	10.5	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	42.1	5.7	6.8
Percentage of households with computer	10.1	64.9	46.6
Percentage of households with Internet access	4.7	63.3	51.5
Percentage of individuals using the Internet	12.2	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.3	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Conclusion:** The telecommunications sector in Haiti has great potential for development as the majority of the market remains untapped. The future is promising regarding both the fixed-line and the mobile segments, with increased competition and investment levels.

## Honduras

**The increasing competition in the telecommunications market and Government efforts to bring additional investments and bridging the digital gap are transforming the ICT sector in Honduras.**

**Mobile services:** Mobile subscriptions are largely dominated by the prepaid modality, representing more than 90 per cent of the total number. The emerging levels of competition on mobile services, which currently house three operators (one is State-owned), have attracted international investment, with an interest in increasing service coverage and exploring untapped sections of the market. The mobile-broadband segment has been growing steadily and is several times more popular among users than fixed-broadband. The LTE technology was first launched at the end of 2014 by Tigo Honduras, closely followed by its competitor Claro, with State-owned Hondutel lagging behind.<sup>225,226</sup> Another important incentive for the mobile sector is the increasingly popular payments via mobile money. Especially in countries such as Honduras, where only about 20 per cent of the population holds an account with a financial institution, mobile payment has been a welcome alternative.<sup>227</sup>

**Fixed services:** Fixed services adoption is well below the regional and global levels. In addition, the remote rural areas have not received any investments, remaining underserved in particular regarding fixed-broadband. DSL and cable modem technologies are the most commonly available, with recent investments being directed at a fibre network roll-out. Similar to the other segments within the telecommunications sector in the country, fixed-broadband services are relatively expensive, representing another obstacle for an increase in adoption.<sup>228</sup>

**Government policy:** The body responsible for sector regulation is the *Comisión Nacional de Telecomunicaciones* (CONATEL), founded in 1995. CONATEL oversees various aspects regarding the telecommunications sector, from spectrum auction and licensing to programmes of universal access and consumer rights. During recent years, CONATEL has launched a series of programmes directed at bridging the digital gap, such as *Internet del Pueblo*, focusing on providing schools and public areas with free Internet access, and

Key indicators for Honduras (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	5.2	24.4	13.6
Mobile-cellular sub. per 100 inhab.	91.2	114.2	101.5
Fixed-broadband sub. per 100 inhab.	2.6	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	24.7	82.7	52.2
3G coverage (% of population)	70.3	93.6	85.0
LTE/WiMAX coverage (% of population)	50.8	77.4	66.5
Mobile-cellular prices (% GNI pc)	7.4	3.6	5.2
Fixed-broadband prices (% GNI pc)	16.8	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	9.2	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	13.3	5.7	6.8
Percentage of households with computer	23.5	64.9	46.6
Percentage of households with Internet access	24.6	63.3	51.5
Percentage of individuals using the Internet	30.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	33.4	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

*Capacitaciones en TICs*, focusing on the creation of educational programmes to introduce the population to ICTs.<sup>229</sup> The Government has also concentrated its efforts on other areas, with the launch of the country's first Internet exchange point in 2016, and the organization of multi-band spectrum auctions (frequencies in the 700 MHz, 900 MHz and 2 500 MHz range), designed to attract more operators to the market and increase competitiveness.<sup>230,231</sup>

**Conclusion:** The Honduran telecommunications market is undergoing a phase of development, with untapped potential in almost all segments, as current service uptake levels leave room for growth. The Government is working on attracting investment and promoting competition, while concomitantly preparing the population for the use of ICT services.

## Hungary

**Hungary has a well-developed mobile infrastructure with a high mobile-cellular penetration. Mobile-broadband population coverage is almost complete, while the number of subscriptions is still to reach the levels of its European neighbours. The fixed market is dominated by the incumbent operator, but competition is increasing in the fixed-broadband sector and penetration rates are close to the EU average.**

**Mobile services:** The privatization of the mobile market started in 1993 when some shares of the state-owned operator Matáv Hungarian Telecommunications Company Ltd. were sold to Deutsche Telekom and Ameritech International. In 2000, Deutsche Telekom became the majority shareholder of the operator, which is known today as Magyar Telekom.<sup>232</sup> Magyar Telekom continues to hold the highest market share in the mobile market followed by its competitors Telenor Hungary and Vodafone. The first MVNO started to offer services in 2012 using Vodafone's network and the number of MVNOs is growing since. All three mobile network operators hold licences to offer 3G and LTE services. While close to 100 per cent of the population are covered by mobile-broadband networks, mobile-broadband uptake is much slower and penetration is low compared to the European average, but also in relation to Hungary's neighbours.<sup>233</sup>

**Fixed services:** Fixed-line telephony was the last market to be fully liberalized in Hungary in 2001.<sup>234</sup> The incumbent operator Magyar Telekom is still the market leader with a share of more than 50 per cent of fixed-telephone subscriptions. There is a strong infrastructure-based competition on the broadband market. The dominant technology in Hungary is DSL, but cable has had a higher share of new subscriptions in recent years. More than 60 per cent of households have access to cable, which is above the European average (Kormany, 2014). While Magyar Telekom is the fixed-broadband market leader, its main competitors UPC and Digi have been able to achieve significant market shares.

**Government policy:** Hungary became an EU member in 2007 and with accession to the EU, measures were taken by the government to liberalize the telecommunication sector in line

Key indicators for Hungary (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	31.5	37.7 13.6
Mobile-cellular sub. per 100 inhab.	119.1	118.0 101.5
Fixed-broadband sub. per 100 inhab.	28.5	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	44.5	80.1 52.2
3G coverage (% of population)	99.0	98.5 85.0
LTE/WiMAX coverage (% of population)	98.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	2.0	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.9	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.9	0.6 6.8
Percentage of households with computer	76.4	79.6 46.6
Percentage of households with Internet access	78.6	82.5 51.5
Percentage of individuals using the Internet	79.3	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	154.8	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

with EU policies. In 2004, Hungary's Electronic Communications Act introduced regulation based on EU standards. Its main purpose was to put in place the conditions for effective competition in the telecommunication market. The act also introduced mobile and fixed number portability (MTITC, 2016). As an EU member state, the broadband development targets are in line with the Digital Agenda for Europe. Hungary aims to achieve full broadband coverage with at least 30 Mbit/s, and 50 per cent coverage with at least 100 Mbit/s by 2020. The National Infocommunication Strategy 2014-2020 involves the government in the construction of the national backbone network. All government institutions will be connected with high-speed Internet, with a special focus on public institutions in rural areas of Hungary.<sup>235</sup>

**Conclusion:** Hungary has developed a vibrant and competitive telecommunication market. As part of the Digital Agenda for Europe, Hungary has set ambitious goals to further this development and increase the deployment of NGA infrastructure.

## Iceland

***Iceland has a mature and advanced telecommunication market. With a population that is quick to adapt to new technologies, penetration rates are high for fixed and mobile services and well above the European average.***

**Mobile services:** Iceland has a competitive mobile market with affordable prices and high penetration rates. The market shares of the three main operators, namely Nova, Siminn and Vodafone, are almost equal. Nova as well as operator 365 started their services in 2007, further boosting competition in the market. Mobile-broadband penetration is very high and well above the European average. 3G services were first offered in 2007 and LTE was launched in 2013 by operator Nova followed by Siminn a few months later (PTA, 2015). Today, most of the population is covered by 3G services and LTE is expanding rapidly. Iceland's regulator PTA launched a tender in April 2017 to auction additional LTE spectrum in four bands. <sup>236</sup>

**Fixed services:** Siminn, the incumbent operator privatized in 2005, holds the highest market share in both the fixed-telephone and fixed-broadband markets. Alternative operators are effectively competing with Siminn and are driving prices down. Fixed-telephone penetration, while on the decline in line with the global trend of fixed-to-mobile substitution, is still high in the country. Fixed-broadband penetration is also above the European average and prices for fixed-broadband services are very affordable. Next generation networks continue to be extended rapidly in order to bring high speed Internet to Icelanders (PTA, 2015).

**Government policy:** Although negotiations for EU membership were put on hold by the Iceland Government in 2015, the country is part of the European Economic Area (EEA). Through the EEA, Iceland is part of the European single market and adheres to the EU regulatory framework for telecommunications.<sup>237</sup> Iceland has thus adopted the EU directives concerning electronic communications and liberalized its telecommunication markets. High-speed Internet is already widely available in Iceland, but continues to be the main concern for users and the government. In 2016, the Icelandic parliament Althingi approved a USD 4 million project for the development of high speed networks. The

Key indicators for Iceland (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	48.4	37.7 13.6
Mobile-cellular sub. per 100 inhab.	118.0	118.0 101.5
Fixed-broadband sub. per 100 inhab.	37.6	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	104.0	80.1 52.2
3G coverage (% of population)	99.0	98.5 85.0
LTE/WiMAX coverage (% of population)	95.5	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.3	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.9	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.3	0.6 6.8
Percentage of households with computer	98.5	79.6 46.6
Percentage of households with Internet access	97.0	82.5 51.5
Percentage of individuals using the Internet	98.2	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	997.8	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

government hopes to close the digital divide in areas underserved by private operators, where “citizens are subject to impairment of their human rights through lack of a viable Internet connection” according to a government report (PTA, 2015).

**Conclusion:** Iceland is one of the world's most advanced information societies. High speed mobile and fixed networks are commonplace in Iceland. Almost the entire population of Island is online and ardent Internet users. The government continues to promote network expansion in underserved areas and a regulatory regime that supports competition and innovation is in place.

## India

***This large market is evolving from a fragmented regional service provision environment to one characterized by increasing industry consolidation and nationwide operators.***

**Mobile services:** The market has evolved from licences attributed on a regional basis to greater consolidation and countrywide presence. There are 13 providers offering mobile cellular services, of which five have nationwide operations. The largest operators are those with nationwide or near-national operations and the top four account for almost 70 per cent of all subscriptions. BHARTI leads the market, followed by Vodafone, IDEA and state-owned Bharat Sanchar Nigam, Ltd. (BSNL). India has the second largest number of mobile subscriptions in the world. Mobile broadband using 3G technologies were launched in 2008. There have been a number of spectrum auctions for LTE since 2012, and operators have gradually been launching LTE using different frequencies. There is room for growth, as just 59 per cent of mobile Internet subscriptions were broadband in 2016.

**Fixed services:** Eight service providers offer fixed telephone service but none nationwide. The two largest fixed telephone line operators, BSNL and Mahanagar Telephone Nigam, Ltd. (MTNL), are state-owned. BSNL operates everywhere except the cities of Delhi and Mumbai, where MTNL provides a service. Fixed-telephone penetration is low. The top ten Internet Service Providers account for 98 per cent of all subscriptions. In 2016, DSL accounted for almost three-quarters of fixed broadband subscriptions, with fibre representing less than 2 per cent. There are over 1 million kilometres of optical fibre in the national backbone. The largest operator is BSNL, while some of the other operators have more limited backbone networks and the railway company (Railtel) and power utility (PowerGrid) also lease fibre. The National Fibre-Optic Network (NFON) is a public private partnership that aims to extend fibre-optic backbones to rural areas. India is connected to over a dozen undersea fibre-optic cables, has cross-border terrestrial links with neighbouring countries, and is a main source of international capacity for landlocked Bhutan and Nepal. The National Internet Exchange of India was established by the Government in 2008 with points of presence in seven cities. The Mumbai

Key indicators for India (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	1.9	10.0	13.6
Mobile-cellular sub. per 100 inhab.	87.0	98.9	101.5
Fixed-broadband sub. per 100 inhab.	1.4	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	16.8	47.4	52.2
3G coverage (% of population)	79.7	87.6	85.0
LTE/WiMAX coverage (% of population)	73.5	73.6	66.5
Mobile-cellular prices (% GNI pc)	1.8	3.2	5.2
Fixed-broadband prices (% GNI pc)	4.8	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.9	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.2	5.4	6.8
Percentage of households with computer	15.2	37.8	46.6
Percentage of households with Internet access	22.6	45.5	51.5
Percentage of individuals using the Internet	29.5	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	16.0	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Convergence Hub, which was launched only in 2014, has grown into the largest Internet Exchange Point in South Asia, with over 60 participants.

**Government policy:** The Telecom Regulatory Authority of India (TRAI) was established in 1997 to regulate the sector. The relevant legislation remains the *Indian Telegraph Act of 1885*, which has been amended many times. Policy making is split between the Ministry of Electronics and Information Technology, covering matters related to the Internet other than licensing, and the Ministry of Communications, which is responsible for telecommunications. The 2012 *National Telecommunications Policy* was instrumental in introducing nationwide licences. It calls for mobile penetration of 100 per cent in rural areas by 2020, recognition of broadband as a basic necessity, and download speeds of 2 Mbps by 2020 including the availability of 100 Mbps. *Digital India* is a flagship government programme with a vision to transform India into a digitally empowered society and knowledge economy. It is an umbrella initiative covering a number of government agencies and departments and centred on three key areas: digital infrastructure as a utility for every citizen; governance and services on demand; and digital empowerment of citizens.

**Conclusion:** This large nation is a leader in ICT-enabled outsourcing services. The Government's efforts in extending fibre-optic backbones to rural areas and enabling greater economies of scale is expected to result in lower costs and greater affordability and likely to narrow the gap in ICT access between rural and urban areas.

## Indonesia

**Operators in the sprawling archipelago nation are transitioning their networks to the latest generation of mobile and fixed technologies.**

**Mobile services:** There are seven operators providing mobile services. However, the market is dominated by the three largest, which provide nationwide services and had a combined market share of around 85 per cent in 2016. The largest is TELKOMSEL, which is 45 per cent owned by the incumbent fixed line operator PT Telkom, with the remainder owned by Singapore Telecom. The other two are INDOSAT, a subsidiary of Qatar's OOREDOO, and XL, a subsidiary of the Malaysian AXIATA mobile group. The population coverage of 2G networks is extensive and by 2011, there were more mobile phone subscriptions than people in Indonesia. As a result of multiple SIM cards, the actual level of availability is lower: the *National Socio Economic Survey* found that 88 per cent of households had a mobile phone in 2015 (93 per cent in urban areas and 83 per cent in rural areas).<sup>238</sup> Mobile broadband has been available for over a decade following the deployment of 3G networks in 2006. All of the leading operators launched LTE in 2014. Smartphone penetration has been growing rapidly.

**Fixed Services:** The incumbent PT Telkom was partially privatized in 1995, when it was listed on the stock exchange. The Government holds 52 per cent of its shares. PT Telkom is the leader in the fixed telephone service market. It provides services over traditional copper lines but has a long term plan to transition these to fibre-optic cable with triple play (voice, Internet and TV). PT Telkom used to operate a fixed wireless CDMA telephone service but this was shut down in 2015 and the remaining subscribers transferred to its mobile network. Other operators provide fixed telephone services using wireless local loop or as part of a bundled service with cable television or fibre subscriptions. PT Telkom is the leading player in the fixed broadband market through ADSL and, increasingly, optical fibre (up to 100 Mbps). It competes with cable television and new optical fibre-based market entrants in the fixed broadband segment. A number of fixed wireless operators have already deployed, or are in the process of transitioning to, LTE for their networks. There is an extensive domestic backbone of over 80 000 kilometres connecting major islands

Key indicators for Indonesia (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	4.2	10.0	13.6
Mobile-cellular sub. per 100 inhab.	149.1	98.9	101.5
Fixed-broadband sub. per 100 inhab.	2.0	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	34.2	47.4	52.2
3G coverage (% of population)	74.9	87.6	85.0
LTE/WiMAX coverage (% of population)	22.6	73.6	66.5
Mobile-cellular prices (% GNI pc)	3.3	3.2	5.2
Fixed-broadband prices (% GNI pc)	10.6	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.4	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.0	5.4	6.8
Percentage of households with computer	19.1	37.8	46.6
Percentage of households with Internet access	47.2	45.5	51.5
Percentage of individuals using the Internet	25.4	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	24.9	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

through underwater fibre-optic cables in a ring configuration to provide redundancy. Indonesia also has launched several satellites for domestic connectivity, and remote villages are connected by VSAT. The country is connected to over a dozen regional and intercontinental submarine cables. The first IXP was launched in 1997 and by the end of 2016 there were twelve.

**Government policy:** The Ministry of Communication and Information Technology (MCIT) sets policies and supervises the telecommunications industry. In 2014, the Government launched the *Indonesia Broadband Plan*, which aims by 2019 to provide fixed broadband access to all government offices, hospitals, and schools at speeds of at least 2 Mbps. The Indonesian Telecommunication Regulatory Authority (BRTI) is the authorized regulator for the industry.

**Conclusion:** Competition was introduced some time ago, resulting in growing uptake of mobile and broadband services. One consequence is the duplication of key facilities affecting affordability. The broadband plan calls for infrastructure sharing and open access to bottleneck facilities.

## Iran (Islamic Republic of)

***The Islamic Republic of Iran has forged ahead with telecommunications development, and mobile broadband in particular is showing strong growth.***

**Mobile services:** The historical telecommunications operator, the partly privatized Telecommunication Company of Iran (TCI), is slightly ahead in the mobile market through its mobile subsidiary Mobile Communication Company of Iran (MCI). South Africa's MTN entered the market as a mobile competitor to MCI in 2006 through 49 per cent ownership of the IRANCELL brand. A few smaller operators have recently been launched or have only regional operations. Iran's mobile market mushroomed following the entry of MTN. At the time of MTN's launch, only 1 per cent of the population had a mobile phone subscription. By 2016, the number of mobile subscriptions exceeded the population with 93 per cent of homes having a mobile phone (94 per cent in urban areas and 88 per cent in rural zones).<sup>239</sup> Mobile broadband is at a more nascent stage but has been growing rapidly. MCI launched 3G in 2012, and in 2014 MTN launched both 3G and LTE.

**Fixed services:** TCI is the only provider of fixed-telephone services. Unlike many other developing nations, penetration is relatively high. TCI is the leader in the fixed broadband market, offering ADSL and optical fibre at speeds of up to 50 Mbps. WiMAX providers are looking to migrate to LTE for fixed wireless access. Backbone networks are operated by the Telecommunications Infrastructure Company of Iran (TIC), which has an extensive national optical fibre backbone and metropolitan rings totaling over 200 000 kilometres. Iran has had submarine connectivity since 1992 and is currently served by half a dozen international undersea fibre-optic cable systems. In addition, it has cross-border terrestrial connections with Azerbaijan, Pakistan and Turkey, and offers international bandwidth to landlocked Afghanistan, Armenia and Turkmenistan. There are IXPs in the five leading cities. Although established only in 2016, the IXPs are already processing a significant amount of traffic.

**Government policy:** The Ministry of Information and Communications Technology (MICT) is responsible for postal services,

Key indicators for Iran (I.R.) (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	38.2	10.0	13.6
Mobile-cellular sub. per 100 inhab.	100.1	98.9	101.5
Fixed-broadband sub. per 100 inhab.	11.6	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	33.8	47.4	52.2
3G coverage (% of population)	62.7	87.6	85.0
LTE/WiMAX coverage (% of population)	28.9	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.4	3.2	5.2
Fixed-broadband prices (% GNI pc)	1.2	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.8	5.4	6.8
Percentage of households with computer	61.4	37.8	46.6
Percentage of households with Internet access	62.2	45.5	51.5
Percentage of individuals using the Internet	53.2	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	15.2	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

telecommunications and information technology. The Communications Regulatory Authority (CRA) was established in 2003. Broadband was a key part of the Islamic Republic of Iran's fifth Five-Year Development Plan covering the period 2011-2015. The plan called for 36 million broadband connections by 2016 and deployment of FTTP networks in the country's ten largest cities. As a result of the impact of international sanctions, the plan's targets were not completely met. However, greater broadband connectivity remains a goal of the sixth Five-Year Development Plan (2016-2021).

**Conclusion:** Significant infrastructure investment has developed widespread nationwide coverage of mobile networks and a national fibre-optic backbone. There is a high level of basic mobile access and mobile broadband has been growing rapidly since its recent deployment.

## Iraq

***Iraq has a competitive market for mobile services, despite the ongoing crisis, which is taking its toll on essential services. The country continues to maintain a functioning mobile sector in many geographic areas. With three competing mobile operators, Iraq has relatively low prices for mobile-cellular and mobile-broadband services but prices for fixed-broadband services remain high.***

**Mobile services:** The mobile-broadband penetration in Iraq is lower than the average penetration in the Arab States region. Mobile services remain competitive in Iraq, and are growing fast. Many mobile network sites are currently unavailable and the operators are concentrating their efforts on maintaining services at the sites they are able to readily access. Three mobile operators ensure the market remains competitive: Zain Iraq, Asiacell and Korek Telecom. 3G services were first launched by Zain in 2015, followed by the other mobile operators, all using the 2100 MHz band. LTE services have been deployed in northern Iraq in the 1800 MHz band by Alcatel-Lucent and Regional Telecom. Mobile money services are increasing in Iraq.

**Fixed services:** Unlike the mobile market, the fixed market is still a monopoly. Iraq Telecommunications and Post Company (ITPC) is the only fixed operator in the country. The fixed telecommunication sector has shown little investment or interest in developing it. Recently, the Iraq Ministry of Communications (MoC) launched a fibre-to-the-home (FTTH) roll-out project in partnership with fibre network operator ScopeSky. Newroz telecom, a major ISP in the Kurdistan Region, leases its optical fibre network and offers wireless Internet.

**Government policy:** Two governmental entities are competent to govern telecommunication licensing in Iraq - the Ministry of Communications (MoC), and the Communications and Media Commission (CMC). MoC operates two state-owned companies - the Iraqi Telecommunication and Post Company (ITPC), and the State Company for Internet Services (SCIS). The ITPC is responsible for the optical fibre network, the microwave backbone, and limited fixed wireless local loop (WLL) CDMA network, whilst the SCIS is handling the Internet subscribers and Internet

Key indicators for Iraq (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	5.5	7.7	13.6
Mobile-cellular sub. per 100 inhab.	82.2	107.1	101.5
Fixed-broadband sub. per 100 inhab.	n.a.	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	16.4	45.2	52.2
3G coverage (% of population)	73.0	81.9	85.0
LTE/WiMAX coverage (% of population)	n.a.	33.8	66.5
Mobile-cellular prices (% GNI pc)	2.1	4.3	5.2
Fixed-broadband prices (% GNI pc)	4.4	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.1	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.6	5.5	6.8
Percentage of households with computer	28.0	43.3	46.6
Percentage of households with Internet access	20.1	45.3	51.5
Percentage of individuals using the Internet	21.2	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	n.a.	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

communication in Iraq, providing wireless Internet access for government agencies, DSL, and dial-up VOIP services and Internet protocol (IP) address registration. The CMC is the primary regulatory body in Iraq and is responsible for regulating telecommunications and media, promulgating policy for frequency management, and licensing wireless and telecommunication services. The CMC is Iraq's first independent media and telecommunications regulator established in accordance with the Iraq Constitution and Order No. 65. CMC aims to regulate and develop the media and telecommunication sector in Iraq under the modern international criteria.

**Conclusion:** While growth in the Iraqi telecommunication sector is currently affected by the crisis; it is expected that there will be opportunities for growth in both the mobile communication and mobile-broadband markets in the future as well as increased interest in developing a more robust fixed telecommunication sector. The operators have begun preparing for the future, with expectations that mobile data traffic will rise.

## Ireland

***Ireland’s telecommunication market is well-developed with high penetration rates for both mobile and fixed services. Both markets are characterized by increasing levels of competition and the development of NGA networks.***

**Mobile services:** Ireland has an advanced and competitive mobile market. Penetration rates for mobile broadband are well above the European average and prices for both prepaid and postpaid services are affordable. Vodafone acquired Eircell, the mobile branch of incumbent Eircom (now Eir), in 2001 and holds the market lead in terms of mobile-broadband subscriptions. Following the 2015 acquisition of O2/Telefonica by operator Three, the latter became a major operator in the Irish mobile market. Three has contributed to shaping the market with its high 3G and LTE data allowances.<sup>240</sup> The entry of two new mobile operators, Virgin Media and ID, in the market in 2015 has further contributed to increasing the levels of competition (Commission for Communications Regulation, 2016).

**Fixed services:** Eir, the Ireland incumbent operator, is leading the competitive fixed-broadband market ahead of rivals such as Virgin Media, Vodafone and Sky, which are attracting more and more customers in recent years with their single play and bundled offers.<sup>241</sup> Fixed-broadband penetration is just below the European average. xDSL is the dominant broadband technology in the country and VDSL subscriptions have seen very high growth recently, with more than a 25 per cent increase from 2015-2016 (Commission for Communications Regulation, 2016). Operators, including Eir, Enet, Siro and Vodafone are increasingly investing in fibre technology. According to Eir, the company has spent more than EUR 440 million on NGA networks since 2012 in an effort to reach over 80 per cent of the population by 2020.<sup>242</sup>

**Government policy:** Ireland’s telecommunication market was opened to competition in 1998 in line with the EU’s Full Competition Directive. EU policies continue to shape the market. The National Broadband Plan for Ireland, which was adopted in 2012, meets the Digital Agenda for Europe targets of 100 per cent coverage with 30 Mbit/s and subscriptions over 100 Mbit/s for 50 per cent of households by 2020. It aims

Key indicators for Ireland (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	39.7	37.7 13.6
Mobile-cellular sub. per 100 inhab.	102.1	118.0 101.5
Fixed-broadband sub. per 100 inhab.	28.5	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	99.7	80.1 52.2
3G coverage (% of population)	95.0	98.5 85.0
LTE/WiMAX coverage (% of population)	90.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.5	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.3	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.3	0.6 6.8
Percentage of households with computer	84.1	79.6 46.6
Percentage of households with Internet access	87.0	82.5 51.5
Percentage of individuals using the Internet	82.2	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	183.9	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

at promoting investments in infrastructure, providing a supportive legislative and regulatory environment and developing leading edge ICT research.<sup>243</sup> As underlined by the broadband strategy, the government is determined to achieve fast and reliable broadband Internet access throughout the country. The “State Intervention” strategy aims to connect every premises in Ireland where there is no existing or planned NGA network, by means of an extensive broadband infrastructure programme.<sup>244</sup>

**Conclusion:** National and EU telecommunication policies have enabled Ireland to evolve into a highly connected society. The ambitious goals for broadband access followed by a comprehensive broadband infrastructure programme underlines Ireland’s ambitions to continue along this path.

## Israel

**Incumbent operator Bezeq continues to dominate the Israeli telecommunication market, but is facing increasing competition in the fixed and mobile sectors. Penetration rates for fixed services are around the European average and the vibrant mobile sector continues to grow driven by demand for high-speed mobile-broadband services.**

**Mobile services:** Israel has a vibrant and competitive mobile market. The privatization of incumbent operator Bezeq (now operating under the brand name Pelephone) started in 1991, followed by the opening of the mobile market to a second operator (Cellcom) in 1994. At the end of 2016, five mobile network operators and a number of MVNOs competed in the mobile market. These include MNOs Partner Communications, Hot Mobile, and Golan Telecom.<sup>245</sup> The latter two entered the market in 2012 and are both owned by transnational French telecommunication groups. With their low-priced offers, they have been able to gain significant market shares and intensified competition between the operators. Mobile-broadband penetration is increasing, and above the European average. Operators continue to invest in 3G and LTE networks and 3G population coverage is almost complete.<sup>246</sup>

**Fixed services:** Israel's fixed-broadband penetration is just below the European average. Bezeq, the former state-owned provider, continues to dominate the fixed telecommunication market, despite the end of its monopoly in 1999. Bezeq faces strong competition from the cable operator HOT, which unified the cable companies that were allowed to provide fixed-broadband and telephony services starting from 2002. Apart from cable, facilities-based competition remains limited as the launch of a wholesale market over the incumbent operator network only started effectively in 2015. Based on a new wholesale framework published by the Minister of Communications, seven operators are offering Internet services based on bitstream access over the incumbent network, including the MNOs, Cellcom and Partner Communications. Regarding NGA networks, Bezeq and HOT are investing in the roll-out of FTTB and hybrid fibre-coaxial networks, respectively, in order to increase Internet speeds (Ministry of Communications, 2016). In addition, the Israel Electric Corporation is leading a joint venture, called Unlimited, which

Key indicators for Israel (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	41.6	37.7 13.6
Mobile-cellular sub. per 100 inhab.	131.7	118.0 101.5
Fixed-broadband sub. per 100 inhab.	28.1	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	93.4	80.1 52.2
3G coverage (% of population)	99.0	98.5 85.0
LTE/WiMAX coverage (% of population)	70.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	1.1	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.1	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.4	0.6 6.8
Percentage of households with computer	81.1	79.6 46.6
Percentage of households with Internet access	75.7	82.5 51.5
Percentage of individuals using the Internet	79.8	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	158.7	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

is deploying an independent FTTB network in Israel.<sup>247</sup> Fixed-telephone penetration is high in Israel, although on the decline in line with the worldwide trend towards fixed-to-mobile substitution.

**Government policy:** Israel does not have an independent regulatory agency, but the Ministry of Communications is responsible for setting ICT policy and putting in place regulations. Specially appointed government committees are usually formed to decide major policies and reforms.<sup>248</sup> The government has followed the path of “progressive liberalization and privatization” of the telecommunication sector and sold its controlling shares of the incumbent Bezeq in 2005. Israel telecommunication policies are based on best-practices in the EU, such as the opening of Bezeq networks to its competitors, which was recommended by the Gronau committee in 2008.<sup>249</sup> In order to advance the roll-out of NGA networks and fully benefit from high-speed infrastructure, the Israel Government adopted the “Digital Israel” initiative in 2013. At the heart of the initiative is the construction of an optical fibre network throughout the country.<sup>250</sup>

**Conclusion:** Over recent decades, Israel has developed into a highly-connected society with a vibrant ICT market. NGA is increasing and an ever growing number of Israelis are using the Internet. The government is supporting growth in the sector and has adopted the “Digital Israel” initiative to prioritize the roll-out of NGA networks.

## Italy

**Italy's telecommunication market is the fourth largest in Europe in terms of revenue. The mobile market has undergone significant changes in recent years, and its market structure and competition is set to intensify. While mobile penetration is high in the European context, the fixed-broadband market lags behind in terms of quantity and quality of connections.**

**Mobile services:** Italy has a very competitive mobile market with high penetration rates for mobile-cellular and mobile-broadband services. Unlike most other EU markets, the Italy mobile market is dominated by prepaid customers (around 80 per cent in 2015) and characterized by multiple-SIM ownership, which in part explains the high mobile-cellular penetration (Wind Telecomunicazioni Group, 2015). Incumbent operator Telecom Italia was privatized in 1997 and competition was first introduced in 1995 when operator Omnitel (now Vodafone) entered the market. Wind started to offer services in 1999, followed by Blu in 2000 (OECD, 2001b).<sup>251</sup> Blu ceased services in 2002 and H3G became Italy's fourth mobile network operator. The 2017 merger between H3G and Wind created the dominant Italian mobile operator, Wind Tre. All operators are offering LTE services and are investing heavily in the extension of next generation networks. Telecommunication group Iliad, which had a disruptive effect on the telecommunication market in France, is set to launch services in Italy after its acquisition of part of the spectrum assets of H3G-Wind.<sup>251</sup>

**Fixed services:** Fixed-line subscriptions are taking off as more and more are subscribing to high-speed broadband services. However, fixed-broadband penetration is below that of other major European countries and also lower than the European average. Fixed operators are investing to expand high-speed networks, which are still lagging behind other European countries when it comes to advertised speeds. Telecom Italia, the incumbent operator, is losing market share in the face of increasing competition from numerous alternative operators. There is a strong north-south divide in Italy with regard to ICT access, whereby the centre-north has a significantly higher penetration than the south of the country (AGCOM, 2015).

Key indicators for Italy (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	33.1	37.7	13.6
Mobile-cellular sub. per 100 inhab.	148.5	118.0	101.5
Fixed-broadband sub. per 100 inhab.	25.4	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	85.5	80.1	52.2
3G coverage (% of population)	100.0	98.5	85.0
LTE/WiMAX coverage (% of population)	96.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.5	1.0	5.2
Fixed-broadband prices (% GNI pc)	1.6	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.6	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.4	0.6	6.8
Percentage of households with computer	64.7	79.6	46.6
Percentage of households with Internet access	69.2	82.5	51.5
Percentage of individuals using the Internet	61.3	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	82.3	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** As a founding member of the EU, Italy's telecommunication policies are aligned with the EU framework. In recent years, the focus of the EU and national policy makers has been on the extension of high-speed broadband networks. In order to achieve the targets set by the Digital Agenda for Europe, Italy adopted its strategy for next generation access networks in 2015. The strategy aims at creating favourable conditions for infrastructure development including the mapping of existing infrastructures, introduction of tax incentives as well as subsidized grants for private operators. Furthermore, the government will directly invest in infrastructure, when the private market fails to provide access (AGCOM, 2015).

**Conclusion:** Italy has a well-developed telecommunication market, in particular with regards to mobile. Private operators as well as the national government are investing in high-speed broadband networks in order to increase broadband access and speeds and overcome the country's regional digital divide.

## Jamaica

***Jamaica's telephony services are ubiquitous. In terms of subscriptions, the mobile sector is dominant over the fixed services, with considerably higher availability and the ability to control expenditures through prepaid services. There is, however, room for considerable improvement in relation to broadband infrastructure and coverage.***

**Mobile services:** The mobile market is dominated by two operators, Cable and Wireless Jamaica and Digicel, which provide both voice and data services and own their network infrastructure.<sup>252</sup> A third network operator, Symbiote Investments Limited, was granted a licence to operate for a 15-year period and it started services roll-out at the end of 2016. Deployment of LTE technology is relatively recent, with all three operators having acquired the necessary spectrum rights.<sup>253</sup> The Government is facilitating increased competition by inviting mobile virtual network operators (MVNOs) to bid for licenses.

**Fixed services:** The fixed services market is shared by three operators – Digicel, Cable and Wireless Jamaica, and Columbus Communications Jamaica (Cable and Wireless and Columbus Communications have operated under the single brand Flow since August 2015). In 2014, Jamaica established its first local Internet Exchange Point (IXP). According to the Office of Utilities Regulation (OUR) and eGov Jamaica Limited, the executing agencies for the Internet exchange point project, the establishment of the local IXP is expected to facilitate service quality improvement as well as result in immediate cost savings to local ISPs.

**Government policy:** The Ministry of Science, Energy and Technology is responsible for providing the overall policy and legislative framework to guide the development of the telecommunications sector. The OUR, which began operations in 1997, has primary responsibility for the regulation of the telecommunications sector while the Spectrum Management Authority has responsibility for spectrum-related issues. The OUR oversees the development of the telecommunications sector, aiming for a sustainable and efficient service delivery, having played a pivotal role in the implementation of number portability in 2015. It is currently working on updating sector regulation, and has developed quality of service

Key indicators for Jamaica (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	11.0	24.4	13.6
Mobile-cellular sub. per 100 inhab.	115.6	114.2	101.5
Fixed-broadband sub. per 100 inhab.	10.1	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	88.9	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	5.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.3	3.6	5.2
Fixed-broadband prices (% GNI pc)	5.3	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	3.8	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.9	5.7	6.8
Percentage of households with computer	39.1	64.9	46.6
Percentage of households with Internet access	36.7	63.3	51.5
Percentage of individuals using the Internet	45.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	47.9	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

rules as well as LRIC Models for the determination of fixed and mobile termination rates. The OUR in the process of developing infrastructure-sharing rules and guidelines as to what is to be considered unreasonable and unfair contract terms with respect to customer contracts for telecommunications services and facilities.

**Conclusion:** The Jamaican telecommunications sector is a free market with the role of the Government limited to facilitating the enabling environment through the application of appropriate legislative and regulatory tools. Jamaica, having achieved ubiquity in telephony, is now focused on implementing initiatives aimed at expanding the broadband network across the island and improving broadband adoption rates.

## Japan

**Government planning, R&D investment and sophisticated consumers have contributed to Japan's rapid adoption of the latest technologies and to its achieving extensive high-speed ICT coverage.**

**Mobile services:** The incumbent NTT leads the mobile market through its DoCoMo subsidiary, followed by KDDI and Softbank. There is a high level of access to mobile communications, and the *Communications Usage Trend Survey* found that 96 per cent of households had a mobile phone in 2015.<sup>254</sup> The country has been a high-speed mobile leader and was the first to launch 3G in 2001. By 2008, 100 per cent of the population was already covered by 3G, and 2G services were terminated in 2012. Japan was one of the first countries to deploy LTE in 2010, and LTE-Advanced services offering download speeds of 370 Mbps were launched in 2015. The deployment of 5G networks is planned for 2020.

**Fixed services:** NTT was privatized beginning in 1985. The NTT Act requires the Government to own at least one-third of the company. Changes to the NTT Act in 1997 led to the separation of NTT into two regional (NTT East and West) and one long-distance company. NTT is the largest fixed telephone service operator. It has been gradually migrating customers from copper landlines to fibre-optic links. Despite the popularity of mobile, 72 per cent of Japanese households had a fixed line telephone in 2016.<sup>255</sup> NTT is the largest fixed broadband retail operator, as well as providing other service providers with wholesale access to its fibre-optic network. FTTP accounted for 76 per cent of fixed broadband subscriptions at the end of March 2017, with the remainder made up of ADSL, coaxial cable and fixed wireless. By 2015, an ultra-high-speed broadband service (i.e., with download speeds of 30 Mbps or more) was available to 99.98 per cent (including mobile communications) of Japanese households. Both NTT and KDD have extensive national fibre-optic backbones including a submarine cable network that loops the Japanese archipelago. Japan is the main hub for interregional and trans-Pacific submarine systems, with 17 cable landing stations. There are 16 IXPs spread across the country, and the Japan Network Access Point (JPNAP) is the biggest IXP in the Asia-Pacific region in terms of traffic.

Key indicators for Japan (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	50.6	10.0	13.6
Mobile-cellular sub. per 100 inhab.	131.8	98.9	101.5
Fixed-broadband sub. per 100 inhab.	31.4	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	132.3	47.4	52.2
3G coverage (% of population)	99.9	87.6	85.0
LTE/WiMAX coverage (% of population)	99.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	1.0	3.2	5.2
Fixed-broadband prices (% GNI pc)	0.6	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.5	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.5	5.4	6.8
Percentage of households with computer	81.0	37.8	46.6
Percentage of households with Internet access	97.2	45.5	51.5
Percentage of individuals using the Internet	92.0	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	83.0	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** Sector oversight and regulation is the responsibility of the Ministry of Internal Affairs and Communications (MIC). The main regulatory law is the 1985 *Telecommunications Business Act*. Japan has long had a tradition of multi-year plans, such as the 2001 *e-Japan*, the 2005 *u-Japan* and the 2009 *i-Japan*, to guide sector development and to ensure that the country remains an ICT leader. MIC made basic strategy forecasting IoT-based society named "IoT Comprehensive Strategy" in 2017. The concept of the strategy is that big-data collected by IoT devices would bring accurate solutions against social challenges by analyzing them through AI. For example, MIC has been encouraging to make reference models of IoT-used services in the fields such as sharing economy, agriculture, medical and healthcare, and spread these models all over Japan. Also MIC is trying to implement AI into the society and develop more intelligent AI.

**Conclusion:** Japan is an ICT leader, not only in terms of developing, piloting and adopting the latest technologies, but also as an active participant in international standards-setting bodies.

## Jordan

**Jordan has been a regional leader in developing, adopting and utilizing ICTs. The telecommunication sector is dominated by three cellular operators; Zain, Orange and Umniah. In addition to these operators, several Internet service providers are providing FTTH and other data communication services.**

**Mobile services:** Mobile-cellular penetration, one of the highest in the Arab States countries and globally, has grown fast in the last few years, in particular after the deployment of LTE by the three mobile operators in 2015. The mobile sector is a highly competitive market, Zain was established in 1994. Orange was the second mobile operator and launched its services in 2000, and the third operator, Umniah, was granted its licence in 2005. Jordan was one of the first countries in the Arab States region to have had LTE services offered by all mobile operators. The Telecommunication Regulatory Commission (TRC) has allocated frequencies in the 1800 MHz, 2300 MHz, and 2600 MHz for LTE use. Jordan operators have invested heavily in the last three years in 3G/LTE, and FTTH deployment. Jordan imposes one of the highest taxes in the world on telecommunication services, however the prices of mobile-cellular service is one of the cheapest in the Arab States region mainly due to the very high degree of competition among mobile operators.

**Fixed services:** Jordan fixed broadband has increased rapidly during the last few years, as a result of extensive investment by the Internet service providers (ISPs). The offered speeds vary between 10 and 300 Mbit/s with relatively competitive prices. As a result of high competition among the ISPs in optical fibre network deployment, and in offering competitive prices, the proportion of individuals using the Internet is above the average level for both the Arab States region and globally.

**Government policy:** TRC is one of the oldest regulatory bodies in the Arab States. It was established as a financially and administratively independent jurisdictional body through the Telecommunications Law of 1995, and the amending law of 2002. The primary function of the TRC is to regulate the ICT and postal sectors. The first statement of government policy on the information and communications technology

Key indicators for Jordan (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	5.2	7.7	13.6
Mobile-cellular sub. per 100 inhab.	125.6	107.1	101.5
Fixed-broadband sub. per 100 inhab.	5.8	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	125.6	45.2	52.2
3G coverage (% of population)	99.0	81.9	85.0
LTE/WiMAX coverage (% of population)	87.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	1.6	4.3	5.2
Fixed-broadband prices (% GNI pc)	7.8	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.3	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.6	5.5	6.8
Percentage of households with computer	53.1	43.3	46.6
Percentage of households with Internet access	79.0	45.3	51.5
Percentage of individuals using the Internet	62.3	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	8.2	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

sectors and postal sector was issued in 2003, and focused on the liberalization of mobile and fixed line telecommunication sectors. The main progress as a result of this policy was the licensing of the third mobile operator. The second policy statement in 2007 focused on creating the conditions necessary to achieve effective competition, and also aimed at ensuring the effectiveness of TRC. TRC adapted the unified licensing regime as a result of this policy and thus opened the door for competition in the fixed broadband market. In 2012, the government approved the third policy statement, which focused on a fully competitive telecommunications environment. During this period frequency licences for 3G/LTE telecommunication services have been issued and assigned to all mobile operators in Jordan. Mobile network operators in Jordan are required by the TRC to pay annual revenue share of 10 per cent.

**Conclusion:** The ICT sector in Jordan has witnessed a remarkable development over the past 15 years, and resulted in placing Jordan among the most connected countries in the Arab States region. Most of Jordan is covered by 3G and LTE, and the deployment of FTTH is spreading at high speeds in urban cities. The government has a national broadband network to provide high speed connectivity between public facilities, hospitals, universities, schools and government agencies.

## Kazakhstan

**Kazakhstan has a highly-developed mobile cellular network infrastructure. Prices of telecommunication services are relatively low and continue to fall. As a result, Kazakhstan has the highest level of mobile-broadband penetration in the CIS region. The country is also a regional leader in access to computers and Internet use.**

**Mobile services:** Mobile communications is presently the most dynamic market in the telecommunication sector. There are three mobile-cellular operators in Kazakhstan: Kcell<sup>256</sup> (Kcell, Activ), Kar-Tel (Beeline)<sup>257</sup> and Mobile Telecom-Service (Tele2, Altel).<sup>258,259,260</sup> 3G technology was introduced in 2011. By 2015, it covered all settlements with above 10 000 inhabitants. The first LTE network was launched in 2012. By 2014, LTE networks covered towns with populations above 50 000. It is planned to provide LTE services in all local centres by the end of 2017. The number of LTE subscribers exceeded 2 million by the end of 2016. Mobile cellular telecommunication operators are allowed to use their GSM, DCS-1800 (GSM-1800) and UMTS/WCDMA (3G) frequency bands for LTE services. In recent years a rural telecommunication network development project was implemented. Rural areas were covered by CDMA/EVDO networks. Obsolete analogue exchanges (PBXs) were replaced by wireless local loop (WLL) base stations. Localities of 50 or more inhabitants acquired access to telephone services and broadband Internet of up to 3.1 Mbit/s.<sup>261</sup> Many of them (801) were installed in 2016.<sup>262</sup> In the same year, mobile network portability (MNP) was introduced.<sup>263</sup>

**Fixed services:** In 2008, the national telecommunication operator Kazakhtelecom finished the project of national information backhaul network construction that started in 1997. By 2008, over 11 500 km of optical fibre lines had been deployed.<sup>264</sup> The network connected regional centres, Astana and Almaty cities. It enabled further e-government development, ensured high quality of Internet and telephone services, and increased core capacity for international Internet traffic transit. Digital fixed telephony replaced analogue for long-distance intercity and international links in 1999. Analogue systems of local telephone networks had been replaced by digital by the end of 2015.

Key indicators for Kazakhstan (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	23.2	20.7	13.6
Mobile-cellular sub. per 100 inhab.	150.8	141.2	101.5
Fixed-broadband sub. per 100 inhab.	13.9	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	78.9	59.7	52.2
3G coverage (% of population)	86.8	77.1	85.0
LTE/WiMAX coverage (% of population)	69.0	45.9	66.5
Mobile-cellular prices (% GNI pc)	0.4	1.7	5.2
Fixed-broadband prices (% GNI pc)	0.6	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.5	3.1	6.8
Percentage of households with computer	76.2	67.4	46.6
Percentage of households with Internet access	84.4	68.0	51.5
Percentage of individuals using the Internet	76.8	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	87.2	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

From 2011 to 2014, Kazakhtelecom deployed FTTH (fibre-to-the-home) networks in cities of regional significance. By the end of 2016, more than 600 000 subscribers got Internet access over FTTH.<sup>265</sup> Kazakhstan is planning to continue to provide rural areas with fixed broadband access. One of the goals is to provide local state institutions with at least 10 Mbit/s Internet access, and to deploy FTTx networks in 1227 rural localities in 2018 to 2020. From 2021 to 2025, it aims to use alternative technologies to optical fibre to cover more than 4000 settlements.<sup>266</sup>

**Government policy:** The Kazakhstan Government makes significant efforts to develop the ICT sector. The national programme *Informational Kazakhstan – 2020* was approved in 2013.<sup>267</sup> The activities under the programme aim to increase public administration efficiency, improve ICT infrastructure availability and accessibility, provide ICT education for population, businesses and public officials, develop national Internet content and media.<sup>268</sup> A lot of attention is being paid to e-services development. Kazakhstan ranks 33<sup>rd</sup> among 193 countries in the United Nations E-government Development Index.<sup>269</sup> To adapt to fast changing ICT environment the ‘Digital Kazakhstan’ national programme was recently developed.<sup>270</sup> It covers the period from 2017 to 2021 and highlights state-of-the-art ICT directions such as, intelligent transportation systems, Internet-of-things, smart cities, blockchain technology. Since 2017, one of the main goals of ICT development in Kazakhstan has been to provide the population with broadband Internet access.<sup>271</sup> Kazakhstan also is also developing the transit networks capacity, and a direct network connection between Kazakhstan and Turkmenistan

was opened in 2013. Kazakhtelecom completed the project of a new transit network construction aimed at increasing gateway capacities to international telecommunication operators (in particular, Rostelecom, MegaFon, China Telecom, China Mobile) in 2014.<sup>272</sup> Internet traffic of about 75 Gbit/s is being transmitted from Europe to Asia and vice versa through Kazakhstan. It is expected that the traffic volume will increase to 537 Gbit/s by 2030. E-services are developing, and the popularity of data-centres is growing. In 2017, 24 data-centres were in operation. The largest TIER-III data-centre was opened in 2012. Kazakhstan's national company, Zerde, is an important stakeholder in building ICT sector cooperation in the CIS region.<sup>272</sup>

**Conclusion:** ICT growth rate in Kazakhstan is one of the highest in the region. The government implements its policy in telecommunications via strategies, plans, and projects with clearly stated targets. Telecommunication operators are involved in these activities. As a result, the population is getting access to quality services provided over high-speed telecommunication infrastructure.

## Kenya

**The East African nation aims to leverage its strategic location and growing submarine cables to become an ICT hub for the region.**

**Mobile services:** There are three mobile network operators (MNOs) and three operational mobile virtual networks operators, with SAFARICOM having the largest market share in the mobile market. SAFARICOM, an MNO, launched in 1997 with 40 per cent owned by the United Kingdom mobile group Vodafone, 35 per cent held by the Government of Kenya, and the remainder traded on the Nairobi Stock Exchange. Other operators include (a) AIRTEL, a subsidiary of the Indian mobile group, which launched in 2000; (b) TELKOM KENYA rebranded to Telkom following the exit of France Telecom (Orange), which entered the market in 2008 and was taken over by Helios Investment Partners in June 2017; (c) FINSERVE, a virtual mobile network operator owned by a Kenyan financial group; (d) SEMA MOBILE, enabling communities to connect and collaborate through customized mobile solutions; and (e) MOBILE PAY, which offers mobile money transfers services as well as voice, data and messaging (SMS) Services. Mobile household penetration is one of the highest in sub-Saharan Africa, with the 2015 *Malaria Indicator Survey* reporting that 90 per cent of homes had mobile phones, including 97 per cent in urban areas and 86 per cent in rural ones.<sup>273</sup> Mobile broadband was deployed in 2008 with the launch of 3G. Safaricom launched LTE in 2014, while the other operators have been piloting the technology and plan to launch commercially soon. Kenya was one of the first countries to deploy mobile money, which has proven widely successful in the nation. Kenya has one of the highest penetrations of mobile money in the world, at 85.2 per cent of mobile subscriptions as of December 2016.<sup>274</sup>

**Fixed services:** Incumbent Telkom Kenya was partly privatized in 2007, when 70 per cent was sold to Orange France. It was subsequently rebranded as Orange. In 2017, Orange France sold its shares to Helios Investment Partners, a private equity firm, which then rebranded it to Telkom Kenya. Telkom Kenya dominates in fixed telephony, but new fibre-based operators offering triple play services are starting to have an impact. Fixed Internet technologies offered in the market include fixed wireless, ADSL, cable

Key indicators for Kenya (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.2	1.0	13.6
Mobile-cellular sub. per 100 inhab.	81.3	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.3	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	26.2	22.9	52.2
3G coverage (% of population)	78.0	59.3	85.0
LTE/WiMAX coverage (% of population)	21.5	25.7	66.5
Mobile-cellular prices (% GNI pc)	2.3	14.2	5.2
Fixed-broadband prices (% GNI pc)	39.7	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.4	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	4.4	17.7	6.8
Percentage of households with computer	14.8	9.6	46.6
Percentage of households with Internet access	22.3	16.3	51.5
Percentage of individuals using the Internet	26.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	69.0	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

modem and optical fibre. Unlike most other sub-Saharan African markets, cable modem and optical fibre far outnumber ADSL subscriptions. By 2016, more than 6 000 km of the National Optic Fibre Backbone (NOFBI) Network had been deployed to all 47 counties in the country. NOFBI is open access with cost-oriented pricing available to all telecommunication operators. In addition to NOFBI, there are several other fibre backbones deployed by wholesale infrastructure providers. The arrival of The East African Marine System (TEAMS) undersea cable in 2009 linking Kenya to the United Arab Emirates enabled access to cheaper international bandwidth. TEAMS is noteworthy as it was instigated by the Government as a public–private partnership with open access and cost-based prices. Since then, Kenya has connected to three other submarine cables (Eastern Africa Submarine System (EASSY), Lion 2 and SEACOM), with others planned. The country has emerged as the leading international bandwidth hub in East Africa. The Kenya IXP was launched in 2002 and is one of sub-Saharan Africa’s largest, with 36 members; a second IXP launched in Mombasa in 2014.

**Government policy:** The Ministry of Information, Communications and Technology is responsible for sector policy. The Kenya National ICT Master Plan 2013/14–2017/18 establishes the direction for the sector. The Plan’s vision is to make Kenya a regional ICT hub and transition the country into a knowledge economy. It aims to (a) enhance the legal and regulatory environment; (b) provide simple-to-use e-government services; (c) increase the use of ICT in critical economic sectors; (d) stimulate growth of ICT businesses to enhance employment; (e) trigger and scale

up ICT innovation; and (f) foster a dynamic ICT sector. The National Broadband Strategy is a medium-term plan (2013–2017) for advancing high-speed Internet in the country. It outlines average speeds to be obtained by 2017 (40 Mbit/s in urban areas and 5 Mbit/s in rural areas) as well as coverage to be reached by various institutional sectors (35 per cent for households and 100 per cent for schools and health institutions). The Communications Authority of Kenya was originally established in 1999 as the regulatory agency for posts, telecommunications and broadcasting. Its third strategic plan, covering the period 2013–2018, lays out the Authority’s vision of transition from a simple regulator to an ICT facilitator. The four key pillars include (a) providing an enabling environment for ICT development; (b) enhancing and modernizing the Authority’s institutional capacity; (c) facilitating sector infrastructure and service development; and (d) promoting sector market development. The Konza Techno City is an IT park being constructed around 60 km south of Nairobi on 5 000 acres of land. It is planned to support more than 200 000 people working in IT-enabled services.

**Conclusion:** Kenya’s Government has long recognized the importance of the ICT sector for achieving national development goals, and has undertaken the necessary steps to create an enabling environment. This includes playing a leading role to obtain the country’s first undersea submarine cable. With a vibrant and innovative ICT sector, the nation is emerging as the digital hub for the East Africa region.

## Kiribati

**Difficult geographical and economic circumstances inhibit telecommunications development in this remote Pacific island country. Recent sector changes and the arrival of a submarine cable will lower costs and make the Internet more accessible.**

**Mobile services:** Amalgamated Telecoms Holdings Kiribati Limited (ATHKL) is currently the only mobile operator. ATHKL was created in May 2015 when Amalgamated Telecoms Holdings of Fiji acquired the assets of the incumbent Telecom Services of Kiribati Limited (TSKL) on the islands of South Tarawa, Betio and Kiritimati. ATHKL is also operating TSKL assets which the Government retained on the outer islands pending the establishment of a public-private partnership. Expanding mobile coverage throughout the country is challenging, given the small population and the number of far-flung islands. In 2015, 35 per cent of households had a mobile phone.<sup>275</sup> 3G was launched in 2013 and ATHKL launched LTE services in the capital Tarawa at the end of 2015. A project supported by the World Bank, Australia and New Zealand includes a component to extend mobile broadband services to remote outer islands.

**Fixed services:** ATHKL is the sole provider of fixed telephone services. The number of fixed telephony subscribers is limited. ATHKL offers LTE router service and are migrating all previous DSL subscribers to a new IPVPN service based on LTE data. VSAT is also used, particularly in remote locations. Several wireless ISPs have begun offering services using Wi-Fi. Kiribati's remote situation has hitherto precluded connection to undersea fibre-optic cable. Instead, it relies solely on satellite for international Internet connectivity, which has affected the supply and growth of the Internet market owing to high costs. A new international telecommunications service provider, Ocean Links, was awarded a licence and started Internet services operations mainly to business and government customers in September 2017. Mobile services are expected to commence in late 2017. A project is under way to establish a submarine cable connection that will link Kiribati to Nauru and extend to the Federated States of Micronesia, where it will link up with the HANTRU1 Cable System that extends to Guam, a major hub. Internet capacity will be sold by the wholesaler,

Key indicators for Kiribati (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	0.6	10.0	13.6
Mobile-cellular sub. per 100 inhab.	48.5	98.9	101.5
Fixed-broadband sub. per 100 inhab.	0.1	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	0.9	47.4	52.2
3G coverage (% of population)	60.0	87.6	85.0
LTE/WiMAX coverage (% of population)	40.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	5.5	3.2	5.2
Fixed-broadband prices (% GNI pc)	65.8	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	5.3	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	52.6	5.4	6.8
Percentage of households with computer	7.3	37.8	46.6
Percentage of households with Internet access	6.9	45.5	51.5
Percentage of individuals using the Internet	13.7	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	4.4	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

which is a new and locally established company, on an open-access basis to ensure equal access for all fixed and mobile networks operated by local retailers on Tarawa and nearby islands, which account for more than two-thirds of the country's population.

**Government policy:** Sector oversight is the responsibility of the Ministry of Information, Communication, Transport and Tourism Development (MICTTD). The 2011 *National ICT Policy* recognizes the importance of affordable and reliable ICT services as a key input to economic growth, particularly for unserved and underserved remote areas, and helped to trigger the creation of the regulator and privatization of the incumbent. The policy is currently under review with the aim of incorporating new policy initiatives covering the wider ICT sector and areas such as cybersecurity, e-commerce, e-government and disaster information management. The *Communications Act* of 2012 liberalized the sector and led to the establishment in 2013 of the Communications Commission of Kiribati (CCK) as sector regulator, which is also responsible for managing the DOT KI (.ki) domain name.

**Conclusion:** This Pacific island country has recently privatized its incumbent operator and is looking to a public-private partnership to manage telecommunications in the remote outer islands. Forthcoming connectivity to an undersea fibre-optic cable should lower Internet costs dramatically.

## Korea (Republic of)

**The government has promoted the sector through ongoing strategies to ensure that the country is a broadband leader. Eager consumers, competitive markets and strong links between the research community, hardware manufacturers and service providers facilitate this status.**

**Mobile services:** The country has a sophisticated mobile market and has been a leader in deploying the latest technologies. There are three operators. SK Telecom is the market leader, followed by the incumbent Korea Telecom and LG U+. LTE was launched as far back as 2011. There is virtually nationwide LTE population coverage, and approximately 80 per cent of the country's mobile connections are through LTE. In 2017, 93 per cent of the population used smartphones to access the Internet.<sup>276</sup> With tri-band carrier aggregation of LTE-Advanced, the country has the fastest mobile network service available globally – four times faster than standard LTE. Operators are aiming to pilot 5G in time for the PyeongChang 2018 Winter Olympics, with the commercial launch planned for the following year.

**Fixed services:** The incumbent Korea Telecom was privatized between 1993 and 2002 through sales of government shares. It is the market leader in fixed-telephone services. In terms of fixed broadband, KT is also the market leader. Other leading fixed-broadband stakeholders include SKT and LGU+, while other operators, mainly cable TV companies, make up around 15 per cent of the market. Over 90 per cent of households have access to 1 Gbps service. Several fixed broadband technologies are in use, including xDSL and hybrid fibrecoaxial, but most operators are migrating to FTTP, which accounted for 74 per cent of subscriptions in 2016. This includes redistribution through in-building LANs owing to the high proportion of multilevel housing units in the country. There are several nationwide fibre-optic backbones operated by telecommunication companies, Internet providers and the electric power utility. The country's strategic location between China and Japan facilitates access to over a dozen regional and international submarine cables. There are three IXPs.

**Government policy:** The Ministry of Science and ICT is the sector policy maker. Since the 1980s,

Key indicators for Korea (Rep.) (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	56.1	10.0	13.6
Mobile-cellular sub. per 100 inhab.	122.7	98.9	101.5
Fixed-broadband sub. per 100 inhab.	41.1	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	111.5	47.4	52.2
3G coverage (% of population)	99.0	87.6	85.0
LTE/WiMAX coverage (% of population)	99.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	1.2	3.2	5.2
Fixed-broadband prices (% GNI pc)	1.5	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.0	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.4	5.4	6.8
Percentage of households with computer	75.3	37.8	46.6
Percentage of households with Internet access	99.2	45.5	51.5
Percentage of individuals using the Internet	92.7	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	54.3	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

the Republic of Korea has promoted policies with time-bound targets and goals promoting ICTs as a strategic tool for national development, such as *Cyber Korea 21* (1999), *e-Korea* (2002) and *u-Korea* (2005). These typically called for coordination between government, business and research communities. In 2016, the Government released the *Mid- to Long-Term Master Plan in Preparation for the Intelligent Information Society*. The plan describes how the country will react to the fourth industrial revolution characterized by the cloud, big data, mobile services and the Internet of Things. It is underpinned by four key strategies: i) fostering an intelligent information society on the basis of public-private partnerships, with businesses and citizens playing leading roles and the Government and research community providing support; ii) devising and implementing a balanced policy regime that encompasses technologies, industries and society and shapes the development of a more humane society; iii) providing strategic support for the prompt securing of rights and access to Intelligent IT and other related resources in order to ensure and foster industrial competitiveness in advance; and iv) reforming policies and expanding the social security net on the basis of social consensus. The Korea Communications Commission (KCC) was founded in 2008 to handle regulatory and other issues related to the convergence of broadcasting and telecommunications. The *Telecommunications Business Act* of 1995 and its amendments are the main legislation covering regulation of the sector.

**Conclusion:** The Government has been successful at guiding the nation towards ever-higher levels of informatization through ongoing strategic

plans. This is reflected in the figure of 93 per cent of citizens aged three years and over using the Internet in 2016.

## Kuwait

***Kuwait has an advanced ICT sector that could encourage continuing expansion in telecommunication and spur progress in the industry. With three competing operators, the country has some of the most affordable prices of fixed and mobile-broadband services in the Arab States region.***

**Mobile services:** The Kuwait mobile sector is highly developed and competitive with three mobile operators. Mobile-broadband and cellular penetration levels are among the highest in the world. The three major mobile providers in Kuwait (Zain, Ooredoo, Viva) are highly competitive and while Zain has the highest market share, the other two are not far behind. Viva joined the market in 2008 and rose quickly to capture market share against the existing two players. With mobile penetration at high levels, focus has shifted to the mobile data market. All three operators have upgraded their networks to support faster downlink speeds and are increasingly focused on mobile content and applications. Zain has launched M2M services for corporate customers as well as VoLTE services. Viva, Zain, and Ooredoo have all turned their attention towards LTE-A. The Ministry of Communication (MoC), sector regulator until 2016, granted competing operators the 3G and LTE frequencies: 3G frequencies are 2100 MHz for all three operators; the LTE frequencies are in the 1800 MHz band for all three operators.

**Fixed services:** To date, the fixed-line and international long distance (ILD) services remain a state-owned monopoly. The MOC operates the fixed-line network. In 2007, the MOC commenced the deployment of the FTTx network in the country using the Gigabit Passive Optical Network (GPON) that aims to renew the telecommunication infrastructure in Kuwait. This infrastructure is owned by the MOC, while five Internet Service Providers (ISPs), (Qualitynet, Fastelco, Gulfnet, KEMS, MADA), are managing network subscriptions, and offering FTTx services to end users using fibre ducts owned by the MOC.

**Government policy:** In 2014, the Kuwaiti Parliament approved a law for the establishment of the country's first independent telecommunications regulator, Communication and Information Technology Regulatory Authority (CITRA). The new commission will regulate the

Key indicators for Kuwait (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	11.0	7.7	13.6
Mobile-cellular sub. per 100 inhab.	146.6	107.1	101.5
Fixed-broadband sub. per 100 inhab.	2.8	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	280.2	45.2	52.2
3G coverage (% of population)	98.0	81.9	85.0
LTE/WiMAX coverage (% of population)	98.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.4	4.3	5.2
Fixed-broadband prices (% GNI pc)	0.3	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	5.5	6.8
Percentage of households with computer	83.5	43.3	46.6
Percentage of households with Internet access	77.7	45.3	51.5
Percentage of individuals using the Internet	78.4	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	69.5	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

mobile, landline, and broadband sectors. CITRA also governs all aspects of the telecommunication sectors previously sub-managed by the Ministry of Communication. Kuwait is the last country in the Gulf region to establish such a regulatory body. CITRA announced that its focus will be: competition policy and regulation; price control; interconnection regulation; dispute resolution; licensing; spectrum management; universal service policy and funds. CITRA focus on information technology (IT) will be; Internet management; IT public sector governance.; IT sector development; national cyber security; smart government strategy; IT standards and regulations ;IT national investments; and monitor IT process.

**Conclusion:** The high income of its inhabitants and residents, and efforts made over the past 15 years, have resulted in making Kuwait one of the world's most connected countries. Most of its households have Internet access and most of its citizens use the Internet on a regular basis. CITRA aims to fully liberalize the telecommunication sector through the privatization of fixed telephony infrastructure post services, and international gateways. The government is currently developing a national broadband plan and expanding the GPON network.

## Kyrgyzstan

**Kyrgyzstan has an open-access and competitive telecommunication market. Mobile services prevail over fixed services. A significant increase in 3G and LTE subscribers is observed and projected in the coming years.**

**Mobile services:** The mobile-broadband market shows advances in the context of 3G/LTE technology deployment, mobile devices availability, and increases in the number of users and Internet traffic growth. The mobile-cellular market started to develop in 1998. Today, there are three active mobile operators (Beeline, MegaCom, and O!) using GSM/3G (900, 1800 MHz), UMTS/WCDMA (900, 2100 MHz) and LTE (800, 1800, 2100, 2500 MHz) technologies. Companies providing services over CDMA and D-AMPS/TDMA networks ceased their operation in 2016. 3G-services were launched in 2010, LTE services emerged at the end of 2011.<sup>277</sup> The largest operator has around 40 per cent of the market, while the other two operators have an equal share of the rest of the market. Some fixed network operators have also launched LTE services. In 2015, Kyrgyzstan held the first auction on digital dividend frequencies (790-862 MHz) in the CIS region.<sup>278 279</sup> It is planned to introduce mobile network portability (MNP) by 2018.<sup>280</sup> RAN Sharing technology is also used by mobile operators in order to widen the coverage area of all operators, especially in rural areas.

**Fixed services:** The fixed telephone network penetration level is below the CIS region average. The national telecommunication operator, Kyrgyztelecom, owns about 70 per cent of the market, serving around 95 per cent of fixed subscribers. It also offers wireless local loop (WLL) services over a CDMA-450 network. Fixed-broadband services were launched in 2006, but its development is hampered by low level urbanization, relatively high prices and competition with mobile-broadband services. Most fixed-broadband Internet access networks are deployed in urban areas. However, both fixed and mobile services require high capacity backhaul networks to meet the growing demand for broadband access. Leading telecommunication operators (Kyrgyztelecom and mobile telecommunication operators) are building fibre-optic networks across the country. In 2015, the total length of fibre-optic lines increased by 36 per cent. By increasing

Key indicators for Kyrgyzstan (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	6.6	20.7	13.6
Mobile-cellular sub. per 100 inhab.	131.4	141.2	101.5
Fixed-broadband sub. per 100 inhab.	4.2	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	46.1	59.7	52.2
3G coverage (% of population)	60.0	77.1	85.0
LTE/WiMAX coverage (% of population)	40.0	45.9	66.5
Mobile-cellular prices (% GNI pc)	4.0	1.7	5.2
Fixed-broadband prices (% GNI pc)	8.4	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.0	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	4.4	3.1	6.8
Percentage of households with computer	21.4	67.4	46.6
Percentage of households with Internet access	18.8	68.0	51.5
Percentage of individuals using the Internet	34.5	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	65.4	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

backhaul network capacity, Kyrgyzstan increased the network capacity to transit and terminate larger volumes of international Internet traffic, which is vital because the biggest part of Internet traffic in Kyrgyzstan is inbound traffic coming from outside Kyrgyzstan.

**Government policy:** In 2002, the national strategy, ICT for the Republic of Kyrgyzstan development, set out the following priorities: governance through ICT, ICT education, ICT-economy (e-trade development, etc.). The strategy did not set tangible outputs, terms, and indicators. ICT goals were also described in the Kyrgyzstan development strategy for 2009-2011, such as: national data transmission network construction; integration of national network into the Internet; population provision with telephone services; analogue to digital network transition; laying optical fibre lines, etc. The current national strategy for 2013-2017 focuses on modern technology implementation, particularly, in the state customs service, education, and banking. In 2017, the Kyrgyzstan Government is focused on the Taza koom initiative. Taza koom is a national digital transformation programme aimed at building a strong society centred on human rights, freedoms, values, and potential. The goal of Taza koom is to improve people's lives through the power of technology, digital infrastructure and data. The programme is considered to be a key component of the national strategy of sustainable development till 2040 and involves the development of public services, smart towns and villages, infrastructure, and human capital.<sup>281</sup>

**Conclusion:** Kyrgyzstan has gradually transformed its fixed-telephone networks from analogue to

digital. The Internet market has grown significantly over the past few years. It is expected that current transport network development programmes will facilitate the importance of Kyrgyzstan as a transit country and reduce international Internet traffic costs.

## Lao People's Democratic Republic

***A distinctive model of private and state ownership is used to extend telecommunication access in the only landlocked nation in South-East Asia.***

**Mobile services:** There are four mobile operators, all with a mix of private ownership and government shareholding. They also have full service licences and are involved in the fixed telephone and broadband market. Star Telecom (UNITEL) is a joint venture between a government-owned company and Vietnam's VITETEL group. Lao Telecom is 51 per cent owned by the Government and 49 per cent by Thai investors. Entreprise Telecom du Lao (ETL), the state-owned incumbent, was partially privatized in 2016 when 51 per cent was sold to a Chinese group. Vimpelcom Lao is 78 per cent owned by Veon, a group that includes one of the largest telecom operators in Russia. 2G is widely available with 86 per cent of Laotian households having a mobile phone in 2015 (95 per cent in urban areas, 83 per cent in rural areas with roads, and 69 per cent in rural areas without roads).<sup>282</sup> Mobile broadband was launched in 2008 with the deployment of the first 3G network. UNITEL, and Lao Telecom launched LTE in 2015.

**Fixed services:** The mobile operators also participate in the fixed-line telephone market via copper wire connections or wireless local loops. Fixed broadband is limited mainly to urban areas, and in 2015 ADSL accounted for 58 per cent of subscriptions while FTTP accounted for 36 per cent (at speeds of up to 60 Mbps).

The national fibre-optic backbone is over 60 000 kilometres long and runs along main highways, with cross-border links to surrounding countries. There is also a metropolitan ring in Vientiane. For Laos PDR, as the only landlocked country in South-East Asia, connections to neighbouring countries with a coastline is critical, and Laos accesses submarine cables via cross-border links to Cambodia, China, Thailand and Viet Nam. The Lao National Internet Center was established as an IXP in 2010.

**Government policy:** The Ministry of Posts and Telecommunications (MPT) oversees and regulates the sector on the basis of the 2011 *Telecommunications Law*. ICT is recognized as an

Key indicators for Lao P.D.R (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	17.7	10,0	13,6
Mobile-cellular sub. per 100 inhab.	55.4	98,9	101,5
Fixed-broadband sub. per 100 inhab.	0.3	11,3	12,4
Active mobile-broadband sub. per 100 inhab.	34.7	47,4	52,2
3G coverage (% of population)	69.0	87,6	85,0
LTE/WiMAX coverage (% of population)	7.0	73,6	66,5
Mobile-cellular prices (% GNI pc)	4.7	3,2	5,2
Fixed-broadband prices (% GNI pc)	16.5	14,5	13,9
Mobile-broadband prices 500 MB (% GNI pc)	1.7	2,7	3,7
Mobile-broadband prices 1 GB (% GNI pc)	4.2	5,4	6,8
Percentage of households with computer	12.3	37,8	46,6
Percentage of households with Internet access	18.7	45,5	51,5
Percentage of individuals using the Internet	21.9	41,5	45,9
Int. Internet bandwidth per Internet user (kbit/s)	17.5	48,0	74,5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

important cross-cutting sector in the *8th Five-Year National Socio-Economic Development Plan (2016–2020)*. Priority activities include ensuring 100 per cent Internet coverage across the country and establishing the national policy on broadband services to determine an expansion plan and ensure access to broadband services for people across the country.

**Conclusion:** The strategy of competition between government-private sector joint ventures has resulted in a relatively high level of mobile access for a least developed country. ICT has taken on a new urgency in the country's development plan, particularly ensuring the widespread availability of broadband Internet.

## Latvia

**Latvia has an advanced telecommunication market with high mobile and fixed penetration rates, just below the European average. While the fixed-broadband network is among the fastest in Europe, there is a significant digital divide between urban and rural parts of the country that are underserved by ICTs.**

**Mobile services:** Four mobile network operators and a number of virtual network operators are active in Latvia's competitive mobile market. Mobile-cellular penetration is above the European average, while mobile-broadband remains slightly below the average. LTE services were first launched in the 1800 Mhz band by the operator LMT. Coverage was expanded when Tele2 and Bite started to offer LTE services as well and further spectrum was released.<sup>283</sup> Data consumption is growing rapidly in Latvia. Indeed, the country saw a growth of 175 per cent in mobile data consumption per subscription during 2015, mainly due to one of the leading operators offering plans with no data cap nor fair usage policy and including TV services in the mobile subscription (PTS, 2015).

**Fixed services:** Lattelcom, the incumbent operator, lost its monopoly in 2003, but continues to hold a dominant position in the fixed market. Fixed-broadband penetration is below the European average and also lower compared to Latvia's Baltic neighbours, mostly due to lacking access in rural areas. However, availability of NGA networks is higher than in the European average and above the share in other Nordic and Baltic countries with the exception of Sweden. Lattelcom is leading fibre roll-out, and increasing investments are being made in FTTx infrastructure.<sup>284</sup>

**Government policy:** Latvia joined the European Union in 2004, which brought about the liberalization of the telecommunication market in 2003 as a prerequisite for membership. Latvia has since adopted EU directives with regard to telecommunications and set goals for broadband development in line with DAE targets for 2020. The national broadband strategy runs from 2013-2020 and aims at providing 100 per cent coverage with 30 Mbit/s and 50 per cent of households with 100 Mbit/s by 2020. In order to achieve these goals, broadband needs to be extended to rural areas of Latvia. Therefore, the government with support

Key indicators for Latvia (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	18.0	37.7 13.6
Mobile-cellular sub. per 100 inhab.	131.2	118.0 101.5
Fixed-broadband sub. per 100 inhab.	25.7	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	74.4	80.1 52.2
3G coverage (% of population)	95.0	98.5 85.0
LTE/WiMAX coverage (% of population)	99.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.5	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.5	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	0.6 6.8
Percentage of households with computer	78.0	79.6 46.6
Percentage of households with Internet access	77.3	82.5 51.5
Percentage of individuals using the Internet	79.9	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	246.7	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

from European funds is building dark fibre and access points in rural areas, with private providers delivering the last mile to customers.<sup>285</sup>

**Conclusion:** Latvia has seen a transformation of its telecommunication market enabled by national and EU policies. In order to overcome the digital divide that affects rural areas of the country, the government is investing in NGA networks to connect underserved areas.

## Lebanon

**Lebanon has a high level of fixed and mobile-broadband service usage. With two state-owned mobile-cellular operators, one state-owned operator for fixed-telephony services, and many Internet service providers and data service providers, the country offers a wide range of advanced ICT services.**

**Mobile services:** Mobile-cellular penetration is close to the Arab States region and global averages, while mobile-broadband penetration is above the region and global averages. There are two licensed operators for mobile-cellular services in Lebanon: Alfa, and Touch. Both operators are government owned. Touch is managed by Zain Group, while Alfa is managed by Orascom Telecom. Spectrum licences were granted in the 900MHz/1800MHz/2100MHz bands to both mobile operators to provide 3G, launched by both operators in 2011. In 2015, both operators launched LTE networks. Both operators offer M2M SIMs for corporate entities that can be used for M2M service applications, such as managing fleets and monitoring ATM machines. They also offer Tap2Pay, which is Near Field Communication (NFC) service in collaboration with MasterCard. The Ministry of Telecommunications (MoT) declared that by 2017, LTE should cover more than 85 per cent of Lebanon.

**Fixed services:** The fixed voice and data market is government owned as represented by the MoT. Ogero is the MoT's execution arm when it comes to the network's development, operations and maintenance. Ogero, established in 1972, is state-owned and acts under the supervision of the MoT. The penetration of fixed telephony in Lebanon is one of the highest in the Arab States. Fibre infrastructure is currently being deployed. There are more than 70 Internet service providers, and six licensed data service providers that compete with Ogero in the Internet connectivity and services markets.

**Government policy:** Telecommunication Law 431 was issued in 2002 to provide the governing framework, liberalize the Telecommunication Sector in the nation and to set the mechanisms for its transfer to the private sector. The TRA was established in accordance with this law as an independent public institution to liberalize, regulate, manage the frequency spectrum, and

Key indicators for Lebanon (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	35.8	7.7	13.6
Mobile-cellular sub. per 100 inhab.	96.4	107.1	101.5
Fixed-broadband sub. per 100 inhab.	25.6	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	67.2	45.2	52.2
3G coverage (% of population)	99.0	81.9	85.0
LTE/WiMAX coverage (% of population)	89.2	33.8	66.5
Mobile-cellular prices (% GNI pc)	2.6	4.3	5.2
Fixed-broadband prices (% GNI pc)	2.7	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.7	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.3	5.5	6.8
Percentage of households with computer	78.1	43.3	46.6
Percentage of households with Internet access	77.7	45.3	51.5
Percentage of individuals using the Internet	76.1	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	55.1	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

develop communications in Lebanon. This Law has not been enacted yet. The MOT 2020 Vision is to have the fibre optic infrastructure installed through the entire country.<sup>286</sup> The subscriber base for fixed broadband services is growing and exceeded 0.5 million x-DSL users in 2016. The government is about to start a nationwide FTTX fibre project which will lead to substantial Improvements to the broadband infrastructure and boost the digital economy in Lebanon.<sup>287</sup>

**Conclusion:** The ICT sector has grown significantly in Lebanon in the last 10 years. With the government supporting and financing the 2020 Telecom Vision project some great progress will be made over the next few years. Infrastructure improvements will not only assist Lebanon in terms of communication delivery, but also increase mobile data usage, along with its promising start-up culture. It is important to mention, however, that the ICT infrastructure in which Lebanon is heavily investing is being stressed to its capacity limits due to the influx of refugees in the previous few years. This is delaying and more often derailing Lebanon's plans to grow its ICT services to a higher level.

## Lesotho

***This small landlocked country was one of the first African countries to implement sector reform that included establishing a regulator, privatizing the incumbent and introducing competition. This has resulted in some of the highest levels of mobile-broadband coverage in Africa.***

**Mobile services:** There are two mobile providers: Vodacom Lesotho (VCL), a subsidiary of the South African mobile group, which launched in 1996; and Econet Telecom Lesotho (ETL), the country's incumbent telecommunications operator, which launched in 2002. Penetration is relatively high for the region, with the State of ICT in Lesotho survey reporting that 79 per cent of individuals owned a mobile phone in 2016, including 87 per cent in urban areas and 72 per cent in rural areas. One factor is relatively high 2G coverage that reaches 98 per cent of the population, one of the highest levels in sub-Saharan Africa. The universal service fund has played a role in extending mobile coverage to underserved areas. Mobile-broadband was introduced relatively early in Lesotho, when Vodacom launched its 3G network in 2008. This early start has also resulted in one of the highest 3G coverage rates in Africa, at 100 per cent of the population. LTE was introduced in 2014 and population coverage is high by regional standards, at 69 per cent of the population.

**Fixed services:** The incumbent fixed line operator Telecom Lesotho was partly privatized in 2000, when 70 per cent was sold to a consortium comprising Econet Wireless International, Eskom Enterprises and Mauritius Telecom. Econet Wireless International, a South African-headquartered mobile group, bought the shares of the other consortium members in 2008. ETL provides fixed telephony using copper lines (subscription-based) and wireless local loop (prepaid). The copper line network has declined due to the popularity of mobile phones. ETL offers fixed-broadband using fixed ADSL (up to 16 Mbit/s) and optical fibre (up to 100 Mbit/s), as well as fixed wireless LTE (up to 150 Mbit/s). Five ISPs also offer fixed wireless broadband. The national fibre backbone has been progressively expanded. This is particularly important for landlocked Lesotho to access undersea fibre-optic cables. There are several cross-border connections with South Africa to access submarine cables in that

Key indicators for Lesotho (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	1.9	1.0
Mobile-cellular sub. per 100 inhab.	106.6	74.6
Fixed-broadband sub. per 100 inhab.	0.1	0.4
Active mobile-broadband sub. per 100 inhab.	36.9	22.9
3G coverage (% of population)	96.0	59.3
LTE/WiMAX coverage (% of population)	75.0	25.7
Mobile-cellular prices (% GNI pc)	7.1	14.2
Fixed-broadband prices (% GNI pc)	9.6	39.4
Mobile-broadband prices 500 MB (% GNI pc)	6.4	9.3
Mobile-broadband prices 1 GB (% GNI pc)	8.0	17.7
Percentage of households with computer	8.2	9.6
Percentage of households with Internet access	27.9	16.3
Percentage of individuals using the Internet	27.4	19.9
Int. Internet bandwidth per Internet user (kbit/s)	4.5	51.0

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

country. Lesotho is a participant in EASSy, which went live in 2010, and lands on the East Coast of South Africa. The universal service fund is used to support the operations of the Lesotho Internet Exchange, launched in 2011, and was used to acquire infrastructure for the national domain name registry (.ls).

**Government policy:** The Ministry of Communications, Science and Technology is responsible for sector oversight. Lesotho's Vision 2020 guides the sector, where technology is identified as a key pillar, with the goal of 90 per cent of households having access to communication and development technology. The country's Communications Policy has four strategic goals: (a) strengthen regulatory capacity; (b) promote the convergence of services and networks based on the Internet; (c) foster universal access to a diverse range of high-quality communications services at affordable prices; and (d) promote a competitive communications market. The Lesotho Communications Authority (LCA) (formerly Lesotho Telecommunications Authority) is responsible for the regulation of telecommunications, broadcasting, radio frequency and postal services. The Lesotho Communications Authority carries out its functions in relation to the Communications Act of 2012. The Universal Access Agency administers the Universal Access Fund (UAF) which, as noted, has been instrumental in expanding mobile coverage and supporting the IXP and domain name system. The UAF receives 25 per cent of LCA's surplus funds at year end and 1 per cent of annual net operating income of the main operators.

**Conclusion:** Lesotho's early reform efforts have paid off in terms of a high level of mobile-broadband coverage. The results are particularly impressive given that Lesotho is both landlocked and a least developed country.

## Liberia

***This West African country became a virtually wireless nation after the civil war devastated the fixed network. The arrival of submarine cable has created opportunities to transform the ICT landscape.***

**Mobile services:** There are three mobile operators: LONESTAR is a subsidiary of the South African MTN group and the first operator to launch a GSM network in the country in 2001; Orange is a subsidiary of the French telecom group, which entered the market in 2016 through the purchase of CELLCOM (which had launched the country's second GSM network in 2004); and NOVAFONE, whose predecessor company launched in 2015, was purchased by MTN when an attempt to sell it to the incumbent Liberia Telecommunications Corporation (LIBTELCO) fell through. In 2013, 65 per cent of households in the country had mobile telephones, with a large divide between 82 per cent in urban (82 per cent) and 42 per cent in rural (42 per cent) areas.<sup>288</sup> The operators have launched the latest 3G technologies and Orange introduced LTE in 2016 on the 1 800 MHz band.

**Fixed services:** The incumbent fixed line operator LIBTELCO is State-owned. The fixed-telephone network in Monrovia was badly damaged during the civil war and destroyed in rural areas. LIBTELCO is the sole fixed-telephone provider using CDMA wireless local loop. Internet access is provided by a number of fixed wireless broadband providers. Fibre-optic connections are available for businesses in Monrovia. The Government is deploying a national fibre-optic backbone as part of the West Africa Regional Communications Infrastructure Programme (WARCIP). It calls for deploying fibre from the West to the East of the country as well as to key border crossings. The arrival of ACE in 2012 not only increased international Internet bandwidth more than sevenfold, it also lowered wholesale prices by 75 per cent, as the country was no longer solely reliant on satellite. The Cable Consortium of Liberia was established as a public–private venture between the Government and telecommunication operators to manage access to ACE in an open and cost-effective manner. The Liberia IXP was launched in Monrovia in 2015.

**Government policy:** The Ministry of Posts and Telecommunications provides ICT sector oversight

Key indicators for Liberia (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.2	1.0	13.6
Mobile-cellular sub. per 100 inhab.	67.5	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.2	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	100.4	22.9	52.2
3G coverage (% of population)	63.0	59.3	85.0
LTE/WiMAX coverage (% of population)	4.4	25.7	66.5
Mobile-cellular prices (% GNI pc)	51.1	14.2	5.2
Fixed-broadband prices (% GNI pc)	n.a.	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	12.6	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	75.8	17.7	6.8
Percentage of households with computer	2.6	9.6	46.6
Percentage of households with Internet access	3.0	16.3	51.5
Percentage of individuals using the Internet	7.3	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	14.8	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

as well as responsibility for operating postal services. The latest National Telecommunications and ICT Policy covered the period 2010–2015, with the goal of people-centred, universally accessible and cost-effective ICT systems and services. The policy has 15 objectives for telecommunications, 26 for ICTs, and identifies 9 priority projects. The Liberia Telecommunication Authority is the statutory regulatory body established by the Telecommunications Act of 2007. The Authority enforces sector regulations and is responsible for universal access as well as input for the broadcasting digital migration strategy, and transitioning laws and regulations to harmonize with ECOWAS guidelines.

**Conclusion:** The ICT sector in Liberia was scarcely developed before the outbreak of the civil war in 1989. The war resulted in much of the country's infrastructure being destroyed or vandalized. ICT access in the West African nation is practically entirely wireless. The arrival of a submarine cable has transformed the landscape, and creates opportunities to extend coverage and services nationwide.

## Libya

**Libya enjoyed a leading infrastructure among Arab States before 2011, since then political and social instability have damaged and disrupted the telecommunication sector. With six competing operators, the country offers low prices of fixed, mobile and Internet services.**

**Mobile services:** With one of the highest mobile-cellular penetration rates in Africa, and above the average of Arab States region, the mobile voice market is approaching saturation, supported by low tariffs. Opportunities remain in the broadband sector where market penetration is still relatively low. Libya has two state-owned cellular companies: Almadar Aljadid and Libyana. The first cellular operator, Almadar Aljadid, started operations in Libya in 1997, and is part of the Libyan Post, Telecommunication, and Information Technology Holding Company ((LPTIC), and currently is launching an HSPA+ services. Libyana, the second market player, which launched services in 2004, has a dominant position in the mobile cellular market. Libyana is currently the only mobile operator to offer 3G services in the 2100 MHz band, having launched its HSDPA network in September 2006. In March 2017, Libyana launched an LTE network using the 1800 MHz band, which covers the cities of Tripoli, Zawiya, Sabha, and Misrata, although the company expects to add further locations to its footprint in the near future.

**Fixed services:** Despite the high level of fixed line penetration, fixed broadband penetration remains low. The state-owned Hatif Libya currently holds the responsibility for providing fixed line voice telephony in Libya. The previous incumbent, the General Posts and Telecommunications Company (GPTC) was split into eight separate entities, Hatif Libya, Almadar, Libyana, Aljeel Aljadeed, Bunya for Investments, Libya International Telecom Company (LITC), and Libya Telecom and Technology (LTT). LTT is the only Internet service provider in the country. Fibre deployment is limited, and offered by Hatif Libya and Aljeel Aljadeed.

**Government policy:** The General Authority for Communication & Informatics (GACI) is the telecommunication regulatory body in Libya. GACI was established in 2006 to follow-up the services and activities of the post and telecommunications and the enforcement of related legislation. Its responsibilities include: preparing technical

Key indicators for Libya (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	21.5	7.7	13.6
Mobile-cellular sub. per 100 inhab.	119.8	107.1	101.5
Fixed-broadband sub. per 100 inhab.	2.6	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	34.9	45.2	52.2
3G coverage (% of population)	78.1	81.9	85.0
LTE/WiMAX coverage (% of population)	n.a.	33.8	66.5
Mobile-cellular prices (% GNI pc)	1.3	4.3	5.2
Fixed-broadband prices (% GNI pc)	4.4	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.5	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.2	5.5	6.8
Percentage of households with computer	23.5	43.3	46.6
Percentage of households with Internet access	22.0	45.3	51.5
Percentage of individuals using the Internet	20.3	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	5.3	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

specifications and standards for communication systems, supervising telecommunication networks, systems and satellite services, and taking all legal measures against telecommunication and post service violations. A new telecommunications law has been drafted and the government is in the process of establishing a new independent regulatory authority. Since the previous regime, 25 Internet service providers have already been licensed to compete with the government-owned former monopoly, as well as 23 VSAT operators.<sup>289</sup>

**Conclusion:** Opportunities remain in the broadband sector where market penetration is still relatively low. Massive investments had been made by the former government into a next-generation national optical fibre backbone network. Despite the current instability notable moves to develop the ICT sector are being witnessed. Hatif Libya seeks to expand fixed wireless service in all regions of the country.

## Liechtenstein

***The Principality of Liechtenstein has a very dynamic mobile market where, despite its small size, several mobile network operators compete. Vertical separation in the fixed market fosters synergies at the infrastructure level while leaving room for competition at the service level. Households and enterprises enjoy affordable telecommunication services and penetration rates are above the regional average both for fixed and mobile services.***

**Mobile services:** There are three MNOs in Liechtenstein: the majority state-owned Telecom Liechtenstein, Salt (Liechtenstein), and Swisscom. In addition, consumers may also choose to subscribe directly to the Swiss tariff plans of Salt Mobile, and Swisscom, which offer plans where customers enjoy local rates while in Liechtenstein. That is, despite having a Swiss number, domestic rates rather than roaming tariffs are applied to these customers while they are in Liechtenstein. Customers opting for plans from Liechtenstein's MNOs enjoy the roam-like-at-home tariffs stipulated by the EU Roaming Regulation while roaming in EU countries, whereas customers opting for Swiss tariffs have to pay roaming charges when travelling to other EU countries.<sup>290</sup> The three MNOs in Liechtenstein launched LTE services concurrently in 2015.

**Fixed services:** The majority state-owned incumbent Telecom Liechtenstein holds 85 per cent of the fixed market share. A separate fully state-owned utility company, Liechtensteinische Kraftwerke (LKW), owns, operates and maintains most of the fixed-network infrastructure (copper, cable, and fibre). LKW also manages the electric power network infrastructure in the Principality and is preparing the roll-out of a national FTTB access network, with expected completion in the early 2020s. While in decline, uptake of fixed telephone services is still relatively high in Liechtenstein compared with most other European countries. However, there is a trend towards IP-based bundled services that combine voice, Internet and TV (WTO, 2017).

**Government policy:** As a member of the European Economic Area (EEA), the EU telecommunication acquis applies in Liechtenstein. The latest revision to the Communications Act was in 2010 and is in the process of being reviewed to transpose the

Key indicators for Liechtenstein (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	43.4	37.7 13.6
Mobile-cellular sub. per 100 inhab.	117.4	118.0 101.5
Fixed-broadband sub. per 100 inhab.	42.2	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	119.3	80.1 52.2
3G coverage (% of population)	99.0	98.5 85.0
LTE/WiMAX coverage (% of population)	96.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.2	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.3	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.2	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.2	0.6 6.8
Percentage of households with computer	90.5	79.6 46.6
Percentage of households with Internet access	n.a.	82.5 51.5
Percentage of individuals using the Internet	98.1	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	556.8	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

latest EU telecommunication directives in the area of electronic communications. The Office for Communications is the telecommunication regulatory body in Liechtenstein and oversees the obligations imposed to the MNOs (e.g. regulated termination rates and retail roaming tariffs) as well as to the two dominant fixed operators: Telecom Liechtenstein and LKW. With the aim of promoting investment in a small market while fostering competition, two key policies have been implemented: the obligation to share mobile towers imposed to all MNOs and the vertical separation of the fixed-line incumbent. The latter was a decision of the Government of the Principality of Liechtenstein that came into effect in 2007, thus separating the network infrastructure operations and the retail businesses of the fixed incumbent. The Office for Communications oversees that wholesale access to LKW network is granted to all players on a non-discriminatory basis.

**Conclusion:** Despite its small size, Liechtenstein's telecommunication market benefits from a competitive environment in the fixed and mobile segments based on the non-discriminatory access for all telecommunication service providers to the network infrastructure. The determined policy and regulatory initiatives undertaken by the government and the regulator have fostered competition and supported infrastructure investment. This is reflected in the high fixed-broadband penetration rate achieved by the Principality, well above the European average, as well as the early development and high growth rates recorded in the mobile-broadband market.

## Lithuania

**Lithuania has a vibrant and advanced telecommunication market with high penetration rates and affordable prices for customers. The small Baltic country of just under 3 million inhabitants is one of the leading countries for fibre roll-out in Europe and the world.**

**Mobile services:** Lithuania's highly competitive mobile market is served by three MNOs (Telia, Bite Lietuva, and TELE 2) and ten MVNOs (European Commission, 2017). Prices for both mobile-cellular and mobile-broadband services are very affordable and continue to decrease. Number portability, which was introduced in 2004, had an important impact on the level of competition and thus drove down prices by removing barriers to customer choice.<sup>291</sup> Mobile-broadband penetration is slightly below the European average, but growing fast. The highest share of investments by mobile operators are made in LTE networks, which were first introduced in 2011 by Telia.<sup>292</sup>

**Fixed services:** Fixed-broadband penetration in Lithuania is slightly below the European average, but showed very high growth rates in recent years. Incumbent operator Telia still holds the largest market share in the fixed sector. However, regulatory measures have strengthened competition to the extent that new entrants were able to decrease Telia's market share to just over 50 per cent. The Lithuania Government as well as private operators are investing heavily in fibre infrastructure in order to increase Internet speeds. The share of fibre subscriptions out of the total number of fixed-broadband subscriptions is above 50 per cent and thus among the highest in Europe. Broadband speeds are among the fastest in the region as well (PTS, 2015). In line with the global trend towards fixed-to-mobile substitution, fixed-telephone penetration is on the decline in Lithuania.

**Government policy:** Lithuania became an EU member in 2004, just one year before the law to liberalize the telecommunication sector came into force. The EU membership had a decisive impact on telecommunication policies and the regulatory environment in Lithuania. In line with the EU policy, the focus of the government is on broadband development. The country's Digital Agenda focuses on providing incentives for

Key indicators for Lithuania (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	17.8	37.7	13.6
Mobile-cellular sub. per 100 inhab.	140.7	118.0	101.5
Fixed-broadband sub. per 100 inhab.	28.7	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	69.8	80.1	52.2
3G coverage (% of population)	100.0	98.5	85.0
LTE/WiMAX coverage (% of population)	98.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.3	1.0	5.2
Fixed-broadband prices (% GNI pc)	1.0	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.4	0.6	6.8
Percentage of households with computer	70.5	79.6	46.6
Percentage of households with Internet access	71.7	82.5	51.5
Percentage of individuals using the Internet	74.4	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	198.6	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

broadband investments by private operators. Where there was little economic interest for private investment, the government completed several development projects in order to extend NGA infrastructure to rural areas of the country. Lithuania's strategy also looks at the demand side, which it aims to stimulate through the development of relevant content and skills to use ICTs. Broadband Internet, a public entity owned by the Ministry of Transport and Communications, is in charge of implementing the national broadband strategy and operates a public backhaul network which connects numerous public and private institutions. It also provides open access services to private providers.<sup>293</sup>

**Conclusion:** The efforts led by the Lithuania Government, spurred by EU accession, have transformed Lithuania into a highly developed ICT nation. Lithuania's digital agenda focuses on the extension of NGA networks and aims to bridge the digital divide between urban and rural areas.

## Luxembourg

**One of Europe's last state-owned operators dominates the telecommunication market in this small state with very high mobile and fixed penetration rates and affordable prices. Luxembourg stands out for being an international connectivity hub, taking advantage of its privileged position at the heart of Europe.**

**Mobile services:** Penetration rates for mobile-cellular and mobile-broadband services are well above the European average and offers are very affordable to Luxembourg customers. 3G and LTE coverage are almost complete and operators continue to invest to improve mobile connectivity and speeds. All three mobile network operators active in Luxembourg offer LTE services, which were first launched in 2012 (Service des médias et des communications, 2013). State-owned operator POST Luxembourg (formerly LUXGSM) dominates the mobile market with about half of the total subscription base (European Commission, 2017).

**Fixed services:** Luxembourg has a very-well developed fixed telecommunication infrastructure. Penetration rates for fixed-telephone and fixed-broadband are above the European average and prices are affordable. While mobile-cellular penetration is high, fixed-telephone penetration does not show the same downward trend that can be observed in other mature markets. Operators are investing heavily in fibre infrastructure with the goal of making Luxembourg the first “fibre” country of the European Union, with full fibre coverage (Service des médias et des communications, 2013). Investments in fibre also helped to underpin Luxembourg’s position as an international connectivity hub and top location for data centres in Europe.<sup>294</sup> POST Luxembourg, the state-owned incumbent operator, dominates the telecommunication market despite the market liberalization in 1998.

**Government policy:** Luxembourg is a founding member of the European Union. While it has adopted EU telecommunication directives, its policies are distinct, as the incumbent operator POST Luxembourg is state-owned. The small state has already achieved the targets set by the Digital Agenda for Europe. Its national broadband plan, which was adopted in 2010, aims to achieve 1 Gbit/s download and 500 Mbit/s upload speeds for 100 per cent of the population by 2020. This

Key indicators for Luxembourg (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	50.3	37.7 13.6
Mobile-cellular sub. per 100 inhab.	138.9	118.0 101.5
Fixed-broadband sub. per 100 inhab.	36.9	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	87.6	80.1 52.2
3G coverage (% of population)	99.0	98.5 85.0
LTE/WiMAX coverage (% of population)	95.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.4	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.7	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.2	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.1	0.6 6.8
Percentage of households with computer	95.9	79.6 46.6
Percentage of households with Internet access	96.4	82.5 51.5
Percentage of individuals using the Internet	97.5	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	8,397.9	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

is to be achieved through the roll-out of fibre technology with a priority set on connecting public and academic institutions. Furthermore, the strategy introduces an obligation to provide reception infrastructure for optic fibre and ready in-house cabling in new dwellings. Competition between operators is to be strengthened and alternative operators are allowed access to the incumbent’s network.<sup>295</sup>

**Conclusion:** Luxembourg, one of the smallest European markets, has a very advanced ICT infrastructure and is on the way to becoming Europe’s first fibred nation. ICT household penetration is very high and almost the entire population is online.

## Madagascar

*The fourth largest island in the world is seeking to become an Indian Ocean hub, while recognizing the need to address the large digital divide between the country's rural and urban areas.*

**Mobile services:** There are four facilities-based mobile operators in Madagascar: AIRTEL, a subsidiary of the Indian mobile group, launched in 1997; Orange, a subsidiary of Orange France, launched in 1998; Telecom Malagasy (TELMA), the incumbent, which entered the market in 2006; and Gulfsat Madagascar, which products and services are branded under the name Blueline. Despite the number of operators, there are coverage gaps and affordability challenges in Madagascar. Household penetration is relatively low, at just over a third of homes in 2016, with a significant difference between urban (73 per cent) and rural areas (29 per cent).<sup>296</sup> All of the operators have deployed 3G and, following renewal of their licenses, deployed LTE mobile-broadband networks.

**Fixed services:** Incumbent operator TELMA had been partly privatized since its creation, with a subsidiary of then-France Telecom owning 34 per cent. Those shares, along with an additional 36 per cent, were sold in 2004 to a consortium led by a private mobile group based in Hong Kong Special Administrative Region of China. A privately held local group, AXIAN, eventually gained control of TELMA; it also operates mobile networks throughout the Indian Ocean region in Comoros, Mayotte and Reunion. TELMA provides fixed-telephone service using copper lines and wireless local loop. Its fixed-broadband offerings include ADSL and fixed wireless using WiMAX, and offers fibre-optic connections, mainly to businesses. Other ISPs use fixed wireless broadband technology. TELMA has several thousand kilometres of optical fibre in its national backbone. The arrival of undersea fibre-optic cables – Lower Indian Ocean Network (LION) in 2009 and Eastern Africa Submarine System (EASSy) in 2010 – has dramatically boosted international bandwidth and reduced prices. The Madagascar Global Internet eXchange was launched in 2016 in Antananarivo.

**Government policy:** The Ministry of Posts, Telecommunications and Digital Development is the sector policy-maker. It is supporting a

Key indicators for Madagascar (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.6	1.0	13.6
Mobile-cellular sub. per 100 inhab.	32.1	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.1	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	8.1	22.9	52.2
3G coverage (% of population)	63.0	59.3	85.0
LTE/WiMAX coverage (% of population)	23.1	25.7	66.5
Mobile-cellular prices (% GNI pc)	44.9	14.2	5.2
Fixed-broadband prices (% GNI pc)	152.0	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	15.1	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	40.0	17.7	6.8
Percentage of households with computer	6.2	9.6	46.6
Percentage of households with Internet access	7.0	16.3	51.5
Percentage of individuals using the Internet	4.7	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	14.3	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

number of projects to widen ICT infrastructure and use. This includes (a) extending infrastructure to uncovered zones; (b) development of the Smart City Nosy Be; (c) deployment of so-called “digital window” computer labs in educational institutions; (d) expanding the higher education research network and distributing tablet computers to schools. The Authority for Regulation of Communications Technologies (ARTEC) replaced the previous regulator, the Malagasy Office of Studies and Regulation of Telecommunication, in 2015. The change broadens the regulatory portfolio to include ICT in addition to telecommunications. ARTEC regulates according to Law 2005-023 of 17 October 2005 revising Law 96-034 of 27 January 1997 on Institutional Reform of Telecommunications and ICT.

**Conclusion:** The large island has significant potential as an ICT hub given its strategic location in the Indian Ocean. The challenge remains to address the wide divide in ICT access between urban and rural areas, which could be lessened by enhancing the utilization of universal access funds.

## Malawi

***As a landlocked country, the Government is keen to facilitate backbone development in order to access additional cross-border Internet capacity through undersea cables.***

**Mobile services:** There are two mobile operators. Telekom Networks Malawi Limited (TNM) launched in 1995 as a joint venture between incumbent Malawi Telecommunications Limited (MTL) and Telekom Malaysia. TNM acquired Telekom Malaysia's stake in 2007 and in 2008 listed some of its shares on the local stock market, with the remainder of the company owned by local business interests. AIRTEL, a subsidiary of the Indian mobile group, launched in 1999. While mobile coverage is ubiquitous in urban areas, it has been challenging to achieve widespread rural coverage due to electricity constraints. Coupled with relatively high prices, partly due to a variety of taxes, access is relatively low, with just under half (45 per cent) of households having mobile phones in 2015.<sup>297</sup> There is a wide gap between urban (85 per cent) and rural (42 per cent) homes in household mobile telephone penetration. Mobile-broadband was introduced in 2009, when TNM launched 3G, followed by AIRTEL a year later. TNM deployed a commercial LTE network in 2016.

**Fixed services:** MTL is the incumbent operator. It was partly privatized in 2006, when 80 per cent was sold to a consortium led by Press Corporation, the country's largest conglomerate, which also owns 41 per cent of TNM. In 2006, MTL's fibre-optic backbone was separated into a new company, Open Connect Limited (OCL). MTL is the sole provider of fixed-telephone services. Fixed-broadband options include ADSL, fixed wireless broadband and optical fibre for businesses and government in urban areas. A national fibre-optic network is critical for landlocked Malawi. OCL operates the most expansive fibre-optic backbone, with cross-border connections to Tanzania to access the East Africa Submarine System (EASSy) submarine cable. Until recently, it had a monopoly. However, new backbone operators have recently entered the market, including SimbaNet, Electricity Supply Corporation of Malawi and AIRTEL. The Malawi Internet Exchange was established in Blantyre in 2008.

**Government policy:** The Ministry of Information and Civic Education provides policy guidance on

Key indicators for Malawi (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.1	1.0	13.6
Mobile-cellular sub. per 100 inhab.	40.3	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	18.5	22.9	52.2
3G coverage (% of population)	42.0	59.3	85.0
LTE/WiMAX coverage (% of population)	15.8	25.7	66.5
Mobile-cellular prices (% GNI pc)	26.4	14.2	5.2
Fixed-broadband prices (% GNI pc)	24.7	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	14.8	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	25.7	17.7	6.8
Percentage of households with computer	6.4	9.6	46.6
Percentage of households with Internet access	11.5	16.3	51.5
Percentage of individuals using the Internet	9.6	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	4.2	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

matters concerning the media, access to public information, broadcasting, telecommunications, postal services, civic education and ICT. The 2013 National ICT Policy sets the direction for the sector. The overarching goal is to contribute to the country's socio-economic development through maximum integration of ICT in all sectors and the provision of ICT services to the rural areas. The Malawi Communications Regulatory Authority is the regulator responsible for posts, telecommunications and broadcasting, established pursuant to Section 3 of the Communications Act, 1998.

**Conclusion:** A new direction is being established for the ICT sector as more players from the public and private sector emerge in the backbone market. This should result in additional connections to different undersea fibre networks in neighbouring countries, making access and usage of ICTs more affordable.

## Malaysia

***The Government is promoting high-speed Internet, with particular attention to rural areas and the is advantaged through Universal Service Provision initiatives.***

**Mobile services:** There are four major mobile operators: MAXIS, a publicly listed Malaysian company; CELCOM, formerly the incumbent's mobile arm and now owned by the Axiata Group; DiGi, a subsidiary of the Norwegian Telenor group; and U Mobile (Singapore's ST Telemedia has 49 per cent stake), which entered the market in 2008. There are also several mobile virtual network operators (MVNOs). Mobile penetration exceeds 100 per cent and 98 per cent of households had a mobile phone in 2015.<sup>298</sup> Mobile broadband has grown significantly since the launch of 3G networks in 2003. LTE services were launched in 2013 and operators have also deployed LTE-Advanced with download speeds of over 200 Mbps.

**Fixed services:** The incumbent Telekom Malaysia was partially privatized beginning in 1990 and ongoing sales since then have resulted in the Government now directly owning just over a quarter of the company. Telekom Malaysia is the leading fixed telephony provider. Fixed telephony has declined since its peak in 2010 owing to the popularity of mobile. The decline has been partly offset by bundling voice with fixed broadband. Fibre broadband subscriptions have been increasing, mainly as a result of the roll-out of the Government's High Speed Broadband Project (HSBB), a public-private partnership with Telekom Malaysia to rollout fibre-optic connections in selected areas. Telekom Malaysia and Time dotCom have extensive national fibre-optic networks. In addition, Fibrecomm has an optical fibre network alongside the transmission network of electricity company Tenaga Nasional Berhad, and Fibreail has a fibre-optic network that takes advantage of rail and gas network rights-of-way. There are several submarine cables between Peninsular Malaysia and East Malaysia, as well as an undersea cable linking several locations in eastern Malaysia. The country is well provisioned with regional and intercontinental submarine cables and connected to more than ten systems. The Malaysia Internet Exchange was launched in 2006 and has over 50 members exchanging

Key indicators for Malaysia (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	15.6	10.0	13.6
Mobile-cellular sub. per 100 inhab.	141.2	98.9	101.5
Fixed-broadband sub. per 100 inhab.	8.7	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	91.7	47.4	52.2
3G coverage (% of population)	95.0	87.6	85.0
LTE/WiMAX coverage (% of population)	88.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.7	3.2	5.2
Fixed-broadband prices (% GNI pc)	1.1	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.8	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.4	5.4	6.8
Percentage of households with computer	72.2	37.8	46.6
Percentage of households with Internet access	76.9	45.5	51.5
Percentage of individuals using the Internet	78.8	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	42.6	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

domestic traffic. WiMAX operators are shifting to LTE.

**Government policy:** The Ministry of Communications and Multimedia (MCMC) is responsible for sector policy. The *Communications and Multimedia Act* of 1998 set out a new licensing framework for the industry. Malaysia became one of the first developing countries in the world to adopt technology-neutral licences distinguishing between infrastructure, services and content. The *Malaysian Communications and Multimedia Commission Act* (1998), created a new regulatory body, the Malaysian Communications and Multimedia Commission (MCMC), a regulatory body responsible for telecommunications, broadcasting and Internet regulation as well as industry promotion. The ongoing *National Broadband Initiative* has a target of 95 per cent broadband coverage for urban areas by 2020. The target speeds are 100 Mbps for urban households and at least 20 Mbps in 50 per cent of suburban and rural areas. The country's Universal Service Provision initiative has funded access for rural and other disadvantaged citizens including expanding mobile broadband coverage, creation of public broadband and broadband community centres and distribution of subsidized devices.

**Conclusion:** The country's competitive mobile market has resulted in a high level of access, and the Government has been engaged for over a decade in promoting high-speed Internet infrastructure and access. Malaysia has been a trendsetter among developing countries in terms of its licensing framework and the undoubted impact of its universal service fund.

## Maldives

***The Maldives is a good example of effective transition to liberalization of the ICT sector that has generated impressive levels of mobile-broadband coverage.***

**Mobile services:** The first GSM mobile network was launched in 1999, and the Maldives introduced mobile competition in 2005. By 2016, all inhabitants were covered by a 3G signal, and over half by LTE. The market leader is the incumbent operator Dhivehi Raajjeyge Gulhun Public Limited Company (DHIRAAGU). Six per cent of government shares in the company were offered to the public in 2011, leaving the government with 42 per cent shares, and in 2013 Cable & Wireless's 52 per cent stake in the company was purchased by the Bahrain Telecommunications Company. The second mobile operator is OOREDOO Maldives Public Limited Company, a subsidiary of the Qatari mobile group. Mobile penetration passed 100 per cent in 2007, two years after the introduction of competition. In 2014, 97 per cent of households had a mobile phone, with virtually no difference between the capital Male (97 per cent) and other atolls (96 per cent) (NBS Maldives, 2014). Mobile broadband has been popular since the introduction of 3G in 2005 and the whole population was covered by the end of 2015. LTE was launched in 2014 with rapid deployment reaching nationwide coverage by early 2017.

**Fixed services:** DHIRAAGU is the main fixed telephone service provider. The incumbent also offers ADSL with speeds of up to 15 Mbps, and in 2015 launched fibre-optic broadband with speeds of up to 100 Mbps. Focus Infocom and Ooredoo Maldives, the two other Fixed broadband providers, also offer fiber broadband with speeds up to 100 Mbps. Interestingly there are more fixed broadband subscriptions than fixed landlines in the country. The Maldives is well endowed with fibre-optic backbone connectivity, with two national networks and two international submarine cables. In 2007, an 850-kilometre undersea fibre-optic cable was deployed to Sri Lanka and another cable deployed both to India and Sri Lanka. In 2012, a national fibre-optic submarine backbone was completed. Spanning over 1 000 kilometres, it links all the main islands. A second national undersea fibre backbone was deployed in 2017.

Key indicators for Maldives (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	5.8	10.0	13.6
Mobile-cellular sub. per 100 inhab.	223.0	98.9	101.5
Fixed-broadband sub. per 100 inhab.	8.0	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	72.7	47.4	52.2
3G coverage (% of population)	100.0	87.6	85.0
LTE/WiMAX coverage (% of population)	80.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	1.0	3.2	5.2
Fixed-broadband prices (% GNI pc)	3.5	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.4	5.4	6.8
Percentage of households with computer	71.1	37.8	46.6
Percentage of households with Internet access	54.7	45.5	51.5
Percentage of individuals using the Internet	59.1	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	59.7	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The 2001 *Telecommunication Policy* initiated the process of liberalization. A regulator, the Communications Authority of Maldives, was established in 2003, followed by the introduction of competition in Internet and mobile services. The *Maldives Telecommunication Bill* was ratified in 2015. The Ministry of Home Affairs is responsible for ICT sector oversight. A second *Telecommunications Policy* was introduced in 2006 and the *National Broadband Policy* in 2014. The broadband policy covers the period 2014-2018 and calls for broadband to be made available on all inhabited islands, for ISPs to offer an entry-level broadband plan not exceeding 4 per cent of GDP per capita, and for 100 Mbps to be made available for all commercial and industrial centres.

**Conclusion:** Despite a challenging geography of some 200 inhabited islands, the Maldives has witnessed impressive ICT growth. The introduction of mobile competition in 2005 triggered a surge in subscriptions and virtually all households have a mobile phone. The country's ICT infrastructure is one of the strongest in South Asia, with nationwide LTE coverage, availability of fibre-optic broadband and fibre-optic national and international backbones.

## Mali

***This landlocked West African nation has achieved a high level of basic telecommunication access, despite limited competition in the mobile market. The Government is making efforts for further developing the ICT sector.***

**Mobile services:** There are two mobile operators: MALITEL, the mobile arm of the incumbent Telecommunications Society of Mali (SOTELMA), which launched services in 2000; and Orange, a subsidiary of Senegal’s incumbent operator SONATEL, which entered the market with a global license (mobile, fixed and Internet) in 2003. Despite only two operators, competition has been fierce, particularly since the 2009 privatization of SOTELMA. As a result, there is widespread GSM coverage and high uptake, with the *2015 Malaria Indicator Survey* finding that 90 per cent of households had a portable phone: 98 per cent in urban areas and 88 per cent in rural areas.<sup>299</sup> A third mobile license has been awarded to the Planor–Monaco Telecom International consortium, which will operate through the Malian company Alpha Telecom. Orange launched 3G in 2010, followed by MALITEL in 2012. Operators are waiting on licenses for the deployment of LTE networks.

**Fixed services:** The incumbent SOTELMA was privatized in 2009 following sale of 51 per cent of its shares to Morocco Telecom. It is the most active operator on the fixed-telephone market, offering service using copper lines and wireless local loop CDMA. In fixed Internet, it has deployed ADSL and fixed wireless broadband. Other operators provide fixed wireless broadband. Orange and SOTELMA have built out around 6 000 km of fibre-optic networks to neighbouring countries so that landlocked Mali can access undersea fibre-optic cables. Mali is surrounded by seven countries, of which five are sea-facing. The first connection was to Senegal, since at the time it was the closest neighbour that had submarine cables. Since then, fibre has been built out to all borders except one, and Mali has access to several undersea fibre-optic cables. The Government has also deployed over 3 000 km of fibre-optic cable to connect administration buildings throughout the country.

**Government policy:** The Minister of the Digital Economy, Information and Communication is

Key indicators for Mali (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	1.2	1.0 13.6
Mobile-cellular sub. per 100 inhab.	120.5	74.6 101.5
Fixed-broadband sub. per 100 inhab.	2.1	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	24.9	22.9 52.2
3G coverage (% of population)	23.0	59.3 85.0
LTE/WiMAX coverage (% of population)	0.0	25.7 66.5
Mobile-cellular prices (% GNI pc)	19.5	14.2 5.2
Fixed-broadband prices (% GNI pc)	26.4	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	12.5	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	20.0	17.7 6.8
Percentage of households with computer	3.2	9.6 46.6
Percentage of households with Internet access	8.9	16.3 51.5
Percentage of individuals using the Internet	11.1	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	0.6	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

the sector policy-maker. The Government has identified ICT as one of four key economic sectors, along with agriculture, trade and education. One of the flagship government projects is the Digital Complex of Bamako, featuring a training institute, data centre, offices for ICT businesses, incubator and exhibition hall. The 2011 Ordinance Relative to Telecommunications and Information and Communications Technology is the relevant law guiding the sector. The Malian Authority for Regulation of Telecommunications/ICT and Posts is the independent administrative authority responsible for sector regulations, created in 2011, when it replaced the Telecommunications Regulation Committee. In addition to its regulatory duties, the Authority is also responsible for universal service and managing the country code top-level domain name (.ml). In 2015, the Government adopted *Plan Mali Digital 2020*, a national strategy of development of the digital economy, which aims to further develop ICT sector.

**Conclusion:** The landlocked LDC has made impressive gains in connecting the population to mobile phones. Through deployment of fibre-optic cables across the country and the adoption of a new digital strategy, the Government is making efforts to strengthen the ICT sector in Mali.

## Malta

**Malta, the European Union member state with the smallest population of just over 400 000 inhabitants and the highest population density, has a very well developed telecommunication market. The market is competitive and penetration rates are high for mobile and fixed services.**

**Mobile services:** Malta has a vibrant mobile market with strong growth rates and competition between the operators. The mobile market is served by three mobile network operators, and smaller virtual operators. Vodafone is the market leader, closely followed by Go Mobile and Melita taking the third place. Mobile-broadband penetration remains below the European average, but is showing a strong growth rate (MCA, 2016). LTE was first launched in November 2013 and 3G, and LTE population coverage is complete. Operators have also started to rollout LTE-Advanced networks.

**Fixed services:** The country has a very high penetration of fixed services with fixed-telephone and fixed-broadband penetration rates above the European average. Go, which is the incumbent operator and majority-owned by Tunisie Telecom, holds the largest share in both the fixed-telephone and fixed-broadband markets, but is facing strong competitors in both markets (MCA, 2016). Malta's small size and high population density provided the conditions for the roll-out of both the traditional public telephone network by the incumbent operator as well as a cable network by alternative operator Melita cable, also referred to as the "cable incumbent".<sup>300</sup> In 2016, fixed-broadband subscriptions were based on cable (47 per cent), xDSL (44 per cent), FTTH (6 per cent) and fixed wireless (3 per cent). Broadband speeds are increasing consistently and, in 2016, subscriptions with speeds of more than 30 Mbit/s made up more than half of the total subscriptions (MCA, 2016).

**Government policy:** Malta's telecommunication sector was liberalized prior to European Union accession in 2004. Regulatory measures were aligned with EU directives and competition increased. Broadband development is an important focus of policy-makers in Malta. The *Digital Malta Strategy 2014-2020* included amongst its objectives the continued roll-out of ultra-fast broadband infrastructure. It aims at

Key indicators for Malta (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	54.2	37.7 13.6
Mobile-cellular sub. per 100 inhab.	123.1	118.0 101.5
Fixed-broadband sub. per 100 inhab.	39.6	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	71.4	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	100.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.8	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.1	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.8	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	0.6 6.8
Percentage of households with computer	81.6	79.6 46.6
Percentage of households with Internet access	81.1	82.5 51.5
Percentage of individuals using the Internet	77.3	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	1,596.3	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

achieving 100 per cent coverage with broadband at speeds of 30 Mbit/s (which has now been achieved) and 50 per cent take-up of 100 Mbit/s by 2020. To achieve these goals, the government follows a technology-neutral approach and emphasizes the importance of competition in the telecommunication market (Government of Malta, 2014). The Malta Communications Authority (MCA) has also published measures for the assignment of the 800 MHz spectrum band to strengthen competition in the mobile-broadband sector.

**Conclusion:** Over the past decades, Malta has developed into one of the EU's most advanced telecommunication markets. ICT household penetration is similar to the European average and more than two-thirds of the population are using the Internet. Malta's Digital Strategy puts the country on the road to continue this development, by further investing in fixed- and mobile-broadband infrastructure and creating a competitive environment.

## Marshall Islands

**Despite challenges owing to the high costs of connecting its relatively small population dispersed over a number of atolls, this Pacific Island nation is making steady progress in increasing connectivity.**

**Mobile services:** The majority state-owned National Telecommunications Authority (NTA) is the only service provider. GSM mobile service is available in the capital Majuro and on five atolls and islands. NTA skipped the deployment of 3G mobile broadband and went straight to LTE, which was launched in Majuro in March 2017.

**Fixed services:** NTA is the only provider of fixed telephone services, which have limited uptake. Fixed broadband using ADSL with speeds up to 1.5 Mbps is available on five atolls. Leased lines and self-provisioned fibre-optic connections are available for businesses. Wi-Fi is available in the capital and Ebeye atoll. Internet cafes are provided on some of the atolls using satellite. Majuro and Kwajalein, a US government military site, are connected to an undersea fibre-optic cable system (HANTRU) that links the Marshall Islands to Guam and the Federated States of Micronesia. HANTRU was commissioned in 2010.

**Government policy:** The Ministry of Transport and Communications (MTC) is responsible for the overall regulation, promotion and development of transportation and communications. A draft Communications Law calls for the creation of the Office of the Regulator. Meanwhile, the *National Telecommunications Authority Act* of 1990 remains the relevant legislation. The national *ICT Policy* adopted in 2012 provides for market liberalization including increasing private participation and investment in the provision of ICT services, strengthening the incumbent to operate in a competitive environment, and introducing competition.

**Conclusion:** Despite geographic challenges in the provision of telecommunication services, the Marshall Islands are taking steps towards market liberalization. The recent launch of LTE networks is also expected to boost the ICT sector in this Pacific Island nation.

Key indicators for Marshall Islands (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	n.a.	10.0	13.6
Mobile-cellular sub. per 100 inhab.	n.a.	98.9	101.5
Fixed-broadband sub. per 100 inhab.	1.9	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	0.0	47.4	52.2
3G coverage (% of population)	n.a.	87.6	85.0
LTE/WiMAX coverage (% of population)	n.a.	73.6	66.5
Mobile-cellular prices (% GNI pc)	5.6	3.2	5.2
Fixed-broadband prices (% GNI pc)	12.6	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	n.a.	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	n.a.	5.4	6.8
Percentage of households with computer	20.7	37.8	46.6
Percentage of households with Internet access	18.1	45.5	51.5
Percentage of individuals using the Internet	29.8	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	34.6	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

## Mauritania

***Mauritania ICT sector is witnessing great developments thanks to increased competition and high penetration of mobile cellular, mobile broadband, and increased Internet users. Fixed broadband and mobile-broadband service prices remain relatively high in Mauritania and affordability remains a major barrier.***

**Mobile services:** Mobile-cellular penetration levels are close to the Arab States region and global averages, however, mobile-broadband penetration lags behind these averages. This can be attributed to the difficulties in covering the large geographical area of the country. The level of competition is considered high in a mobile sector with three operators. The Post Office and Telecommunications (OPT) was in monopoly before 2000. After the dismantling of the monopoly of the OPT, the telecommunications and postal activities were separated. Competition started following the award of two GSM licenses granted in May 2000 to Mattel (owned by Tunisie Telecom) and in July 2000 to Mauritel (owned by Maroc Telecom), the latter comes from the former monopoly (OPT). In 2007, the third operator, Chinguitel (a subsidiary of Sudatel), launched its cellular and fixed services, thus ending the duopoly of Mauritel Mobile and Mattel. All three operators acquired technology-neutral licences. Chinguitel was the first operator to launch 3G services in 2007. Mauritel Mobile launched 3G services in 2009, and Mattel in 2011. All operators are providing 3G services in the 2100 MHz band. None of the operators have yet acquired an LTE licence.

**Fixed services:** The fixed-line penetration is low and in decline, due to high investment and replacement by mobile technologies. Mauritania mobile and fixed-wireless operators are providing fixed ADSL services in main cities. Mauritel launched ADSL services in 2006. Mobile and fixed-wireless operators are providing fixed services in rural areas, mainly through the national universal service fund or from international development banks, such as the World Bank. Extensive efforts are made to roll out fibre backbone infrastructure between major cities, and to cover rural areas with satellite broadband services.

**Government policy:** The Regulatory Authority is an independent public corporation, with financial and managerial autonomy, governed by a law of

Key indicators for Mauritania (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	1.3	7.7	13.6
Mobile-cellular sub. per 100 inhab.	86.5	107.1	101.5
Fixed-broadband sub. per 100 inhab.	0.3	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	30.2	45.2	52.2
3G coverage (% of population)	41.0	81.9	85.0
LTE/WiMAX coverage (% of population)	0.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	16.3	4.3	5.2
Fixed-broadband prices (% GNI pc)	10.0	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	29.2	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	29.2	5.5	6.8
Percentage of households with computer	5.0	43.3	46.6
Percentage of households with Internet access	11.2	45.3	51.5
Percentage of individuals using the Internet	18.0	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	4.5	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

2001. The Regulatory Authority is responsible for regulating activities and laws within the territory of the Islamic Republic of Mauritania in the sectors of water, electricity, telecommunications, and postal services. The Regulatory Authority mission in each sector is to ensure continuity of service and to protect public interests that ensures effective, fair and healthy competition, economic and financial stability, and includes consultation with users and operators. The regulator has the power to impose sanctions in case of breach of their obligations under the laws, regulations and specifications.

**Conclusion:** The efforts made by the Government of Mauritania, and the three telecommunication operators over the past 15 years have improved connectivity and reduced the digital divide. Mauritania's recent plans include: to further develop countrywide high-speed networks by licensing LTE services, expand satellite broadband coverage, and roll out fibre-to-the-home network in the capital and main cities.

## Mauritius

***The Indian Ocean Island State is successfully leveraging ICT as a strategic pillar with one of the most advanced digital economies in sub-Saharan Africa.***

**Mobile services:** There are three mobile operators in the country. EMTel was originally a joint venture of the Luxembourg-based MILLICOM mobile group and local firm Currimjee Jeewanjee and Co; the latter bought out the former's shares in 2014. EMTel was the first mobile operator in the southern hemisphere when it launched in 1989. The second mobile operator, CELLPLUS, the mobile arm of the incumbent Mauritius Telecom (MT), entered the market in 1996. The last was MTML, a subsidiary of Mahanagar Telephone Nigam Limited, the State-owned operator in the Indian cities of Mumbai and New Delhi. It originally launched using CDMA technology and later deployed a GSM network in 2011. Mauritius has near-ubiquitous coverage due to its small land size and high population density. In 2016, 95 per cent of households had mobile telephones.<sup>301</sup> Mauritius has been at the forefront of mobile-broadband deployment in the region. EMTel launched the first 3G network in Africa in 2004, followed by HSDPA in 2007 and LTE in 2012. The other mobile operators have also deployed 3G and LTE networks.

**Fixed services:** MT was privatized in 2000, when 40 per cent was sold to then-France Telecom (Orange). It is the main provider of fixed-telephone services, offering plain copper line service as well as bundled service with television and/or Internet. In the fixed-broadband market, MT offers ADSL as well as fibre-optic packages up to 200 Mbit/s. EMTel also offers fixed-telephone service and fixed-broadband with speeds up to 140 Mbit/s. Other ISPs offer fixed-broadband wireless and MT has also deployed free Wi-Fi hotspots in 350 locations around the island. MT has an extensive national backbone network, and other operators have built out fibre routes with selected coverage areas. Mauritius was one of the earliest African nations to connect to undersea fibre-optic cable through SAFE in 2002. In 2009, it connected to the Lower Indian Ocean Network (LION), linking Mauritius with Reunion and Madagascar. In 2010, the Government implemented an open access policy at landing stations to ensure non-discriminatory access by all operators. The

Key indicators for Mauritius (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	31.0	1.0 13.6
Mobile-cellular sub. per 100 inhab.	144.2	74.6 101.5
Fixed-broadband sub. per 100 inhab.	16.9	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	51.7	22.9 52.2
3G coverage (% of population)	95.4	59.3 85.0
LTE/WiMAX coverage (% of population)	36.7	25.7 66.5
Mobile-cellular prices (% GNI pc)	0.6	14.2 5.2
Fixed-broadband prices (% GNI pc)	0.3	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.7	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.0	17.7 6.8
Percentage of households with computer	61.2	9.6 46.6
Percentage of households with Internet access	63.8	16.3 51.5
Percentage of individuals using the Internet	53.2	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	63.5	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Mauritius IXP launched in 2015 and has a dozen members, including all of the main telecom providers and ISPs operating in the country.

**Government policy:** The Ministry of Technology, Communication and Innovation has overall responsibility for the sector, including strategies for e-government and cybersecurity. The 2012 National Broadband Policy lays out the country's vision for high-speed Internet access through 2020. Its overall aim is to facilitate affordable and universal access to broadband infrastructure and service to create the opportunities for the country to grow as a knowledge-based society. The five policy objectives are (a) to achieve robust competition and, as a result, maximize consumer welfare, innovation and investment; (b) to ensure efficient allocation and management of scarce resources, such as spectrum, facilities (e.g. poles) and rights-of-way, to encourage network upgrades and competitive entry; (c) to reform current universal service mechanisms to support universal deployment of broadband even in high-cost areas, and ensure that low-income Mauritians can afford broadband; (d) to support efforts to boost adoption and utilization of broadband; and (e) to facilitate reform to laws, policies, standards and incentives to maximize the benefits of broadband in sectors where Government influences significantly, such as public education, health care and government operations. Targets include close to 100 per cent of households having affordable access to download speeds of 100 Mbit/s, as well as being able to use broadband to track and manage their real-time energy consumption. The Information and Communications Technology Authority (ICTA) is the national regulator for the ICT sector as mandated under the Information and

Communication Technologies Act of 2001, while the Postal Authority caters for the regulation of postal and courier services in Mauritius under the Postal Services Act 2002. The Information and Communication Technologies Act of 2001 provides for the regulation of the sector.

**Conclusion:** Early liberalization of the telecom sector and the Government's vision of ICT as a strategic pillar of the economy have driven ICT uptake in the country. Mauritius has widespread access to the latest broadband technologies, and has a growing offshore ICT-enabled business processing outsourcing sector.

## Mexico

**Despite undergoing a market liberalization process two decades ago, the national telecommunications sector has been slow to develop, with penetration rates below the regional averages. In 2013, a reform act was adopted which prioritizes a competitive environment with accessible prices, quality of service and coverage, giving the regulator, the Instituto Federal de Telecomunicaciones (IFT), the autonomy and power to promote the three aforementioned pillars (IFT, 2016). The industry has flourished in the past few years, generating growth rates of more than 10 per cent since the fourth quarter of 2015 and attracting substantive foreign direct investment (FDI) (totalling a tenth of the total FDI in Mexico for 2015).**

**Mobile services:** Despite being the second largest mobile market in Latin America in terms of unique subscribers, the penetration levels remain lower than the regional averages. The market is led by Telcel, which had 67 per cent of the market share in the first quarter of 2017 and is subject to asymmetric regulation for possessing significant market power. The other two operators, Movistar and AT&T, are respectively second and third in terms of presence. Telcel is facing increasing competition from new mobile virtual network operators (MVNOs), whose market share has been increasing, as well as reorganizing itself in order to shrink its market share to comply with the 2013 reform act requirements.<sup>302</sup> Most mobile subscriptions are prepaid in Mexico. Smart phones are the most commonly used device to access the Internet in Mexico, but there is considerable discrepancy within the population, as people with higher education and wealthier groups are overly represented among the smart phone users.<sup>303</sup> Before the 2013 Reform Act, only 222 MHz of spectrum for mobile services was allocated. This increased to 449 MHz in the first quarter of 2017. Moreover, with the aim of improving mobile broadband and market competition, 594 MHz are expected to be allocated by 2019 (IFT, 2016).

**Fixed services:** At the beginning of 2017, Telmex, the incumbent, had more than 60 per cent of the market share and is under asymmetric regulation by the regulatory body for possessing significant market power. In terms of technology used to provide fixed-broadband, copper networks are

Key indicators for Mexico (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	16.2	24.4	13.6
Mobile-cellular sub. per 100 inhab.	88.2	114.2	101.5
Fixed-broadband sub. per 100 inhab.	12.7	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	59.3	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	83.8	77.4	66.5
Mobile-cellular prices (% GNI pc)	0.8	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.3	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.3	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.0	5.7	6.8
Percentage of households with computer	45.6	64.9	46.6
Percentage of households with Internet access	47.0	63.3	51.5
Percentage of individuals using the Internet	59.5	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	37.6	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

the most present, with cable modem in second place, followed by optical fibre. The latter of these is becoming increasingly available and more often employed, its usage having increased 185 per cent from 2014 to 2017.<sup>304</sup>

**Government policy:** The national body responsible for regulating the sector, IFT, has actively engaged in the promotion of competition, especially by implementing asymmetric regulations for dominant operators, and sector development by encouraging investment. The Mexican population has been reaping the benefits of public efforts; for instance, between June 2013 and August 2017, telecommunication prices decreased by 28.9 per cent, although during the same period the consumer price index increased by 17.3 per cent. During this period, national long distance charges were eliminated, international long distance prices were cut by more than 40 per cent and there was an overall price reduction of 43 per cent in mobile services.

**Conclusion:** As the sector develops and services become increasingly available and affordable, the challenge remains to bridge the digital divide within Mexico itself, as the country's population is marked by high inequality in terms of revenue and education, both of which have a direct impact on ICT usage.

## Micronesia (Federated States of)

***This Pacific Island nation faces the challenges of a small population dispersed over a large area. Planned submarine cable projects should transform the ICT environment. The Federated States of Micronesia (FSM) has been a sovereign nation since achieving independence in 1986 from a US-administered UN trusteeship. FSM operates under a Compact of Free Association with the United States, which was amended and renewed in 2004.***<sup>305</sup>

**Mobile services:** The state-owned incumbent Federated States of Micronesia Telecommunications Corporation (FSMTC) is the sole mobile operator. In 2014, 46 per cent of households had a mobile phone.<sup>306</sup> A 3G network was deployed in 2015 and is available mainly in urban areas.

**Fixed services:** FSMTC is the sole provider of fixed line telephone services. It also provides ADSL fixed broadband. The country is connected to the HANTRU-1 undersea fibre-optic cable, which landed in 2010 linking Pohnpei to Guam.

**Government policy:** The Department of Transportation, Communications and Infrastructure (DTCI) is responsible for the ICT sector. The first ICT and Telecommunications Policy was issued in 2012 with five goals: i) to achieve accessible, secure and affordable broadband communications for all; ii) to strengthen ICT human resources and increase human resource development opportunities through the use of ICT; iii) to improve economic growth and sustainable development through ICT; iv) to utilize ICT for good governance; and v) to create an enabling ICT environment through policy reform and improvements in legal frameworks. The process of implementing the fifth goal of the National ICT Policy was initiated through adoption of the *Telecommunications Act of 2014*. It addresses each strategic objective of the envisioned policy and legal reforms to create an enabling ICT environment. First, the 2014 Act ends FSMTC's statutory monopoly and provides a framework for the introduction of competition in the sector. Second, it provides for the establishment of an independent sector regulator. Third, the 2014 Act provides for the adoption of a universal access policy. In furtherance of its National ICT Policy, the Government has also

Key indicators for Micronesia (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	6.5	10.0	13.6
Mobile-cellular sub. per 100 inhab.	22.2	98.9	101.5
Fixed-broadband sub. per 100 inhab.	3.0	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	0.0	47.4	52.2
3G coverage (% of population)	15.0	87.6	85.0
LTE/WiMAX coverage (% of population)	0.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	9.4	3.2	5.2
Fixed-broadband prices (% GNI pc)	11.1	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	10.1	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	n.a.	5.4	6.8
Percentage of households with computer	24.5	37.8	46.6
Percentage of households with Internet access	31.4	45.5	51.5
Percentage of individuals using the Internet	33.4	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	23.2	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

obtained a commitment from the World Bank to provide a USD 47.5 million grant to be used to fund international telecommunications infrastructure investments, and related technical assistance and project management activities, with the goal of improving broadband international connectivity to Chuuk, Kosrae and Yap.

**Conclusion:** Providing extensive and affordable coverage has been a challenge for the Federated States of Micronesia. The country comprises 607 small islands spread over more than 2.5 million km<sup>2</sup> of ocean. New submarine cables will link all four states in a national broadband network with the opportunity of significantly lower Internet costs.

## Moldova

**Mobile-broadband penetration in Moldova is similar to the CIS region average. The territory and population is widely covered by 3G/LTE signal.**

**Mobile services:** There are three mobile telecommunication operators in Moldova sharing the market: 65.5 per cent (Orange Moldova), 30.2 per cent (Moldcell) and 4.2 per cent (Moldtelecom).<sup>307</sup> The first 3G networks were launched in 2008 by Moldcell and Orange Moldova. LTE services over Moldcell and Orange Moldova networks became available in 2012.<sup>308</sup> Orange Moldova dominates LTE deployment having 94 per cent geographic coverage and 97 per cent of the population covered while others had less than 10 per cent territory and 30 per cent population coverage at the end of 2016.<sup>309</sup> The mobile broadband market is growing fast in Moldova. In 2016, the number of subscribers increased by 30.1 per cent. Mobile and fixed network portability services were launched in 2013. In 2016, the quantity of ported numbers had reached 1.94 per cent of all mobile subscribers and 0.73 per cent of all fixed subscribers.<sup>310</sup>

**Fixed services:** Moldtelecom shares two thirds of the fixed broadband market, Starnet Soluții (20.2 per cent), Sun Communications (5.3 per cent) and over 80 other data transmission service providers (9.9 per cent).<sup>311</sup> The fixed broadband market, along with mobile broadband, is one of the fastest developing sectors of the ICT sector in Moldova. In 2016, the number of fixed broadband subscribers increased by 4.3 per cent. Most subscribers (56.5 per cent) use FTTH technologies, far more than xDSL (36.1 per cent) and coaxial cable (6.9 per cent). Subscriptions with connections from 30 to 100 Mbit/s are the most popular (49 per cent of all fixed-broadband connections) with those from 10 to 30 Mbit/s connections used by 35 per cent of subscribers.<sup>312</sup> As long as the demand on high-speed Internet service grows, Moldova continues to raise its international Internet bandwidth. In contrast to Internet access, fixed telephony penetration has decreased since 2013. In 2016, fixed telephony operators lost 2.6 per cent of their subscribers.<sup>312</sup>

**Government policy:** The telecommunication market in Moldova was liberalized by 2004. By 2014, the market consisted of 30 fixed services

Key indicators for Moldova (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	34.3	20.7	13.6
Mobile-cellular sub. per 100 inhab.	111.0	141.2	101.5
Fixed-broadband sub. per 100 inhab.	16.3	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	56.2	59.7	52.2
3G coverage (% of population)	99.0	77.1	85.0
LTE/WiMAX coverage (% of population)	97.0	45.9	66.5
Mobile-cellular prices (% GNI pc)	3.7	1.7	5.2
Fixed-broadband prices (% GNI pc)	5.4	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.1	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.0	3.1	6.8
Percentage of households with computer	71.0	67.4	46.6
Percentage of households with Internet access	76.0	68.0	51.5
Percentage of individuals using the Internet	71.0	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	144.1	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

operators, 3 mobile services operators, 55 Internet providers and 148 television services providers.<sup>313</sup> Moldova legislation in the ICT sector is mainly aligned to the European Union legal framework.<sup>314</sup> In 2010, the Program of Broadband Internet Access Development 2010-2013 was approved. Its goal was to overcome the digital divide between rural and urban areas. The following target indicators were set: 20 per cent of fixed-broadband penetration and 20 per cent of mobile broadband penetration by 2013. The corresponding indicators reached 13.4 per cent for fixed-broadband subscriptions and 47.3 per cent for mobile-broadband subscriptions by 2013.<sup>315</sup> The programme facilitated subscriber number growth, Internet infrastructure availability and electronic services development. In 2013 the government approved the national strategy of information society development, Digital Moldova 2020. It focuses on three pillars: access and infrastructure (improvement of connectivity and network access), digital content and electronic services (promoting digital content and generating services), and capacities and utilization (strengthening literacy and digital skills to enable innovation and stimulate usage).<sup>316</sup> According to the strategy, information society development will be based on a secure digital environment.

**Conclusion:** Moldova has a dynamic and competitive telecommunication market, which is characterized by high Internet access speeds, high level of mobile services accessibility, and technological development. Telecommunication authorities try to apply best practices of market regulation in order to create a favourable environment for information society development

while having minimum intervention from the government.

## Monaco

**Monaco Telecom is the only local provider of telecommunication services in the Principality of Monaco. French mobile operators are providing mobile-cellular and mobile-broadband services, but in the fixed sector, Monaco Telecom is the only provider in the country. The country's fixed network is well developed and penetration rates are high, while mobile penetration is below the European average.**

**Mobile services:** Monaco's small territory of only 2km<sup>2</sup> is covered by French mobile networks and French operators Orange, Bouygues Telecom, SFR, and Free. The market leader and only local network provider Monaco Telecom is offering services using the Orange France network. Monaco Telecom, which is owned by the founder of French operator Free and the Monaco Government, is currently building its own network and aims to launch services in 2018. Given Monaco Telecom's small area of operation and the intense level of competition it is facing from French operators, Monaco Telecom is allowed to have around 30 per cent higher prices than French operators according to government regulations.

**Fixed services:** The country has very high fixed-telephone and fixed-broadband penetration rates that are well above the European average. Monaco Telecom holds a monopoly of the fixed sector and offers bundles including fixed-telephony, Internet access and broadcast television services. ADSL services were first launched in 2000 and broadband Internet is currently provided via cable and ADSL. Retail fixed-telephone and fixed-broadband prices are regulated based on the definition of a reference offer set by regulation. Prices are set based on the selected plans from French operators on top of which a 30 per cent margin is allowed to Monaco Telecom.<sup>317</sup> The roll-out of FTTH is ongoing in 2017 and the government aims at connecting all buildings with fibre by 2025.

**Government policy:** There is no independent telecommunication regulator, but the Department of Electronic Communications, which is part of the Ministry of Public Works, the Environment and Urban Development, is charged with regulating the market in Monaco.<sup>318</sup> The country's development plan for 2016-2020 prioritizes the roll-out of NGA networks, which will be in part financed by the

Key indicators for Monaco (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	120.7	37.7 13.6
Mobile-cellular sub. per 100 inhab.	86.3	118.0 101.5
Fixed-broadband sub. per 100 inhab.	48.2	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	74.8	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	97.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.3	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.4	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.3	0.6 6.8
Percentage of households with computer	84.1	79.6 46.6
Percentage of households with Internet access	78.3	82.5 51.5
Percentage of individuals using the Internet	95.2	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	95.2	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

government. Monaco Telecom is to deploy its own LTE network and put in place roaming agreements with foreign providers. By 2025, the government aims to provide full FTTH coverage and the roll-out is ongoing in 2017 (State of Monaco, 2016).

**Conclusion:** Monaco is a highly connected country with almost the entire population using the Internet. The government prioritizes the continued roll-out of fixed and wireless NGA networks and the deployment of Monaco Telecom's own mobile network, in order to support ICT development in Monaco.

## Mongolia

**Despite the difficult circumstances of a large landlocked country and the second lowest population density in the world, Mongolia has made notable strides in telecommunication coverage, in particular using wireless communications.**

**Mobile services:** There are four mobile operators in the country, all majority held by Mongolian companies: Mobicom, Unitel, Skytel and G-Mobile. Mobile penetration (subscriptions per 100 people) exceeded 100 by 2014 when 97 per cent of households had a mobile phone (NSO Mongolia, 2014). Mobile-broadband population coverage is high, with 3G networks launched in 2009 and LTE in 2016.

**Fixed services:** The incumbent operator Telecom Mongolia was partly privatized in 1995 when a 40 per cent stake was sold to Korea Telecom. It is the country's largest fixed-line carrier. Unlike most other developing nations, there is a relatively high degree of competition in the fixed market, with five operators. Nevertheless, Mongolia's fixed-line penetration is low owing to the popularity of mobile. Fixed-line subscriptions are now largely bundled into triple play offers. Fixed broadband choices include DSL, optical fibre and Wi-MAX, with optical fibre accounting for the largest share of subscriptions. As Mongolia is a landlocked country, national backbone connectivity is critical. Mongolia's domestic fibre-optic networks cover over 30 000 kilometres and deployment tripled between 2009 and 2014. The government-owned Information Communication Network Company (Netcom) accounts for around half of the country's total fibre deployment. Mobicom and Skytel also have backbone networks. The Mongolian Railway operates a 1 400-kilometre fibre network along its north-south line, and the Government operates a VSAT network for rural connectivity. International connectivity is achieved through terrestrial connections to China and Russia, and from there traffic is routed to overland Asia-Europe networks and through submarine cables. The Mongolian Internet Exchange was established in 2001 and has around 20 participants.

**Government policy:** The country has continuously liberalized the sector over recent decades. Steps include partial privatization of the incumbent telecommunication operator (Telecom Mongolia)

Key indicators for Mongolia (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	7.6	10.0	13.6
Mobile-cellular sub. per 100 inhab.	113.6	98.9	101.5
Fixed-broadband sub. per 100 inhab.	7.6	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	57.1	47.4	52.2
3G coverage (% of population)	95.0	87.6	85.0
LTE/WiMAX coverage (% of population)	6.9	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.8	3.2	5.2
Fixed-broadband prices (% GNI pc)	2.1	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.6	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.4	5.4	6.8
Percentage of households with computer	23.6	37.8	46.6
Percentage of households with Internet access	23.6	45.5	51.5
Percentage of individuals using the Internet	22.3	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	166.1	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

in 1995, creation of a regulatory authority, the Communications Regulatory Commission (CRC), in 2001, and the introduction of competition in the mobile and Internet markets. The Communications and Information Technology Authority (CITA) is responsible for sector policies. Several policy documents have established the framework for evolution of the sector over the years. The *National Program on High Speed Broadband (2011-2015)* developed legal and regulatory frameworks to support the expansion of high-speed broadband networks including targets for speeds of 100 Mbps in urban areas and 50 Mbps in the provinces.

**Conclusion:** There is a high degree of competition between Mongolian-led companies in the country's telecommunication markets, resulting in high levels of access. Despite the country's large size and low population density, backbone networks are well developed and international connectivity assured through cross-border connections to its two large neighbours.

## Montenegro

**Montenegro is one of the smallest markets in Europe with a population of close to 700 000 inhabitants. The accession process to the European Union officially started in 2011 and is greatly influencing the telecommunication sector, as regulations have been aligned with EU norms and competition has been strengthened.**<sup>319</sup>

**Mobile services:** The first GSM provider in Montenegro was established in 1996 under the name Promonte and was fully acquired by Telenor in 2004. At present, Telenor is the market leader closely followed by its competitors Crnogorski Telekom and M:Tel. All three mobile operators are majority owned by foreign companies: Telenor is majority-owned by the Norway Government; Crnogorski Telekom is majority-owned by Hrvatski Telekom and M:Tel by Telekom Serbia. The M:Tel entry into the market in 2007 as the third operator had a significant impact on the level of competition in Montenegro. Mobile-cellular penetration in the country is very high<sup>320</sup>. This can be attributed to the fact that Montenegro is a popular destination for tourists, who purchase SIM cards during their vacation (EBRD, 2012a). Mobile-broadband penetration has been increasing rapidly, but remains behind the European average and that of most neighbouring countries. 3G population coverage is almost complete and LTE population coverage is close to 90 per cent. Telenor, Crnogorski Telekom and M:Tel launched 3G services in 2007; LTE was introduced by Telenor in 2012, Crnogorski telekom in 2013 and M:Tel in 2017.<sup>321</sup>

**Fixed services:** Crnogorski Telekom, M:Tel, Telemach (part of United Group) and Telenor are the major players in the fixed-line market. Fixed-telephone penetration is relatively low in Montenegro in relation to the Balkan countries and the European average. Fixed-broadband penetration, on the other hand, is comparable to that of neighbouring countries. Fixed broadband is available through a variety of technologies. ADSL is the most important access technology, but cable and FTTx are also available, while the latter has seen the most important growth in recent years.<sup>322</sup>

**Government policy:** The Agency for Telecommunications was established by the Decision of the Government of the Republic of Montenegro dated 8 March 2001. The Agency

Key indicators for Montenegro (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	23.8	37.7	13.6
Mobile-cellular sub. per 100 inhab.	167.5	118.0	101.5
Fixed-broadband sub. per 100 inhab.	18.5	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	60.7	80.1	52.2
3G coverage (% of population)	95.0	98.5	85.0
LTE/WiMAX coverage (% of population)	85.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	1.6	1.0	5.2
Fixed-broadband prices (% GNI pc)	2.2	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.6	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.2	0.6	6.8
Percentage of households with computer	58.2	79.6	46.6
Percentage of households with Internet access	69.8	82.5	51.5
Percentage of individuals using the Internet	69.9	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	202.9	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

is established as an independent regulatory authority, functionally independent of all entities that exploit telecommunications networks and provide electronic communications networks, equipment or services. After the adoption of the Law on Postal Services in 2005, the Agency took over the competencies related to postal affairs. Following the adoption of the Law on Electronic Communications in August 2008, the Agency has continued, in accordance with the provisions of the Law, to operate as the Agency for Electronic Communications and Postal Services.<sup>323</sup> In 2013, a new law on electronic communications came into force, which increased the Agency independence. Mobile termination rates were significantly lowered, and a regional roaming regulation between Bosnia and Herzegovina, TFYR Macedonia, Montenegro, and Serbia was introduced.<sup>324</sup>

**Conclusion:** Following independence and the accession process to the European Union and the telecommunication acquis, the telecommunication sector has grown increasingly independent and competitive. Despite its size, four privately-owned, international operators are active in the market and advanced technologies (LTE, FTTx) are rolled out.

## Morocco

**Morocco has expanded its mobile and fixed services to cover the entire national territory and population. With high mobile penetration rates, some of the lowest prices for broadband Internet access, and with the latest ICT technologies and services, Morocco is one of the most advanced ICT countries in Africa and the Arab States region.**

**Mobile services:** Mobile cellular has above average penetration rates compared with other Arab States countries and globally. The same applies to mobile-broadband penetration, which has grown fast in the last few years. This can be attributed to the strong competition between the three telecommunication operators. Maroc Telecom, the incumbent operator, began facing competition in 2000 from Medi Telecom. The third mobile operator is Wana Corporate also launched its mobile services in 2006. The National Telecommunication Regulatory Agency (ANRT) awarded three 3G licences to mobile operators in 2006 and LTE licences in 2015. The regulator has assigned 900 MHz and 2100 MHz for 3G services and frequencies in the 800 MHz, 1800 MHz and 2.6-GHz bands for LTE services. These services have facilitated the take-up of mobile broadband in rural areas, thus contributed to the national broadband plan. In order to insure the best coverage of LTE services, the bid for attributing LTE licences imposed specific obligations on operators, requiring them to cover a minimum of the population by 2020 and to provide a minimum download speed.

**Fixed services:** Three operators are competing in fixed broadband sector particularly for B2B market. Most of the new broadband connections are wireless and optical fibre. To accommodate the increasing voice and Internet traffic, operators have upgraded their optical fibre national backbone networks and international connectivity. Actually, the three operators are offering FTTH (fibre to the home) services in major cities in Morocco. Regulatory rules such as: number portability, unbundling, and infrastructure sharing, are in operation in Morocco.

**Government policy:** Morocco was one of the first countries in the region to set up a regulatory environment for the telecommunications and ICT sector as a means of fostering a level playing field

Key indicators for Morocco (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	6.0	7.7	13.6
Mobile-cellular sub. per 100 inhab.	120.7	107.1	101.5
Fixed-broadband sub. per 100 inhab.	3.7	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	46.0	45.2	52.2
3G coverage (% of population)	95.0	81.9	85.0
LTE/WiMAX coverage (% of population)	68.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	4.4	4.3	5.2
Fixed-broadband prices (% GNI pc)	4.0	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.0	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	4.0	5.5	6.8
Percentage of households with computer	54.9	43.3	46.6
Percentage of households with Internet access	68.5	45.3	51.5
Percentage of individuals using the Internet	58.3	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	25.7	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

for private operators. The telecommunication law of 1997 paved the way for the liberalization of the sector and ended the monopoly of the state owned company. This was followed by the implementation of successive digital plans. The first e-Morocco strategy was launched in 2001, followed by a second updated version in 2005 laying out the vision until 2010 (e-Morocco 2010). *Maroc Digital 2013* plan, which covered the period from 2009 to 2013, focused on removing barriers via digital inclusion and e-government development and on making the sector regionally competitive. The most recent plan, *Maroc Digital 2020* plan aims to learn from the previous experiences and its agenda goes beyond digital governance and digital government and covers the whole of the digital economy. Under this plan, the Agency for Digital Development was created to be responsible for service delivery and to uptake as well as the optimization and modernization of government platforms.

**Conclusion:** The efforts made by the Government of Morocco have resulted in making Morocco one of the most connected countries in the Arab States region. Most households have Internet access and most of its citizens throughout Morocco use ICTs on a regular basis. *Maroc Digital 2020* should enable Morocco to position itself as a regional economic hub, and accelerate the digital transformation for the emergence of a digital economy as well as the effective democratisation of the usages and practices of Internet to benefit the population and the economy through e-government and financial inclusion services etc.).

## Mozambique

***In addition to opening its mobile market to competition, there is a flurry of activity to build out the national backbone infrastructure throughout the country, sharply boosting access.***

**Mobile services:** There are three mobile operators. Mozambique Cellular (MCEL), a subsidiary of the incumbent telecom operator, launched as the country's first mobile operator in 1997. Competition in the mobile segment was introduced in 2003 when Vodacom, a subsidiary of the South African mobile group launched. A third operator entered the market in 2012 with the arrival of MOVITEL, a subsidiary of the Vietnamese VIETTEL group. In 2015, just over half of the households (55 per cent) had mobile telephones, of which 78 per cent in urban homes and 46 per cent in rural ones.<sup>325</sup> Mobile-broadband using 3G technology was launched by MCEL in 2008, Vodacom in 2010 and MOVITEL in 2012, when it entered the market. The 3G technology cheaper than fixed offerings and hence most Internet access in the country is mobile-broadband.

**Fixed services:** The incumbent operator is State-owned Telecommunications of Mozambique (TDM) (90 per cent belongs to the Government and 10 per cent to management and employees). Although TDM's exclusivities have ended, it is essentially the only fixed-telephone provider offering service over copper lines and CDMA wireless local loop. On the fixed-broadband market, TDM offers ADSL up to 4 Mbit/s, fixed wireless access using CDMA EVDO and through a subsidiary, and cable modem with speeds up to 8 Mbit/s in urban areas. It competes with other ISPs that offer fixed wireless broadband. TDM, Vodacom and MOVITEL have been rolling out fibre-optic, and Mozambique's backbone extends more than 46 000 km, one of the biggest networks in sub-Saharan Africa. The commissioning of two fibre-optic submarine cables, which added significantly to Mozambique's international Internet capacity, and resulted in a massive drop in wholesale prices improved international Internet connectivity when Mozambique connected to the SEACOM cable in 2009, followed by the Eastern Africa Submarine System (EASSy) a year later. Two other cables are planned. The Mozambique Internet Exchange, created in 2002, is one of the oldest in the region.

Key indicators for Mozambique (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.3	1.0	13.6
Mobile-cellular sub. per 100 inhab.	54.1	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.2	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	34.0	22.9	52.2
3G coverage (% of population)	35.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	6.0	14.2	5.2
Fixed-broadband prices (% GNI pc)	21.0	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	5.2	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.2	17.7	6.8
Percentage of households with computer	6.5	9.6	46.6
Percentage of households with Internet access	16.2	16.3	51.5
Percentage of individuals using the Internet	17.5	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	1.1	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Ministry of Transport and Communications is responsible for sector oversight. There has been a focus on various projects, such as digital migration, e-government and cybersecurity. A new Telecommunications Law was adopted in 2016. The National Communications Institute of Mozambique (INCM) is the regulator responsible for telecommunications and posts. Its creation was authorized in 1992, when the sector reform process initiated, with TDM separated from posts and being commercialized. INCM also administers the Universal Access Service Fund.

**Conclusion:** Mozambique is progressing with ICT development. Connection of the country's first undersea cable in 2009, introduction of additional competition in the mobile market in 2012 and intensification of the national backbone network are laying the ground for wider coverage, better quality and cheaper prices. This will enhance digital inclusion in the country. In addition, the new Telecommunications Law enforces the sharing of infrastructure aiming to reduce the duplication of investment, allowing for additional coverage in rural areas.

## Myanmar

***The relatively recent liberalization of Myanmar's telecom sector has seen it leapfrog to the latest mobile technologies.***

**Mobile services:** Myanmar Posts and Telecommunications (MPT), the government-owned incumbent, was the sole operator that provided fixed, mobile and Internet services in Myanmar's mobile sector. As the Union Government began to reform its ICT sector, the government introduced competition into all segments of the sector. Integrated Nationwide Telecommunications Licenses were awarded in 2014 to Telenor Myanmar Limited (TML) from Norway and Ooredoo Myanmar Limited (OML) from Qatar to compete along with MPT (partnering with Japan's KDDI Corporation & Sumitomo Corporation). The results have been remarkable with a significant rise in teledensity in recent years. Both TML and OML deployed 3G mobile broadband from launch with rapid growth in mobile data use and LTE networks were deployed in 2016. The fourth License was issued to Myanmar National Tele and Communications Co.,Ltd (MNTC), a consortium of Myanmar companies and Viettel from Vietnam in 2017.

**Fixed services:** MPT is the main provider of fixed-telephone services. Fixed-telephone penetration is relatively high for a low-income nation as a result of the lack of mobile phones until recently. MPT is the leading fixed broadband operator providing ADSL and optical fibre (with speeds of up to 100 Mbps) in urban areas. In addition to the mobile operators offering mobile broadband access, there are several ISPs providing fixed wireless Internet and fibre-optic connections. The launch of new mobile networks has been accompanied by a flurry of activity in national fibre-optic backbone investment. Over 38,000 kilometers of fiber network has been laid down nationwide. In addition, the Korean Export Import Bank provided a loan for the construction of a fibre-optic route connecting almost 40 cities across the country. Similarly, Myanmar's international Internet connectivity has radically improved from around 30 Gbps before the start of sector reform to over 300 Gbps by 2016-2017. It has had a link to the SEAMEWE-3 submarine cable since 1999. In 2016, two other undersea cables landed in the country (Asia-Africa-Europe and SEAMEWE-5) and a submarine cable to Thailand is under construction.

Key indicators for Myanmar (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	0.9	10.0	13.6
Mobile-cellular sub. per 100 inhab.	92.7	98.9	101.5
Fixed-broadband sub. per 100 inhab.	0.2	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	54.5	47.4	52.2
3G coverage (% of population)	94.8	87.6	85.0
LTE/WiMAX coverage (% of population)	9.2	73.6	66.5
Mobile-cellular prices (% GNI pc)	1.9	3.2	5.2
Fixed-broadband prices (% GNI pc)	18.6	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.5	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.7	5.4	6.8
Percentage of households with computer	13.6	37.8	46.6
Percentage of households with Internet access	24.4	45.5	51.5
Percentage of individuals using the Internet	25.1	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	6.4	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

In addition to China, Myanmar also has cross-border terrestrial fibre-optic connections to India and Thailand.

**Government policy:** The 2013 *Telecommunications Law* triggered reform of the sector by liberalizing the market to a licensing-based regime. The Ministry of Transport and Communications (formerly Ministry of Communications and Information Technology) is both policy-maker and regulator (the regulatory function carried out by its Posts and Telecommunications Department). The Ministry is also preparing a Universal Service Strategy and US Framework to connect the remaining part of the population who are unconnected. The draft *Telecommunications Master Plan* has the vision of Myanmar as a "mobile-first, digitally connected nation" with three enabling objectives: i) create a Myanmar national broadband infrastructure asset; ii) develop communications and services for Myanmar people and iii) create an enabling institutional framework. As an important step for liberalization, the Ministry is also preparing for the establishment of an Independent Regulatory body naming Myanmar Communications Regulatory Commission (MCRC).

**Conclusion:** The ICT landscape has been transformed since the adoption of a new telecommunications law in 2013 opening the market to competition. Myanmar has taken concrete steps to reform the country's telecoms sector to develop ICT sector. One result of the late market opening is that Myanmar was able to leapfrog straight into mobile broadband technologies. There has been an astounding

increase in access to mobile networks over a short period.

## Namibia

**The Southern African nation has a high level of basic communications access with efforts underway to diversify the market to reach higher levels of broadband usage and services.**

**Mobile services:** There are two mobile operators. Mobile Telecommunications Limited (MTC) was the first mobile operator, launched in 1995; 66 per cent of its shares belong to State-owned Namibia Post and Telecommunications Holdings Limited (NPTH) and 34 per cent to Samba Dutchco B.V., a Dutch registered holding company. The other mobile provider is operated by Telecom Namibia, the incumbent operator, which is fully owned by NPTHL. Telecom Namibia took over the previous operator Leo in 2013 and rebranded it as TN Mobile. As a result, both mobile operators in the country are subsidiaries of NPTHL. Household penetration is high, with 89 per cent having mobile phones, including 95 per cent in urban areas and 81 per cent in rural areas.<sup>326</sup> TN Mobile, which entered the market in 2007, launched 3G in 2008, followed by MTC in 2013. Both have launched LTE, MTC in 2012 and TN Mobile in 2013. MTC was the first African operator to trial so-called 4.5G in 2016, reaching speeds of 1 Gbit/s. MTC has been aggressively rolling out mobile-broadband to rural areas – its 3G network covered 66 per cent of the population in 2017. In order to encourage take-up, it offers subsidized smartphones preloaded with 5 GB of free data to rural residents under its oSmartPhona initiative.

**Fixed services:** Telecom Namibia is the only fixed-line telephone service provider offering service through copper lines and fixed wireless CDMA, although CDMA was completely phased out in 2015. Several operators provide fixed-broadband services using technologies such as ADSL (speeds up to 10 Mbit/s), fixed wireless broadband and fibre to the premises (though take-up of the latter is still low). Telecom Namibia has deployed more than 12 000 km of fibre-optic cable in the national backbone network, which reaches all regional administrative capitals and key border crossings. MTC also has deployed some fibre routes in its network. Connection to the WACS undersea fibre-optic cables in 2012 has ushered in a new era of cheaper and more abundant international Internet capacity. The Internet Exchange Point Namibia was launched in 2014.

Key indicators for Namibia (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	7.7	13.6
Mobile-cellular sub. per 100 inhab.	109.2	101.5
Fixed-broadband sub. per 100 inhab.	2.6	12.4
Active mobile-broadband sub. per 100 inhab.	66.1	52.2
3G coverage (% of population)	53.0	85.0
LTE/WiMAX coverage (% of population)	39.0	66.5
Mobile-cellular prices (% GNI pc)	0.8	5.2
Fixed-broadband prices (% GNI pc)	7.8	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.0	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.8	6.8
Percentage of households with computer	20.0	46.6
Percentage of households with Internet access	29.5	51.5
Percentage of individuals using the Internet	31.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	15.9	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Ministry of Information and Communication Technology (MICT) is the sector policy-maker. It has a three-year Strategic Plan covering the period from 2014/15 to 2016/17. The focus is on the three areas under its competency: ICT development, print media and audiovisual services. The adoption of the *Communications Act of 2009* resulted in a service-neutral licensing regime and the creation of a new regulator. The Communications Regulatory Authority of Namibia regulates telecommunications, broadcasting, postal services and radio spectrum. It replaced the previous regulator, the Namibia Communications Commission, operational from 1992 until 2008.

**Conclusion:** Namibia is one of the frontrunners in Africa on ICT development, and was one of the first countries in Africa to launch both commercial 3G and LTE networks, resulting in a high level of access to mobile telecommunication services. While the high level of market concentration and limited ownership diversity pose a challenge to creating an innovative and vibrant ICT sector, the Government is making significant efforts to strengthen its national backbone network towards decentralization and to make effective e-governance available to the broader public.

## Nauru

**One of the world's smallest island nations has seen mobile access soar after the deployment of a network by a large mobile group. This remote Pacific nation — over 300 kilometres from its closest neighbour — is a wireless testbed with mobile broadband and low-latency satellite connectivity.**

**Mobile services:** Given that there are just over 10 000 Nauruans living on one island, there is a sole operator, DIGICEL, part of the Irish-owned mobile group, with considerable experience of operating in small island States throughout the Caribbean and Pacific. DIGICEL launched GSM service in 2009 and its seven base stations cover practically the entire 21 square kilometre island. In 2011, 90 per cent of households had a mobile phone.<sup>327</sup> 3G was introduced in August 2014 and LTE was launched in late 2016.

**Fixed services:** Nauru Telecom, as a government monopoly, provided telecommunication services until 2009. It experienced technical and financial problems, and in June 2009 DIGICEL was awarded a licence with two-year exclusivity. The fixed landline network has largely fallen into a state of disrepair, and apart from the Government, most people on the island use mobile for voice communications. Similarly, there is only limited fixed broadband Internet access, which is offered mainly to government departments and businesses. Fixed wireless Internet access is available using WiMAX. In addition to DIGICEL, CENPAC operates an Internet cafe, manages Nauru's country code top level domain name (.NR) and has deployed a six kilometre fibre-optic backbone for government use on the west side of the island. CENPAC also competes with DIGICEL in the business Internet market. Nauru relies on satellite links for international Internet capacity. In 2015, it connected to the O3b low-latency, high-bandwidth network. Data usage has increased such that international bandwidth has grown over 100 per cent, requiring three satellite upgrades. The Asian Development Bank is supporting a project for an undersea fibre-optic cable that will link Nauru with the Federated States of Micronesia and Kiribati.

**Government policy:** The Ministry of Telecommunications is responsible for sector oversight and government ICT deployment. The

Key indicators for Nauru (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	n.a.	10.0	13.6
Mobile-cellular sub. per 100 inhab.	97.3	98.9	101.5
Fixed-broadband sub. per 100 inhab.	n.a.	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	36.4	47.4	52.2
3G coverage (% of population)	98.0	87.6	85.0
LTE/WiMAX coverage (% of population)	98.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	2.0	3.2	5.2
Fixed-broadband prices (% GNI pc)	3.5	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	n.a.	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	n.a.	5.4	6.8
Percentage of households with computer	n.a.	37.8	46.6
Percentage of households with Internet access	n.a.	45.5	51.5
Percentage of individuals using the Internet	n.a.	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	n.a.	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Regulatory Directorate of the Department of Telecommunications is responsible for sector regulation. The *National Sustainable Development Strategy 2005 – 2025* sets out the goals for the ICT sector, the two main short-term milestones being: i) every household / business has access to a prepaid telephone system based on wireless technology; and ii) district / household level Internet connectivity and fixed line systems are properly maintained for the public service.

**Conclusion:** Mobile communications took off following the issue of a licence to DIGICEL, which leveraged its group expertise to install a GSM network quickly and, later on, a 3G network. The remote island nation has also successfully deployed the latest generation of fast satellite technology to support broadband networks. The country is now looking forward to connection to an undersea fibre-optic cable.

## Nepal

**Despite the challenges of its mountainous terrain, the landlocked nation has achieved a relatively high level of mobile access driven by the Government's efforts to improve connectivity and strengthen the ICT sector.**

**Mobile services:** There are three mobile operators. They include the incumbent, state-owned Nepal Doorsanchar Company Limited (NDCL); NCELL, a subsidiary of the Malaysian AXIATA mobile group; and Smart Telecom Private Limited (STPL), a local company. In addition, United Telecom has recently got an approval to run mobile service. Despite the difficulty of expanding coverage in the mountainous country, 91 per cent of all households had a mobile phone (CBS Nepal, 2015). Mobile Internet is increasingly popular since the deployment of 3G in 2010. NDCL launched LTE in early 2017 and the other two operators are waiting for regulatory approval to launch LTE.

**Fixed services:** NDCL dominates the fixed telephone market. Four other companies also provide fixed telephone services using VSAT or Wireless Local Loop (WLL) technologies. Fixed telephone penetration is low owing to its limited coverage and the popularity of mobile. There are a number of ISPs. Fixed broadband (ADSL, cable modem, fibre/LAN) accounted for 64 per cent of subscriptions in 2016, with fixed wireless (CDMA EVDO, WiMAX and VSAT) making up the remainder. Construction of Nepal's national fibre-optic backbone commenced in 2002. The network is largely constructed alongside highways and also uses optical fibre from the Nepal Electric Authority. Links to more remote areas are achieved using microwave and satellite systems. As a landlocked nation, Nepal is reliant on neighbouring India for access to submarine cables. There are several cross-border fibre-optic links. The Nepal Internet Exchange was established in 2002 and has over thirty participants.

**Government policy:** The Ministry of Information and Communications (MIC) is responsible for sector policy. The Nepal Telecommunications Authority (NTA), established in 1998, is responsible for sector regulation. The relevant legislation is the *Telecommunications Act, 1997*. The *Ten-Year Master Development Plan (2011 – 2020 A.D.)* for telecommunications outlines programmes for achieving key objectives including making

Key indicators for Nepal (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	3.0	10.0	13.6
Mobile-cellular sub. per 100 inhab.	111.7	98.9	101.5
Fixed-broadband sub. per 100 inhab.	0.8	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	30.8	47.4	52.2
3G coverage (% of population)	90.0	87.6	85.0
LTE/WiMAX coverage (% of population)	20.7	73.6	66.5
Mobile-cellular prices (% GNI pc)	3.8	3.2	5.2
Fixed-broadband prices (% GNI pc)	10.3	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	9.5	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	9.5	5.4	6.8
Percentage of households with computer	11.2	37.8	46.6
Percentage of households with Internet access	15.0	45.5	51.5
Percentage of individuals using the Internet	19.7	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	3.9	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

basic telecommunication services available within "shouting distance"; providing on-demand telecommunications services in urban areas and for manufacturing and commercial enterprises; ensuring that urban consumers have the opportunity to use services from different service providers, which shall be gradually extended to rural subscribers; and enhancing network capability to support efficient utilization of ICT for improving the quality of life of the Nepalese. The *National Broadband Policy* of 2015 outlines the government's vision for affordable, secure, reliable and ubiquitous high-speed Internet. It sets several targets for 2018, including a broadband penetration rate of 30 per cent at a minimum of 512 kbps and a download speed of at least 10 Mbps on demand in urban areas.

**Conclusion:** Despite being a landlocked country with a challenging geography, Nepal has achieved a respectable level of access to mobile technologies, which has been driven by a competitive market.

## Netherlands

**The Netherlands telecommunication market is very competitive, with high mobile and fixed penetration rates and affordable prices for customers. In Europe, the Netherlands is among the leading countries for NGA coverage.**<sup>328</sup>

**Mobile services:** Penetration rates for mobile-cellular and mobile-broadband services penetration are above the European average. Mobile-cellular and in particular mobile-broadband offers in the Netherlands are affordable. Dutch incumbent operator KPN holds the market lead in the mobile market. Its strongest competitors are Vodafone, T-Mobile and Tele2. Tele2 started out as a mobile virtual network operator in 2001 and began to roll out its own LTE network in 2015, making it the fourth operator to use its own mobile-broadband network.<sup>329</sup> Since they were awarded LTE licences in 2012, all four operators have been investing heavily in LTE roll-out and offer nationwide coverage.<sup>330</sup>

**Fixed services:** Fixed infrastructure is very well developed in the Netherlands. Fixed-telephone penetration, while decreasing in line with the global trend for fixed-to-mobile substitution, is among the highest in the region and fixed-broadband penetration stands out as well. Incumbent operator KPN holds the highest market share in the fixed sector. The operator continues to make significant investments in its optical fibre and copper networks, making speeds of up to 200 Mbit/s over the copper network possible. Alternative operators are taking advantage of regulated access to the KPN network and are thus able to compete with the incumbent and offer attractive services to customers.<sup>331</sup>

**Government policy:** The main goal for the government with regard to ICT development is to fulfil the growing demand for high-speed Internet access. In order to support a market-based infrastructure roll-out in a competitive ICT market, the government aims at removing unnecessary constraints and costs and thus providing a positive climate for broadband investments. An open and high speed infrastructure is one of the five lines of action identified in the Digital Agenda for the Netherlands, the national broadband strategy. While the 2011-2015 Agenda was mostly focused on the digitization of the government itself, the current agenda takes a more comprehensive

Key indicators for Netherlands (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	40.1	37.7	13.6
Mobile-cellular sub. per 100 inhab.	123.7	118.0	101.5
Fixed-broadband sub. per 100 inhab.	42.5	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	88.9	80.1	52.2
3G coverage (% of population)	99.0	98.5	85.0
LTE/WiMAX coverage (% of population)	99.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.7	1.0	5.2
Fixed-broadband prices (% GNI pc)	1.0	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.5	0.6	6.8
Percentage of households with computer	89.6	79.6	46.6
Percentage of households with Internet access	92.2	82.5	51.5
Percentage of individuals using the Internet	90.4	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	196.1	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

approach and aims to achieve the digitization of sectors such as healthcare and mobility. The government takes a technology neutral and market-based approach to broadband development. The strategy also emphasizes the role of local and regional actors in coordinating infrastructure roll-out and facilitating the exchange of information.<sup>332</sup>

**Conclusion:** The Netherlands is among the most developed countries in terms of ICTs in the region and worldwide. The country has a very advanced fixed market and high ICT household penetration rates. In an effort to further continue this development, the government is taking a market-based approach and aims at creating a positive climate for further investments in ICTs.

## New Zealand

***New Zealand is forging ahead with wholesale retail separation as the model to drive widespread uptake of fixed-broadband services.***

**Mobile services:** There are three mobile network operators: Spark (the former incumbent); Vodafone (a subsidiary of the UK Vodafone Group); and 2degrees. The first two launched in the 1990s, while 2degrees entered the market in 2009. Mobile-broadband coverage is high. All three providers operate 3G, launched in 2005, and LTE networks, launched in 2013. The government has completed the first phase of the *Rural Broadband Initiative (RBI)*, which has provided for new or improved broadband to over 300,000 rural households and businesses. A second phase to extend coverage was announced in August 2017, and will be completed by the end of 2022. The *Mobile Black Spot Fund (MBSF)* will fund greater mobile coverage on approximately 1,000 km of state highway and in over 100 tourism locations where no coverage currently exists.

**Fixed services:** Telecom New Zealand (Telecom) was privatized in 1990 and structurally separated in 2011. At that time the government facilitated key changes to the sector including the structural separation of Telecom into retail services (Spark) and wholesale (Chorus) businesses. In 2014, Telecom changed its name to Spark. Vodafone is the second-biggest fixed-line retailer. It owns the hybrid fibre co-axial cable network that provides services in Christchurch and Wellington, the second and third largest cities. Fixed-broadband services are also offered by other retailers, whose presence in the market has been gaining ground. The Government launched the *Ultra-Fast Broadband (UFB)* programme, a public/private partnership whereby wholesalers are constructing fibre to the premises (FTTP) for resale by retailers. The number of fibre connections continues to increase rapidly and as at June 2017 34.8 per cent of households and businesses able to connect, are connected.

**Government policy:** The Ministry of Business, Innovation and Employment is responsible for overseeing the ICT sector. The government's target is that by 2025, 99 per cent of New Zealanders will be able to access broadband with peak speeds of at least 50 Mbps, and the remaining 1 per cent will be able to access at least 10 Mbps. The

Key indicators for New Zealand (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	37.9	10.0	13.6
Mobile-cellular sub. per 100 inhab.	125.0	98.9	101.5
Fixed-broadband sub. per 100 inhab.	33.0	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	101.3	47.4	52.2
3G coverage (% of population)	98.0	87.6	85.0
LTE/WiMAX coverage (% of population)	90.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.2	3.2	5.2
Fixed-broadband prices (% GNI pc)	1.8	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.4	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	5.4	6.8
Percentage of households with computer	86.6	37.8	46.6
Percentage of households with Internet access	85.7	45.5	51.5
Percentage of individuals using the Internet	88.5	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	109.6	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

government's target for UFB is that by the end of 2022, 87 per cent of New Zealanders will be able to access FTTP broadband with speeds close to 1Gbps. The government is investing around NZ\$1.8 billion to ensure that as many New Zealanders as possible can experience the benefits of UFB. RBI is using a range of technologies to provide faster Internet to hundreds of thousands of rural homes and businesses outside UFB areas. In 2017 the government completed a review of the Telecommunications Act 2001, which considered the regulatory settings for communications markets in New Zealand. The review proposed that regulation for fixed services should be more aligned with regulation of utilities such as electricity, gas and airports. A Bill reflecting the review outcomes is currently before Parliament. The Commerce Commission is responsible for regulating the telecommunications sector. Established under the *Commerce Act* 1986, it is an independent agency responsible for promoting competition in regulated sectors where effective competition does not exist, including telecommunications, dairy, electricity, and airport markets.

**Conclusion:** Although New Zealand has a high level of access to mobile broadband, the Government has promoted fibre access as a key economic enabler. This has guided restructuring of the industry through separation of the incumbent's wholesale and retail units and the creation of a fibre infrastructure deployment model based on open access principles and wholesale and retail provision. The UFB programme significantly extends consumer access to FTTP services nationally.

## Nicaragua

**Despite having a well-developed mobile-cellular sector, the fixed services market remains untapped. The majority of Nicaraguan ICT users are concentrated in urban areas, with infrastructure deficiency in the most remote areas being one of the obstacles to service uptake.**<sup>333</sup>

**Mobile services:** There have been only two operators in the mobile market for many years: Claro, having approximately two thirds of the market, and Movistar. Both operators launched LTE services during 2015, but the availability remains concentrated around the bigger urban centres.<sup>334</sup> A third mobile operator joined the market in 2016, CooTel, owned by the Chinese Xinwei Telecom Enterprise Group. The operator was conceded licensing in 2012, under the condition that it would extend its network to remote areas; therefore, coverage is expected to improve. The operator also aims to charge very competitive rates, which should improve service pricing in the segment.<sup>335</sup>

**Fixed services:** The fixed-telephony market is concentrated under the two operators, Movistar and Claro, although Claro holds most of the market share, approximately 90 per cent. The fixed segment began to lose ground to mobile services in 2002, and current penetration rates are well below regional and global levels. Other Internet service providers – Rostejnologuii, Yota Mobile and IWB Holding – have joined the market, increasing competition levels as well as investment.<sup>336</sup>

**Government policy:** The Nicaraguan telecommunications sector is overseen by the *Instituto Nicaragüense de Telecomunicaciones y Correos* (TELCOR). TELCOR acts in several areas, from fostering competition and enforcing the national legislation to ICT education and universal service.<sup>337</sup> In 2014, the Government launched the *Centro de Estudios Avanzados en Banda Ancha para el Desarrollo* (CEABAD), which engages ICT professionals employed to coordinate and teach the population how to use ICTs, especially broadband.<sup>338</sup> Nicaragua has also planned to launch its own satellite soon, which will improve call quality and data speed once in orbit.<sup>339</sup>

**Conclusion:** The Government recognizes the importance of developing its telecommunications

Key indicators for Nicaragua (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	5.8	24.4	13.6
Mobile-cellular sub. per 100 inhab.	122.1	114.2	101.5
Fixed-broadband sub. per 100 inhab.	2.8	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	22.8	82.7	52.2
3G coverage (% of population)	80.0	93.6	85.0
LTE/WiMAX coverage (% of population)	45.7	77.4	66.5
Mobile-cellular prices (% GNI pc)	19.2	3.6	5.2
Fixed-broadband prices (% GNI pc)	14.8	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	6.1	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	8.5	5.7	6.8
Percentage of households with computer	13.1	64.9	46.6
Percentage of households with Internet access	16.2	63.3	51.5
Percentage of individuals using the Internet	24.6	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	29.2	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

sector and has engaged in several different areas and projects to stimulate and foster cooperation and competition. Broadband is expected to be the main driver of sector expansion.

## Niger

***Despite the challenge of being a landlocked country, with the largest land area in West Africa, much of it covered by the Sahara Desert, Niger is striving to universalize access to ICTs through an evolving regulatory framework and high-level government backing.***

**Mobile services:** The mobile market consists of four operators: AIRTEL (owned by the Indian mobile group), the first operator to launch, in 2001, under the then CELTEL brand; Orange (93 per cent owned by Orange France); Niger Telecom (created in 2016 from the merger of the incumbent SONITEL and mobile operator SAHELCOM); and MOOV (owned by Morocco Telecom). AIRTEL has the largest market share of the mobile voice market, followed by Orange. Despite four operators, penetration is relatively low due to the high proportion of people under the age of 15 (about 50 per cent of the population). The penetration rate of the population over 15 is 87.9 per cent. Penetration in urban locations is high. In 2012, 83 per cent of urban households had telephones, compared with 44 per cent in rural areas.<sup>340</sup> A 3G network was first launched by Orange in 2011, followed by AIRTEL in 2015 and MOOV in 2017.

**Fixed services:** Despite Orange's global license allowing it to provide any service except for LTE, Niger Telecoms dominates the fixed-telephone line market, with the majority of subscriptions wireless CDMA. Likewise, most fixed Internet is through fixed wireless, with 23,242 ADSL and 262 fibre-optic subscriptions at the end of 2016. Niger Telecom's national backbone consists of 1 500 km of fibre-optic cable, and connects to border crossings in Benin, Burkina Faso and Nigeria for access to undersea cables. Starting in December 2017, the African Development Bank (AfDB) will build 1,007 km of optical fiber to connect Niger to Algeria, Chad and Nigeria (by a third interconnection at Magaria). Orange and NIGER TELECOMS each have a metropolitan fiber network in Niamey.

**Government policy:** The Ministry of Posts, Telecommunications and Digital Economy is responsible for the ICT sector. The road map for ICTs in the country is the 2012 Sector Policy Paper on Telecommunications and Information and Communication Technologies with five main

Key indicators for Niger (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.8	1.0	13.6
Mobile-cellular sub. per 100 inhab.	43.5	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.1	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	18.9	22.9	52.2
3G coverage (% of population)	32.4	59.3	85.0
LTE/WiMAX coverage (% of population)	7.5	25.7	66.5
Mobile-cellular prices (% GNI pc)	33.4	14.2	5.2
Fixed-broadband prices (% GNI pc)	154.4	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	10.4	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	20.8	17.7	6.8
Percentage of households with computer	2.9	9.6	46.6
Percentage of households with Internet access	3.1	16.3	51.5
Percentage of individuals using the Internet	4.3	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.8	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

axes: (a) adaptation of the legal and institutional framework; (b) infrastructure development; (c) promotion of universal access to ICT services; (d) development of applications and content; and (e) strengthening ICT capacities. The 1999 Ordinance on Telecommunications Regulation, updated by a 2010 Ordinance, guides the sector regulatory framework. The Telecommunications and Postal Regulatory Authority is in charge of regulation, control and monitoring activities in the telecommunications and postal sectors. The Authority's Strategic Plan covering the period 2014–2018 has two focus areas: (a) enhancing effective and efficient regulation; and (b) improving its organization and management. The Sector has recently been reorganized by the creation of the National Agency for Information System (ANSI) under the supervision of the Presidency, replacing the Haut Commissariat à l'Informatique et aux Nouvelles Technologies de l'Information et de la Communication (HC/I/NTIC). In addition to the duties of the former HC/I/NTIC, ANSI will manage the Universal Access Fund.

**Conclusion:** In spite of geographic and economic challenges, Niger is gradually forging ahead to develop its information society. Ongoing liberalization of the ICT sector, legal and regulatory reforms and strengthening of institutional capacity are driving this.

## Nigeria

***Sub-Saharan Africa's largest economy is keen to leverage the potential of ICTs for development. A competitive ICT market, backed by forward regulatory strategies, is facilitating this.***

**Mobile services:** There are four GSM operators: AIRTEL, a subsidiary of the Indian mobile group; MTN, a subsidiary of the South African MTN Group; EMTS, a subsidiary of ETISALAT of the United Arab Emirates; and GLOBACOM, owned by a privately held Nigerian group. There are also two operators using CDMA technology, Visafone and Multilinks, but their market share is negligible. NATCOM acquired the assets of the bankrupt incumbent operator NITEL in 2015, including its mobile licenses, and recently launched under the brand Ntel. Almost four in five households had mobile phones in 2015; this includes 90 per cent of urban homes and 71 per cent of rural ones, indicating a need to widen access in rural areas.<sup>341</sup> All of the GSM operators have launched 3G and LTE, with mobile-broadband the prevalent mode of Internet access in the country.

**Fixed services:** The demise of the incumbent NITEL means that there is no dominant operator for fixed telephony. Four operators provide fixed telephony (MTN, Glo, ipNX and 21st Century), while two provide fixed wireless telephony (Visafone and Multilinks). Most fixed-broadband access is via fixed wireless using WiMAX, plus a growing number of fixed LTE operators. Fibre-optic broadband is starting to be deployed in some urban areas. Most of the mobile operators have varying degrees of fibre-optic backbones, as does NATCOM, which inherited NITEL's national backbone. Although optical fibre reaches all state capitals, the fibre backbone does not extend down to lower administrative levels. The Government is aiming to adopt an open access wholesale market regime with a backbone infrastructure provider for different geographic regions. International bandwidth was limited and costly due to NITEL's monopoly on international fibre bandwidth via the SAT-3/WASC submarine cable system. This ended in 2009, when the Glo-1 cable landed in the country, followed by ACE, Main One and WACS undersea fibre-optic cables, as well as the Nigeria Cameroon Submarine Cable System. The IXP of Nigeria, with sites in Lagos and Abuja, was launched in 2007 and has more than 30 members,

Key indicators for Nigeria (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.1	1.0	13.6
Mobile-cellular sub. per 100 inhab.	81.8	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.1	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	22.9	22.9	52.2
3G coverage (% of population)	54.0	59.3	85.0
LTE/WiMAX coverage (% of population)	50.8	25.7	66.5
Mobile-cellular prices (% GNI pc)	1.8	14.2	5.2
Fixed-broadband prices (% GNI pc)	13.4	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.7	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.7	17.7	6.8
Percentage of households with computer	10.6	9.6	46.6
Percentage of households with Internet access	15.2	16.3	51.5
Percentage of individuals using the Internet	25.7	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	11.3	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

including all of the country's leading telecom operators and ISPs.

**Government policy:** The Federal Ministry of Communications has the responsibility for sector oversight. The 2012 National Information and Communication Technology (ICT) Policy lays out the sector direction with the main goals of creating a conducive environment for the rapid expansion of ICT networks and providing services that are accessible to all at reasonable costs, and that contribute to the development of the various socio-economic sectors. Key objectives include (a) to facilitate and support development of a nationwide ICT infrastructure that will support national broadband connectivity and accelerate socio-economic development; (b) to connect all federal and state networks to a national fibre backbone; and (c) to provide a reliable, accessible, secure and reasonably priced ICT connectivity to national and international ICT infrastructure. The National Information Technology Development Agency, part of the Ministry, is responsible for implementing the policy. The National Broadband Plan covers the period 2013–2018, with the goal of increasing mobile-broadband penetration to 80 per cent by 2018. The Nigerian Communications Commission is the sector regulator, with its mandate guided by the Nigerian Communications Act of 2003.

**Conclusion:** Nigeria is sub-Saharan Africa's largest economy, providing huge potential for developing the ICT sector. There is a high level of retail competition in the mobile market. This needs to be extended to the retail fixed-broadband and wholesale backbone markets so that high-speed

connectivity can extend to all parts of the country and meet the needs of business and government.

## Norway

**Norway's telecommunication market is very advanced and the population are active users of ICTs with penetration rates for fixed and mobile services above the European average. Incumbent operator Telenor is the market leader in all segments, but faces increasing levels of competition from new entrants.**

**Mobile services:** Norway's mobile market is served by three mobile network operators and a number of MVNOs. Incumbent Telenor holds the highest market share of around 50 per cent.<sup>342</sup> Second-placed operator Telia significantly improved its position through the acquisition of Tele2 in 2015. The Norwegian Competition Authority (NCA) granted the acquisition by Telia under the conditions that Telia sells infrastructure to the third mobile operator ICE and allows MVNOs to use its network.<sup>343</sup> Mobile-cellular penetration has reached very high levels and mobile-broadband penetration is well above the European average. Prices for mobile-cellular and in particular mobile-broadband offers are among the most affordable worldwide. At the same time, speeds and the amount of data included in mobile subscriptions per month are increasing and at the end of 2015, one out of five mobile-cellular subscriptions had at least 5 GB per month included (NKOM, 2016b).

**Fixed services:** Fixed-broadband penetration is very high and above the European average. Fibre connections in particular have seen a rapid growth in recent years and in 2016, most fixed-broadband subscriptions were based on fibre, overtaking DSL and cable-based connections. Operators continue to invest in fixed-broadband infrastructure, with a particular emphasis on fibre, which made up more than 50 per cent of all investments in fixed networks in recent years. Viken Fiber is the strongest Telenor competitor in the fibre sub-sector and both are competing for the market lead. The number of fixed-telephone subscriptions has declined since 1998 underlining the strong trend towards fixed-to-mobile substitution (NKOM, 2016a).

**Government policy:** Norway is not a member of the EU, but joined the European Economic Area (EEA) and is thus obliged to adhere to EU electronic communication directives. At national level, the government emphasizes the role of

Key indicators for Norway (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	15.5	37.7 13.6
Mobile-cellular sub. per 100 inhab.	110.3	118.0 101.5
Fixed-broadband sub. per 100 inhab.	40.8	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	112.6	80.1 52.2
3G coverage (% of population)	99.0	98.5 85.0
LTE/WiMAX coverage (% of population)	99.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.2	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.5	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.1	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.2	0.6 6.8
Percentage of households with computer	97.6	79.6 46.6
Percentage of households with Internet access	97.1	82.5 51.5
Percentage of individuals using the Internet	97.3	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	269.0	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

ICTs to make the public sector more efficient, boost innovation and value creation in the business sector in order to achieve an inclusive development of society.<sup>344</sup> The government eNorway plan thus focuses on different institutions and users of ICTs, from individuals and culture to industry, the public sector and life-long learning. The plan outlines numerous actions in order to enhance access to, and use of ICTs. Norway's Digital Agenda looks at how ICTs can be utilized for "a simpler everyday life and increased productivity" (Norwegian Ministry of Local Government and Modernisation, 2015).

**Conclusion:** The country is among the most advanced information societies globally. Household ICT penetration is very high and most of the population is using the Internet. The government emphasizes the role of ICTs for the development of the society and economy and thus puts in place actions to further this development.

## Oman

***Oman has a healthy level of competition with two mobile network operators: Omantel and Ooredoo Oman (formerly Nawras), and two mobile resellers (MVNOs), which have captured over 17 per cent of the mobile subscriber market share. Oman has comparable prices for fixed and mobile broadband services, which are below the average prices in the Arab States region measured as a percentage of the gross national income (GNI) per capita (ITU data).***

**Mobile services:** Oman has a highly developed mobile network with high mobile penetration levels. Most parts of the country are covered with 3G and LTE services. Omantel is the incumbent cellular operator in Oman. Ooredoo Oman (Formerly Nawras) was the second cellular operator to launch in the market and ended the Omantel monopoly on cellular mobile services in 2005. The two operational MVNOs in the Omani market are: FRIENDi and Renna Mobile. Telecommunications Regulatory Authority (TRA) granted the right of using 900 MHz for 2G services to Ooredoo and Omantel, later on this band was re-farmed to be used on technology neutral basis. In addition, the right of using 2100 MHz frequency band was granted for 3G services to Ooredoo and Omantel. LTE was launched in Oman in 2012: Omantel commercially launched the first LTE network in July 2012 using the 1800/2300 Bands; and Ooredoo announced the commercial launch of its LTE services in February 2013 using the 1800MHz bands. In 2015, TRA granted the rights to use the radio spectrum for fourth generation technology (LTE) in the bands 800 and 2600 MHz for Omantel and Ooredoo.

**Fixed services:** The fixed services market is reasonably competitive in Oman. TRA granted the third fixed line licence in 2012 to Awasr, another Omani company. As a result, the Fibre-to-the-home services are offered by the three telecommunication operators. In addition, the Information Technology Authority (ITA) was set up by Royal Decree 2006 to implement national IT infrastructure projects. In February 2017, ITA and Omantel have signed an agreement to renew the Oman Government Network (OGN) contract. The contract was first signed in July 2006 for a period of five years and was renewed in 2011 for another five years. Oman Broadband Company, OBC, established by the government in 2013 to

Key indicators for Oman (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	9.8	7.7	13.6
Mobile-cellular sub. per 100 inhab.	159.2	107.1	101.5
Fixed-broadband sub. per 100 inhab.	6.2	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	91.3	45.2	52.2
3G coverage (% of population)	96.0	81.9	85.0
LTE/WiMAX coverage (% of population)	88.8	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.6	4.3	5.2
Fixed-broadband prices (% GNI pc)	2.8	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.9	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.9	5.5	6.8
Percentage of households with computer	87.5	43.3	46.6
Percentage of households with Internet access	86.1	45.3	51.5
Percentage of individuals using the Internet	69.8	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	66.1	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

implement the goals identified in the National Broadband Strategy (NBS) would be the passive infrastructure provider (both fixed services and backhaul connectivity provider) by means of fibre access to licensees.

**Government policy:** TRA was established in 2002 to implement the government policy of liberalizing the telecommunication sector and enhancing competition for the telecommunication services in the Sultanate of Oman. The government issued Telecom Policy Framework in 2012, which aims to increase Internet penetration; prepare the suitable conditions for effective competition in the provision of infrastructure, telecommunication services and promote competition in the provision of these services; expand the provision of full range of telecommunication services in unserved villages. The government approved a national broadband strategy in 2013, which set out targets to increase penetration of broadband services and strategies to achieve these targets. Oman Broadband Company (OBC), a government funded company, was created to provide national optical fibre backbone network to be used/shared by all fixed licensed operators.

**Conclusion:** The efforts made by the Sultanate of Oman over the past 15 years have resulted in transforming Oman into a liberalised market for fixed and mobile services. Nearly all urban city households have Internet access and most of its citizens use the Internet on a regular basis. Oman aims to further develop countrywide high-speed networks, and has embarked on a project to bring telecommunication services to 410 villages in unserved areas of Oman by the end of 2017.

## Pakistan

**The recent introduction of high-speed mobile broadband and significant policy initiatives is driving growth in the world's ninth largest cellular market towards digital economy.**

**Mobile services:** Pakistan's mobile sector is a vibrant, open and a growing market with the participation of international telecommunication operators. There are four active operators following industry consolidation over the last few years. Jazz was formed from 2016 merger between MOBILINK and WARIDTEL and is owned by VEON Group (formerly VimpelCom Ltd.). CMPAK is a 100 per cent owned subsidiary of China Mobile following its 2007 purchase from Millicom. Launched in 2005, Telenor Pakistan is a subsidiary of the Norwegian Telenor Telecommunications Group. Pak Telecom Mobile Limited (PTML) was launched by incumbent Pakistan Telecommunication Company Limited (PTCL) in 2001 under the brand Ufone and is now part of the UAE's ETISALAT Group following PTCL's privatization in 2006. Pakistan has 140 million cellular mobile subscribers with high population coverage of cellular network. In 2016, 92 per cent of households have a mobile phone (96 per cent in urban areas and 90 per cent in rural ones) (PBS Pakistan, 2016). Pakistan has seen a significant success in broadband accessibility through a series of spectrum auctions for 3G and LTE services, starting in 2014 and the subsequent auctions in 2016 and 2017 to provide impetus to growth and meet the extraordinary demand. With an exponential growth, mobile broadband subscribers have reached 44.5 million in just three years of its inception, accounting to 32 per cent of total mobile subscribers. Currently, all cellular mobile operators have LTE spectrum, except for Ufone.

**Fixed services:** Pakistan has made significant progress in national and international connectivity. Several companies operate national fiber optic backbones including PTCL and wholesalers with a total length fiber optic now stands at 85,549 Kms. The country's Universal Service Fund has also been used to extend the fibre network to rural areas. The terrestrial fibre network extends to China, the Islamic Republic of Iran, and India, and Pakistan provides access to its submarine cables for landlocked Afghanistan. Access to submarine cable has been increasing. Pakistan is connected to half a dozen undersea fibre-optic networks:

Key indicators for Pakistan (2016)	Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	1.6	10.0
Mobile-cellular sub. per 100 inhab.	71.4	98.9
Fixed-broadband sub. per 100 inhab.	0.9	11.3
Active mobile-broadband sub. per 100 inhab.	20.1	47.4
3G coverage (% of population)	67.0	87.6
LTE/WiMAX coverage (% of population)	27.0	73.6
Mobile-cellular prices (% GNI pc)	2.0	3.2
Fixed-broadband prices (% GNI pc)	5.0	14.5
Mobile-broadband prices 500 MB (% GNI pc)	1.1	2.7
Mobile-broadband prices 1 GB (% GNI pc)	6.0	5.4
Percentage of households with computer	16.1	37.8
Percentage of households with Internet access	22.1	45.5
Percentage of individuals using the Internet	15.5	41.5
Int. Internet bandwidth per Internet user (kbit/s)	16.6	48.0

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

SeaMeWe3 (1999), -4 (2005) and -5 (2016); TWI1 (2006); IMEWE (2010); and AAE-1 (2017), with two more scheduled for deployment in 2018. There are more than 17 operators in fixed services and the incumbent PTCL dominates the fixed line sector. Both landlines and wireless CDMA are used for fixed telephone service. Fixed broadband consists mainly of ADSL followed by coaxial cable and FTTH and makes up around two thirds of the fixed broadband market. Fixed wireless broadband includes WiMax and CDMA EVDO technologies. The first Pakistan Internet Exchange Point (IXP) was launched in 2017 at Islamabad with eight participants and the consultations on a second IXP at Karachi are underway.

**Government policy:** The Ministry of Information Technology and Telecom is responsible for sector policy. The Pakistan Telecommunication Authority (PTA) was established under the *Telecom Reorganization Act* of 1996 to regulate the sector. Over the last few years, the Government has demonstrated its commitment to complete Pakistan's transition to a digital economy through a series of policy initiatives. The *Telecom Policy 2015* and *IT Policy 2016* have provided a comprehensive reform agenda and several implementation plans are currently underway. Legal framework for cyber security has been enacted through the *Prevention of Electronic Crimes Act, 2016*. National incubation centres initiative is another significant step to contribute to digital economy through innovation and entrepreneurship. The draft *Digital Pakistan Policy* has 15 policy goals with the overall vision "to become a strategic enabler, by making the full use of ICT, for an accelerated digitization ecosystem,

aiming to expand knowledge based economy and drive socio-economic growth."

**Conclusion:** Broadband infrastructure has been increasing recently in response to mobile broadband spectrum awards, continuing expansion of the national fibre-optic backbone, launch of the Internet Exchange Point, national incubation centres and multiple connections to new undersea cables. This is laying the groundwork for the country's vision of a Digital Pakistan.

## Panama

**The telecommunications sector in Panama has been under full competition since 2003, when the Government ended Cable and Wireless' monopoly.<sup>345</sup> The country's booming economy and potential for growth, particularly in terms of broadband uptake, has attracted investors to the sector. Mobile money has also been at the centre of attention in Panama, with approximately 55 per cent of the adult population being underserved by financial services, especially in rural areas.<sup>346</sup>**

**Mobile services:** Mobile-cellular is exceptionally successful in Panama, with penetration rates well above most countries; however, most subscriptions remain of the prepaid type, with postpaid representing only 11 per cent of the total.<sup>347</sup> The market is under full competition and services are provided by four operators – Cable and Wireless, Movistar, Claro and Digicel. Mobile-broadband has become increasingly more popular in recent years, with LTE technology becoming available since the beginning of 2015 (3G having been launched in 2008).<sup>348</sup>

**Fixed services:** Fixed-broadband has been a popular choice since DSL services surpassed simple dial-up access in 2005. Currently, cable modem is the most commonly used fixed-broadband technology, representing little under two-thirds of the total, with DSL taking second place.<sup>349</sup> The market is dominated by Cable and Wireless, whose resistance to unbundle its network has jeopardized the creation of a level playing field for all market competitors.<sup>350</sup>

**Government policy:** The entity responsible for regulating the telecommunications sector in Panama is the *Autoridad Nacional de los Servicios Públicos*, which was created in 1996.<sup>351</sup> The Government of Panama is very engaged in the development of ICT services, especially regarding the innovative and successfully launched programme “*Internet para Todos*” (Internet for all) in 2008, within the scope of the *Red Nacional de Internet*.<sup>352</sup> Through this programme, more than 80 per cent of the national population now has free access to wireless broadband in public areas such as schools and parks, and efforts are also made in terms of educating and preparing the population to use ICTs.

Key indicators for Panama (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	15.8	24.4	13.6
Mobile-cellular sub. per 100 inhab.	127.0	114.2	101.5
Fixed-broadband sub. per 100 inhab.	9.5	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	59.0	82.7	52.2
3G coverage (% of population)	92.7	93.6	85.0
LTE/WiMAX coverage (% of population)	11.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.3	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.2	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.5	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.0	5.7	6.8
Percentage of households with computer	42.5	64.9	46.6
Percentage of households with Internet access	53.9	63.3	51.5
Percentage of individuals using the Internet	54.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	55.1	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Conclusion:** In line with the regional trend, fixed telephony has been outshined by the mobile-cellular take-up, with mobile broadband also being widely more popular than its fixed counterpart. Whereas the mobile-cellular market is saturated, there lies potential for data services to grow as broadband becomes more popular, especially due to public efforts.<sup>353</sup>

## Papua New Guinea

***The Pacific's largest developing country economy dramatically boosted mobile access following the introduction of competition in 2007.***

**Mobile services:** The state-owned incumbent TELIKOM launched GSM services in 2003. Its operations were later spun off to a local business group and re-launched as BEMOBILE in 2009. The mobile group DIGICEL entered the market as the second operator in 2007. The market exploded after the introduction of competition and mobile penetration rose sharply. DIGICEL has a large market share and Papua New Guinea is its second largest market in terms of the number of subscribers and the largest by revenue. Mobile broadband has grown since the launch of 3G in 2011 but coverage is constrained by the country's complex geography. DIGICEL launched LTE in 2014 and TELIKOM re-entered the market in 2016 with both 3G and LTE networks.

**Fixed services:** TELIKOM is the main fixed telephone service provider. Fixed telephone lines are limited to a few urban areas, while wireless local loop using WiMAX technology is available elsewhere. Fixed broadband penetration is restricted to certain urban locations. TELIKOM offers ADSL with speeds of up to 24 Mbps. DIGICEL has introduced fibre to the building for businesses, while TELIKOM offers leased line fibre-optic connections. Fixed wireless broadband is available via LTE.

PNG DataCo Limited was established in 2014 as a wholesaler to own, manage, operate and maintain the Government's wholesale telecommunications infrastructures and assets. These include fibre-optic routes along natural gas pipelines and electric utilities poles, as well as submarine cable networks. The PNG National Submarine Fibre Cable Network is a 5 500-kilometre network that will complement existing domestic submarine links and connect outer islands into a national network that should be completed by 2018. The country connected to its first international submarine cable, the Australia-Papua New Guinea-2 (APNG-2), in 2006 and subsequently to the PIPE Pacific Cable-1 (PPC-1) in 2009. An IXP was commissioned in Port Moresby in 2017.

**Government policy:** Sector oversight is the responsibility of the Ministry of Communication

Key indicators for Papua New Guinea (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	<i>2.0</i>	10.0	13.6
Mobile-cellular sub. per 100 inhab.	<i>48.6</i>	98.9	101.5
Fixed-broadband sub. per 100 inhab.	<i>0.2</i>	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	<i>9.2</i>	47.4	52.2
3G coverage (% of population)	<i>60.9</i>	87.6	85.0
LTE/WiMAX coverage (% of population)	<i>n.a.</i>	73.6	66.5
Mobile-cellular prices (% GNI pc)	<i>8.8</i>	3.2	5.2
Fixed-broadband prices (% GNI pc)	<i>4.2</i>	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	<i>9.7</i>	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	<i>14.2</i>	5.4	6.8
Percentage of households with computer	<i>4.3</i>	37.8	46.6
Percentage of households with Internet access	<i>8.8</i>	45.5	51.5
Percentage of individuals using the Internet	<i>9.6</i>	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	<i>20.1</i>	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

and Information Technology (MCIT). The *National ICT Policy* of 2008 called for sector reform leading to the creation of the National Information and Communications Technology Authority (NICTA) in 2010, following the adoption of the *National Information and Communications Technology Act* in 2009. NICTA regulates the broadcasting, Internet and telecommunication sectors. NICTA is implementing several Universal Access and Service projects to expand telecommunication services in rural areas. One example is the move to expand 3G coverage in rural areas by financing the installation of new cell towers. The *National Broadband Policy* of 2013 is aligned with national development strategies and has seven specific objectives: i) economic growth; ii) social growth; iii) enhanced public and private sector efficiency; iv) ICT training and use in schools; v) improved health delivery; vi) enhanced global integration; and vii) improved efficiency of key economic industries particularly in the primary sector.

**Conclusion:** Despite the challenges of enhancing widespread coverage of ICT infrastructure because of Papua New Guinea's difficult terrain, the country has made strides in ICT since its connection to submarine cables and the introduction of competition.

## Paraguay

**Being a landlocked country, Paraguay depends on its neighbours for access to submarine cables, an important factor that has slowed development and uptake of broadband services in the country.<sup>354</sup> On the other hand, mobile services have enjoyed relative success, especially because of the competitive market, as well as mobile money's popularity and more affordable pricing.**

**Mobile services:** The mobile market has been under competition since 1998 and currently hosts four operators – Tigo, Telecom, Claro and Vox.<sup>355</sup> Mobile-cellular penetration rates are high, following the regional trend, partially because mobile has been a substitute for the less available fixed counterpart. Mobile-broadband penetration rates remain relatively low but the competitive market and ongoing service coverage expansion are expected to positively impact the segment. Another important aspect is the common use of mobile money by nationals, with Paraguay being the regional leader in the development of this practice.

**Fixed services:** Fixed-telephony and VoIP are under the monopoly of the State-owned *Corporación Paraguaya de Comunicaciones* (Copaco),<sup>356</sup> which has resulted in poor levels of infrastructure due to continued underinvestment. Despite the fact that the fixed-broadband market is under competition, development continues to be jeopardized by the refusal from Copaco to unbundle the local loop. ADSL remains in the hands of Copaco, whereas cable modem technology is also provided by Tigo Hogar. Service provision is mostly limited to the more developed urban areas, with the remote areas being underserved.<sup>357</sup> Both cable modem and fibre optic technologies have witnessed a growing demand as well as improvement in speed, and the Government has declared that fibre optic deployment is one of its main focuses for the coming years, along with an increase in affordability.

**Government policy:** The national telecommunication regulator, *Comisión Nacional de Telecomunicaciones* (CONATEL), was created in 1995. The current development programme, namely the *Plan Nacional de Telecomunicaciones 2016–2020*, emphasizes several aspects, for instance, the pressing need to render the services

Key indicators for Paraguay (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	4.9	24.4	13.6
Mobile-cellular sub. per 100 inhab.	104.8	114.2	101.5
Fixed-broadband sub. per 100 inhab.	3.4	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	46.5	82.7	52.2
3G coverage (% of population)	95.4	93.6	85.0
LTE/WiMAX coverage (% of population)	78.5	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.7	3.6	5.2
Fixed-broadband prices (% GNI pc)	6.6	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.4	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.0	5.7	6.8
Percentage of households with computer	30.3	64.9	46.6
Percentage of households with Internet access	26.0	63.3	51.5
Percentage of individuals using the Internet	51.3	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	21.0	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

more affordable (targeting a reduction of up to 80 per cent on data services pricing), adjust interconnection rates to foster competitiveness, and increase the number of connected households to 60 per cent, among others. As to making broadband more affordable, the Government will concentrate both on reducing the use of international broadband and negotiating new tariffs.

**Conclusion:** The public and private efforts in developing the telecommunications sector in Paraguay have been effective to date, with steadily growing adoption rates, decrease in prices and infrastructure development.

## Peru

**Peru is an example of a country within the Americas region with challenging topography in terms of ICT infrastructure deployment, which gives a clear advantage to the mobile sector over its fixed alternative. The Government has actively engaged in programmes to develop the ICT sector, both in terms of improving and updating the legislation and deploying networks, notably the National Fibre-Optic Backbone.**

**Mobile services:** There are four mobile network operators competing for market share in the mobile segment – Telefónica, Claro, Entel and Bitel – with the first holding almost half the total subscriptions. There is increased competitiveness in the mobile market, with mobile number portability requirements being in place since 2007 and the entrance of mobile virtual network operators (MVNOs), such as Virgin, which joined the market in 2016 (OSIPTEL, 2017). Despite penetration rates that are in line with the regional levels, there is a clear divide within the population, with one-fifth of Peruvians not owning a mobile phone. In terms of mobile broadband, the operators have heavily invested in the sector in recent years, especially in terms of LTE deployment.<sup>358</sup> The country has come a long way since first assigning LTE licenses in 2013, substantially improving coverage and service pricing.

**Fixed services:** Number portability requirements are also in place in respect to the fixed services, with the market being dominated by Telefónica and followed by Claro in terms of market shares. Fixed-broadband is mainly available via DSL and cable-modem technologies (OSIPTEL, 2017), but its penetration rates are well below the regional and global levels.

**Government policy:** The body in charge of regulating the telecommunication sector is the *Organismo Supervisor de Inversión Privada en Telecomunicaciones* (OSIPTEL). Created in 1991, it is actively engaged in the promotion of a competitive environment and expansion of services to reach the entire population. To foster competition, OSIPTEL put in place measures such as number portability requirements and tariff controls – notably enforcing reduction in retail prices and interconnection rates, among others – and it has recently implemented net

Key indicators for Peru (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	9.7	24.4	13.6
Mobile-cellular sub. per 100 inhab.	117.1	114.2	101.5
Fixed-broadband sub. per 100 inhab.	6.7	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	62.0	82.7	52.2
3G coverage (% of population)	70.8	93.6	85.0
LTE/WiMAX coverage (% of population)	44.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.0	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.6	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.7	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.6	5.7	6.8
Percentage of households with computer	33.5	64.9	46.6
Percentage of households with Internet access	26.4	63.3	51.5
Percentage of individuals using the Internet	45.5	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	33.3	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

neutrality regulations. The Government has also been promoting broadband programmes, with considerable funding dedicated to the deployment of a fibre optic backbone within the scope of the National Broadband Plan, which aims to connect up to 80 per cent of Peru's territory.<sup>359</sup>

**Conclusion:** Despite the challenging landscape and social disparities in the country, the telecommunications sector has seen considerable improvement in recent years, with the active participation of the Government and operators. There remains an enormous potential for market players, as broadband adoption rates remain feeble.

## Philippines

**The largest South-East Asian archipelago nation has achieved a high level of GSM mobile coverage, with most ICT services provided in a duopoly environment.**

**Mobile services:** The Philippines mobile market has undergone ongoing consolidation. In 2000, there were ten licensed operators but by 2016, the market was largely a duopoly between the incumbent operator (Smart) under the group Philippine Long Distance Telephone Company (PLDT), and Globe Telecom, whose main shareholders are the local Ayala Corporation and Singapore Telecom. There are some Mobile Virtual Network Operators (MVNOs) and dormant licensees. 2G mobile coverage of the population is virtually total. Mobile penetration passed the 100 per cent mark in 2012 but there is room for growth with 84 per cent of homes had a mobile phone (91 per cent in urban areas, 78 per cent in rural areas) (Philippine Statistics Authority, 2014). Mobile broadband was first deployed in 2006 with the launch of 3G networks, and with coverage reaching over three quarters of the population and is the main form of Internet access. Both operators launched LTE in 2012 and have deployed since 2013 LTE-Advanced reaching download speeds of 1 Gbps. The regulator is contemplating auctioning more frequencies and issuing a third mobile licence for companies not holding spectrum.

**Fixed services:** PLDT is one of the few incumbent operators around the world that has long been privately owned. PLDT and Globe dominate the fixed telephone market with nationwide services. There are some regional carriers but they have only a small share of the market. Both PLDT and Globe offer fixed broadband services over ADSL and FTTP, with speeds of up to 1 Gbps. FTTP, launched in 2011, has recently picked up speed as it expands to other cities outside Manila. Fixed wireless Internet (WiMAX) is also available and some ISPs are deploying fixed LTE wireless networks.

PLDT and Globe have extensive national fibre-optic backbone employing a mix of underground, overhead and submarine cable. The country's strategic location and considerable coastline facilitate access to international submarine cable systems. As far back as 1997, it connected to its first undersea fibre-optic network, the Asia Pacific

Key indicators for Philippines (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	3.7	10.0	13.6
Mobile-cellular sub. per 100 inhab.	<i>109.2</i>	98.9	101.5
Fixed-broadband sub. per 100 inhab.	5.5	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	<i>46.3</i>	47.4	52.2
3G coverage (% of population)	<i>93.0</i>	87.6	85.0
LTE/WiMAX coverage (% of population)	<i>80.0</i>	73.6	66.5
Mobile-cellular prices (% GNI pc)	3.2	3.2	5.2
Fixed-broadband prices (% GNI pc)	7.1	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.1	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.1	5.4	6.8
Percentage of households with computer	<i>34.0</i>	37.8	46.6
Percentage of households with Internet access	<i>39.1</i>	45.5	51.5
Percentage of individuals using the Internet	55.5	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	<i>43.4</i>	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Cable Network (now out of service). Today, the Philippines is linked to over half a dozen regional and intercontinental submarine networks. The Philippine Open Internet Exchange (PHOpenIX) was launched in 2007 and has 57 members.

**Government policy:** The Department of Information and Communications Technology (DICT) is the sector policy maker and is charged with implementing strategies. The draft *National Broadband Plan* has the vision of "resilient, comfortable and vibrant life for all, enabled by open, pervasive, inclusive, affordable, and trusted broadband Internet access." In accordance with that vision, the Government will establish policies to spur competition and ensure availability, affordability and quality of broadband Internet access. The National Telecommunications Commission (NTC), an attached agency of the DICT, is the sector regulator. The main legislation covering sector regulation is the 1995 Republic Act No. 7925 (*Public Telecommunications Policy Act*).

**Conclusion:** Despite having a largely duopoly market, the country has achieved a high level of basic mobile access and has deployed the latest wireless and fixed technologies with high download speeds, at least in urban areas. It is also well endowed with international Internet bandwidth driven by its large overseas population and burgeoning business process outsourcing industry.

## Poland

**Poland is one of the biggest markets in Europe with a population of 38 million inhabitants. The country has a competitive telecommunication market in line with the principles set forth by the European Union.**

**Mobile services:** Poland has a competitive mobile market, with affordable prices for mobile-cellular and mobile-broadband services. Orange Polska, Poland's incumbent operator, continues to hold the largest market share in the mobile sector. The market was opened to competition in 1996. A tender was organized and Polkomtel and T-Mobile Poland (at that time Polska Telefonia Cyfrowa sp. z o. o. - Era GSM) were granted licences to compete with the incumbent. Another tender was carried out in 2005 with the aim to make the mobile market more competitive. Poland's fourth mobile network operator P4 finally launched services in 2007 (UKE, 2005). The first mobile virtual network operator entered the market in December of 2006 (UKE, 2006). In 2016, a2mobile started to offer mobile services, making it the fifth operator using its own network infrastructure (UKE, 2016). Mobile-cellular penetration is very high in Poland. A law to make the registration of all prepaid SIM cards compulsory entered into force in 2016 and led to a decrease in the number of SIM cards.<sup>360</sup> Full population coverage with 3G services was achieved in 2005 and mobile-broadband penetration is on the rise.

**Fixed services:** The state-owned telecommunication company TPSA lost its monopoly of local services in 1992 and TPSA shares were gradually sold, with the transaction of the final 4 per cent of the shares taking place in 2010.<sup>361</sup> International services were finally open to competition in 2003 (OECD, 2002). The incumbent operator, owned and operated by Orange remains the dominant operator on the fixed market for both fixed-telephony and fixed-broadband. Cable operators are important players on the market with their bundled offers including fixed-broadband. Fixed-broadband penetration, while increasing in recent years remains relatively low in comparison with other European countries. Rural areas in particular are underserved by NGA networks (European Commission, 2017).

**Government policy:** As part of the accession to the European Union, the National Regulatory

Key indicators for Poland (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	21.3	37.7	13.6
Mobile-cellular sub. per 100 inhab.	138.7	118.0	101.5
Fixed-broadband sub. per 100 inhab.	19.2	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	68.6	80.1	52.2
3G coverage (% of population)	100.0	98.5	85.0
LTE/WiMAX coverage (% of population)	100.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.7	1.0	5.2
Fixed-broadband prices (% GNI pc)	0.9	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.1	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.7	0.6	6.8
Percentage of households with computer	80.1	79.6	46.6
Percentage of households with Internet access	80.4	82.5	51.5
Percentage of individuals using the Internet	73.3	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	83.3	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Authority was established in 2000.<sup>362</sup> With the focus of the EU member states being on broadband development, Poland set ambitious goals building on the Digital Agenda for Europe targets. The national broadband plan was adopted in 2014 and aims at providing 100 per cent coverage of households with Internet at 30 Mbit/s and 50 per cent coverage with 100 Mbit/s by 2020. Investments in broadband infrastructure are being made by the EU, the government, and private investors.<sup>363</sup> In order "to create a digital boost for the development of Poland" the Ministry of Administration and Digitization was created by the government in 2011, followed by the Ministry of Digital Affairs, which was established in 2015. Its aims are to increase Internet access, develop web content and services, and promote digital skills.<sup>364</sup>

**Conclusion:** Poland's telecommunication sector has undergone important changes in the past decade leading to an increase in competition. In line with the Digital Agenda for Europe, the country has set ambitious goals for broadband development thus underlining its determination to foster ICT development. This is further reflected in the creation of the Ministry of Administration and Digitization in 2011, followed by the Ministry of Digital Affairs, which was established in 2015.

## Portugal

**Portugal has a well-developed telecommunication market that has recently undergone significant ownership changes. Growth in ICTs continues to be driven by NGA connections.**

**Mobile services:** The Portugal mobile market is served by three mobile network operators – MEO, Vodafone and Nos – as well as a number of virtual network operators. Meo, a brand of Portugal Telecom, is the incumbent operator and market leader. According to the regulator ANACOM, mobile subscription numbers have stabilized in 2016, after two cycles of intense growth driven by the introduction of mobile-broadband. There is also a clear trend concerning the migration from prepaid to postpaid subscriptions. While in 2009 almost three-quarters of all mobile subscriptions were prepaid, they represented slightly less than 50 per cent of total subscriptions in 2016. The change in the trend can be explained by the introduction of convergent bundled or multiple-play offers. Indeed, at the end of 2016, 41 per cent of mobile customers had acquired mobile service as part of a multiple-play offer (ANACOM, 2017b).

**Fixed services:** Due to significant growth in recent years, Portugal's fixed-broadband penetration stands above the European average. Increases in the number of FTTH/B subscriptions make up the largest share of gains in fixed-broadband subscriptions. With average annual growth rates in fibre subscriptions of around 30 per cent, fibre made up 32 per cent of fixed-broadband subscriptions in 2016 and thus exceeded the European average by almost 6 percentage points. Economic pressures on operators have resulted in a number of ownership changes in the fixed sector. Most notably, the incumbent operator Portugal Telecom was sold from Oi to the French telecom group Altice in 2015.<sup>365</sup> MEO, which is controlled by Portugal Telecom, is the market leader, followed by Grupo NOS, Vodafone, and Grupo Apax (ANACOM, 2017a).

**Government policy:** Portugal joined the European Union in 1986, a step that had (and continues to have) a significant impact on the ICT market. One of the most recent examples of this is the decision of the government to relinquish its special rights on the incumbent operator, Portugal Telecom, in July 2011, as had been requested by the European

Key indicators for Portugal (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	45.1	37.7 13.6
Mobile-cellular sub. per 100 inhab.	109.1	118.0 101.5
Fixed-broadband sub. per 100 inhab.	31.8	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	61.1	80.1 52.2
3G coverage (% of population)	99.3	98.5 85.0
LTE/WiMAX coverage (% of population)	98.8	92.2 66.5
Mobile-cellular prices (% GNI pc)	1.0	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.5	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	0.6 6.8
Percentage of households with computer	72.7	79.6 46.6
Percentage of households with Internet access	74.1	82.5 51.5
Percentage of individuals using the Internet	70.4	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	177.8	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Commission.<sup>366,367</sup> EU and national ICT policies are focusing on the extension of broadband networks. Portugal's national broadband strategy, adopted in 2012, aims to reach a coverage of at least 30 Mbit/s for 100 per cent of the population and a coverage of at least 100 Mbit/s for 50 per cent of all households until 2020. Next to the roll-out of broadband networks, the Digital Agenda for Portugal focuses on delivering better public services to citizens, promoting smart mobility, employment and e-commerce as well as reducing the digital gap between urban and rural areas of the country.<sup>368</sup>

**Conclusion:** Portugal's telecommunication market has seen a positive development, despite the general economic downturn. The government is encouraging investments in NGA networks in order to expand high-speed connectivity and increase the number of those online.

## Qatar

**Qatar is a rapidly developing country and has a highly advanced ICT infrastructure. Ooredoo (formerly Qtel) and Vodafone offer advanced fixed and mobile services with some of the lowest prices in the region. Additionally, Qatar National Broadband Network (Qnbn) offers passive fixed services on a wholesale basis, Harris Salam, QSAT and RIGNET offer VSAT services, and Es'hailSat offers public satellite services.**

**Mobile services:** Mobile-cellular penetration rates in Qatar are amongst the highest in the world. Similarly, the mobile broadband subscription rate is three times as high as global and regional averages. Competition was introduced into the market with the award of a mobile licence to Vodafone in 2008. Mobile broadband use in Qatar is growing rapidly and so is subscriber demand for faster mobile broadband. In 2006, Ooredoo launched 3G services and Vodafone launched 3G services in 2009, reaching 100 per cent population coverage in 2010. Ooredoo launched the first LTE network in 2013 and Vodafone Qatar launched LTE services in 2014. Today, both operators operate LTE networks affording subscribers with widespread mobile access to data rates exceeding 32Mbit/s.

**Fixed services:** Vodafone was awarded a fixed license in 2010. Qnbn was set up in 2011 by the Supreme Council of Information and Communication Technology (ictQATAR) as one of the region's first government initiatives to drive nation-wide optical fibre broadband infrastructure roll-out, by offering wholesale broadband optical fibre infrastructure services to licensed network service providers and operators of private networks. Ooredoo has rolled out optical fibre broadband infrastructure to nearly 100 per cent of households across Qatar with speeds up to 10Gbps for both consumers and businesses.

**Government policy:** ictQATAR was established according to Law No 36 of 2004 as the telecommunication regulator in Qatar. The Telecommunications Law of 2006 empowered ictQATAR to issue regulatory instruments to regulate the telecommunication sector. The Communications Regulatory Authority (CRA) replaced ictQATAR as the Communications Regulator by virtue of Emiri Decree 42 in 2014

Key indicators for Qatar (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	19.3	7.7	13.6
Mobile-cellular sub. per 100 inhab.	151.2	107.1	101.5
Fixed-broadband sub. per 100 inhab.	10.5	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	148.9	45.2	52.2
3G coverage (% of population)	99.6	81.9	85.0
LTE/WiMAX coverage (% of population)	99.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.3	4.3	5.2
Fixed-broadband prices (% GNI pc)	1.0	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.2	5.5	6.8
Percentage of households with computer	89.0	43.3	46.6
Percentage of households with Internet access	95.8	45.3	51.5
Percentage of individuals using the Internet	94.3	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	86.9	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

with a broader mandate that includes also the ICT, the postal sector and access to digital media. The Ministry of Transport and Communications, was established in accordance with *Emiri Decree No. 4 of 2016*, and, with respect to communications, is responsible for setting ICT policy and strategy to support the *Qatar National Vision 2030* of a highly developed ICT sector in Qatar and a knowledge-based economy. The Ministry also performs a crucial role in overseeing the development the ICT sector, as well as developing e-government programs and boosting capacity and digital literacy. In 2017, *Telecom Law 36 of 2006*, was amended to strengthen CRA's enforcement powers and to establish a clear governance structure for the ICT sector.

**Conclusion:** Efforts made by the government and licensed operators over the past 15 years have resulted in making Qatar one of the world's most connected countries with a nation covering fibre network. Qnbn is building a robust optical fibre network, and the competing operators are utilizing this network to provide high speed Internet access to businesses and households across the nation. Ooredoo and Vodafone are preparing to launch 5G services by 2020, opening the door for Internet of things (IoT) services and supporting the realisation of Qatar National Vision 2030.

## Romania

**Romania has a competitive mobile market, with very affordable prices and high penetration rates. The country's accession to the EU in 2007 spurred competition and prompted regulatory reforms in line with the EU acquis. Competition in the fixed-broadband market is infrastructure-based and fibre is the most popular choice, making Romania one of the European countries with the highest average broadband speeds.**

**Mobile services:** Four mobile network operators are serving the market. Three of them are pan-European providers (Orange Romania S.A., Vodafone Romania S.A., Telekom RMC S.A.) and one regional operator (RCS & RDS S.A.). There are also a number of MVNOs active in the market, but their share remains very small (ANCOM, 2015).<sup>369</sup> Mobile-cellular and mobile-broadband penetration are high and close to the European average and prices for both services are very affordable. All MNOs are offering LTE services and LTE coverage is being extended, while 3G has already reached nearly full population coverage.

**Fixed services:** Fixed-broadband penetration in Romania is relatively low compared to the European average and neighbouring countries. Romania's national broadband plan identifies several reasons for this: the late market liberalization (2003) and launch of DSL services (2005), limited use of personal computers, high mobile-broadband take-up and low incomes, especially in rural areas.<sup>369</sup> The market is evolving, however, both in terms of subscription numbers and broadband technology. Competition is strong and mostly infrastructure-based. There are three major facilities-based ISPs and around 660 smaller operators offering services (ANCOM, 2016). A particular characteristic of the market is the fact that the incumbent operator Telekom Romania does not have the highest market share in fixed broadband. Instead, the market leader is RCS & RDS, an integrated telecommunication provider, which offers FTTx services. Given the high percentage of fibre connections, average broadband speeds are among the highest in Europe.<sup>370</sup>

**Government policy:** Romania joined the European Union in 2007. Before and following the accession, European regulations and directives had a direct impact on the telecommunication market. The

Key indicators for Romania (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	19.1	37.7	13.6
Mobile-cellular sub. per 100 inhab.	106.4	118.0	101.5
Fixed-broadband sub. per 100 inhab.	20.7	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	73.7	80.1	52.2
3G coverage (% of population)	99.9	98.5	85.0
LTE/WiMAX coverage (% of population)	75.2	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.7	1.0	5.2
Fixed-broadband prices (% GNI pc)	0.9	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.2	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.5	0.6	6.8
Percentage of households with computer	74.0	79.6	46.6
Percentage of households with Internet access	72.4	82.5	51.5
Percentage of individuals using the Internet	59.5	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	155.5	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

focus of the government in recent years is on digitalization and broadband development. The National Strategy for the Romanian Digital Agenda 2020 illustrates the government efforts in this regard. In line with European targets, Romania aims at achieving 100 per cent households with fixed-broadband coverage by 2020, 80 per cent households with over 30 Mbit/s broadband coverage and 45 per cent households with over 100 Mbit/s coverage. Special emphasis is placed on broadband development in rural and disadvantaged areas. Stimulating competition and promoting mobile-broadband access were also identified as main drivers of growth.<sup>371</sup> Ro-NET, a project to build broadband infrastructure in disadvantaged areas, was launched by the Ministry of Communications and Information Society in 2015. The Ministry will remain the owner of the optical fibre backhaul infrastructure that is to cover over 3 000 km throughout Romania.<sup>372</sup>

**Conclusion:** The accession into the European Union has shaped its telecommunication market. Romania is continuing to develop its ICT market and promotes and invests in broadband infrastructure in order to increase access, in particular in rural and disadvantaged areas of the country.

## Russian Federation

**The telecommunication market is dynamic and operators offer innovative technologies and services. Despite the large territories to cover, telecommunication services are accessible to the majority of the population while prices remain at relatively low levels.**

**Mobile services:** Development of mobile services began in the early 1990s. First CDMA 2000 networks emerged in 2002, EV-DO in 2005 and 3G/UMTS in 2007.<sup>373</sup> LTE commercial services started to be offered in 2011.<sup>374</sup> The first UMTS-900 network was launched in 2012.<sup>375</sup> There are four major telecommunication operators (MegaFon, VimpelCom, MTS and Tele2) that share 99 per cent of mobile subscribers.<sup>376</sup> To foster competition and provide subscribers with another degree of freedom mobile number portability (MNP) was introduced in 2014. Since then over 4.7 m telephone numbers have been ported.<sup>377</sup> In 2014, two large companies declared their partnership in building LTE networks and spectrum sharing.<sup>378</sup> In the beginning of 2017, around quarter of mobile base stations offered LTE services.<sup>379</sup> Operators diversify their services. Besides mobile-cellular and broadband services they offer television broadcasting, fixed-broadband Internet access, fixed telephony, cloud-based services, mobile payments. In 2016, MTS, MegaFon, and Tele2 launched Wi-Fi calling service to provide voice services over Wi-Fi. MTS and Ericsson have agreed on cooperation to foster 5G development.

**Fixed services:** The fixed-broadband market started to emerge in 2002 when there were only a few thousand subscribers. The active phase of development began in 2006 and the stable growth continues. By 2017, five leading companies have two-thirds of fixed-broadband subscriptions. The market leader Rostelecom has more than 35 per cent of subscriptions. Operators offer bundles of services and increase connection speeds by deploying FTTx technologies to attract clients and sustain profits.<sup>380</sup> At the end of 2014, download speeds exceeded 4 Mbit/s for more than 70 per cent of fixed-broadband connections.<sup>381</sup>

**Government policy:** In 2008, the *Strategy of Information Society Development* was approved, which was followed by the national programme *Information Society 2011-2020*. In 2017, the *Digital Economy in the Russian Federation* programme

Key indicators for Russian Federation (2016)	CIS	World
Fixed-telephone sub. per 100 inhab.	22.8	20.7
Mobile-cellular sub. per 100 inhab.	161.7	141.2
Fixed-broadband sub. per 100 inhab.	19.4	15.8
Active mobile-broadband sub. per 100 inhab.	74.9	59.7
3G coverage (% of population)	75.0	77.1
LTE/WiMAX coverage (% of population)	59.0	45.9
Mobile-cellular prices (% GNI pc)	0.4	1.7
Fixed-broadband prices (% GNI pc)	0.6	3.3
Mobile-broadband prices 500 MB (% GNI pc)	0.3	1.4
Mobile-broadband prices 1 GB (% GNI pc)	0.5	3.1
Percentage of households with computer	74.3	67.4
Percentage of households with Internet access	74.8	68.0
Percentage of individuals using the Internet	76.4	65.1
Int. Internet bandwidth per Internet user (kbit/s)	51.9	59.0

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

was developed. The main goal is to provide people with modern ICT services and to create a new digital environment. One of the issues that the Ministry of Telecom and Mass Communications faces is to narrow the digital divide among regions and between city and rural areas. For that reason universal services reform was initiated in 2014. Adopted changes assume that around 14 000 settlements with populations ranging from 250 to 500 people will be provided with broadband Internet access by 2018. Rostelecom is responsible for the universal services implementation.<sup>382</sup> To facilitate mobile broadband development technological neutrality was introduced in 450/900/1800 MHz spectrum bands in 2014. By the end of 2014, the Regulator adopted rules allowing radio access network sharing. It also simplified rules for wireless broadband network launches and allowed spectrum sharing in a set of spectrum bands from 800 MHz to 2,5GHz by issuing regulations in 2015. Regulation authorities also make efforts to end national roaming charges. Information security issues and quality of service also remain in the focus of government policy. Satellite communications are also considered as a means to bridge the digital divide in remote areas. Several communications satellites were launched in recent years.

**Conclusion:** The Russian Federation has a vibrant telecommunication market. The regulatory authority aims to overcome the digital divide between regions and provide the population with modern telecommunication services by creating a favorable competition environment, adopting regulations and supporting infrastructure renovation.

## Rwanda

***The Government of this landlocked East African nation has been proactive with its strategic vision for the sector, and the country has achieved one of the highest levels of mobile-broadband coverage in sub-Saharan Africa.***

**Mobile services:** There are three mobile operators: MTN, a subsidiary of the South African mobile group, launched the country's first mobile network in 1998; the Luxembourg-based mobile group MILLICOM entered the market in 2009, operating under the TIGO brand; and AIRTEL, owned by the Indian mobile group, launched in 2012, absorbing the mobile assets of the defunct incumbent RWANDATEL. Although 2G coverage is widespread and absolute prices among the cheapest in sub-Saharan Africa, household penetration is relatively low, due to Rwanda's small per capita income. In 2015, 60 per cent of households had mobile phones, with a notable difference between urban (86 per cent) and rural areas (54 per cent).<sup>383</sup> A 3G network was launched in 2009, and its coverage reaches over 90 per cent of the population. In 2014, the Government launched a wholesale LTE network. It is operated as a public-private partnership with Korea Telecom, with capacity sold to existing mobile operators and fixed wireless ISPs. The Government is targeting 95 per cent LTE population coverage by 2018.

**Fixed services:** The incumbent operator RWANDATEL was privatized in 2005. RWANDATEL was declared insolvent in 2011. Liquid Telecom, a Mauritius-based group that launched in 2013, purchased RWANDATEL'S fixed network. The majority of fixed-broadband subscriptions are fixed wireless through WiMAX or fixed LTE. Three ISPs provide fixed broadband using ADSL or optical fibre. Liquid Telecom began offering fibre to small businesses and homes with the launch of a 100 Mbit/s service in 2015. In 2010, the Government completed the rolling out a national fibre-optic backbone with more than 3 000 km of fibre installed and distributed to all 30 districts and 11 border points. This wholesale network is run as a public-private partnership owned by the Government and Korea Telecom. Access is open to all operators at cost-based prices. In addition, there are several thousand kilometres of fibre deployed by other operators (i.e. MTN, Liquid Telecom, AIRTEL and TIGO), as well as optical

Key indicators for Rwanda (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.1	1.0	13.6
Mobile-cellular sub. per 100 inhab.	69.9	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.2	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	27.0	22.9	52.2
3G coverage (% of population)	92.1	59.3	85.0
LTE/WiMAX coverage (% of population)	62.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	8.4	14.2	5.2
Fixed-broadband prices (% GNI pc)	152.6	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.4	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	39.2	17.7	6.8
Percentage of households with computer	4.5	9.6	46.6
Percentage of households with Internet access	9.3	16.3	51.5
Percentage of individuals using the Internet	20.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	7.5	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

fibre deployed in the transmission lines of the State-owned electricity company Rwanda Energy Group leased to telecommunication operators. Landlocked Rwanda accesses cross-border undersea fibre-optic cables in Kenya and Tanzania for international bandwidth. The Rwanda Internet Exchange launched in 2004.

**Government policy:** The Ministry of Youth and ICT is responsible for sector policy and strategy. It develops five-year sector plans in alignment with overall national development goals. The SMART Rwanda Master Plan, covering the period 2015–2020, builds on the previous plans, with a focus on innovation in order to use ICTs as a transformational enabler to digitize the economy generating growth and job creation. The key strategy document driving high-speed communications in the country is the 2013 National Broadband Policy. The policy's goal is to transform Rwanda into an Information society driven by "universal access to high speed, reliable, affordable and secure broadband infrastructure and services by 2020". Kigali Innovation City is being developed on the outskirts of the city. It aims to attract multinational information technology firms and domestic start-ups alongside higher education institutions to create a tech ecosystem. The hopes are that the synergies from anchoring educational institutions alongside tech companies in a cluster will generate innovative applications and services, and help grow the domestic ICT industry, as well as generate exports. The Rwanda Utilities Regulatory Authority was created in 2001 as a multi-sector regulator. In addition to telecommunications, it is also responsible for media, posts, water, energy, sanitation and transport. The Authority is also

responsible for the Rwanda Internet Exchange, the Internet country domain name (.rw) and the Universal Access Fund. Law No. 24/2016 of 18 June 2016 Governing Information and Communication Technologies is the relevant legislation for the sector.

**Conclusion:** Government steps of creating a regulator, privatizing the incumbent, introducing competition and developing a broadband strategy have resulted in a high level of broadband infrastructure in the country. The SMART Rwanda Master Plan envisions taking ICTs to the next level by using their transformational capabilities and developing a vibrant ICT-enabled sector.

## Saint Kitts and Nevis

***Saint Kitts and Nevis displays a well-developed telecommunications sector, with penetration rates mostly above regional and global levels, and pricing well below the average for the region.***<sup>384</sup>

**Mobile services:** Mobile services are responsible for the largest part of the industry's revenue, as well as benefiting from the highest share of investments. There are three operators competing for market share: LIME, Digicel and UTS Cariglobe. In recent years, mobile-broadband has experienced continued success, with the majority of subscribers having data in addition to their voice plans. The LTE network has been available in Saint Kitts and Nevis since 2013 via Digicel's network, with LIME launching its LTE services a few years later.<sup>385, 386</sup> Joining a few other countries in the region, Saint Kitts and Nevis is a member of the Eastern Caribbean Telecommunications Authority (ECTEL), an overarching regulatory body that assists in the creation and implementation of relevant policies and regulation.

**Fixed services:** Fixed services are successful in terms of penetration, particularly in comparison with regional and global levels. Whereas fixed-telephone has remained stable despite the downward trend seen in the majority of countries, fixed-broadband is becoming increasingly popular, with cable modem being the most employed format.

**Government policy:** The sector regulator, the National Telecommunications Regulatory Commission (NTRC), was created in 2000<sup>387</sup> and oversees the development of ICTs, ensuring a level playing field for market competitors. The NTRC works closely with ECTEL to advance the sector from various perspectives, for instance implementing number portability in recent years, discussing net neutrality and more recently adopting a new Electronic Communications Bill.<sup>388,389,390</sup>

**Conclusion:** Saint Kitts and Nevis has seen significant success in developing the national telecommunications sector, with substantial improvements in service pricing, network infrastructure and service adoption. The sector has a positive outlook in the years to come, with increased investment and collaborations with

Key indicators for Saint Kitts and Nevis (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	31.2	24.4	13.6
Mobile-cellular sub. per 100 inhab.	136.9	114.2	101.5
Fixed-broadband sub. per 100 inhab.	29.3	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	77.1	82.7	52.2
3G coverage (% of population)	100.0	93.6	85.0
LTE/WiMAX coverage (% of population)	n.a.	77.4	66.5
Mobile-cellular prices (% GNI pc)	2.0	3.6	5.2
Fixed-broadband prices (% GNI pc)	2.8	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.1	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.2	5.7	6.8
Percentage of households with computer	71.7	64.9	46.6
Percentage of households with Internet access	72.6	63.3	51.5
Percentage of individuals using the Internet	76.8	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	165.4	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

regional organizations remaining at the core of its success.

## Saint Lucia

**All segments of the telecommunications sector are under competition in Saint Lucia, and service pricing is typically below regional and international levels. Industry investment has undergone a substantial decrease in recent years, and most of the previous investment was directed towards upgrading mobile networks. Operators' revenues also experienced a decrease in 2015; nevertheless, the sector revenues amounted to approximately 6 per cent of the national GDP of Saint Lucia in the same year.**

**Mobile services:** There are two operators providing mobile services in Saint Lucia, the incumbent LIME and Digicel.<sup>391</sup> Mobile services revenue accounts for over half of the industry's total revenues, and mobile phones are the primary means to access the Internet in the country. Mobile-broadband has been available to consumers since 2013, and has been the segment producing the most substantial increase in terms of service uptake in recent years.<sup>392,393</sup> Saint Lucia is one of the five members of the Eastern Caribbean Telecommunications Authority (ECTEL), an overarching regulatory body that assists in the creation and implementation of relevant policies and regulation.

**Fixed services:** Fixed-telephone penetration has remained relatively stable over the past couple of years in Saint Lucia, despite the regional and global downward trends. The market has been largely dominated by the incumbent LIME, which was cemented with the acquisition of the only other competitor, Flow.<sup>394</sup> The fixed-broadband segment has also seen an increase in penetration levels in recent years.

**Government policy:** The sector regulator, the National Telecommunications Regulatory Commission (NTRC), was created in 2000, and advises the sector Ministry on various matters to ensure the sustainable and harmonized development of ICT services in Saint Lucia.<sup>395</sup> The NTRC is also responsible for price regulation and fostering competition, as well as managing the national universal service fund. The current outlined priorities for the universal service fund are ensuring and expanding Internet access, and bringing telecommunications services to schools and other public institutions, among others.<sup>396</sup> The regulator also works closely with ECTEL to

Key indicators for Saint Lucia (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	19.1	24.4	13.6
Mobile-cellular sub. per 100 inhab.	94.8	114.2	101.5
Fixed-broadband sub. per 100 inhab.	16.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	37.0	82.7	52.2
3G coverage (% of population)	37.1	93.6	85.0
LTE/WiMAX coverage (% of population)	n.a.	77.4	66.5
Mobile-cellular prices (% GNI pc)	4.5	3.6	5.2
Fixed-broadband prices (% GNI pc)	5.5	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.4	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.8	5.7	6.8
Percentage of households with computer	43.7	64.9	46.6
Percentage of households with Internet access	43.1	63.3	51.5
Percentage of individuals using the Internet	46.7	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	7.6	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

develop and implement various policies on various subjects, for instance, net neutrality, consumer protection and submarine cable legislation, the latter two being covered by the recently approved Electronic Communications Bill.<sup>397,398</sup>

**Conclusion:** Saint Lucia's telecommunications sector presents enormous potential for development, especially in terms of both fixed and mobile-broadband, as there is an untapped part of the population that has yet to adopt these services. The collaboration with the regional regulator, ECTEL, provides an invaluable opportunity, not only to learn and partner with its neighbouring countries, but also to ensure that ICT development remains a priority within the scope of public policies.

## Saint Vincent and the Grenadines

***There has been considerable improvement in service uptake in Saint Vincent and the Grenadines, and operators have invested heavily in infrastructure development during recent years.***

**Mobile services:** The mobile market accounts for more than half of the sector's revenue. Mobile-broadband has experienced great success since its launch, in 2015, with most subscriptions currently including data services. Despite the fact that the majority of mobile services subscriptions remain prepaid, the situation is expected to change as the postpaid type presents stronger growth. Saint Vincent and the Grenadines is one of the five countries that signed up to the Eastern Caribbean Telecommunications Authority (ECTEL), an overarching regulatory body that assists on the creation and implementation of relevant policies and regulation. Despite lagging behind in terms of service penetration in all segments, there has been considerable improvement in service uptake, and operators have invested heavily in infrastructure development during recent years.

**Fixed services:** Despite being under full competition, the fixed-telephone market has recently witnessed the merger of its two sole operators. Fixed-broadband adoption rates and revenue continue to grow as the service becomes increasingly available to the population, with ADSL and cable modem being the most popular technologies employed.

**Government policy:** The body in charge of sector regulation, the National Telecommunications Regulatory Commission (NTRC), actively promotes universal service and has developed a myriad of projects under the national universal service fund to increase access, notably through free Internet access points, subsidizing Internet subscriptions and equipping schools with Internet, among others. The NTRC, along with the sector Ministry and the Caribbean Regional Communication Infrastructure Programme, have recently developed a national broadband plan draft, encompassing the period from 2017 to 2021, constructed with the aim of fostering competition and investment in the sector, along with increasing service quality.<sup>399</sup> The NTRC also works closely with ECTEL to develop and implement various policies, such as plans to implement net

Key indicators for Saint Vincent and the Grenadines (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	18.8	24.4	13.6
Mobile-cellular sub. per 100 inhab.	103.0	114.2	101.5
Fixed-broadband sub. per 100 inhab.	20.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	49.4	82.7	52.2
3G coverage (% of population)	100.0	93.6	85.0
LTE/WiMAX coverage (% of population)	0.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	4.8	3.6	5.2
Fixed-broadband prices (% GNI pc)	6.1	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.7	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.4	5.7	6.8
Percentage of households with computer	63.9	64.9	46.6
Percentage of households with Internet access	51.0	63.3	51.5
Percentage of individuals using the Internet	55.6	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	188.7	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

neutrality and, more recently, the Electronic Communications Bill, designed to tackle important and varied subjects, from consumer protection to the submarine cable legislation.<sup>400</sup>

**Conclusion:** The Government of Saint Vincent and the Grenadines and the private sector have focused their efforts on the development of the telecommunications sector, which can be seen as infrastructure and service uptake rates improve over the years.

## Samoa

**Mobile access has improved dramatically since the launch of competition in 2007. The arrival of a second undersea cable should see Internet bandwidth and pricing improve dramatically in this South Pacific nation.**

**Mobile services:** Telecom Samoa Cellular Limited (TSCL), jointly owned by the Government of Samoa and Telecom New Zealand, began an analog AMPS network operation in 1997 as the country's only cellular mobile operator. Its exclusivity ended in 2005 under a Deed of Settlement between the parties. Digicel, an Irish-owned mobile group, after getting the first GSM licence, purchased TSCLand in October 2006 launched a GSM network with 80 per cent population coverage at the start. A second GSM licence was awarded to the state-owned fixed-line operator SamoaTel which launched its network in January 2007. Coverage became widespread and mobile phone penetration in Samoan households rose dramatically following the launch of competition. The incumbent SamoaTel was privatized in 2011 when a 75 per cent stake was sold to Bluesky, a telecommunications company based in American Samoa; the Unit Trust of Samoa, a government-owned investment fund, holds the remaining 25 per cent. An agreement was reached in 2016 for Fiji's Amalgamated Telecom Holdings to purchase Bluesky's operations throughout the Pacific. Almost all of the households (96 per cent) had a mobile telephone, with little difference between urban (97 per cent) and rural (95 per cent) households (Bureau of Statistics Samoa, 2011). There has been a marked improvement in mobile services in 2016 with 99 per cent of the population covered by mobile cellular service and more than 80 per cent of the population covered by at least a 3G mobile network. Both mobile operators launched mobile broadband in 2011 using HSPA+ technology. Digicel launched LTE in 2016, and Bluesky in early 2017.

**Fixed services:** Samoa had a relatively high penetration of fixed telephone lines for a developing economy; this is partly a legacy of the delay in introducing mobile competition. Following the entry of a second mobile operator and the launch of GSM networks, fixed lines declined rapidly and by 2011, only one fifth of households had a fixed line, fewer than ten years earlier. There are five Internet Service Providers (ISPs) in

Key indicators for Samoa (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	5.0	10.0	13.6
Mobile-cellular sub. per 100 inhab.	77.6	98.9	101.5
Fixed-broadband sub. per 100 inhab.	1.1	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	22.6	47.4	52.2
3G coverage (% of population)	84.5	87.6	85.0
LTE/WiMAX coverage (% of population)	37.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	5.0	3.2	5.2
Fixed-broadband prices (% GNI pc)	11.8	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.8	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.4	5.4	6.8
Percentage of households with computer	24.0	37.8	46.6
Percentage of households with Internet access	29.1	45.5	51.5
Percentage of individuals using the Internet	29.4	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	13.2	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Samoa providing Internet services to households, businesses, government offices and communities using mobile networks, dial up and ADSL using telephone network and fixed wireless broadband technologies using WiMAX. These ISPs are the two major telecommunication operators Bluesky Samoa Limited and Digicel (Samoa) Limited, in addition to Computer Services Limited (CSL) Lesa's Telephone Services (LTS) and NETVO Samoa Limited. Bluesky offers fixed broadband using ADSL technology. Two other ISPs offer Internet services using fixed wireless. Fixed broadband penetration is low owing to the popularity of mobile broadband and its lower prices. In 2009, the Samoa-American-Samoa (SAS) fibre-optic submarine cable was completed. This provides Samoa with international Internet bandwidth connectivity to Hawaii via American Samoa. ASH and SAS were deployed when the unused PACRIM East cable between Hawaii and New Zealand was moved and refurbished, reducing installation costs. Because PACRIM East was the first fibre-optic cable across the Pacific, the technology is somewhat antiquated and capacity is limited. A new undersea fibre-optic cable, Tui-Samoa, is therefore being deployed between Samoa and Fiji. The 1 470-kilometre cable will land on both of Samoa's two main islands and is due to be launched at the end of 2017. Bluesky's domestic backbone network is primarily underground fibre-optic cable, which is generally resilient to cyclone-related hazards. The Samoa National Broadband Highway (SNBH) is the government owned communications network linking government offices throughout Apia and other locations launched in 2014. SNBH uses fiber optic cable and microwave for backhaul and fiber,

Wi-Fi and the country's first implementation LTE for local access.

**Government policy:** The Ministry of Communications and Information Technology (MCIT) is responsible for policy while the Office of the Regulator (OOTR), established in 2006, is responsible for oversight of telecommunications, broadcasting, postal services and electricity. The *Telecommunications Act 2005* is the key legislation leading to the creation of the Regulator and introduction of competition. The MCIT published the *National Broadband Policy* in 2012 with four key priorities: i) improving access; ii) ensuring affordability; iii) facilitating infrastructure; iv) increasing utilization. It established different targets for broadband connectivity for households and businesses and by location (rural or urban), to be achieved by 2020 including 100 per cent of schools.

**Conclusion:** The country has achieved a high level of mobile penetration following the introduction of competition. The deployment of a second undersea cable should see further improvements in broadband connectivity.

## São Tomé and Príncipe

***The arrival of a submarine cable has transformed the twin island archipelago ICT sector, now with abundant Internet capacity to leverage ICTs for achieving national development goals.***

**Mobile services:** There are two mobile operators: the incumbent São Tomé Company for Telecommunications (CST), which launched in 2002; and UNITEL, subsidiary of the Angolan mobile operator, which ended the monopoly when it entered the market in 2014. In 2014, 82 per cent of households had mobile phones, with only a small difference between urban (84 per cent) and rural areas (78 per cent).<sup>402</sup> Mobile-broadband was introduced relatively late, when CST introduced 3G in 2012 while UNITEL deployed 3G at launch.

**Fixed services:** CST was partly privatized in 1989, when 51 per cent of its shares were sold to Portugal Telecom. Although UNITEL has a full-service license, CST currently is the sole provider of fixed-telephone services in the country. CST offers fixed-broadband over ADSL, with speeds up to 2 Mbit/s, and has a fibre-optic offering with speeds up to 200 Mbit/s, the fastest in sub-Saharan Africa. A high-capacity microwave connection was deployed between the islands of São Tomé and Príncipe in 2015. The transmission link covers 176 km, one of the longest microwave routes in the world, and provides 300 Mbit/s of capacity, more than nine times the previous link. São Tomé and Príncipe relied on satellite for international Internet connectivity until the arrival of the ACE undersea fibre-optic cable in 2012. STP Cable was established as a public-private partnership to manage the country's holdings in ACE with the goal of open access and cost-based wholesale costs. Members of STP Cable are the Government and the two telecommunication operators. Connection to ACE increased speeds by a factor of 100 and significantly lowered prices. Phase 4 of ACE began in 2017, which will result in a new link from São Tomé and Príncipe to South Africa, providing redundancy through an additional route to other submarine cables.

**Government policy:** The country's Poverty Reduction Strategy Paper calls for promoting access to information with policy measures, including increasing accessibility, using ICTs for government services and developing entrepreneurial initiatives. The Ministry of

Key indicators for S. Tomé & Príncipe (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	2.8	1.0	13.6
Mobile-cellular sub. per 100 inhab.	85.7	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.7	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	84.4	22.9	52.2
3G coverage (% of population)	26.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	7.9	14.2	5.2
Fixed-broadband prices (% GNI pc)	18.9	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	3.1	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	18.9	17.7	6.8
Percentage of households with computer	16.8	9.6	46.6
Percentage of households with Internet access	20.0	16.3	51.5
Percentage of individuals using the Internet	28.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	37.3	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Public Works, Infrastructure, Transport and Communications is responsible for implementing ICT policy. With the support from the World Bank through the Central African Backbone project a strategic plan for ICT was developed, which has not been approved by the government yet. The General Authority for Regulation is the multi-sector regulator responsible for telecommunications, posts, water and electricity, established by the 14/2005 decree. The 3/2004 Base Law of Telecommunications guides the Authority's activities for that sector. The Authority is also responsible for managing the universal service fund and providing technical assistance for the transition to digital broadcasting.

**Conclusion:** A relatively high level of basic access to ICTs has been achieved thanks to the arrival of the ACE submarine cable and introduction of competition provide a platform to leverage high-speed digital technologies to diversify the economy and enhance delivery of government services.

## Saudi Arabia

***Saudi Arabia has continued to adopt advanced technologies and ICT services. The ICT market is highly competitive, with relatively low prices and high usage of fixed and mobile broadband services.***

**Mobile services:** Saudi Arabia ranks as one of the top countries in mobile cellular and mobile broadband penetration compared to other Arab States countries and globally. This can be attributed to the strong competition between its three telecommunication operators: the incumbent operator Saudi Telecommunication Company (STC), Mobily, and Zain. STC was the first company in Saudi Arabia to provide mobile services. STC began facing competition when Mobily (Etihad Etisalat Company) was granted the second licence in 2004 and launched its services in 2005. The third mobile operator, Zain, entered the ICT market in 2008. All three competing companies offer a wide range of mobile services (GSM, 3G, and LTE). Spectrum in the 700MHz/900MHz/1800MHz/2100MHz bands were awarded to these operators with the licences. In 2014, the regulator licensed two mobile virtual network operators (MVNOs): Virgin collaborated with STC, and Lebara partnered with Mobily and started offering a variety of mobile services.

**Fixed services:** The number of Internet users has increased rapidly in recent years. The main reasons behind the increase is the high competition between the data service providers, who have deployed FTTH networks in all major cities, in addition to high affordability of citizens and residents. The increase in the demand for Internet services and broadband is linked to high use of social networking applications, video on demand, and gaming.

**Government policy:** Communications and Information Technology Commission (CITC) was established in 2001. The key achievements by the Ministry of Communications and Information Technology (MCIT) and CITC during the last 15 years include: liberalizing mobile and fixed telecommunication markets, promoting fair and effective competition, developing a national frequency plan and a national numbering plan, establishing a universal service fund, introducing a unified licensing regime, issuing

Key indicators for Saudi Arabia (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	12.0	7.7	13.6
Mobile-cellular sub. per 100 inhab.	157.6	107.1	101.5
Fixed-broadband sub. per 100 inhab.	10.8	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	78.5	45.2	52.2
3G coverage (% of population)	97.2	81.9	85.0
LTE/WiMAX coverage (% of population)	88.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.7	4.3	5.2
Fixed-broadband prices (% GNI pc)	1.1	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.0	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	5.5	6.8
Percentage of households with computer	69.0	43.3	46.6
Percentage of households with Internet access	94.6	45.3	51.5
Percentage of individuals using the Internet	73.8	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	78.2	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

an e-Transaction act and a cyber security act. In line with the Saudi Arabia Vision 2030, and in implementation of the National Transformation Program 2020, CITC and MCIT support and promote the Kingdom's economy, develop the ICT sector, and build national talents. The MCIT is currently developing strategies and initiatives to achieve the strategic objectives assigned to it in the National Transformation Program. The 10 strategic objectives set out by the Ministry include: provide critical resources, especially frequency spectrum for ICT providers, and to provide broadband services to all regions in the Kingdom by stimulating investments in infrastructure and developing tools and techniques, and regulatory frameworks.

**Conclusion:** Over the past 15 years, the Kingdom of Saudi Arabia has achieved great success in the deployment of ICT services, and promotion of their use, resulting in making Saudi Arabia one of the world's most connected countries. The success of the strategic objectives is expected to strengthen the position of Saudi Arabia as a global ICT hub.

## Senegal

**Senegal is aiming to leverage digital technologies to cement its position as an ICT hub for the West Africa sub-region.**

**Mobile services:** There are three nationwide mobile operators: the incumbent SONATEL, offering service under the Orange brand; TIGO, a subsidiary of Luxembourg-headquartered MILLICOM, which has been in the Senegalese market since 1999; and EXPRESSO, which launched operations in 2009 and is a subsidiary of SUDATEL, the incumbent telecommunication operator in Sudan. Senegal has one of the highest levels of mobile access in sub-Saharan Africa. In 2015, 93 per cent of households had a portable telephone, with not a huge difference between urban (97 per cent) and rural (89 per cent) areas.<sup>403</sup> In 2009, EXPRESSO launched the country's first wireless broadband network based on lesser-used CDMA technology. In 2010, it then launched a 3G+ network, followed by SONATEL in 2011 and TIGO in 2013. SONATEL commercially launched LTE in 2016, when its license was renewed. Under the conditions of its license renewal, SONATEL is obligated to provide LTE coverage to 70 per cent of the population by 2020 and 90 per cent by 2025.

**Fixed services:** SONATEL was partly privatized in 1997, when shares were sold to then-France Telecom (now Orange). Some of its shares were listed on the regional stock exchange and some offered to employees, resulting in a mixed ownership (Orange France Group (42 per cent), the Government of Senegal (27 per cent), publicly held (25 per cent) and employees (8 per cent)). SONATEL has also emerged as a significant regional investor, establishing operations in Mali in 2002, Guinea and Guinea-Bissau in 2007, and Sierra Leone in 2016. SONATEL dominates the fixed telecommunications market. A universal service provider launched operations in the region of Matam in 2013. Most fixed broadband connections are using ADSL. Although fibre-optic connections are available and offered by all operators, they are mainly targeted at large businesses or government. In early 2017, three new ISP licenses were issued. There is also discussion about establishing neutral wholesale international and national backbone operators. There are some 9 000 km of fibre-optic cable deployed across the country. SONATEL and the Government have their own nationwide backbones, while the other two operators also

Key indicators for Senegal (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	1.9	1.0 13.6
Mobile-cellular sub. per 100 inhab.	98.7	74.6 101.5
Fixed-broadband sub. per 100 inhab.	0.6	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	26.1	22.9 52.2
3G coverage (% of population)	50.0	59.3 85.0
LTE/WiMAX coverage (% of population)	21.6	25.7 66.5
Mobile-cellular prices (% GNI pc)	17.3	14.2 5.2
Fixed-broadband prices (% GNI pc)	20.0	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	8.3	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	7.2	17.7 6.8
Percentage of households with computer	15.1	9.6 46.6
Percentage of households with Internet access	19.9	16.3 51.5
Percentage of individuals using the Internet	25.7	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	5.0	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

have some fibre-optic infrastructure, as does the electrical utility. Leveraging its favourable geography on the West Coast of Africa, Senegal was one of the first countries in the region to connect to an undersea fibre-optic network through the Atlantis-2 cable in 2000. Since then, two other cables have landed in Dakar: SAT-3/WASC in 2002, and ACE in 2012. There are plans to launch an IXP.

**Government policy:** The Ministry of Posts and Telecommunications is responsible for ICT policy and strategy in the country. The Telecommunications and Post Regulatory Authority was created in 2001 as sector regulator. The 2011 Code of Telecommunications governs its activities. The key policy document is the 2016 Digital Senegal Strategy. It calls for making broadband a priority by supporting public-private partnerships for infrastructure sharing and deploying networks in unserved areas. The policy's vision is "digital for all" by 2025. The strategy calls for application of broadband across different areas such as connecting schools, putting government services online and wider use of electronic commerce. A large technology park is being constructed near Diamniadio, around 100 km from Dakar. With state-of-the-art broadband infrastructure, it aims be the leading ICT cluster in West Africa.

**Conclusion:** Senegal began the process of ICT sector reform early on by partly privatizing its incumbent telecommunication operator SONATEL in 1997. The Government licensed a second mobile operator in 1998, created a sector regulator in 2001 and issued a third operator license in 2007. Though most of these steps took place in

the “narrowband” era, they laid the foundation for deployment of broadband technologies. The Government’s recent efforts will further strengthen Senegal as a leading ICT hub in West Africa.

## Serbia

***Serbia has some of the highest penetration rates for mobile services in the Balkans and a competitive market with three competing operators. The fixed market was liberalized relatively late in 2010 and fixed-broadband penetration remains low compared to the European average.***

**Mobile services:** Serbia's mobile-cellular and mobile-broadband penetration are relatively high compared with neighbouring countries and around the European average. Srbija Telekom has the largest market share in terms of subscriptions, with 47 per cent of total subscriptions at the end of 2016, although in terms of revenues Telenor has the largest share in the Serbian mobile market. Srbija Telekom, which is majority owned by the Republic of Serbia, has been offering mobile services since 1998. Its competitors are Telenor, with a 31 per cent market share, and Vip Mobile, which holds 22 per cent of the mobile market in the country. Both Telenor and Vip Mobile started operations in 2006, when the mobile market was liberalized. Telenor is majority owned by the Telenor Group, and Vip Mobile by Telekom Austria. Two virtual mobile operators were present in 2016, but only one of them provided services in late 2016. Mobile number portability was introduced in 2011 and a regional roaming agreement with Montenegro, TFYR Macedonia and Bosnia and Herzegovina is in place since 2015. Mobile-broadband penetration is relatively high and comparable to the European average. In March 2015, LTE services were launched in Serbia and all three mobile operators continue to invest in LTE deployment (RATEL, 2016).

**Fixed services:** Telekom Srbija is the market leader in the fixed segment as well, with a market share of 46 per cent. Until 2010, Telekom Srbija held a monopoly in fixed telephony. By the end of 2016, 30 registered operators provided fixed-telephone services in Serbia. The fixed-telephone penetration is one of the highest in the Balkans and close to the European average. Fixed-broadband penetration is somewhat lower compared to neighbouring countries and the European average (RATEL, 2016).

**Government policy:** Serbia's ongoing integration with the EU has had an important impact on the telecommunication sector and fostered

Key indicators for Serbia (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	34.8	37.7
Mobile-cellular sub. per 100 inhab.	120.6	118.0
Fixed-broadband sub. per 100 inhab.	19.2	30.2
Active mobile-broadband sub. per 100 inhab.	67.4	80.1
3G coverage (% of population)	98.5	98.5
LTE/WiMAX coverage (% of population)	78.2	92.2
Mobile-cellular prices (% GNI pc)	3.0	1.0
Fixed-broadband prices (% GNI pc)	3.0	1.2
Mobile-broadband prices 500 MB (% GNI pc)	1.0	0.6
Mobile-broadband prices 1 GB (% GNI pc)	1.2	0.6
Percentage of households with computer	65.8	79.6
Percentage of households with Internet access	64.7	82.5
Percentage of individuals using the Internet	67.1	77.9
Int. Internet bandwidth per Internet user (kbit/s)	26.3	178.0

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

the sector liberalization and modernization. Telecommunication reform was promoted and the country has participated in different projects aiming to assist in improving Serbia's ICT infrastructure. The process of liberalization and the end of Telekom Srbija monopoly in the telecommunication sector began with the adoption of the Serbia Telecommunications Law in 2003, which also established the Republic Telecommunication Agency (RATEL, 2016).

**Conclusion:** The liberalization and modernization of Serbia's telecommunication market over the past two decades have resulted in high mobile penetration. A majority of households are connected to the Internet and broadband is on the rise in Serbia.

## Seychelles

***The Indian Ocean archipelago is the least populated nation in Africa, with one of the highest levels of ICT access in the region.***

**Mobile services:** There are two mobile operators in Seychelles: Cable and Wireless, a subsidiary of Cable and Wireless Communications (CWC); and AIRTEL, a subsidiary of the Indian mobile group. Mobile penetration is high, with 94 per cent of households having a mobile phone, the third-highest level in sub-Saharan Africa.<sup>404</sup> Mobile-broadband has been available since 2006 with the launch of 3G networks. The mobile network has been upgraded to the latest technology with AIRTEL launching LTE using 800 MHz in 2014 (its first LTE deployment in Africa) and LTE using 1800 MHz in 2015; Cable & Wireless launched LTE in 2015 using the 800/1800 MHz spectrum.

**Fixed services:** Incumbent Cable and Wireless has always been private and its operations in Seychelles date to 1893. Parent CWC is owned by Liberty Global. Cable and Wireless Seychelles offers prepaid and postpaid copper landline telephone service. In addition, Intelvision offers fixed telephony over its fibre-optic network and Kokonet offers voice-over-Internet Protocol (VoIP). Fixed-broadband is available through ADSL, fibre-optic and fixed wireless technologies. Fixed-broadband penetration is high by regional standards.

The landing of Seychelles East Africa System (SEAS) submarine cable in mid-2012 has revolutionized Internet access through the dramatic increase in international bandwidth and consequent drop in prices. The country's interest in SEAS is managed by Seychelles Cable System Ltd. (SCS), a public-private partnership whose owners consist of the Government of Seychelles, AIRTEL, and Cable and Wireless. The 1 930 km fibre-optic cable goes to Tanzania, where it is connected to other submarine cable systems in the region. SCS has an ownership stake in EASSy through its participation in the West Indian Ocean Cable Company.

**Government policy:** The Department of Information Communications Technology under the Office of the President is responsible for sector policy and regulation as well as the implementation of e-government. The main legislative document is the Broadcasting and

Key indicators for Seychelles (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	22.1	1.0 13.6
Mobile-cellular sub. per 100 inhab.	161.2	74.6 101.5
Fixed-broadband sub. per 100 inhab.	14.9	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	22.6	22.9 52.2
3G coverage (% of population)	90.0	59.3 85.0
LTE/WiMAX coverage (% of population)	41.1	25.7 66.5
Mobile-cellular prices (% GNI pc)	1.1	14.2 5.2
Fixed-broadband prices (% GNI pc)	1.2	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.6	17.7 6.8
Percentage of households with computer	56.7	9.6 46.6
Percentage of households with Internet access	55.2	16.3 51.5
Percentage of individuals using the Internet	56.5	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	52.4	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Telecommunication Act of 2000. The National ICT Policy has five focus areas: (a) promotion of affordable, modern and high-quality ICT infrastructure and services; (b) fostering an enabling legal and regulatory framework to ensure growth of the ICT sector; (c) development of human resources with appropriate ICT skills; (d) leveraging ICT to attract investment and stimulate economic growth; and (e) enabling online government services.

**Conclusion:** The Government has installed a predictable regulatory framework and generated a realistic degree of competition in the ICT sector given the country's small population. It was proactive in creating a public-private partnership in order to procure a critical undersea fibre-optic connection. These strategies have resulted in Seychelles having some of the highest ICT penetration rates in sub-Saharan Africa.

## Sierra Leone

***The West African nation has embarked on the expansion of its telecommunications infrastructure following the civil war, including enabling a competitive mobile market and access to submarine cable. More interventions are necessary to bridge the urban rural digital divide and strategize ICT for economic growth.***

**Mobile services:** The country has three mobile operators: Orange, a subsidiary of Senegal's SONATEL, which took over AIRTEL in 2016 and rebranded as Orange; SMART, which launched in 2014 and is owned by Timeturns Holdings, a mobile group registered in Cyprus; and AFRICELL, which launched in 2005 and is owned by a Lebanese mobile group. Fifty-five per cent of households had mobile phones in 2013, including 85 per cent in urban areas but just 41 per cent in rural ones. One of the challenges is the lack of electricity in many rural areas. In respect to mobile-broadband, the first 3G network was launched by AFRICELL in 2011, followed by Orange in 2012 and SMART in 2014.

**Fixed services:** Sierra Leone Telecommunications Company (SIERRATEL) is the State-owned incumbent. It has been progressively rebuilding network infrastructure damaged during the country's civil war. SIERRATEL provides fixed-telephone service using copper lines and, more broadly, CDMA wireless local loop. SIERRATEL offers fixed-broadband with its CDMA EVDO fixed wireless product. There are also fixed wireless broadband operators. There is a national broadband network spanning around 400 km constructed. It forms part of the ECOWAS Regional Backbone initiative, stretching from the Liberian to the Guinean border. The country's first undersea fibre-optic cable link became a reality in 2012, when Sierra Leone connected to the ACE system. The connection is managed by Sierra Leone Cable Limited (SALCAB), incorporated as a limited liability company in 2012 and 100 per cent owned by the Government of Sierra Leone. SALCAB manages the Government's assets in the national backbone and ACE, and provides cost-based open access to telecommunication companies in the country. Open access to ACE was stymied until 2015, when the Parliament voted to end SIERRATEL's monopoly over international gateways.

Key indicators for Sierra Leone (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.3	1.0	13.6
Mobile-cellular sub. per 100 inhab.	97.6	74.6	101.5
Fixed-broadband sub. per 100 inhab.	n.a.	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	23.4	22.9	52.2
3G coverage (% of population)	40.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	23.2	14.2	5.2
Fixed-broadband prices (% GNI pc)	38.9	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	21.7	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	33.2	17.7	6.8
Percentage of households with computer	4.2	9.6	46.6
Percentage of households with Internet access	10.7	16.3	51.5
Percentage of individuals using the Internet	11.8	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	n.a.	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The sector policy-maker is the Ministry of Information and Communication. The National ICT Policy dates from 1999. Initiatives included (a) amending the legal and regulatory framework; (b) establishing a Centre for ICT Intelligence; (c) improving Internet connectivity; (d) expanding fixed and mobile networks in remote areas; (e) developing services and applications by local suppliers; (f) building capacity and developing national ICT skills; (g) providing ICT services and skills for the marginalized/disadvantaged; (h) developing geo-information; (i) providing affordable universal access/service; and (j) conducting an ICT and E-readiness Survey. The National Telecommunications Commission is the sector regulator guided by the Telecommunications Amendment Act of 2015.

**Conclusion:** Despite the challenging circumstances emerging from civil war, Sierra Leone has a competitive mobile market and is making efforts to improve Internet connectivity. The Government has facilitated access to wholesale networks and adopted a new telecommunications law that establishes the foundation for deeper infrastructure development and enabling ICT in other sectors of the economy.

## Singapore

**The island nation has striven incessantly to be a regional ICT leader. Its proactive Government ensures that the nation remains at the forefront of technology, with widespread access and low prices.**

**Mobile services:** Singapore has one of the most developed mobile markets in the world, with high penetration, the latest technology and low prices. The market consists of the incumbent Singapore Telecom along with M1 and StarHub, all publicly listed companies. In addition, TPG Telecom recently entered the market after winning the auction for a fourth licence in December 2016. Mobile access is ubiquitous with 90 per cent of individuals aged 7 and above owning a mobile cellular phone in 2016 (Infocomm Media Development Authority, 2017). Mobile broadband has been available since 2005 when 3G was launched, and LTE was deployed in 2011. 2G networks have been phased out since April 2017, while LTE subscriptions accounted for 71 per cent of the market in July 2017. Smartphone penetration is high with almost three quarters (74 per cent) of the population aged seven years and older used a smartphone.<sup>405</sup>

**Fixed services:** Singapore Telecom is the main provider of fixed telephone services, using copper landlines and, increasingly, optical fibre through bundled offers. Other operators also provide fixed telephony as part of double or triple play offers. Although subscriptions have fallen, penetration remains high compared to other countries. The overwhelming majority of broadband subscriptions in the country are for optical fibre as a result of the Next Gen Nationwide Infocomm Infrastructure wholesale/retail service model and the ease of connecting the large number of multilevel residential and office buildings in the country. Singapore has one of the highest penetrations of fibre to the home/building in the world.<sup>406</sup> The country is a leading international Internet connection hub for regional and international undersea fibre-optic cables. There are at least five Internet Exchange Points and the Singapore Internet Exchange, launched in 2010, is the largest in South-East Asia.

**Government policy:** The *Telecommunications Act*, as last amended in 2017, and subsidiary legislation, provides the underlying legal

Key indicators for Singapore (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	35.0	10.0	13.6
Mobile-cellular sub. per 100 inhab.	148.0	98.9	101.5
Fixed-broadband sub. per 100 inhab.	25.6	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	146.0	47.4	52.2
3G coverage (% of population)	100.0	87.6	85.0
LTE/WiMAX coverage (% of population)	100.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.2	3.2	5.2
Fixed-broadband prices (% GNI pc)	0.5	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.2	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.3	5.4	6.8
Percentage of households with computer	86.6	37.8	46.6
Percentage of households with Internet access	91.1	45.5	51.5
Percentage of individuals using the Internet	81.0	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	982.9	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

framework for the sector. Oversight for the telecommunication sector is the responsibility of the Info-communications Media Development Authority of Singapore (IMDA). The Authority was created in 2016 from the merger of the Info-communications Development Authority of Singapore (IDA) and the Media Development Authority of Singapore (MDA) in response to the converged media and information and communications sectors. This followed the launch, in August 2015, of the Infocomm Media 2025, the first integrated industry development plan for the info-communications and media sectors. It also recognises the importance of the Digital Economy in transforming many sectors in the economy. The Infocomm Media 2025 has three key thrusts: i) capitalize on data, advanced communications and computational technologies; ii) nurture an infocomm media ecosystem that encourages risk-taking and continuous experimentation; and iii) connect people through infocomm media.

**Conclusion:** Singapore has long had ongoing ICT plans that are adapted to industry changes and thus effective and relevant. The competitive ICT market ensures that the country continually adopts the latest technologies. The result is a country that is a global leader in connectedness to ultra-high-speed broadband networks.

## Slovakia

***Slovakia has a highly competitive mobile market, with affordable prices for mobile-cellular and mobile-broadband services. The fixed voice market is still largely dominated by the incumbent operator and penetration rates are comparatively low.***

**Mobile services:** Four mobile operators are active in Slovakia. The former state-owned operator, EuroTel, was fully privatized and rebranded as T-Mobile in 2005.<sup>407</sup> In 2010 Slovak Telekom became the legal successor of T-Mobile Slovensko. Slovakia's second mobile operator Globtel was acquired by France Télécom in 2002 and the company was rebranded to Orange in 2003. In 2006, Telefónica O2 won the bid for Slovakia's third mobile licence and started its services the following year.<sup>408</sup> Mobile-number portability was introduced in 2006.<sup>409</sup> Slovakia's fourth mobile operator Swan has been offering mobile-cellular services since 2015, further increasing competition in the market.<sup>410</sup> In addition to mobile services, Orange and Swan have been offering fixed services to Slovakian customers since 2006 and 2000, respectively. Mobile-cellular penetration is relatively high and mobile broadband is growing rapidly, with a penetration rate close to the European average. Mobile-cellular and mobile-broadband prices are very affordable and a high percentage of the population is covered by a 3G or even LTE signal.

**Fixed services:** Slovakia has a very low fixed-telephone penetration and the fixed-broadband penetration remains below the European average as well. The fixed-voice market was officially liberalized in 2003, but the incumbent operator Slovak Telekom (now fully owned by Deutsche Telekom) continues to maintain a quasi-monopoly in the fixed-voice market.<sup>411</sup> In the fixed-broadband market, the incumbent's market share stands at 34 per cent in 2016 and thus below the European Union average (European Commission, 2017). This highlights the strong competition in the fixed-broadband market.

**Government policy:** The liberalization of the telecommunication sector, as many other aspects of Slovakia policy, was shaped by the accession to the European Union in 2004. The telecommunication market was liberalized, competition intensified, and regulatory measures

Key indicators for Slovakia (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	15.1	37.7	13.6
Mobile-cellular sub. per 100 inhab.	128.0	118.0	101.5
Fixed-broadband sub. per 100 inhab.	24.5	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	78.7	80.1	52.2
3G coverage (% of population)	94.0	98.5	85.0
LTE/WiMAX coverage (% of population)	87.0	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.9	1.0	5.2
Fixed-broadband prices (% GNI pc)	1.1	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.8	0.6	6.8
Percentage of households with computer	80.9	79.6	46.6
Percentage of households with Internet access	80.5	82.5	51.5
Percentage of individuals using the Internet	80.5	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	52.4	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

aligned with those of the European Union. Concerning broadband development, Slovakia's National Broadband Strategy, and the Strategic Document for Digital Growth and Next Generation Access Infrastructure 2014-2020, are at centre of the ICT agenda. The strategy aims at having all households covered with 30 Mbit/s high-speed Internet. In order to increase competition and ensure the profitability of investments, the government has simplified the building of ICT networks, coordinated its construction and regulated prices as well as access to networks.<sup>412</sup>

**Conclusion:** Most of the population is using the Internet and policies are in place that aim at further increasing competition in the mobile markets and access to and use of broadband networks. Telecom operators in Slovakia have been undertaking extensive investment in their own networks, especially since 2016, thanks to which the LTE network currently covers more than 87 per cent of the population.

## Slovenia

***Slovenia's fixed market, while dominated by the incumbent operator, has relatively high penetration rates compared with other Central European countries. At the same time, convergence in broadband services has been strong in the country and mobile-broadband subscriptions are on the rise.***

**Mobile services:** Four mobile network operators are serving the market, three of them having nation-wide coverage. In addition, there are five MVNOs. The incumbent operator Telekom Slovenije merged with mobile market leader Mobitel in 2011, further fortifying the Telekom Slovenije market share, which stands at 47 per cent in 2016, and which is well above the European Union average (34 per cent) (European Commission, 2017).<sup>413</sup> Telekom Slovenije was the first operator to offer LTE services in late 2012. Almost the entire population is covered by a 3G signal and LTE coverage is close to complete as well.

**Fixed services:** Fixed-telephone and fixed-broadband penetration are close to the EU average and higher than in most other Central European countries. Slovenia has implemented all of the competitive safeguards foreseen in the EU regulatory framework, including interconnection regulation, infrastructure access, tariff rebalancing, carrier pre-selection, wholesale broadband access, wholesale line rental and fixed number portability. While market access has been fully liberalized starting from 2001, incumbent operator Telekom Slovenije remains the leading player in the fixed market. Competition is increasing in the fibre sector, with alternative operator T-2 deploying networks and the regulator obliging Telekom Slovenije to offer wholesale broadband access as well as local loop unbundling (EBRD, 2012b). Slovenia's Next-Generation Broadband Network Development Plan found that broadband infrastructure development is lagging behind other European countries mostly in rural areas, where people live in particularly dispersed settlements (The Republic of Slovenia, 2016).

**Government policy:** The 2001 Telecommunications Act brought Slovenia's telecommunication market in line with the EU. The market was liberalized and the monopoly of Telekom Slovenije ended.<sup>414</sup> With regard to

Key indicators for Slovenia (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	35.1	37.7 13.6
Mobile-cellular sub. per 100 inhab.	114.6	118.0 101.5
Fixed-broadband sub. per 100 inhab.	28.3	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	62.2	80.1 52.2
3G coverage (% of population)	98.1	98.5 85.0
LTE/WiMAX coverage (% of population)	97.4	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.2	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.8	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.4	0.6 6.8
Percentage of households with computer	78.1	79.6 46.6
Percentage of households with Internet access	78.4	82.5 51.5
Percentage of individuals using the Internet	75.5	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	239.2	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

broadband development, Slovenia's entry into the EU had an important impact on the government policies in place as well. In 2016, the government adopted the "Development Strategy for the Information Society until 2020 – Digital Slovenia 2020". The strategy aims at providing 96 per cent of Slovenian households with speeds of at least 100 Mbit/s by 2020, and the remaining 4 per cent with at least 30 Mbit/s. The Slovenia government supports the expansion of broadband networks by implementing cost reduction methods such as detailed mapping and coverage analyses, open tenders and regulatory measures that ensure open access networks and the use of existing infrastructure.<sup>415</sup> In the end of 2016, the Ministry inquired about commercial interest in areas not covered by networks offering 100 Mbit/s speed connections and established white spots that would be subject to state aid.

**Conclusion:** EU policies and regulations have shaped the Slovenia telecommunication market and contributed to growth in the sector in the last decade. Policies are in place to continue this development with the government putting an emphasis on broadband development to connect more of the population.

## Solomon Islands

**The introduction of competition in the mobile sector has rapidly increased mobile access and coverage. The launch of an undersea submarine cable is expected to further boost the ICT sector in the Solomon Islands.**

**Mobile services:** The incumbent Solomon Telekom launched its GSM network in September 2003. Bemobile from Papua New Guinea entered the market in 2010. Until the arrival of Bemobile, mobile coverage was essentially limited to urban areas, only ten percent of the population being within reach of a mobile signal. Subscription penetration rose five-fold between 2009 and 2011, from less than 10 per cent of the population to just over half. Coverage of mobile networks has grown rapidly with 78 per cent of households having a mobile phone in 2015 (97 per cent in urban areas and 74 per cent in rural areas) (NSO Solomon Islands, 2017). In the third quarter of 2011, both operators launched 3G (HSDPA) in Honiara and coverage remains limited. Most of the other islands are restricted to 2G Internet access (i.e., GPRS and EDGE).

**Fixed services:** Solomon Telekom was a joint venture between the Government and the United Kingdom's Cable & Wireless. Most of the Government's shares, held by the Investment Corporation of the Solomon Islands (ICSI), were transferred to the National Provident Fund (NPF) so that at the end of 2013 NPF owned 65 per cent. In 2014, CWC sold its shareholding to NPF. Solomon Telekom is the only fixed telephone provider and the number of subscriptions is limited. Solomon Telekom offers ADSL broadband in Honiara, Auki and Gizo. Satsol, a satellite TV provider, also offers Internet services using WiMAX technology with a top speed of 512 kbps. Microwave is used for some domestic backhaul routes but is not a feasible nationwide solution since many islands are too far away. More costly domestic satellite links are used for these locations. International connectivity is via satellite using several providers. In 2012, plans were under way, with the support of the Asian Development Bank, to deploy an undersea fibre-optic cable for international connectivity, and the Solomons Oceanic Cable Company (SOCC) was formed to manage and operate the cable with the proposed route from Honiara to Sydney. However, a rival option emerged and the process was delayed. In

Key indicators for Solomon Islands (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	1.2	10.0	13.6
Mobile-cellular sub. per 100 inhab.	69.9	98.9	101.5
Fixed-broadband sub. per 100 inhab.	0.2	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	12.9	47.4	52.2
3G coverage (% of population)	72.0	87.6	85.0
LTE/WiMAX coverage (% of population)	13.3	73.6	66.5
Mobile-cellular prices (% GNI pc)	8.9	3.2	5.2
Fixed-broadband prices (% GNI pc)	237.4	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	6.3	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	15.8	5.4	6.8
Percentage of households with computer	7.4	37.8	46.6
Percentage of households with Internet access	8.5	45.5	51.5
Percentage of individuals using the Internet	11.0	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	12.0	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

mid-2017, the government announced it would fund the cable running some 3 400 kilometres to Sydney, including a domestic spur linking two provincial cities to Honiara. The cable should be completed in 2019.

**Government policy:** The Ministry of Communication and Aviation (MCA) is responsible for sector oversight. An ICT policy is under development. Meanwhile, the country's *National Development Strategy 2016-2035* lays out the Government's two key mid-term activities for the ICT sector: i) linking communities with telecommunication networks and ii) establishing a fibre-optic submarine cable system and providing broadband services. The *Telecommunications Act* of 2009 prepared the way for sector liberalization by introducing competition. The Act also established a regulatory agency, the Telecommunications Commission of the Solomon Islands (TCSI). A 2009 Settlement Arrangement ended the exclusivities of Solomon Telekom, the incumbent telecommunication operator.

**Conclusion:** Sector reform, including the introduction of competition in the mobile market, has increased access to mobile services. The eventual launch of the submarine cable will sharply increase Internet capacity at lower cost, which should trigger wider access and higher speeds.

## Somalia

***The Somalia telecommunication market has persisted despite the lack of guidance from a central government or sector regulator since 1991. With many competing operators and service providers, Somalia offers competitive telecom and Internet services with relatively low prices compared to neighbouring countries.***

**Mobile services:** Mobile telecommunications have had a positive impact on the economy of Somalia, despite the lack of regulation. Private and unlicensed mobile companies using satellites for international communications have emerged to serve the high demand for communications. Fixed lines and mobile phones are being offered by many telecommunication operators such as: Golis Telecom Somalia, Hormuud, NationLink Telecom, Somali Telecom Group, Galkom, Global Internet Company, Telkom, Netco, Somafone, Telkom Puntland, and Telenet International. Starting in 2012, many mobile operators began launching 3G services in Somaliland and soon expanded to other regions. A number of telecommunication operators are offering LTE services in the region, including Somtel International and Telesom, both of which are based in Somaliland, while Globalsom and Sahal Telecom have launched time division duplex LTE (TD-LTE) networks in Mogadishu. In 2015, global satellite service provider O3b Networks signed satellite connectivity contracts with three Somalia telecommunication operators.

**Fixed services:** The penetration rate of fixed telephone and fixed broadband is low as most of the operators are concentrating in providing mobile services. Internet connections are mainly provided via dial-up, GPRS, ADSL, and long range Ethernet (LRE). Wireless and satellite services also exist in Somalia. Most companies are beginning to provide VoIP services. The installation of East Africa Submarine Cable System (EASSy) in Somalia has supported its ICT and telecommunication infrastructure development.

**Government policy:** The Ministry of Post and Telecommunication (MPT) oversees the ICT and telecommunication sector in Somalia. Somali ICT Development Association (SICTDA) is a non-governmental, non-profit association that aims to promote ICT applications in all aspects of life to accelerate development. There are no regulations or taxes, and no service obligation.

Key indicators for Somalia (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	<i>0.4</i>	7.7	13.6
Mobile-cellular sub. per 100 inhab.	<i>58.1</i>	107.1	101.5
Fixed-broadband sub. per 100 inhab.	<i>0.8</i>	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	<i>2.4</i>	45.2	52.2
3G coverage (% of population)	<i>38.7</i>	81.9	85.0
LTE/WiMAX coverage (% of population)	<i>n.a.</i>	33.8	66.5
Mobile-cellular prices (% GNI pc)	<i>25.1</i>	4.3	5.2
Fixed-broadband prices (% GNI pc)	<i>259.0</i>	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	<i>129.5</i>	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	<i>n.a.</i>	5.5	6.8
Percentage of households with computer	<i>2.6</i>	43.3	46.6
Percentage of households with Internet access	<i>n.a.</i>	45.3	51.5
Percentage of individuals using the Internet	<i>1.9</i>	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	<i>1.4</i>	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Tariffs are among the lowest in Africa. However, the absence of regulation has also led to problems with frequency spectrum coordination and interconnection between networks. There is a growing need in Somalia for a policy and regulatory framework and the establishment of a regulatory body that is managerially and financially independent from the Somalia telecommunication operators. The absence of regulation in the ICT and telecommunication sector has resulted in having illegal companies operating in the country. In 2012, a national communications act was approved that lays the foundation for the establishment of a national communications regulator in the broadcasting and telecommunications sectors.<sup>416</sup> The proposed communications act was approved again in June 2016. However, it was put on hold following concerns raised by the private sector. In May 2017 MPT began a consultation on a new draft communications law that aims to establish the legal, regulatory, and institutional frameworks for the country's thriving telecommunication sector.

**Conclusion:** Recent progress in the political stability and the formation of a new government are good signs of a stabilisation of the country and to become more attractive to foreign investment, which is needed to take the telecommunication and broadband sector to the next level. The government is beginning to regulate the sector and is planning to issue new spectrum licences that will allow the operation of high-speed mobile broadband technologies.

## South Africa

***With the most advanced ICT networks in sub-Saharan Africa, South Africa is striving to enhance its digital capacity by moving to the highest possible broadband speeds.***

**Mobile services:** The mobile market consists of four players: Vodacom (65 per cent owned by Vodafone UK), which launched in 1994; MTN, which also launched in 1994; Cell C, majority owned by OGER Telecom of Saudi Arabia, which launched in 2001; and Telkom, the incumbent fixed-service operator, which entered the mobile market in 2010. Mobile telephony is virtually universal with 87.0 per cent of households having mobile phones in 2016.<sup>417</sup> All of the mobile operators have launched mobile-broadband, including the latest LTE technology. LTE-Advanced trials in the country have achieved download speeds of 1 Gbit/s by through-carrier aggregation and combining different frequencies. The 3G population coverage is practically ubiquitous, with 99 per cent of inhabitants able to receive a signal. More than three-quarters of the population is within range of an LTE signal, the highest level of coverage in sub-Saharan Africa. Consequently, the penetration of smartphones and mobile-broadband use is growing. MTN and Vodacom are also active investors in other African mobile markets. MTN is present in 21 other sub-Saharan African markets, while Vodacom is present in 4 markets.

**Fixed services:** Incumbent Telkom was partly privatized in 1997, when 30 per cent was sold to a consortium. In 2003, the remaining shares were listed on the local stock market. Ownership at the end of 2016 was 39 per cent to the Government, with the remainder divided among institutional and public shareholders. Telkom dominates the fixed-telephone market with the vast majority of its connections copper landlines. Telkom also dominates the fixed-broadband market, primarily through its ADSL offerings, with top speeds of 40 Mbit/s; it also provides ADSL at wholesale. Wireless fixed access and fibre-optic connections are available from a number of ISPs, though take-up is significantly less than ADSL. Telkom's monopoly over the national backbone ended in 2005 and, since then, a number of infrastructure companies as well as the mobile operators have been deploying fibre-optic networks. As a result, the nation is increasingly criss-crossed with fibre-

Key indicators for South Africa (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	8.4	1.0 13.6
Mobile-cellular sub. per 100 inhab.	153.1	74.6 101.5
Fixed-broadband sub. per 100 inhab.	2.1	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	58.6	22.9 52.2
3G coverage (% of population)	98.0	59.3 85.0
LTE/WiMAX coverage (% of population)	73.0	25.7 66.5
Mobile-cellular prices (% GNI pc)	1.5	14.2 5.2
Fixed-broadband prices (% GNI pc)	3.6	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.3	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.0	17.7 6.8
Percentage of households with computer	24.4	9.6 46.6
Percentage of households with Internet access	53.0	16.3 51.5
Percentage of individuals using the Internet	54.0	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	263.0	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

optic backbones, although in some instances at the cost of infrastructure duplication. South Africa is connected to more than a half dozen undersea fibre-optic cables at several landing stations. There are two IXPs: (a) INX, with peering centres in Johannesburg, Cape Town and Durban; and (b) NAP Africa, operating in the same three cities.

**Government policy:** The Department of Telecommunications and Postal Services is the sector policy-maker. There are several sector policies and strategies. The National Integrated ICT Policy White Paper was adopted in 2016. The new policy identifies areas where there are infrastructure and service gaps and how Government and private sector investment can address the gaps to narrow the digital divide. The 2013 South Africa Connect outlines the nation's broadband policy. The overall policy goal is to achieve an average broadband speed of 100 Mbit/s by 2030 with interim targets established for households, schools, medical facilities and government. The Independent Communications Authority of South Africa is responsible for regulating telecommunications, broadcasting and postal industries. The Authority was established in July 2000 as a merger of the telecommunications regulator the South African Telecommunications Regulatory Authority and the Independent Broadcasting Authority. In 2006, the authority's mandate was expanded to include postal services. The Electronic Communications Act (Act 36 of 2006) is the legislation governing the electronic communications and broadcasting sectors, whilst the Postal Services Act of 1998 governs the postal sector.

**Conclusion:** South Africa is at the forefront of the region's technological development with the latest broadband technologies and wide coverage. This has been enabled by a suitable regulatory framework and a competitive private sector-driven market. Cost remains an issue due to significant duplication in backbone networks, with a need to move to a cost-based open access regime.

## South Sudan

***Despite the challenging circumstances, South Sudan, the world's newest nation, is beginning to register uptake of mobile services and satellite communication albeit from a low base.***

**Mobile services:** There is a significant level of competition, with three operators who were in operation before independence, but have since separated their operations from the North. These are: ZAIN, 100 per cent owned by the Kuwaiti mobile group; MTN, 100 per cent owned by the South African mobile group; and VIVACELL, owned by a Lebanese group. SUDATEL, the Sudanese operator, and GEMTEL, owned by the Libyan Government's investment arm, have both withdrawn from the market. Penetration remains low due to limited incomes and the troublesome security situation, which has inhibited coverage extension. Nevertheless, all operators have launched 3G, and mobile-broadband use is growing.

**Fixed services:** Fixed-telephone services are virtually non-existent due to under-deployment before independence and theft of the few copper lines post-independence. GEMTEL had inherited the network but has since ceased operations. Most Internet access is via mobile phones, although there are some fixed wireless and VSAT operators. There is no national fibre backbone, with long distance transmission mainly via microwave, including cross-border to Uganda for access to international bandwidth in Kenya. A project was planned to deploy 400 km of fibre-optic cable next to a highway being constructed from the capital Juba to the Kenyan border, from where Internet traffic will traverse Kenya's backbone to undersea cables in Mombasa. This has been placed on hold due to the political situation. Meanwhile, South Sudan largely relies on high-speed, low-Earth orbiting satellites, such as O3b, for the bulk of its international Internet bandwidth.

**Government policy:** The Ministry of Telecommunications and Postal Services is responsible for the sector. A new Communications Act was adopted in 2012, but strategies and plans to guide the sector have been put on hold due to the political situation. Plans to create a sector regulator, the National Communications Authority, have also been delayed.

Key indicators for South Sudan (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.0	1.0	13.6
Mobile-cellular sub. per 100 inhab.	21.5	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.0	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	1.1	22.9	52.2
3G coverage (% of population)	20.0	59.3	85.0
LTE/WiMAX coverage (% of population)	10.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	2.2	14.2	5.2
Fixed-broadband prices (% GNI pc)	25.8	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	14.1	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	26.1	17.7	6.8
Percentage of households with computer	4.3	9.6	46.6
Percentage of households with Internet access	3.6	16.3	51.5
Percentage of individuals using the Internet	6.7	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	0.4	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Conclusion:** Despite the challenging economic and security situation, mobile and Internet networks continue to operate, mainly in urban areas. Before the outbreak of civil war, the telecommunication sector was vibrant, with plans for deeper sector reform, expansion of mobile coverage and major national backbone deployment. This has all been placed on hold, but if the security situation can be resolved, there is significant potential for the ICT market.

## Spain

**Spain has a competitive and well-developed telecommunication market with high penetration rates for fixed and mobile services. The telecommunication market has undergone a process of mergers and acquisitions in recent years leading to a concentration of almost 80 per cent of the revenues in three transnational operators: Telefonica, Vodafone, and Orange (CNMC, 2016).**

**Mobile services:** Spain is home to Telefonica, the incumbent operator and one of the largest telecommunication companies with operations throughout the globe. Competition was first introduced in 1994, when a second licence was granted to a consortium led by Airtel (now Vodafone). A third operator started to provide services in 1999 (IESE, 2005). The third operator licence was bought by France Telecom (now Orange) in 2005. The following year, a fourth mobile network operator – Yoigo – launched services further increasing the level of competition in Spain. Mobile-broadband penetration is above the European average and prices for both prepaid and postpaid services are affordable. Spanish operators launched 3G in 2004, almost ten years before LTE services were first offered. With operators investing heavily in the roll-out of mobile-broadband networks, population coverage with 3G and LTE services is almost complete.

**Fixed services:** The fixed market is very well developed. Fixed-telephone penetration is high and – against the global trend for fixed-to-mobile substitution – growing slightly because of the increase in fixed-telephone bundles, particularly quadruple and quintuple play offers (CNMC, 2016). Fixed-broadband penetration is close to the European average. The liberalization of the fixed market took place from 1996 to 1998 in line with the EU Full Competition Directive. In 1996, the independent regulatory authority was created and, in the same year, a publicly-owned second operator was allowed to enter the fixed market. With the privatization of the incumbent operator, Telefonica, and the second operator, in 1997 and 1998, respectively, the market opened to competition (IESE, 2005). At present, Telefónica, Vodafone and Orange compete in the fixed-line market with regional facilities-based cable operators. The three main operators are deploying NGA networks, mostly based on FTTH technology,

Key indicators for Spain (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	41.5	37.7 13.6
Mobile-cellular sub. per 100 inhab.	108.8	118.0 101.5
Fixed-broadband sub. per 100 inhab.	29.8	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	87.7	80.1 52.2
3G coverage (% of population)	99.6	98.5 85.0
LTE/WiMAX coverage (% of population)	96.2	92.2 66.5
Mobile-cellular prices (% GNI pc)	1.3	1.0 5.2
Fixed-broadband prices (% GNI pc)	1.1	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	0.6 6.8
Percentage of households with computer	77.1	79.6 46.6
Percentage of households with Internet access	81.9	82.5 51.5
Percentage of individuals using the Internet	80.6	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	113.0	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

and as much as 81 per cent of all households were passed by a fixed NGA network in June 2016 (European Commission, 2017).

**Government policy:** The government is taking a market-based approach to ICT development and aims to put in place the best conditions for growth. Spain's Digital Agenda includes strategies to roll-out high speed networks by making better use of the existing infrastructure, as well as promoting coordination and cooperation between private and public entities. Mobile broadband is to be extended through efficient radio spectrum management and the opening of new spectrum for LTE services. Spain's Digital Agenda also looks at measures targeting the demand side, such as promoting the creation and distribution of online content.<sup>418</sup>

**Conclusion:** Spain has developed into a highly connected country with an innovative and competitive telecommunication market, which is among the main drivers of growth. The government has provided the framework for this development and continues to prioritize the roll-out of high-speed networks.

## Sri Lanka

### *The island nation is a technology leader in the South Asia region.*

**Mobile services:** There are five operators offering mobile services: MOBITEL, a subsidiary of Sri Lanka Telecom (SLT), the incumbent operator 49.5 per cent owned by the Government, 5.5 per cent publicly traded and the remainder held by Malaysian investors; Dialog, 83 per cent owned by the Malaysian AXIATA group with the remainder publicly traded; Hutch, owned by CK Hutchinson Holdings Limited, which is a Cayman Islands-registered conglomerate headquartered in Hongkong (China) and listed company on Whampoa of Hong Kong Stock Exchange; ETISALAT owned by the UAE company; and AIRTEL, owned by the Bharti Airtel Lanka (Private) Limited, which is owned by Airtel Limited of India. The mobile phone market has grown rapidly and 2G population coverage is extensive. There were already more mobile phone subscriptions than people by 2012. In 2012, 81 per cent of Sri Lankan homes had a mobile phone, a sharp increase from just one-third of households in 2006/07.<sup>419</sup> Sri Lanka is a sub-regional leader in deploying mobile technology. It was the first country in South Asia to launch 3G in 2006 and LTE in April 2013. Terrestrial mobile broadband coverage is progressing, with around three quarters of the population covered by a 3G signal and LTE available in urban areas.

**Fixed services:** SLT is the only operator that offers fixed telephone services. SLT and two other operators, Lanka Bell and Dialog Broadband Network, offer fixed wireless telephone services. Fixed lines have been declining but penetration is still relatively high for a developing nation. SLT dominates the fixed broadband market thanks to its large landline network. It offers ADSL and, since April 2014, FTTP in urban areas. ADSL speeds of up to 16 Mbps are available, and there is a common 100 Mbps download speed for fibre-optic services with prices that vary according to data usage. All the country's 329 administrative divisions are to be covered by the national fibre-optic backbone by 2018. Sri Lanka is geographically well situated to leverage undersea cables between Asia and Europe. The country is connected to four fibre-optic submarine cable networks and is in the process of connecting to two others. The Sri Lanka Internet Exchange was launched in Colombo in 2011.

Key indicators for Sri Lanka (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	11.4	10.0	13.6
Mobile-cellular sub. per 100 inhab.	118.5	98.9	101.5
Fixed-broadband sub. per 100 inhab.	4.1	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	18.3	47.4	52.2
3G coverage (% of population)	85.0	87.6	85.0
LTE/WiMAX coverage (% of population)	36.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.3	3.2	5.2
Fixed-broadband prices (% GNI pc)	1.4	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.6	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	5.4	6.8
Percentage of households with computer	25.4	37.8	46.6
Percentage of households with Internet access	21.1	45.5	51.5
Percentage of individuals using the Internet	32.1	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	22.0	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Sri Lanka telecommunication sector is governed by the Sri Lanka Telecommunications Act No 25 of 1991 as amended by Act No. 27 of 1996 and regulated by the institution formed under the Act the Telecommunications Regulatory Commission of Sri Lanka (TRCSL) an institution under the Presidential Secretariat. The Ministry of Telecommunication and Digital Infrastructure (MTDI) is responsible for ICT policy. MTDI also oversees government telecom holdings, namely the operator SLT. The Information and Communications Technology Agency (ICTA), an institute under MTDI, is charged with implementing government policies with regard to ICT and industry promotion. The *ICT Road Map* covers the period 2015-2020 in line with the Digital Sri Lanka vision. It is based on seven key strategies: i) improving digital infrastructure; ii) utilizing ICT for improving governance; iii) enhancing ICT policies, legislation and standards; iv) improving use of ICT applications in key sectors; v) improving citizens' participation in the ICT-enabled society; vi) facilitating ICT industry development; and vii) facilitating trade and business sectors through ICT.

**Conclusion:** Sri Lanka has been South Asia's regional leader in the introduction of high-speed digital technologies. The Government hopes to build on its digital infrastructure to bring about wider adoption of applications and services by citizens and businesses.

## Sudan

***Sudan has suffered from several social conflicts for more than twenty years. As it comes out of these conflicts, Sudan is emerging as one of the largest ICT markets in the region. The country has a relatively well-equipped telecommunication infrastructure by regional standards, including a national optical fibre backbone, wireless fixed line networks, but very limited fibre to the home connections.***

**Mobile services:** Sudan is one of the largest countries in the region by geographical area and around 55 per cent of its population lives in small towns scattered across rural areas. As a consequence, despite the high competition and big investment, mobile-cellular and mobile broadband penetration are below the average in Arab States and globally. Three transnational operators offer mobile-cellular and mobile broadband services in Sudan: MTN, a Sudatel mobile unit, Sudani, and Zain. Unlike other mobile markets in the Arab States, where the incumbent retains a very large market share, none of the three operators in Sudan has a majority of the mobile market. As a result, the Sudan mobile market is very competitive. All three mobile operators offer 3G services in the 2100 MHz frequency band. In 2016, Zain Sudan was the first operator to launch LTE services, followed by Sudani, which announced the commercial launch of an LTE-Advanced network in late 2016. Sudan has a very competitive mobile market and consequently very low handset-based mobile-broadband prices.

**Fixed services:** As in many countries, fixed telephony is in decline in Sudan and it is now far below the average penetration in the Arab States region and globally. Fixed broadband penetration is also very low and mainly based on wireless networks. The incumbent fixed operator, Sudatel, started substituting traditional copper lines with CDMA2000 fixed-wireless access in 2005. Competition in the fixed-line market comes from Canar Telecom, which also opted for CDMA2000 technology, and which was upgraded to the EV-DO standard, and like Sudatel, offers wireless broadband services. In 2017 Canar obtained a 2.3 GHz spectrum licence to roll out a time division duplex LTE (TD-LTE) network.

**Government policy:** Overall responsibility for telecommunication policy is vested in the

Key indicators for Sudan (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	0.3	7.7	13.6
Mobile-cellular sub. per 100 inhab.	68.6	107.1	101.5
Fixed-broadband sub. per 100 inhab.	0.1	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	25.2	45.2	52.2
3G coverage (% of population)	45.9	81.9	85.0
LTE/WiMAX coverage (% of population)	30.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	1.9	4.3	5.2
Fixed-broadband prices (% GNI pc)	7.2	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.3	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.5	5.5	6.8
Percentage of households with computer	18.0	43.3	46.6
Percentage of households with Internet access	33.6	45.3	51.5
Percentage of individuals using the Internet	28.0	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.0	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Ministry of Information and Communications (MCIT). There are two government bodies with responsibility for different aspects of ICT policy and regulation: the National Telecommunications Corporation (NTC), and the National Information Centre (NIC). NIC is primarily concerned with the use of ICT in government. NTC was established under the Telecom Act of 2001, which made it responsible for plans, policies and regulation (including regulating tariffs, licensing operators, frequency management and equipment), while the overall objective of NIC is expanding e-Government services in the country. The NTC funded the universal access and universal service projects through the Sudan ICT Fund, which was established in 2004, and has carried out a range of projects during the last 10 years.

**Conclusion:** In recent years, Sudan has expanded telecommunication networks and Internet services and the ICT sector witnessed remarkable development. The launch of mobile and fixed LTE networks by several, competing fixed and mobile operators, the roll-out of an optical fibre backbone network, the expansion of CDMA2000 network in rural areas, and the use of satellite broadband services is expected to strengthen the Sudan ICT position among countries in the region.

## Suriname

**Suriname's telecommunications services have benefited from the liberalization of the market in 2007.<sup>420</sup> The industry has still the potential to grow as urban coastal areas have access to better infrastructure in comparison with sparsely populated remote areas.**

**Mobile services:** Mobile services in Suriname were under monopoly until 2007, when operator Digicel joined the market.<sup>421</sup> Since then, a third operator, Uniq, launched services in the country, increasing the dynamicity of this competitive environment, which has seen remarkable success with penetration rates that are well above regional and global levels.<sup>422</sup>

**Fixed services:** As opposed to the mobile market, fixed services are under a monopoly controlled by Telesur, the State-owned incumbent. Other Internet service providers offer dial-up Internet, but fixed-broadband remains under the provision of the incumbent, which extended its service offering to include VoIP in 2013.<sup>423</sup>

**Government policy:** An independent national telecommunications regulator, *Telecommunicatie Autoriteit Suriname*, was created in 2004 following the national Telecommunications Act.<sup>424</sup> The public authorities are engaged in different programmes to develop the ICT sector, for instance the establishment of a national ICT institute to better understand the national environment and adopt appropriate policies. It also recognizes the importance of digital literacy. In 1995, Suriname joined a regional organization, the Caribbean Community (CARICOM), whose aim is the development of the region through cooperation and economic integration.<sup>425</sup> CARICOM counts on the efforts of national authorities to implement and develop regional programmes, for instance the Single ICT Space, approved as recently as early 2017.<sup>426</sup> The Single ICT Space aims to support the region's Digital Agenda 2025, within the scope of the Regional Digital Development Strategy of 2013, by harmonizing the policies, legislation and technical standards of country members, as well as promote infrastructure deployment.<sup>427</sup> This should create a welcoming international environment for service providers as well as improve services for the consumers.

Key indicators for Suriname (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	16.1	24.4	13.6
Mobile-cellular sub. per 100 inhab.	145.9	114.2	101.5
Fixed-broadband sub. per 100 inhab.	12.9	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	47.8	82.7	52.2
3G coverage (% of population)	100.0	93.6	85.0
LTE/WiMAX coverage (% of population)	35.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.6	3.6	5.2
Fixed-broadband prices (% GNI pc)	3.1	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.5	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.8	5.7	6.8
Percentage of households with computer	46.4	64.9	46.6
Percentage of households with Internet access	42.4	63.3	51.5
Percentage of individuals using the Internet	45.4	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	66.5	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Conclusion:** The public efforts to increase service adoption as well as the country's membership in regional organizations, for instance CARICOM, reveal great potential for sector development, especially regarding the Single ICT Space programme.

## Swaziland

***The small, landlocked kingdom has been making steady progress in extending ICT coverage and services, taking steps towards sector reform and market liberalization, with the reduction of tariffs a key policy goal.***

**Mobile services:** There is one provider of mobile services in the country, MTN Swaziland, a joint venture of the South African group (49 per cent) and the State-owned incumbent Swaziland Post and Telecommunications Corporation (SPTC) (51 per cent), which launched in 1998. Things soured between the stakeholders when SPTC launched a competing full mobility CDMA service. It was sued by MTN with the International Court of Arbitration ruling in MTN's favour. SPTC was subsequently ordered to terminate the service, with the Government taking control of SPTC's stake in MTN. In addition, 19 per cent of MTN's stake in MTN Swazi company was sold to Swazi Empowerment Limited, a government investment holding. Despite the mobile monopoly, GSM coverage is high in the small, landlocked country, with household mobile phone penetration at 96 per cent (98 per cent in urban areas and 94 per cent in rural ones), the second-highest in sub-Saharan Africa.<sup>428</sup> MTN launched 3G in 2011 and LTE was launched in 2016 using the 1 800 MHz band.

**Fixed services:** Incumbent SPTC offers fixed-telephone services through the SwaziTelecom brand. Fixed-telephone offerings include copper fixed lines and wireless local loop phone service. SwaziTelecom offers fixed broadband through ADSL with connection speeds of up to 5 Mbit/s. It also provides wholesale ADSL access to resellers. There is a nationwide fibre-optic backbone infrastructure with connections to the SEACOM undersea cable through Mozambique and the EASSy undersea cable through South Africa for redundancy. The Mbabane Internet Exchange Point (MB-IX) was launched in 2014.

**Government policy:** The Ministry of Information, Communications and Technology was established in 2009 with responsibility for sector policy. The Communications Commissions Act of 2013 created the Swaziland Communications Commission (SSCOM), taking over responsibility for regulation from SPTC. The Electronic Communications Act of 2013 lays out the framework for regulation of the sector covering competition and licensing.

Key indicators for Swaziland (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	3.2	1.0 13.6
Mobile-cellular sub. per 100 inhab.	76.4	74.6 101.5
Fixed-broadband sub. per 100 inhab.	0.5	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	13.0	22.9 52.2
3G coverage (% of population)	21.2	59.3 85.0
LTE/WiMAX coverage (% of population)	29.6	25.7 66.5
Mobile-cellular prices (% GNI pc)	3.8	14.2 5.2
Fixed-broadband prices (% GNI pc)	15.6	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	5.7	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	9.9	17.7 6.8
Percentage of households with computer	19.2	9.6 46.6
Percentage of households with Internet access	24.0	16.3 51.5
Percentage of individuals using the Internet	28.6	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	5.8	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

In 2016, both MTN and SPTC were issued new full-service licenses allowing them to provide any service. The National Information and Communication Infrastructure Plan 2012–2016 lays out the policy and implementation for aligning ICT with national development goals, and was the thrust behind the launching of the Electronic Communications Act and creation of SSCOM. The Plan targets nine priority areas (human resource capacity, infrastructure development, education, strategic ICT leadership, financial services sector, ICT industry, legal/regulatory frameworks, environmental management and media). There is a particular emphasis on education to promote both basic digital literacy as well as advanced skills for those working in ICT. This includes incorporating computer education in the school curriculum, ensuring ICTs in schools and developing the online learning environment. Secondary school graduates would need to have ICT proficiency before progressing to tertiary institutions, and a programme will be launched in vocational schools targeting those already out of school.

**Conclusion:** Swaziland's move toward sector reform – including a new electronic communications law, creation of a regulator and issuance of full-service licenses – aims to intensify competition in order to lower prices and deepen ICT access, not to mention the country's concentrated efforts to enhance digital skills.

## Sweden

**Mobile and fixed-broadband penetration in Sweden is well above the European average. In particular, Sweden has an advanced mobile-broadband market with affordable prices and a customer base that is open to new technologies.**

**Mobile services:** There are a total of five mobile network operators and several virtual mobile network operators active in the very competitive Swedish market. Telia has the highest market share in the mobile-cellular as well as mobile-broadband markets, followed by Tele2, Telenor, and Hi3g (PTS, 2016). Both mobile-cellular and mobile-broadband penetration rates are very high and well above the European average. In 2009, LTE services were first launched in Sweden's capital Stockholm as well as in Norway's capital Oslo, by Telia.<sup>429</sup> Tele2 and Telenor agreed to share spectrum in several frequency bands and to build a shared 2G and LTE network the same year in order to strengthen their position in the market. Their joint Net4Mobility network now covers 99 per cent of the population.<sup>430</sup>

**Fixed services:** Sweden has a very advanced and competitive fixed market. In line with the global trend, fixed-telephone penetration is on the decline. Fixed-broadband penetration is high and above the European average. Fibre subscriptions have seen the highest growth rates in recent years and took over DSL as the dominant technology in 2014. Speeds are increasing as well with 76 per cent of fibre subscriptions and 58 per cent of cable subscriptions reaching speeds of 100 Mbit/s or more in 2016. The main players in the fixed-broadband market are the incumbent operator Telia, as well as Telenor and Com Hem (PTS, 2016).

**Government policy:** The Swedish Telecommunications Act was introduced in 1993 and brought about the establishment of an independent regulator as well as the liberalization of the market. Sweden became an EU member in 1995, which had an important impact on ICT policies. The country is at the forefront of ICT development globally as well as in comparison to other European countries. The government adopted its broadband plan in 2016 for the period up to 2025. In the short term, Sweden aims to achieve access for 95 per cent of all households and businesses at a minimum speed of 100 Mbit/s by the year 2020. In the long term, the goal is that

Key indicators for Sweden (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	31.8	37.7 13.6
Mobile-cellular sub. per 100 inhab.	128.5	118.0 101.5
Fixed-broadband sub. per 100 inhab.	37.7	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	124.4	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	100.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.2	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.9	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.1	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.2	0.6 6.8
Percentage of households with computer	88.5	79.6 46.6
Percentage of households with Internet access	92.0	82.5 51.5
Percentage of individuals using the Internet	91.5	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	505.6	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

98 per cent of households and businesses should have access to broadband at a minimum speed of 1 Gbit/s, 1.9 per cent at a minimum speed of 100 Mbit/s, and 0.1 per cent at a minimum speed of 30 Mbit/s, no later than the year 2025. The long-term goals of the broadband strategy also include everyone's access to reliable and high-quality mobile services, where they usually find themselves, no later than the year 2023. The role of the government is defined as providing the legal and regulatory framework for the expansion of broadband networks by operators. In rural and remote areas that are not served by private entities, the government will step in and finance broadband projects. In 2010, Sweden's Bredbandsforum was created. It serves as the national competence centre and is tasked with the coordination of different actors in the broadband market such as the government, public authorities and private enterprises in order to facilitate ICT development.<sup>431</sup>

**Conclusion:** Sweden is among the world's most connected countries with high penetration rates for fixed and mobile services and most of the population is using the Internet. The government continues to focus on broadband roll-out and to provide the conditions for a competitive and modern telecommunication market.

## Switzerland

**Switzerland has a well-developed telecommunication market with high penetration rates for fixed and mobile services. NGA networks are widely available and fixed-broadband penetration is among the highest in the world.**

**Mobile services:** The mobile market is served by three mobile network operators and a small number of mobile virtual network operators. According to an analysis by Ofcom, the regulator in Switzerland, the mobile market is among the least competitive markets in Europe. Incumbent operator Swisscom has a market share of more than 50 per cent and its customer base has been very stable over recent decades. The second largest operator is Sunrise, with a market share of around 26 per cent. Orange Swiss entered the market in 1999 becoming Switzerland’s third mobile operator. The company was acquired by Xavier Niel, founder of the French operator Free, in 2015. Mobile penetration rates are very high and prices affordable for Swiss customers. Operators are investing heavily in network roll-out and (almost) complete population coverage with 3G and LTE networks has been achieved. (BAKOM, 2014)

**Fixed services:** Switzerland has a well-developed NGA network compared to other European countries. According to the regulator Ofcom, operators in Switzerland are among the biggest investors in telecommunication networks in Europe. Furthermore, the country has two access networks (the incumbent and the cable provider) that are reaching more than 90 per cent of households and thus provide the best conditions for effective infrastructure-based competition in the broadband market. Penetration rates for fixed-telephone and fixed-broadband services are well above the European averages and prices are affordable. Despite market liberalization in 2006 and the entry of numerous alternative operators, incumbent Swisscom still dominates the fixed market with a share of around 70 per cent of the market. (BAKOM, 2014)

**Government policy:** Although Switzerland has aligned some of its policies with the European Union, Switzerland’s telecommunication policies remain distinct from the EU policies. A major distinction compared to most European countries

Key indicators for Switzerland (2016)	Europe	World
Fixed-telephone sub. per 100 inhab.	47.7	37.7 13.6
Mobile-cellular sub. per 100 inhab.	135.1	118.0 101.5
Fixed-broadband sub. per 100 inhab.	45.6	30.2 12.4
Active mobile-broadband sub. per 100 inhab.	101.5	80.1 52.2
3G coverage (% of population)	100.0	98.5 85.0
LTE/WiMAX coverage (% of population)	99.0	92.2 66.5
Mobile-cellular prices (% GNI pc)	0.4	1.0 5.2
Fixed-broadband prices (% GNI pc)	0.6	1.2 13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	0.6 3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	0.6 6.8
Percentage of households with computer	89.3	79.6 46.6
Percentage of households with Internet access	86.8	82.5 51.5
Percentage of individuals using the Internet	89.4	77.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	269.2	178.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

that fully liberalized their markets in 1997/1998 is the fact that Swisscom is still majority-owned by the government.<sup>432</sup> The first national strategy for the digitalization of Switzerland was published in 1998 and revised in 2006 and 2012. The 2016 “Digital Switzerland” strategy has four key objectives: innovation, growth and prosperity in the digital world, equal opportunities and the participation of all, transparency and security, and contribution to sustainable development.<sup>433</sup>

**Conclusion:** Switzerland is one of the leading countries in ICT development. The government is determined to utilize the opportunities provided by ICTs to make Switzerland an “attractive place to live and as an innovative, future-oriented location for business and research.”<sup>434</sup>

## Syria

***Syria has been in the midst of a crisis for a number of years. This volatile environment is disastrous for Syria's infrastructure and telecommunication networks and equipment have become key targets for attacks. The mobile market is witnessing partial competition between the two licensed operators.***

**Mobile services:** Despite the crisis, mobile-cellular penetration is lower than the average penetration in Arab States and globally. The level of competition is fair with two mobile operators, MTN Syria and Syriatel, which had operated mobile networks under Build, Operate and Transfer (BOT) arrangements for many years till end of 2014. Both operators have been awarded long-term licences (20 years) by the Syrian Telecommunications Regulatory Authority (SyTRA), valid until the end of 2034. Despite the crisis, Syriatel and MTN Syria reported annual increase in the number of mobile and fixed broadband subscribers. Both operators launched 3G/HSDPA service in 2009. Due to the crisis, none of the operators have yet launched LTE (all the needed arrangements are being taken now to launch it). With 3G/HSDPA and LTE networks in place, the focus for mobile data has firmly shifted to mobile broadband offerings. The 3G wireless Internet is available in all major cities. The frequencies for 3G services are in the 2100 MHz band (and there is a plan for 900 MHz use after the completion of the needed reframing). Several price adjustments for mobile services have been made between 2013 and 2016 to compensate for the currency devaluation.

**Fixed services:** Syria has one of the highest fixed line penetration rates in the region. Syrian Telecom (ST) is the only fixed telecommunications company in Syria and is still owned by the government. ST provides ADSL and FTTx broadband access through its own ISP (Tarassul). There are other licensed ISPs operating on an open access data network owned by ST, such as Saw, Aya, the Syrian Computer Society (SCS), etc. ST had planned to rollout FTTH networks in major cities in 2009, but the plan was interrupted by the crisis. In late 2016, ST has completed a new optical fibre link connecting between Aleppo and Damascus. ST resumed its projects to deploy FTTx in major cities 2017.

**Government policy:** The Telecommunications Law no. 18 of the year 2010 stated the roles

Key indicators for Syria (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	15.2	7.7	13.6
Mobile-cellular sub. per 100 inhab.	58.6	107.1	101.5
Fixed-broadband sub. per 100 inhab.	4.4	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	10.4	45.2	52.2
3G coverage (% of population)	78.0	81.9	85.0
LTE/WiMAX coverage (% of population)	0.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	90.2	4.3	5.2
Fixed-broadband prices (% GNI pc)	56.9	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	320.3	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	195.7	5.5	6.8
Percentage of households with computer	49.9	43.3	46.6
Percentage of households with Internet access	43.6	45.3	51.5
Percentage of individuals using the Internet	31.9	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	12.8	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

of different players in the telecom sector as follows: The ministry of communications and technology (MoCT) is responsible for the policies of telecommunication; The Syrian Telecommunications Regulatory Authority (SyTRA) has been established to regulate the telecommunications sector in addition to the Radio Spectrum management; Telecom Service Providers, such as ST (incumbent), Syriatel, MTN Syria, and ISPs. SYTRA awarded a number of licences to many ISPs, and services were launched in the Internet service market. All other forms of fixed-line communication are provided by ST. The Government, in cooperation with the UNDP, formulated the national ICT strategy for Syria. In early 2011, the tendering process of entering a third mobile operator was suspended due to the crisis; however, Syria is still looking for the introduction of a 3rd mobile operator, where ST would reserve the right to a 20 per cent equity share of the operating company.

**Conclusion:** Overall, the ICT sector is facing big challenges in Syria, and future developments depend on the stabilization of the country. Opportunities exist in the growing mobile broadband sector, and reconstruction of the damaged infrastructure and networks. In spite of the difficulties the telecom sector has faced during the crisis, MoCT, in cooperation with service providers could guarantee the continuation of providing telecom services and considerably increasing the deployment of broadband services.

## Tajikistan

**While the coverage of mobile-broadband services in Tajikistan is higher than the CIS average, penetration rates are relatively low. One reason may be the high prices for mobile and fixed services, which are among the highest in the region. However, the Government is making efforts to increase the use of ICT services across the country.**

**Mobile services:** The mobile cellular market in Tajikistan is represented by five telecommunication operators: Tcell, TT-Mobile, Babilon-Mobile, Takom, TK-Mobile. The companies use a wide range of technologies to provide services, such as GSM 900/1800, CDMA 2000, UMTS, and LTE 800/1800-2100 MHz.<sup>435,436,437,438</sup> The first 3G-UMTS network in Tajikistan was launched in 2005 by Babilon-Mobile.<sup>439</sup> WiMAX-based services started in 2007 by Babilon-T and Intercom.<sup>440</sup> LTE emerged in 2012 (launched by Babilon-Mobile) and it is in the process of development.<sup>441</sup> According to the statistics of one of the mobile operators, over 70 per cent of its Internet users exploit LTE enabled devices.<sup>442</sup> Satellite communications are often used by mobile cellular operators to connect their own networks across the country.<sup>443</sup>

**Fixed services:** The number of fixed telephone subscribers is in decline.<sup>444</sup> There is a significant telephone network availability divide between urban and rural areas.<sup>445</sup> The national telecommunication operator, Tajiktelecom, which is under the responsibility of the national regulatory authority, is the main supplier of fixed telephone services.<sup>446</sup> By 2014, 95 per cent of the analogue infrastructure had been replaced by digital systems and most of the backhaul lines were optical fibre. Tajiktelecom is the only operator that covers all regions. For that reason many Internet providers use its infrastructure to provide their services. Five major Internet providers share 95 per cent of the market. They construct optical fibre lines to satisfy demand for data transmission services, although fixed Internet access service penetration remains low.<sup>447</sup>

**Government policy:** In 2003, the ICT for the development of the Republic of Tajikistan strategy was approved. It focuses on four main goals: ICT legislation framework improvement, development and implementation of new ICT applications, ICT infrastructure development, and information

Key indicators for Tajikistan (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	5.3	20.7	13.6
Mobile-cellular sub. per 100 inhab.	106.7	141.2	101.5
Fixed-broadband sub. per 100 inhab.	0.1	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	18.1	59.7	52.2
3G coverage (% of population)	90.0	77.1	85.0
LTE/WiMAX coverage (% of population)	73.6	45.9	66.5
Mobile-cellular prices (% GNI pc)	3.7	1.7	5.2
Fixed-broadband prices (% GNI pc)	8.3	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.2	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	4.2	3.1	6.8
Percentage of households with computer	13.2	67.4	46.6
Percentage of households with Internet access	10.3	68.0	51.5
Percentage of individuals using the Internet	20.5	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.4	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

security. A set of national programmes has been implemented since 2003. The development and implementation of ICT in the Republic of Tajikistan programme, issued in 2004, resulted in supplying public institutions with computers and local area network construction. Some projects on digital telecommunication system deployment and remote area coverage were implemented. A lot of attention in the country is given to information security, and an information security programme was adopted in Tajikistan in 2004. In 2016, the Tajikistan government took a decision to create a centre for international telephone and Internet traffic control.<sup>448,449</sup> The national programme of providing schools with computers took place in 2011-2015. Its objectives were to supply educational establishments with computers and telecommunication equipment, train personnel to use ICT, and connect schools to the Internet.

**Conclusion:** Tajikistan has an open telecommunication market with more than 150 telecommunication services providers at the beginning of 2014. The deployment of new technologies and the Government's efforts in strengthening the ICT sector are promising to increase the access and use of ICTs in Tajikistan.

## Tanzania

***The arrival of submarine cables in the East African nation has spurred greater ICT activity in a sector underpinned by a forward-thinking regulatory environment.***

**Mobile services:** There are six mobile operators, with the top three accounting for over 85 per cent of the market in December 2016. The three market leaders are Vodacom, a subsidiary of the South African mobile group; TIGO, a subsidiary of the Luxembourg-based MILLICOM mobile group; and AIRTEL, a subsidiary of the Indian mobile group. Other mobile operators include ZANTEL, operating on the island of Zanzibar, and a subsidiary of MILLICOM; HALOTEL, a subsidiary of the Vietnamese VIETTEL group; and Smart, owned by the Aga Khan Development Network, with a 51 per cent share, and a Cypriot mobile group, with a 49 per cent stake. Coverage from 2G is high, at over 95 per cent of the population, with 78 per cent of households having a mobile phones in 2015-2016, including (a) 93 per cent on the island of Zanzibar; and (b) 92 per cent of urban and 70 per cent of rural homes on the Tanzania mainland.<sup>450</sup> All the mobile operators have deployed 3G while TIGO, Smart, ZANTEL and Vodacom have commercially launched LTE.

**Fixed services:** Tanzania Telecommunication Limited (TTCL) is the incumbent operator. In 2001, it was partly privatized, when 35 per cent of its shares were sold to a consortium. In 2016, the Government of Tanzania repurchased the outstanding shares and currently again owns 100 per cent. TTCL offers fixed-telephone service through copper landlines. TTCL's fixed-broadband offerings include ADSL (up to 2 Mbit/s), fibre-optic and fixed wireless LTE. It competes with other fixed-broadband providers, primarily using fixed wireless broadband and a few offering fibre-optic connections, mainly to businesses in urban areas. The National ICT Broadband Backbone (NICTBB) infrastructure –covering more than 7 500 km – has been operational since June 2012. It is structured as a public–private partnership between the Government and operators. NICTBB has cross-border connectivity to the neighbouring countries of Kenya, Uganda, Rwanda, Burundi, Zambia and Malawi. Operators provide funding while the Government contribution is through arranging rights of way and their costs. The Government owns the network while operators use the

Key indicators for Tanzania (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.2	1.0	13.6
Mobile-cellular sub. per 100 inhab.	74.4	74.6	101.5
Fixed-broadband sub. per 100 inhab.	3.4	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	9.2	22.9	52.2
3G coverage (% of population)	85.0	59.3	85.0
LTE/WiMAX coverage (% of population)	13.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	6.4	14.2	5.2
Fixed-broadband prices (% GNI pc)	35.9	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	3.0	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.4	17.7	6.8
Percentage of households with computer	3.9	9.6	46.6
Percentage of households with Internet access	8.5	16.3	51.5
Percentage of individuals using the Internet	13.0	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	1.7	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

capacity. All licensed operators use the NICTBB on open access terms with cost-based prices. Part of the network has been deployed along the railway network. The arrival of submarine cables beginning in 2009 has boosted international connectivity, enabling the deployment of the latest broadband technologies. Tanzania is currently connected to the Eastern Africa Submarine System (EASSy) and SEACOM, is the landing point for the Seychelles to East Africa Submarine (SEAS), and several other submarine cables are in the pipeline. The Tanzania Internet Exchange launched in 2004 and has 35 peering members.

**Government policy:** Responsibility for the ICT sector falls under the Ministry of Works, Transport and Communications. The 2016 National ICT Policy lays out the vision for the sector. The policy has 22 specific objectives, with the main objective of transforming Tanzania into an ICT-driven middle-income economy and society. The Tanzania Communications Regulatory Authority was operationalized in 2003, with responsibility for electronic communications, including telecommunications and posts. The primary sector law is the Electronic and Postal Communications Act of 2010.

**Conclusion:** Tanzania has created an enabling environment through a predictable regulatory environment, competition and open access to backbone networks. This is resulting in growing access to ICTs.

## TFYR Macedonia

***The Former Yugoslav Republic of Macedonia is a small market of just over 2 million inhabitants and, as a European Union candidate country, largely aligned with EU regulatory frameworks. With a less developed fixed network, mobile is very important in the country and penetration rates are relatively high for mobile-cellular and increasing for mobile-broadband services.***

**Mobile services:** Following the merger of TFYR Macedonia's second and third operator in 2015, there are only two mobile network operators active on the market. Makedonski Telekom (MakTel), which is part of Deutsche Telekom since 2001, is the market leader.<sup>451</sup> The second operator, One.Vip, was formed by a merger between ONE (owned by Telekom Slovenije Group) and Vip (owned by Telekom Austria Group).<sup>452</sup> Mobile and fix number portability were introduced in 2008 and had a positive impact on competition, especially when porting fees were reduced. MVNOs entered the market in 2010. Mobile-broadband penetration is somewhat below the European average at 56 subscriptions per 100 inhabitants. 3G licences were first awarded in 2008 to MakTel and Vip (later to become one.Vip). At the end of 2013, LTE services were launched commercially. Almost the entire population of TFYR Macedonia is covered by a 3G and LTE signal. Investments in LTE are ongoing, and coverage, capacity and uptake are expected to increase in the years to come. During 2017, both MakTel and one.Vip upgraded their LTE networks to 2CA/3CA and 4x4 MIMO technology.

**Fixed services:** Electronic communication services provided over fixed networks in TFYR Macedonia are well developed but there is still plenty room for improvements. TFYR Macedonia fixed-line market was formally liberalized in 2005, but the incumbent operator Makedonski Telekom AD Skopje continues to dominate the market. By the end of 2016, it had a 37 per cent share of the fixed-broadband access market. Competition is particularly strong from cable operators and fixed wireless access providers. In 2016, One.Vip merged with its sister company Blizoo, a cable provider, to strengthen its position in the market. NGA networks which are capable of delivering at least 30Mbit/s cover about 50 per cent of all households in the country. Most predominant technologies for fixed NGA access are cable networks featuring

Key indicators for TFYR Macedonia (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	17.5	37.7	13.6
Mobile-cellular sub. per 100 inhab.	97.2	118.0	101.5
Fixed-broadband sub. per 100 inhab.	18.1	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	56.4	80.1	52.2
3G coverage (% of population)	99.0	98.5	85.0
LTE/WiMAX coverage (% of population)	91.5	92.2	66.5
Mobile-cellular prices (% GNI pc)	2.5	1.0	5.2
Fixed-broadband prices (% GNI pc)	3.3	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.0	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.3	0.6	6.8
Percentage of households with computer	69.8	79.6	46.6
Percentage of households with Internet access	70.4	82.5	51.5
Percentage of individuals using the Internet	72.2	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	109.0	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

DOCSIS 3.0 technology and FTTH networks. FTTH networks covered 27 per cent of all households by the end of 2016, while cable networks with DOCSIS 3.0 covered almost 50 per cent of the households in TFYR Macedonia.

**Government policy:** The Agency for Electronic Communications, TFYR Macedonia independent regulator, was established in 2005 with the Law on Electronic Communications.<sup>453</sup> TFYR Macedonia has been a candidate for EU membership since 2005 and thus aligned many of its regulations. Legislation in the telecommunication sector is based on the EU regulatory framework. All competitive safeguards were in place by 2009, including reference interconnection offers, number portability, carrier selection and pre-selection, wholesale line rental in the fixed voice market, local loop unbundling and wholesale broadband access in the fixed broadband market (EBRD, 2012c). The policy making body in the TFYR Macedonia is the Ministry of Information Society and Administration. There are two major strategies in place to develop ICTs in the country: the National Strategy for the development of Electronic Communications with Information Technologies and the National Strategy for Information Society Development and Action Plan. Among its objectives are increasing the number of Internet users, the establishment of public e-services and the liberalization of the sector (Former Yugoslav Republic of Macedonia, 2005).

**Conclusion:** The Former Yugoslav Republic of Macedonia has undertaken important steps towards a competitive and modern telecommunication market. Mobile services are well developed and broadband is on the rise.

Strategies are in place to further develop TFYR Macedonia into a highly connected country.

## Thailand

### **Regulatory changes have triggered a massive migration to high-speed mobile broadband.**

**Mobile services:** Laws previously prevented outright ownership of telecommunication infrastructure by private operators. This changed in 2012, when 3G frequency was awarded at auction. Existing concessionaires bid for frequencies through newly established subsidiaries. As a result, networks using 3G frequency are owned by private operators, whereas those using 2G frequencies are operated under build-transfer-operate agreements (BTOs). Operators are rapidly moving their subscribers to the new frequencies in order to reduce concession payments. There are three leading operators: Advanced Info Service (AIS), publicly listed with Singapore Telecom as a key strategic investor; Total Access Communication (DTAC), with the Norwegian mobile group Telenor as a strategic investor; and True, with China Mobile as the strategic investor. There are also smaller operators such as the two state-owned providers, as well as a few mobile virtual network operators (MVNOs). Population coverage of 3G networks is quite extensive. The three leading operators deployed LTE networks between 2013 and 2016. Mobile data take-up has grown rapidly with just over half the population aged six years and over had a smartphone in 2016 (NSO Thailand, 2016).

**Fixed services:** The state-owned Telephone Organization of Thailand (TOT) is the main nationwide fixed telephone service provider. In addition TRUE operates fixed telephone services in urban areas, while TT&T provides services in rural areas. Fixed telephone penetration has been declining as more users opt for mobile phones. TRUE, TOT and Triple T Broadband (3BB) are the leading fixed broadband operators offering ADSL, coaxial cable and fibre-optic connections, although the other mobile operators are also increasing their fixed broadband offerings. The national fibre-optic backbone is quite extensive, reaching most provinces, and continued expansion is adding to its density and capacity. The network connects of both terrestrial and extensive domestic connectivity using festoon submarine cable along Thailand's east and west coasts. The terrestrial network reaches all its neighbours and provides access to the country's international submarine landing points for landlocked Laos. Thailand has

Key indicators for Thailand (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	7.0	10.0	13.6
Mobile-cellular sub. per 100 inhab.	177.2	98.9	101.5
Fixed-broadband sub. per 100 inhab.	10.7	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	94.7	47.4	52.2
3G coverage (% of population)	98.0	87.6	85.0
LTE/WiMAX coverage (% of population)	98.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.9	3.2	5.2
Fixed-broadband prices (% GNI pc)	3.8	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.2	5.4	6.8
Percentage of households with computer	28.4	37.8	46.6
Percentage of households with Internet access	59.8	45.5	51.5
Percentage of individuals using the Internet	47.5	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	49.2	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

been connected to undersea submarine cable since 1997 and currently lands around a dozen cables. In addition, it has terrestrial connectivity to all countries on its borders. The Bangkok Neutral Internet Exchange, established in 2015, has around twenty participants.

**Government policy:** The Ministry of Digital Economy and Society (MDES) is responsible for ICT sector policy. *Thailand Digital Economy and Society Development Plan* targets ICT as a basic public utility that all villages will have access to high-speed Internet in two years and 90 percent of residents who live in municipal and economic areas will be able to access high-speed Internet with a minimum speed of 100 Mbps in three years, with service fee of no higher than two percent of GNP per capita. The National Broadcasting and Telecommunications Commission (NBTC) established in 2011 is responsible for sector regulation.

**Conclusion:** Thailand has an extensive broadband network with a current focus on increasing speeds and extending access to remote villages. Mobile broadband take-up has been astonishing, with barely any 2G subscriptions left following the award of 3G spectrum in 2012.

## Timor-Leste

**Access to telecommunications has been improving in the post-conflict island State, especially since the introduction of competition in the mobile sector.**

**Mobile services:** Timor Telecom launched GSM in 2003 shortly after the country's independence. Timor Telecom came into being following a tender to operate telecommunications in the newly independent country. Timor Telecom was majority owned by Portugal Telecom, whose stake was later purchased by Brazil's Oi. Competition was introduced in 2013 when two additional operators entered the market: the Vietnamese mobile group VIETTEL, operating under the brand TELEMOR, and TCELL, a subsidiary of Indonesia's PT Telkom. All three mobile operators launched 3G that same year. In 2015, 81 per cent of households had a mobile phone.<sup>454</sup> Given that the two new mobile operators deployed 3G at launch, population coverage is high and over a quarter of mobile subscriptions were for 3G during the first quarter of 2016.

**Fixed services:** Timor Telecom operates fixed-line telephone services. Fixed telephone lines are available mainly in urban areas and uptake is low. Similarly, fixed broadband is limited. Timor Telecom offers ADSL with a download speed of 2 Mbps. Fixed wireless broadband offerings include WiMAX and VSAT. There are several national backbone fibre-optic networks in the country, including cross-border links to the neighbouring Indonesian side of Timor island. Cable is generally installed overhead on poles. The Government has been deploying a fibre-optic backbone to connect all district offices. The country does not currently have a connection to regional undersea fibre-optic cables. There has been discussion about connecting to the submarine cable on the Indonesian side of the island or via a submarine cable to Australia but no decision has been made. Meanwhile Timor-Leste relies mainly on low-earth orbit satellites for international Internet connectivity. The Timor-Leste Internet Exchange was established in late 2016.

**Government policy:** The Ministry of Public Works, Transport and Communications is responsible for sector policy. The National Communications Authority is the regulator established by the *Telecommunications Decree-law No. 15* of 28

Key indicators for Timor-Leste (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	0.2	10.0	13.6
Mobile-cellular sub. per 100 inhab.	125.0	98.9	101.5
Fixed-broadband sub. per 100 inhab.	0.1	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	64.6	47.4	52.2
3G coverage (% of population)	96.5	87.6	85.0
LTE/WiMAX coverage (% of population)	0.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	7.4	3.2	5.2
Fixed-broadband prices (% GNI pc)	25.7	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	5.2	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	6.6	5.4	6.8
Percentage of households with computer	16.2	37.8	46.6
Percentage of households with Internet access	23.9	45.5	51.5
Percentage of individuals using the Internet	25.2	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	1.9	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

March 2012. Telecommunications is included as an important infrastructure sector in the country's *Strategic Development Plan (2011-2030)*. The plan led the way for liberalization of the sector. It set four mid-term targets to be accomplished by 2015: i) affordable mobile phone coverage for all Timorese people; ii) affordable high-speed Internet access available in all district capitals and surrounding areas; iii) all schools, health posts and health clinics connected to the Internet; and iv) a regulatory framework put in place to manage a competitive telecommunications market. Three targets were established for 2020: i) all citizens will have access to reliable, affordable and high-speed Internet; ii) all students and health professionals will have portable Internet access devices; and iii) Timor-Leste will be part of the technology-enabled world.

**Conclusion:** Post-conflict Timor-Leste has made notable progress of late in expanding mobile and mobile broadband coverage to its citizens. It needs to reach a decision on international undersea fibre-optic connectivity in order to take advantage of cheap international Internet capacity and establish the essential conditions for higher-speed broadband networks.

## Togo

***The landing of an undersea cable in 2012 has triggered an impetus to liberalize the ICT sector in the West African nation in order to advance the digital economy.***

**Mobile services:** The mobile market in Togo is a duopoly. The two mobile operators are Togo Cellulaire, the mobile arm of the incumbent Togo Telecom that launched in 1997; and Atlantique Telecom Togo, operating under the brand MOOV, a subsidiary of Morocco Telecom, which launched in 1999. Despite somewhat limited competition, mobile penetration is relatively high. In 2014, 74 per cent of households had portable phones, with more than a 30 percentage point gap between urban (91 per cent) and rural (60 per cent) areas.<sup>455</sup> Togo Cell launched 3G in 2011, with MOOV following in 2016. While mobile Internet is the main form of Internet access in the country, mobile-broadband is limited due to the recent competition in that market segment. The Government awarded LTE licenses to the operators in late 2016.

**Fixed services:** The State-owned incumbent Togo Telecom is the sole operator in the fixed-telephone market with fixed copper lines and CDMA wireless local loop. It offers fixed-broadband using CDMA EVDO and WiMAX fixed wireless technology, and ADSL fixed broadband (up to 8 Mbit/s). Togo Telecom has also been deploying public Wi-Fi hotspots. In addition to two mobile operators, there are now four ISPs following the issuance of two new licenses in 2017: Togo Telecom, CAFÉ Informatique & Telecommunication, Group Vivendi Africa and Teolis S.A. Togo Telecom is progressively expanding its national fibre-optic backbone. In 2016, MOOV announced it would build a 450 km fibre-optic backbone stretching from the South to the North of the country. The Government also has 250 km of fibre-optic for its e-government network. The arrival of WACS in 2012 provided Togo with undersea fibre-optic connectivity for the first time. One challenge is open access, since Togo Telecom is an investor in the cable. In anticipation of additional actors in the Internet market, an IXP was launched in 2017.

**Government policy:** The Ministry of Posts and Digital Economy is responsible for sector oversight. The 2017 Law on the Orientation of the Information Society establishes fundamental

Key indicators for Togo (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.5	1.0	13.6
Mobile-cellular sub. per 100 inhab.	74.9	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.6	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	15.5	22.9	52.2
3G coverage (% of population)	45.0	59.3	85.0
LTE/WiMAX coverage (% of population)	0.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	22.3	14.2	5.2
Fixed-broadband prices (% GNI pc)	56.2	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	18.7	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	18.7	17.7	6.8
Percentage of households with computer	6.8	9.6	46.6
Percentage of households with Internet access	7.7	16.3	51.5
Percentage of individuals using the Internet	11.3	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	4.5	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

principles covering ICT access, participation in the information society, ICT education and training, and other areas. The Ministry has been supporting a number of sector strategies, including the regulatory framework, market liberalization, institutional strengthening, infrastructure development and ICT use across different sectors. Another initiative includes the deployment of public Wi-Fi hotspots to ensure no citizen is more than 5 km from broadband. The regulatory framework for the sector is laid out in the 2012 Law on Electronic Communications and several supporting regulations. The Regulatory Authority for the Posts and Telecommunications Sectors is responsible for regulation. It also manages the .tg domain name

**Conclusion:** The Government has embarked on a number of projects since the arrival of the WACS cable in 2012. It is seeking to maximize the potential of the massive increase in Internet capacity to foment a dynamic information society. Initiatives include increasing competition through the issuance of new ISP licenses, extending the fibre-optic backbone and adopting new laws on electronic commerce and the information society.

## Tonga

**The Kingdom of Tonga was one of the first South Pacific countries to launch mobile competition resulting in a high level of access. The arrival of an international submarine cable and the construction of a domestic submarine network will provide the backbone for a vibrant broadband nation.**

**Mobile services:** There are three operators in Tonga. The state-owned incumbent Tonga Communications Corporation (TCC) launched its GSM network in October 2001 under the U-Call brand. A second provider, Shoreline Communications Ltd., launched services in 2002 under the TONFON brand. In 2007, Irish-owned DIGICEL entered the market through its purchase of Shoreline's mobile operation. The introduction of early competition resulted in widespread coverage and high take-up with 95 per cent of households had a mobile phone, with little difference between urban areas (97 per cent) and rural ones (95 per cent).<sup>456</sup> Tonga launched mobile broadband relatively late compared to other South Pacific nations, as it was dependent on the arrival of submarine cable connectivity. TCC deployed its 3G network in December 2013 and DIGICEL followed in July 2014.

**Fixed services:** TCC is the main fixed telephone line provider. The fixed telephone service remains popular compared to many developing nations over half the country's households had a fixed telephone line in 2012. TCC provides fixed broadband using ADSL 2+ in some areas. In addition, fixed wireless is available via WiMAX and VSAT. The Internet service provider OCEANCEL launched fixed wireless services using LTE technology in 2015. TCC and DIGICEL provide Wi-Fi access throughout the Nuku'alofa Central Business District. TCC has a fibre-optic backbone on the island of Tongatapu and uses microwave and satellite for backbone transmission to other islands. An undersea fibre-optic cable linking Tonga to Fiji—a distance of 827 kilometres—was commissioned in August 2013. From Fiji, onward connectivity is provided via the Southern Cross cable to Australia and the United States. The cable is owned and operated by Tonga Cable Limited (TCL), whose shareholders are the Kingdom of Tonga (83 per cent) and TCC (17 per cent). TCL is extending submarine cable to the outer island

Key indicators for Tonga (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	<i>10.3</i>	10.0	13.6
Mobile-cellular sub. per 100 inhab.	<i>74.7</i>	98.9	101.5
Fixed-broadband sub. per 100 inhab.	<i>2.8</i>	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	<i>56.0</i>	47.4	52.2
3G coverage (% of population)	<i>95.0</i>	87.6	85.0
LTE/WiMAX coverage (% of population)	<i>41.1</i>	73.6	66.5
Mobile-cellular prices (% GNI pc)	<i>2.7</i>	3.2	5.2
Fixed-broadband prices (% GNI pc)	<i>1.9</i>	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	<i>2.2</i>	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	<i>n.a.</i>	5.4	6.8
Percentage of households with computer	<i>38.8</i>	37.8	46.6
Percentage of households with Internet access	<i>42.6</i>	45.5	51.5
Percentage of individuals using the Internet	<i>40.0</i>	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	<i>33.9</i>	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

groups of Vava'u and Ha'apai. The project is planned for completion in 2018.

**Government policy:** The Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications (MEIDECC) is responsible for sector policy and regulation. The *Communications Commission Act 2015* set out plans to create a separate regulatory unit; however, MEIDECC still serves as the regulator pursuant to the new Communications Act until the Regulator is being established. In conjunction with this, a new Communications Act came into force on 1 March 2017. The 2008 *National Information and Communications Technology Policy* has the vision of a Connected Kingdom supported by six pillars: i) provision of ICT's in homes and communities; ii) education and skills development; iii) e-government; iv) industry growth and economic development; v) enabling technical infrastructure; and vi) ICT-related legislation. Tonga was also the the first Pacific Island Country to accede to the Budapest Convention on Cybercrime on 9 May 2017, which is Government's effort to address the abuse and misuse of the Internet especially for criminal activities. In 2016, the Government launched its CERT (Computer Emergency Response Team), which will help identify and address ICT threats and help parties deal with incidents and make decisions in crises. A cybercrime legislation is also being drafted to be tabled to the Parliament next year. In addition, the Government is currently preparing to launch a new E-Government initiative in 2018.

**Conclusion:** Competition has resulted in a high level of mobile penetration. Launch of the

submarine cable in 2013 dramatically boosted international Internet capacity, and the extension of fibre-optic cable to connect other islands has prepared the ground for a robust broadband backbone.

## Trinidad and Tobago

***The telecommunications sector of Trinidad and Tobago has represented approximately 3 per cent of the country's annual GDP over recent years. This significant contribution echoes the increasing service adoption rates, which have been on an upward trend over the last decade, with the exception of fixed-telephony. Internet services, both mobile and fixed, are flourishing in the country, with a dynamic market and affordable pricing that encourages service adoption.***

**Mobile services:** Mobile subscriptions have increased in the past year, with prepaid subscriptions representing over four times the number of postpaid subscriptions.<sup>457</sup> The mobile market was liberalized in 2006 and has experienced remarkable growth since, expanding more than 70 per cent just within the first six months immediately after liberalization. Recently, the most significant increase in terms of penetration, approximately 9 per cent, has been witnessed by the mobile Internet segment.<sup>458</sup> There are two mobile operators providing both voice and data services – Telecommunications Services of Trinidad and Tobago (TSTT) and Digicel – that launched LTE in 2012.<sup>459</sup> The mobile market is the main contributor to the industry's revenue, accounting for more than 35 per cent of the total amount.

**Fixed services:** Since its first decrease in adoption rates in 2007, fixed-telephone penetration rates have been on a steady decline, with regard to both subscriptions and revenue.<sup>460</sup> Fixed-broadband, however, has experienced a more positive outlook, with increasing revenues and a competitive environment that hosts eight operators and employs a mix of technologies, among which are ADSL2+ and Fibre to the Curb (FTTC), Fibre to the Business (FTTB) or Home (FTTH).<sup>461</sup>

**Government policy:** The national regulator, Telecommunications Authority of Trinidad and Tobago (TATT), was created in 2004 with the main objective of overseeing the transition to a liberalized competitive environment. TATT is also responsible for spectrum management, quality of service standards, encouraging industry investment and fostering competition in the sector, as well as ensuring sustainable and democratic sector development.<sup>462</sup> For instance,

Key indicators for Trinidad and Tobago (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	20.2	24.4	13.6
Mobile-cellular sub. per 100 inhab.	160.6	114.2	101.5
Fixed-broadband sub. per 100 inhab.	19.0	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	47.3	82.7	52.2
3G coverage (% of population)	75.0	93.6	85.0
LTE/WiMAX coverage (% of population)	10.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.0	3.6	5.2
Fixed-broadband prices (% GNI pc)	1.4	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.3	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.3	5.7	6.8
Percentage of households with computer	71.4	64.9	46.6
Percentage of households with Internet access	70.9	63.3	51.5
Percentage of individuals using the Internet	73.3	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	182.8	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

the regulator signed contracts with third parties to implement fixed and mobile number portability in late 2016 in an effort to increase market dynamism and consumer choice.<sup>463</sup> Another remarkable public initiative, this one with universal service objectives, is National Free Wi-Fi, aiming at providing free public Wi-Fi at numerous locations throughout the country.

**Conclusion:** Despite lagging behind most of the regional services adoption rates, Trinidad and Tobago has been concentrating efforts on developing its telecommunications sector and so far has seen vast improvements. The regulator is currently undergoing an evaluation of its television white spaces to define a better strategy going forward for their use for provision of broadband.

## Tunisia

***Tunisia has developed one of the most sophisticated telecommunication and broadband infrastructures in North Africa. The penetration rates for mobile and Internet services are among the highest in the Arab States. With three competing operators and one mobile virtual network operator (MVNO), the country offers some of the lowest prices of fixed and mobile broadband services in the region.***

**Mobile services:** Mobile cellular and mobile broadband in Tunisia has a rate of penetration above the average in the Arab States and globally. This can be attributed to the strong competition between telecommunication operators. There are three cellular operators in Tunisia: Tunisie Telecom (TT), Ooredoo (formerly Tunisiana) and Orange Tunisie. Lycamobile was the first MVNO to enter the market in 2015 and witnessed strong subscriber growth in 2016. Tunisie Telecom is the incumbent cellular operator in the Tunisian market. Ooredoo was the second cellular operator to enter the market, and started operations in 2002. Orange Tunisie commercially launched its cellular services in 2010. Orange Tunisia launched 3G services in mid-2010, followed by TT at the end of the same year and Ooredoo in 2012. The Tunisian Ministry of Communication Technologies and the Digital Economy (Mincom) issued LTE licences to all three operators in 2016, and they are beginning to offer LTE to consumers in March 2016. For the three operators, the frequency assignments for 3G services are in 900/2100 MHz, while the frequencies for LTE are in the 800/1800/2100 (5 MHz) MHz band.

**Fixed services:** Tunisia has a competitive fixed broadband market with three fixed licensed operators, with Tunisie Telecom being the incumbent fixed operator in the Tunisian market. Orange Tunisie was the second fixed operator to launch in the market. Ooredoo was the third entrant to the market and started operations in November 2013. There are 11 Internet service providers in Tunisia, of which five are private ISPs and six are owned by the government. All the operators are rolling out fibre-to-the-home (FTTH) infrastructure. It is expected that fixed broadband penetration will be substantially increased.

**Government policy:** The National Telecommunication Instance (Instance

Key indicators for Tunisia (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	8.6	7.7	13.6
Mobile-cellular sub. per 100 inhab.	125.8	107.1	101.5
Fixed-broadband sub. per 100 inhab.	5.6	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	63.0	45.2	52.2
3G coverage (% of population)	99.0	81.9	85.0
LTE/WiMAX coverage (% of population)	73.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.9	4.3	5.2
Fixed-broadband prices (% GNI pc)	1.4	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.4	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.1	5.5	6.8
Percentage of households with computer	39.3	43.3	46.6
Percentage of households with Internet access	37.5	45.3	51.5
Percentage of individuals using the Internet	49.6	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	32.0	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Nationale des Télécommunications, (INT)) is responsible for the regulatory framework of the telecommunication market in Tunisia, along with the Ministry of Communication Technologies and Digital Economy (Mincom), (INT), and the National Agency for Frequencies (NFA). INT and ANF are specialized bodies; Article 63 of Telecommunication Law 2001 creates INT while Article 47 of the same law creates NFA. The main roles of the INT are dispute resolution, market regulation, interconnection and consumer protection, while the NFA is responsible for frequency spectrum management, frequency allocation and frequency assignment.

**Conclusion:** The efforts made by INT, Mincom, NFA, and operators over the past 15 years have resulted in making Tunisia one of the most connected countries in the Arab States region. In 2015, the Strategic Digital Council approved Digital Tunisia 2020 Strategic Plan with the vision to make Tunisia an international digital hub and make ICT an important tool for accelerating socio-economic development.

## Turkey

**Turkey has a relatively large telecommunication market with huge potential for growth. Mobile and fixed penetration rates are below the European average, but are increasing rapidly. Three mobile operators are serving the Turkish market and offer relatively affordable plans to Turkish customers.**

**Mobile services:** Turkey's mobile market is one of the most concentrated markets in the Europe region. Incumbent operator Turkcell first started facing competition with the entry of Vodafone in 1994. During the duopoly, Turkcell kept a significant proportion of the market. It was not until 2001, that operators Aria and Aycell entered the market in order to increase competitiveness (DICE, 2010). The operators merged in 2004 and are operating today under the brand Avea. In 2016, Avea was the third placed mobile network operator, after Vodafone and market leader Turkcell (ICTA, 2016). The country has a rapidly growing mobile-broadband market fuelled by a young population open to new trends in technology. In 2009, 3G services were first launched and networks expanded rapidly, covering almost the entire population. LTE was only launched in 2016 and uptake and coverage are increasing<sup>464</sup>.

**Fixed services:** The fixed market shows relatively low penetration rates when compared to European countries. However, operators are investing in network roll-out and upgrades and subscriptions numbers are on the rise. Most fixed-broadband connections are via xDSL, with a growing number of fibre- and cable-based subscriptions. Turk Telekom, the market leader in the fixed segment, has the largest fibre infrastructure in the country and continues to invest in its upgrade and extension.<sup>465</sup> Fixed-telephone penetration is on the decline in line with the global trend towards fixed-to-mobile substitution.

**Government policy:** The privatization of Turkey's telecommunication sector started relatively late compared to other countries in the Europe region, when the majority shares of Turk Telekom were sold in a tender in 2005.<sup>466</sup> Turkey's Information and Communication Technologies Authority (ICTA), the independent telecommunication regulator, was created four years earlier in 2000. The Turkish government further wants to ensure that

Key indicators for Turkey (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	14.3	37.7	13.6
Mobile-cellular sub. per 100 inhab.	96.9	118.0	101.5
Fixed-broadband sub. per 100 inhab.	13.6	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	66.8	80.1	52.2
3G coverage (% of population)	96.0	98.5	85.0
LTE/WiMAX coverage (% of population)	82.5	92.2	66.5
Mobile-cellular prices (% GNI pc)	3.4	1.0	5.2
Fixed-broadband prices (% GNI pc)	1.0	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.6	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	1.8	0.6	6.8
Percentage of households with computer	58.0	79.6	46.6
Percentage of households with Internet access	76.3	82.5	51.5
Percentage of individuals using the Internet	58.3	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	68.1	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

policies are aligned with those of the EU, given that the country has applied for EU membership. Telecommunication policies are aimed at ensuring effective competition and expanding the use of ICTs, in particular broadband.<sup>467</sup> In 2016, ICTA started a series of study meetings for developing a national broadband strategy, recognizing the importance of broadband development and identifying the relevant steps to be taken in order to advance roll-out.<sup>468</sup>

**Conclusion:** Turkey's telecommunication sector has gone through tremendous changes during the last decade, driven by advancements in technology and increasing customer demand. A little more than half of the population is online – and the other half still offline, which illustrates the huge potential of this emerging market.

## Turkmenistan

***The mobile-cellular market is developing intensively in Turkmenistan. Public institutions are being connected to the Internet and the number of Internet users is growing.***

**Mobile services:** At the beginning of 2017, mobile cellular services were provided by two telecommunication operators: Altyn Asyr (state-owned) and MTS. The Turkmenistan government has recently announced the creation of a second state-owned operator (Ai Nazar). Around 77 per cent of the market is controlled by Altyn Asyr, which provides 2G, 3G and LTE services. 3G was launched in 2010 by Altyn Asyr and the company put an LTE network into operation in 2013. Mobile services are becoming more affordable for the population. In 2015, Turkmenistan launched its first telecommunication satellite.

**Fixed services:** National telecommunication company TurkmenTelecom has a monopoly in fixed telephone services. In 2015, there were around 700 exchanges (PBXs) in the country, 90 per cent of them are digital. In the early 2000s, TurkmenTelecom was the only provider of Internet services. Internet access used to be restricted for the general population. Public Internet access was introduced in 2008, but the prices were high. In 2014, Wi-Fi networks started to develop. The TEA (Transit Europe-Asia) is a terrestrial optical fibre cable line that formed the basis for the optical fibre telecommunication network of TurkmenTelecom.<sup>469</sup> Additional lines were deployed to the Caspian Sea. Optical fibre lines connect all major cities in the country.

**Government policy:** The government adopted the national programme of social and economic development of Turkmenistan 2011-2030. There are no ICT-specific policy documents; however, ICT activities are actively implemented in banking and financial spheres, health care, and education. For instance, following the project of ICT support in Turkmenistan that was launched in 2011 in collaboration with United States Agency for International Development (USAID), teachers and officials acquired open access to the Internet, trainings and consultations in ICT, and pedagogical materials. In 2013, a project on electronic document exchange in health care systems was launched. Such ICT projects create demand on ICT infrastructure, which is deployed by the

Key indicators for Turkmenistan (2016)		CIS	World
Fixed-telephone sub. per 100 inhab.	12.2	20.7	13.6
Mobile-cellular sub. per 100 inhab.	157.7	141.2	101.5
Fixed-broadband sub. per 100 inhab.	0.1	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	14.2	59.7	52.2
3G coverage (% of population)	75.8	77.1	85.0
LTE/WiMAX coverage (% of population)	46.1	45.9	66.5
Mobile-cellular prices (% GNI pc)	0.8	1.7	5.2
Fixed-broadband prices (% GNI pc)	3.3	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.4	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	2.6	3.1	6.8
Percentage of households with computer	13.4	67.4	46.6
Percentage of households with Internet access	13.6	68.0	51.5
Percentage of individuals using the Internet	18.0	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	2.3	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

national and private operators. Special attention is also given to the network capacity increase for international voice and data traffic transiting. A new optical fibre line connecting Turkmenistan and Kazakhstan was launched in 2013.

**Conclusion:** In cooperation with international organizations, Turkmenistan is drawing up new sectoral development programmes and is implementing ICT projects. The telecommunication sector is rapidly developing. Modern optical fibre and satellite communication lines are covering the territory of Turkmenistan. ICT technologies are steadily transforming the country.

## Tuvalu

**Deployment of telecommunication networks is difficult in this small and remote Pacific nation. It has a tiny market and is subject to recurring natural disasters. The country's TV domain name is a major source of government revenue.**

**Mobile services:** The state-owned enterprise Tuvalu Telecommunication Corporation (TTC) is the sole provider. The mobile network was destroyed by a storm in 2007 and a new network was deployed in 2009. Mobile phone service is available on five of the nine inhabited islands and atolls. In 2012, 43 per cent of homes had a mobile phone.<sup>470</sup> TTC launched 3G in the capital in 2015, with plans to extend coverage to other islands. It is also planning to launch LTE in the near future.

**Fixed services:** TTC was created as a state-owned enterprise in 1994 under the *Tuvalu Telecommunication Corporation Act*. It is the sole provider of fixed telephone services. Practically all households on the island of Funafuti have a copper fixed telephone line. The 2015 cyclone Pam severely damaged around 80 per cent of the copper fixed telephone network in the outer islands. TTC also provides fixed broadband through ADSL and over VSAT to Internet cafes in the outer islands. Services are limited by the fact that mains electricity is normally available for only 12-18 hours a day. Tuvalu relies on satellites for both domestic and international connectivity. TTC is trying to improve the operational ability of its outer island services through the provision of solar power systems for all VSATs.

**Government policy:** The Ministry of Works, Communications and Transport (MWCT) is responsible for sector policy and regulation as well as government IT. The Government strongly supports the ICT sector in its national strategy with the objective of improving and extending services nationwide, especially to schools, clinics and island administrations ("Kaupule"). The nation's 2012 *Infrastructure Strategy and Investment Plan* identifies three key objectives for the ICT sector: i) ensuring that all telecommunication facilities are solar-powered; ii) expanding Internet services to the outer islands; and iii) establishing a submarine cable link. The country's catchy "TV" Internet domain name is much sought after and has been a major source of revenue for the Government; the payments enabled it to join the United

Key indicators for Tuvalu (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	<i>20.1</i>	10.0	13.6
Mobile-cellular sub. per 100 inhab.	<i>76.4</i>	98.9	101.5
Fixed-broadband sub. per 100 inhab.	<i>10.1</i>	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	<i>0.0</i>	47.4	52.2
3G coverage (% of population)	<i>n.a.</i>	87.6	85.0
LTE/WiMAX coverage (% of population)	<i>n.a.</i>	73.6	66.5
Mobile-cellular prices (% GNI pc)	<i>n.a.</i>	3.2	5.2
Fixed-broadband prices (% GNI pc)	<i>n.a.</i>	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	<i>n.a.</i>	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	<i>n.a.</i>	5.4	6.8
Percentage of households with computer	<i>41.5</i>	37.8	46.6
Percentage of households with Internet access	<i>n.a.</i>	45.5	51.5
Percentage of individuals using the Internet	<i>46.0</i>	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	<i>155.7</i>	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

Nations in 2000. The domain name is managed by Verisign, which under the .tv Agreement with the Government of Tuvalu is committed to paying the Government at least US\$5 million a year until the end of 2021.

**Conclusion:** Tuvalu faces formidable challenges in expanding its ICT infrastructure. It is a remote Pacific archipelago located in a disaster-prone area, with a small population spread over a number of islands. The main island has a relatively high level of ICT access. The country is progressing towards more reliable connectivity in the outer islands through the installation of solar-powered facilities. It is fortunate to have a popular domain name which generates revenues equivalent to around one-third of the country's exports.

## Uganda

**The landlocked East African nation has a forward-looking regulatory framework, but faces challenges extending broadband coverage and services to the largely populated rural zones.**

**Mobile services:** Uganda has one of the most crowded mobile markets in Africa, with eight active operators. However, two account for almost 90 per cent of subscriptions: MTN, a subsidiary of the South African mobile group; and AIRTEL, a subsidiary of the Indian mobile group. Other mobile operators include the incumbent Uganda Telecom Ltd. (UTL); Africell, subsidiary of a Lebanese mobile group that took over Orange's operations in 2014; Smile, a venture between Kenya's Industrial Promotion Services and a Cyprus-registered mobile group; Vodafone, a subsidiary of the United Kingdom mobile group; Sure Telecom, a Singaporean based Telecom; and K2, an indigenous Telecom Company. Despite the large number of operators, it has been a challenge to extend coverage to rural areas. According to the *2016–17 Uganda National Household Survey*, 68.6 per cent of households owned mobile phones, 61.8 percent in rural and 86.1 per cent in urban areas. All of the operators have deployed mobile-broadband networks, including the latest generation LTE by Smile in 2012, Africell and MTN in 2013, and Vodafone in 2015.

**Fixed services:** Incumbent UTL was privatized in 2000, when 51 per cent of its shares were sold. The Libyan Government investment arm purchased the stake of the original buyers as well as additional shares from the Government, resulting in a 69 per cent stake. UTL has faced operating challenges and, in 2017, the Government retook control of the company. UTL is the main provider of fixed-telephone service through copper lines and wireless local loop. On the fixed-broadband market, it offers fixed ADSL and fixed wireless broadband. It is joined by a number of ISPs offering fixed wireless broadband access. Tech giant Google has invested in the CSquared project, building metro fibre networks in Entebbe and Kampala. It offers wholesale Wi-Fi access as well as optical fibre to the premises for resale by ISPs. The first two phases of the Government's National Backbone Infrastructure have been completed, with 1 590 km of fibre-optic cable stretching to the Kenyan and South Sudan borders. Operators have also been deploying fibre-optic networks in the

Key indicators for Uganda (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.9	1.0	13.6
Mobile-cellular sub. per 100 inhab.	55.1	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.3	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	33.7	22.9	52.2
3G coverage (% of population)	64.0	59.3	85.0
LTE/WiMAX coverage (% of population)	15.0	25.7	66.5
Mobile-cellular prices (% GNI pc)	9.9	14.2	5.2
Fixed-broadband prices (% GNI pc)	10.0	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	10.0	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	17.5	17.7	6.8
Percentage of households with computer	7.6	9.6	46.6
Percentage of households with Internet access	8.9	16.3	51.5
Percentage of individuals using the Internet	21.9	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	5.5	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

landlocked country mainly to the Kenyan border for access to undersea cables and for those also operating in Rwanda, to that country. The Uganda IXP is one of the oldest in Africa, launched in 2001, and has more than two dozen members peering traffic.

**Government policy:** The Ministry of ICT and National Guidance is responsible for sector oversight. The Ministry's five-year sector *Strategic and Investment Plan 2015/16-2019/20* guides ICT development in line with the Uganda Vision 2040 and the *National Development Plan*. The Plan covers 11 areas, such as infrastructure, human capacity, cybersecurity, e-government, and local content and services, and by its completion aims to increase ICT access and broadband speeds to 4 Mbit/s and 30 Mbit/s for rural and urban households respectively. The Uganda Communications Commission (UCC) is the sector regulator, formed in 1997 and responsible for telecommunications, broadcasting and posts. The Commission's Act of 2013 enabled the merger of the telecommunications regulator with the broadcasting regulator. UCC administers the Rural Communications Development Fund, which has provided funding for the extension of coverage to rural areas, development of ICT training centres, telecentres and other activities. It is also responsible for the country's Computer Emergency Response Team.

**Conclusion:** Uganda has one of the most progressive ICT sector policy and regulatory environments in Africa. However, the country faces large challenges to developing widespread infrastructure access, due to its sizeable large rural population and low disposable income.

## Ukraine

***Ukraine has a great potential for mobile and fixed-broadband market development. Operators are eager to introduce new services and attract new subscribers.***

**Mobile services:** There are six mobile telecommunication operators in Ukraine: Kyivstar, Vodafone, Lifecell, 3Mob, PeopleNet and InterTelecom. Mobile broadband coverage is growing dramatically. In 2014, the National Commission for the State Regulation of Communications and Informatization (NCCIR) announced a tendering process to acquire frequency bands for UMTS deployment. As a result, in 2015 frequency bands of 30 MHz were acquired by Kyivstar, MTS/Vodafone and Astelit/Lifecell.<sup>471</sup> This boosted mobile-broadband market development as 3G coverage increased significantly in 2015-2016. More than 20 million people used the 3G network by the end of 2016. Most of broadband access Internet connections are wireless (66 per cent). A tender for an LTE-frequency in the 2.6 GHz band, prepared in 2016, is planned to be launched by the end of 2017. The possibility of a 5G network test run is actively being discussed. The number of M2M users increased significantly in 2016.

**Fixed services:** The number of fixed telephone users has been decreasing, as well as operator revenues in fixed telephony.<sup>472</sup> Fixed broadband services generate most of the income from Internet access services. The largest fixed services provider in Ukraine is Ukrtelecom with around 5.3 m of fixed telephone subscriptions and 1.6 million Internet access subscriptions.<sup>473,474 474</sup> Kyivstar provides broadband Internet access services to more than 818 000 subscribers.<sup>475</sup> Volia, Triolan, Data Group, Fregat are also among the top companies when comparing subscription numbers.<sup>476, 477</sup> xDSL connections prevail over other broadband access technologies.<sup>478</sup> However, fibre-optic connections are increasingly prevalent among new subscribers.

**Government policy:** Government policy aims to liberalize legislation. The regulatory authority is planning to simplify market entry of telecommunication companies, and cancel existing practices of licensing specific types of telecommunication services, etc.<sup>479</sup> A legislative framework for effective infrastructure use by

Key indicators for Ukraine (2016)		CIS	World
Fixed-telephone sub. per 100 inhab.	19.8	20.7	13.6
Mobile-cellular sub. per 100 inhab.	132.6	141.2	101.5
Fixed-broadband sub. per 100 inhab.	12.0	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	22.6	59.7	52.2
3G coverage (% of population)	90.0	77.1	85.0
LTE/WiMAX coverage (% of population)	1.4	45.9	66.5
Mobile-cellular prices (% GNI pc)	1.2	1.7	5.2
Fixed-broadband prices (% GNI pc)	1.1	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.9	3.1	6.8
Percentage of households with computer	65.1	67.4	46.6
Percentage of households with Internet access	54.8	68.0	51.5
Percentage of individuals using the Internet	52.5	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	79.9	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

market players has been developed.<sup>480</sup> One of the main priorities of government policy is to facilitate quality of services (QoS) improvement. NCCIR collects operator QoS reports and monitors quality indicators.<sup>481</sup> QoS reports are publicly available. Mobile and fixed number portability (MNP and FNP) are also expected to be launched in the near future.<sup>482</sup> Authorities are working on legislation alignment to the European Union framework.<sup>483</sup>

**Conclusion:** Work is underway to develop new legislation in the sector of information and telecommunication technologies in Ukraine. New strategies for digital transformation, big data, blockchain and agile are discussed at state level.

## United Arab Emirates

**United Arab Emirates (UAE) has transformed itself into a regional and global business hub, which has played a massive role in the deployment and adoption of new ICT technologies, further strengthening the UAE's image as a business destination. Fixed and mobile-broadband prices as a percentage of the gross national income per capita (GNI) are among the cheapest in the Arab States region and globally.**

**Mobile services:** Mobile-cellular penetration is well above the average penetration in the Arab States countries and globally. The same applies to mobile-broadband penetration, which has grown fast and is three times as high as the global and regional averages. In terms of the market landscape, the UAE has two fully integrated telecommunication operators; Etisalat and Emirates Integrated Telecommunications Company (du), as well as seven other niche licensees. Etisalat was established in 1976 and is the incumbent operator in the UAE, introducing GSM services in 1994. Competition started in the market in 2007, when du started its cellular services. Telecom operators are required by the UAE's Ministry of Finance to pay annual royalty fees, which have been regularly updated and currently stand at 15 per cent of revenues and 30 per cent of annual net profits. The UAE is home to a large number of new technologies, and the country remains ahead of other countries in the region with regard to the availability of cutting edge innovations. LTE was launched in in 2011 and is now offered by the two telecommunication operators in the market. At present, mobile services are offered on 800MHz, 900MHz, 1800MHz, 1900MHz and 2600MHz. UAE is planning to licence spectrum by 2020 for 5G networks to power the Internet of Things (IoT).

**Fixed services:** Fibre optic deployment is well ahead of other Arab States. The two main market players provide a large variety of services that include both standalone high speed broadband services and triple and double play services. The UAE market is also home to other innovative M2M and business solutions. The UAE has been fibre-to-the-home (FTTH) connected since 2012, and in 2017 announced the launch of 300 Mbit/s Internet speeds through its FTTH network for customers.

Key indicators for United Arab Emirates (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	23.4	7.7	13.6
Mobile-cellular sub. per 100 inhab.	204.0	107.1	101.5
Fixed-broadband sub. per 100 inhab.	13.3	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	156.7	45.2	52.2
3G coverage (% of population)	100.0	81.9	85.0
LTE/WiMAX coverage (% of population)	99.6	33.8	66.5
Mobile-cellular prices (% GNI pc)	0.2	4.3	5.2
Fixed-broadband prices (% GNI pc)	0.5	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.5	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.8	5.5	6.8
Percentage of households with computer	91.0	43.3	46.6
Percentage of households with Internet access	94.3	45.3	51.5
Percentage of individuals using the Internet	90.6	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	133.7	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

**Government policy:** The Telecommunications Regulatory Authority (TRA) was established according to the UAE Federal Law by Decree No. 3 of 2003 Telecom Law. The TRA is responsible for the management of every aspect of the telecommunications sector. The TRA issues general guidance and instructions for the telecommunication sector necessary for national security and international relations, telecommunication licences, and determines fees for licences. Government policies encourage the deployment of such technologies to maintain the status of the country as a major business and trade hub in the region. The TRA has set the main strategic ICT policy goals as: develop a fair regulatory environment for the ICT sector in the UAE, to enhance competitiveness and effective sustainability; develop the quality of provided ICT services in the UAE, to ensure keeping pace with technological development in the ICT sector; leadership in smart technological infrastructure in the UAE; enhance the smart lifestyle in the UAE; ensure the provision of all administrative services in accordance with the standards of quality, efficiency and transparency; and establish a culture of innovation in the institutional work environment.

**Conclusion:** The efforts made by the Government of the United Arab Emirates over the past 15 years have resulted in making the UAE one of the world's most connected countries. Nearly all of its households have Internet access and most of its citizens use the Internet on a regular basis. The UAE is a global leader in telecommunications and information and communications technology and plans to further develop its ICT sector by being

one of the first countries to deploy 5G networks and services.

## United Kingdom

**The United Kingdom has a highly advanced telecommunication market, characterized by its early liberalization and a fiercely competitive environment. Penetration rates are high for fixed and mobile services and prices are affordable.**

**Mobile services:** The mobile market is characterized by fierce competition and has seen numerous mergers and acquisitions in recent decades. In 2016, British Telecom (BT), the incumbent operator which had pulled out of the mobile market previously, announced the acquisition of market leader EE, which was itself established in 2010 as a joint venture between Deutsche Telekom and Orange. Mobile penetration is high and mobile-broadband networks widely available. EE was the first United Kingdom operator to launch LTE services in October 2012 through its existing spectrum. The LTE auction followed in February 2013, with EE, O2, Vodafone, Three, and Niche Spectrum Ventures Ltd (a BT Group subsidiary) receiving licences. Smartphone has become the preferred device for using the Internet in the UK, and increased Internet access and speeds are leading to changing consumption patterns, such as the remarkable rise in the use of over-the-top messaging services (Ofcom, 2016).

**Fixed services:** Incumbent operator BT has the highest market share of 32 per cent (in 2015) of the fixed-broadband market, albeit lower than the share held by the historic operator in most other European countries.<sup>484</sup> Regulator Ofcom imposed on BT the separation of its retail and wholesale arms to address competition concerns, and in 2017 BT agreed to Ofcom requirements on the legal separation of its network division Openreach.<sup>484</sup> Fixed-telephone and fixed-broadband penetrations are high in the UK and well above the European average. Bundled-services are very popular, with nearly seven in ten households buying at least two ICT services in a bundle in 2016. Fixed-telephone and broadband dual-play plans, and triple-play fixed telephone, broadband and TV packages are most popular.<sup>485</sup> This development has led to increased competition by triple-play providers such as Sky, which had the second highest share of fixed-broadband subscriptions in 2016. Operators continue to invest in network roll-out and upgrades. There are more and more broadband connections over NGA technology and speeds are

Key indicators for United Kingdom (2016)	Europe	World	
Fixed-telephone sub. per 100 inhab.	52.2	37.7	13.6
Mobile-cellular sub. per 100 inhab.	122.9	118.0	101.5
Fixed-broadband sub. per 100 inhab.	39.2	30.2	12.4
Active mobile-broadband sub. per 100 inhab.	91.4	80.1	52.2
3G coverage (% of population)	99.6	98.5	85.0
LTE/WiMAX coverage (% of population)	98.5	92.2	66.5
Mobile-cellular prices (% GNI pc)	0.4	1.0	5.2
Fixed-broadband prices (% GNI pc)	0.2	1.2	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.4	0.6	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.4	0.6	6.8
Percentage of households with computer	89.8	79.6	46.6
Percentage of households with Internet access	91.3	82.5	51.5
Percentage of individuals using the Internet	94.8	77.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	449.1	178.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

increasing accordingly, with average actual speed going up from 22.8 Mbit/s in November 2014 to 28.9 Mbit/s in November 2015 (Ofcom, 2016).

**Government policy:** The United Kingdom started the liberalization of its telecommunication sector in 1984, when the government sold its majority shares in operator BT. The country continues to be a champion of privatization in the telecommunication sector and elsewhere and its example greatly impacted the shaping of the EU policies on telecommunications. The Ofcom decision to require the legal separation between the wholesale and retail arms of the incumbent in 2016 and BT acceptance in 2017 confirm that the United Kingdom remains at the forefront of telecommunication reform. Current national telecommunication policies put the focus on favouring the roll-out of high-speed broadband. In 2015, the government announced plans for a universal service obligation USO for broadband services that would give citizens the right to a broadband connection with speeds of at least 10 Mbit/s by 2020 (Ofcom, 2016).

**Conclusion:** A champion of liberalization, the United Kingdom has developed into one of the world's leading countries for telecommunications. ICT household penetration is high and most people living in the United Kingdom are online.

## United States

**Telecommunications is a well-established sector in the United States, with all segments under competition and penetration levels that are among the highest encountered for all services. Service pricing is extremely competitive in the United States, representing a mere fraction of regional and global averages.**

**Mobile services:** The market for mobile services is mature and its growth rates have been starting to stagnate in recent years; however, 21 million additional subscribers are expected to join the market by 2020. Revenues from voice services are leaving space for those stemming from data services, as mobile-broadband has almost identical numbers in terms of service uptake as mobile-cellular. Operators are actively engaged in upgrading technology, experimenting with 5G and aiming to have the service available to the population during 2018 and 2019.<sup>485</sup> The recent auction in the 600 MHz band is expected to improve the service coverage and network capacity further.

**Fixed services:** Fixed-broadband uptake has been successful in the United States despite competition levels being lower in most areas, with AT&T and Verizon being the most present market players.<sup>486</sup> Coupled with large investments in infrastructure roll-out, especially in both fibre optic and hybrid fibre-copper networks, fixed-broadband is an affordable and fast service (in terms of bandwidth). The challenge remains to reduce the digital divide that separates rural and Native Americans, who are proportionally less likely to have access to high-speed broadband, which can hinder their future in a wide variety of manners, from job opportunities to access to health care and education.

**Government policy:** Given the fast pace at which the telecommunications sector progresses in the United States, the need for an adaptable and reactive regulator is evident. The Federal Communications Commission (FCC), created in 1934, has been paramount to the development and expansion of the sector, and its latest guidelines, the Strategic Plan 2015–2018, outlines the importance of public interest goals such as consumer rights, safety and access to broadband, while ensuring that economic growth and security remain high priorities.<sup>487</sup> Great

Key indicators for United States (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	37.1	24.4	13.6
Mobile-cellular sub. per 100 inhab.	120.8	114.2	101.5
Fixed-broadband sub. per 100 inhab.	32.4	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	124.9	82.7	52.2
3G coverage (% of population)	99.9	93.6	85.0
LTE/WiMAX coverage (% of population)	99.7	77.4	66.5
Mobile-cellular prices (% GNI pc)	0.8	3.6	5.2
Fixed-broadband prices (% GNI pc)	0.8	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	1.2	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.3	5.7	6.8
Percentage of households with computer	87.0	64.9	46.6
Percentage of households with Internet access	84.0	63.3	51.5
Percentage of individuals using the Internet	76.2	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	126.5	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

importance is also given to foster competition in the telecommunications environment, having already introduced net neutrality rules in 2009 and overlooking and approving interconnection rates, but leaving other matters, such as quality of service standards setting and monitoring, to be regulated by the states. Other FCC initiatives are the Forging Our 5G Future, Broadcast Incentive Auction, Connect2Health and Accessible Communications for Everyone.<sup>488</sup>

**Conclusion:** Despite being at a substantially more advanced development stage, the telecommunications sector in the United States still has barriers to overcome, notably the digital divide represented by the diverging access to broadband between urban and more remote areas in the country. Investment and infrastructure development remain a constant in the sector, as operators strive to employ new telecommunications technologies and provide better service. Aside from the traditional public-private partnerships, tech companies have also partnered to roll out state-of-the-art networks, such as Facebook and Microsoft uniting forces to build the MAREA, a submarine cable across the Atlantic.

## Uruguay

**Uruguay's telecommunications sector has demonstrated remarkable development over the past decade, especially in terms of universal access. Bridging the national digital divide has been a priority for the authorities of Uruguay, ensuring that the clear majority of households have broadband access. The Government has made efforts to guarantee that low-income groups have access to the Internet.<sup>489</sup> In fact, Uruguay has the highest percentage of households with computers in the region and, in a study of the population aged 14 years or above who have access to the Internet, 96 per cent are believed to use it at least weekly and 84 per cent daily.<sup>490</sup>**

**Mobile services:** Uruguay hosts a competitive mobile market, with three players holding considerable market share. Antel is the market leader, with more than 50 per cent of the subscriptions (URSEC, 2016), followed by Movistar and then Claro. Mobile-broadband is the segment with the greatest potential at the moment, and all three operators offer broadband services via LTE technology. The amount of mobile subscriptions that do not include data services has decreased over time to only 15 per cent of the total in 2016<sup>492</sup>(URSEC, 2016). Both mobile-cellular and mobile-broadband penetration levels are ahead of the regional and global averages.

**Fixed services:** Despite the regional trend, Uruguay's fixed-line market is a monopoly controlled by the State-owned incumbent, Antel, and remains with penetration rates well above the regional and global levels. Fixed-broadband uptake has also been successful relative to the regional rates, and is provided mainly via fibre optic, with DSL being the second most popular option (URSEC, 2016). Uruguay's improvement in international connectivity has been a result of the 2012 opening of Bicentenario, a submarine cable system, and is expected to further improve following infrastructure deployment by Antel.<sup>492</sup>

**Government policy:** The body responsible for regulating telecommunications is the *Unidad Reguladora de Servicios de Comunicaciones* (URSEC), created in 2001. URSEC works closely with the Ministry and with the private sector to develop the sector in a sustainable and democratic manner, ensuring that universal service and

Key indicators for Uruguay (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	32.4	24.4	13.6
Mobile-cellular sub. per 100 inhab.	148.7	114.2	101.5
Fixed-broadband sub. per 100 inhab.	26.8	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	102.0	82.7	52.2
3G coverage (% of population)	95.0	93.6	85.0
LTE/WiMAX coverage (% of population)	88.0	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.3	3.6	5.2
Fixed-broadband prices (% GNI pc)	0.8	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.6	5.7	6.8
Percentage of households with computer	69.5	64.9	46.6
Percentage of households with Internet access	61.8	63.3	51.5
Percentage of individuals using the Internet	66.4	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	96.7	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

literacy skills remain the focus of its programmes. Uruguay Digital, the overarching programme that has been in place for over a decade, has been at the centre of various agendas – namely in 2008, 2010 and 2015 – which were adapted according to the sector evolution and necessities. In terms of concrete objectives, the public and private partnerships were able to ensure that prices remained affordable, that all children attending public schools had access to a personal computer and that every household was connected with fibre optic, among others. The current agenda, Agenda Uruguay Digital 2020, recognizes the importance of ICTs to the development of various other sectors as well as to the creation of a more direct relationship between the citizens and the Government, not leaving behind the importance of digital policies and online safety (AGESIC, 2016).

**Conclusion:** The Uruguayan telecommunications sector is well developed and the results of sector planning and investment are evident when considering the evolution of service uptake in all segments of the sector, even for those under monopoly, such as fixed-broadband. Challenges remain on certain infrastructure areas, such as completing the LTE coverage and improving connection speed.

## Uzbekistan

**The country has one of the most prospective mobile-broadband markets in the CIS region. LTE networks deployment and Internet access tariff changes are among the main telecommunication market growth factors.**<sup>493</sup>

**Mobile services:** In 1991, the first mobile-cellular telecommunication operator Uzdurobita was established. It provided mobile telephone services in 1992 over an NMT-450 network. In 1995, services in AMPS/DAMP were introduced. In 1996, regulatory measures were taken to attract foreign investment into the mobile cellular telecommunication sector. In 1997, five new operators entered the market. In 2005, a CDMA-450 network started providing services.<sup>494</sup> Today, there are five mobile cellular operators in the market: Unitel (GSM; more than 10 million subscriptions), UMS (GSM; more than 2 million), Uzmobil (GSM; over 1 million), Ucell (GSM; around 9 million), and Perfectum, a CDMA operator with around 1 million subscriptions.<sup>495</sup> All GSM operators deploy LTE networks.<sup>496</sup> Less than 1 per cent of localities were covered by LTE at the beginning of 2017. In the first half of 2017, the Uzbekistan Government reallocated 900/1800 MHz radio frequency bands among mobile telecommunication operators to facilitate market competition. It was considered that previous radio frequency band allocation hindered LTE deployment. It is expected that it will lead to faster LTE deployment and quality of service (QoS) enhancement.<sup>497</sup>

**Fixed services:** In 2006, less than 50 per cent of private branch exchanges (PBX) were digital. By 2014, the process of fixed telephone network digitalization was completed. At the beginning of 2017, there were 654 Internet providers and operators in Uzbekistan. The international Internet gateway capacity reached 54.9 Gbit/s.<sup>498</sup> In 2014-2015, Uzbekistan successfully implemented Wi-Fi networks development programme by installing Wi-Fi access points in many public places, such as airports, railway stations, tourist zones, etc.<sup>499</sup> In order to develop Internet broadband access, more than 1 800 km of optical fibre cable lines were constructed in 2015. Backhaul networks capacities were increased by up to 10 times.<sup>500</sup>

**Government policy:** From 1995 to 2010, a set of ICT development programmes was implemented.

Key indicators for Uzbekistan (2016)	CIS	World	
Fixed-telephone sub. per 100 inhab.	11.3	20.7	13.6
Mobile-cellular sub. per 100 inhab.	77.3	141.2	101.5
Fixed-broadband sub. per 100 inhab.	9.1	15.8	12.4
Active mobile-broadband sub. per 100 inhab.	55.9	59.7	52.2
3G coverage (% of population)	45.3	77.1	85.0
LTE/WiMAX coverage (% of population)	16.9	45.9	66.5
Mobile-cellular prices (% GNI pc)	2.3	1.7	5.2
Fixed-broadband prices (% GNI pc)	3.2	3.3	13.9
Mobile-broadband prices 500 MB (% GNI pc)	3.3	1.4	3.7
Mobile-broadband prices 1 GB (% GNI pc)	16.7	3.1	6.8
Percentage of households with computer	43.9	67.4	46.6
Percentage of households with Internet access	75.4	68.0	51.5
Percentage of individuals using the Internet	46.8	65.1	45.9
Int. Internet bandwidth per Internet user (kbit/s)	5.7	59.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

The activities within these programmes mostly aimed at national telecommunication network construction and renovation. Backbone network connecting all regional centres was built during this period. ICT technologies started to being implemented in public sectors. Attention was also given to education in ICT. From 2005 to 2010, Uzbekistan was involved in UNDP projects, facilitating ICT policy implementation in the country. The 2012 to 2014 government programme focused on integration of government systems, regulation enhancement and information security. The current ICT programme has two main pillars: infrastructure and technological development, and e-government systems and databases development. The first pillar consists of 17 projects aimed at enhancing infrastructure capabilities by increasing broadband access and core network capacity, and creating favourable conditions for quality government services development. By the end of 2017, Uzbekistan is planning to start optical fibre cable production to facilitate optical fibre lines construction and provide all regional centres with LTE signal coverage.<sup>501,502</sup> Close attention is being given to ICT in healthcare system. Uzbekistan is going to create a fully functioning and effective e-health system by 2020. The Uzbekistan Government also established two organizations UZINFOCOM and UNICON. UZ to facilitate ICT regulation development and consulting services.

### Conclusion:

The Government of Uzbekistan is engaged in ICT development. By implementing regulation initiatives it facilitates a competitive environment. The goal of these activities is to provide the

population with high quality e-services over a high-speed and resilient infrastructure. E-government services are particularly focused on an ICT development policy. Many user terminals (250) for e-government online-services access are going to be installed across the country in 2017.<sup>503</sup>

## Vanuatu

***The South Pacific nation has made significant progress in developing its ICT sector in recent years with strong growth in data traffic following the deployment of its first undersea cable link in 2014 and the launch of LTE in 2016.***

**Mobile services:** There are two operators: the incumbent Telecom Vanuatu Limited (TVL), which began offering GSM mobile services in 2002, and Digicel (Vanuatu) Limited. Digicel entered as the second operator when it launched its GSM network in June 2008. The introduction of cellular competition rapidly increased coverage and uptake with 80 per cent of households having a mobile phone (97 per cent of urban households compared to 73 per cent in rural homes).<sup>504</sup> Mobile subscriptions continue to rise year on year. However, even though penetration sits at 80 per cent of the population, there is a significant number of dual SIM handsets and the continued use of both networks due to bundled discount offerings by both operators. Digicel has become the market leader by some margin. It launched its 3G network in December 2011 and TVL followed in January 2013. Digicel launched LTE in 2016 and mobile broadband has developed rapidly with a 1500 per cent growth in mobile data downloaded between 2014 and 2016.

**Fixed services:** TVL was owned in equal shares by the Government, the United Kingdom's Cable & Wireless, and France Telecom. As part of the liberalization process, the Government sold its shares in TVL to the two remaining shareholders. In 2011, Cable & Wireless sold its 50 per cent stake to Mauritius Telecom, which gradually increased its ownership. In 2017, Mauritius Telecom sold TVL to ATH of Fiji. TVL remains the only provider of landline telephones. There are four service providers operating in the broadband Internet space. TVL offers FTTH, DSL, WiMAX and Wi-Fi services; Digicel offers wireless Internet access using WiMAX and Wi-Fi; and Telsat Broadband Limited offers wireless Internet via WiFi and Ku band satellite services (via Kacific Broadband Satellites). A notable milestone was the launch of LTE by WanTok in April 2014 when it began providing fixed wireless services in the capital Port Vila. Both TVL and Digicel have metropolitan fibre rings around Port Vila and Luganville on the island of Espiritu Santo, but otherwise optical fibre in the national backbone is non-existent

Key indicators for Vanuatu (2016)	Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	1.7	10.0
Mobile-cellular sub. per 100 inhab.	81.1	98.9
Fixed-broadband sub. per 100 inhab.	1.7	11.3
Active mobile-broadband sub. per 100 inhab.	22.3	47.4
3G coverage (% of population)	80.0	87.6
LTE/WiMAX coverage (% of population)	25.0	73.6
Mobile-cellular prices (% GNI pc)	9.8	3.2
Fixed-broadband prices (% GNI pc)	24.5	14.5
Mobile-broadband prices 500 MB (% GNI pc)	3.3	2.7
Mobile-broadband prices 1 GB (% GNI pc)	16.5	5.4
Percentage of households with computer	22.6	37.8
Percentage of households with Internet access	29.5	45.5
Percentage of individuals using the Internet	24.0	41.5
Int. Internet bandwidth per Internet user (kbit/s)	21.9	48.0

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

and national backbone connectivity relies mainly on microwave services. The 1 259 kilometre Interchange Cable Network 1 (ICN1), which links Vanuatu to Fiji via fibre-optic cable, was completed in January 2014. With ICN1, traffic is sent to Fiji where it is transferred to the Southern Cross cable and routed to Australia or the United States. The Vanuatu Internet Exchange was launched in 2013.

**Government policy:** The Office of the Government Chief Information Officer (OGCIO) is responsible for ICT sector oversight, guided by the 2013 *National Information and Communication Technology Policy*. The policy covers a five-year period with eight priority areas: i) access to ICTs in Education; ii) access to ICT infrastructure and devices; iii) e-government; iv) integration of ICTs into sectoral policies; v) building trust (mitigating risks and threats related to ICT development); vi) locally relevant content; vii) capacity building; and viii) platform for multi-stakeholder and multi-sector coordination and collaboration. The Telecommunications and Radiocommunications Regulator (TRR) was established under the *Telecommunications and Radiocommunications Regulation Act* of 2009; however, the Office was established in February 2008. Initiatives under the Universal Access Policy (UAP) aim to expand penetration of mobile and broadband services into rural areas, with the objective of 98 per cent population coverage with a minimum download speed of 2 Mbps by January 2018.

**Conclusion:** Vanuatu has made great strides in ICT following liberalization of the telecommunication sector in 2008, which ended TVL's monopoly and led to the introduction of mobile competition

and the launch of the ICN1 submarine cable in 2014. The UAP is expected to significantly expand broadband coverage throughout the country.

## Venezuela

**Despite the substantial increase in revenue between 2014 and 2015 (CONATEL, 2015), the telecommunications sector in Venezuela has suffered setbacks derived from the economic instability of the country, caused by the fall in oil prices and the economic conditions in the Latin America region, among others, resulting in difficulties for investment and adoption of new technologies in the country. The incumbent operator, *Compañía Anónima Nacional Teléfonos de Venezuela (CANTV)*, was renationalized in 2007 (following its privatization in the early 1990s) and remains a major player in all segments of the market, assuming the name of *Movilnet* for mobile services. The nationalization of CANTV was justified by the need for democratization and bridging social inequalities in the communications sector.**<sup>505</sup>

**Mobile services:** The mobile market hosts three mobile network operators: the leader Movilnet, Digitel and Telefonica. Penetration levels for both mobile segments, voice and broadband, are below the regional averages, as they experience further challenges with the economic downturn and consequent effects on slight decrease in the mobile-cellular subscriber base. Despite this decrease, mobile voice traffic and mobile data consumption have continued to increase. The latter at a remarkable rate of 31 per cent in 2016. Mobile broadband was available from 2009 in the form of 3G technology (CONATEL, 2015). In terms of more recent technologies, Digitel was the first to launch LTE services, in 2013, followed by Telefonica in 2015 and the State-owned Movilnet at the beginning of 2017.<sup>506</sup> The three operators started by deploying LTE services in the main cities of Venezuela to continue later with the rest of the country. GSM/UMTS remains the most popular mobile technology, accounting for approximately 75 per cent of the subscriptions, with CDMA in second and LTE third. Data traffic is increasing substantially on a yearly basis (CONATEL, 2016b).

**Fixed services:** The fixed-line market is under competition with six operators: Digitel, Telefónica, Convergía, Corporación-Telemic, Veninfotel and the State-owned incumbent CANTV. In terms of fixed-telephony, the penetration levels peaked in 2014, having been steadily declining ever since. Fixed broadband, on the other hand, has

Key indicators for Venezuela (2016)		The Americas	World
Fixed-telephone sub. per 100 inhab.	24.1	24.4	13.6
Mobile-cellular sub. per 100 inhab.	87.0	114.2	101.5
Fixed-broadband sub. per 100 inhab.	8.2	19.1	12.4
Active mobile-broadband sub. per 100 inhab.	50.3	82.7	52.2
3G coverage (% of population)	90.6	93.6	85.0
LTE/WiMAX coverage (% of population)	67.8	77.4	66.5
Mobile-cellular prices (% GNI pc)	1.4	3.6	5.2
Fixed-broadband prices (% GNI pc)	3.3	6.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.9	2.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	55.0	5.7	6.8
Percentage of households with computer	42.7	64.9	46.6
Percentage of households with Internet access	34.0	63.3	51.5
Percentage of individuals using the Internet	60.0	64.0	45.9
Int. Internet bandwidth per Internet user (kbit/s)	18.9	91.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

experienced slight but steady growth in 2016 (CONATEL, 2015, 2016b).

**Government policy:** The national telecommunications regulator, *Comision Nacional de Telecomunicaciones (CONATEL)*, was created in 1991 and has since worked on enforcing regulatory measures and developing national policies for sector development.<sup>507</sup> The regulator recognizes the importance of ICTs in the evolution of all areas and sectors of the economy, including the paramount challenge of democratizing the digital literacy and popularizing its use. In order to do so, CONATEL created the *Fondo de Responsabilidad Social*, a universal service fund that is frequently used for educational content development for radio and television services.<sup>508</sup> Since 2005, CONATEL has launched several projects financed through the universal service fund with the participation of Venezuelan telecom operators. The Organic Telecommunications Act (LOTEL) was amended in February 2011, published in Official Gazette No. 39,610, dated February 7, 2011. Pursuant to the amended LOTEL, telecommunication networks are treated as a “public interest service.” Under the law, the maximum duration of licenses for the use and operation of radio spectrums is 15 years.

**Conclusion:** The Venezuelan telecommunications sector currently faces challenges: from equipment shortfalls and the need for infrastructure deployment, which is a common factor in the region, to the digital divide among its population.<sup>509</sup> The potential for development remains with the mobile sector, with increased demand for data as well as the substitution of fixed

services; thus, mobile operators have put in place investment plans and deployed infrastructure to upgrade the coverage and improve the provision of the service in the near future.<sup>510</sup>

## Viet Nam

**The country is pursuing a unique model of competition involving different state-owned operators to grow telecommunication networks.**

**Mobile services:** The market is competitive, with five operators. Three state-owned operators dominate the market: VIETTEL, owned by the military; MOBIFONE; and VINAPHONE, owned by the Vietnam Posts and Telecommunications Group (VNPT). There is extensive 2G coverage with 93 per cent of households owning a mobile phone in 2014 (96 per cent in urban areas and 91 per cent in rural areas).<sup>511</sup> Four 3G licences were awarded in 2009. Compared to other countries, the country has been late in introducing LTE. Four licences were issued in 2016, to VIETTEL, VINAPHONE, MOBIFONE and GMOBILE, and most operators launched networks soon after that. VIETTEL has invested in ten mobile operators overseas including four in the Asia-Pacific region.

**Fixed services:** VNPT dominates the fixed telephone market, with VIETTEL and the Saigon Post and Telecommunications Services Corporation (SPT) also offering services. Penetration is far lower compared to mobile but high relative to other middle-income Asia-Pacific economies. VNPT, VIETTEL and FPT Telecom are the leading ISPs using ADSL, fibre-optic and cable modem technologies. VNPT operates a national fibre-optic network that essentially runs alongside main roads and extends to all the country's borders with its neighbours. There are also metropolitan fibre-optic rings around the main cities. Five submarine cables serve Viet Nam through two landing stations. There are Internet Exchange Points in the three largest cities.

**Government policy:** The Ministry of Information and Communications (MIC) is the policy-making and regulatory body. It has a wide remit, its oversight including the press, publishing, posts, telecommunications, information technology, electronics and broadcasting. The Authority of Telecommunications is a ministerial unit which performs advisory and regulatory functions for the telecommunications sector. The *Plan For Developing National Telecommunications Until 2020*, issued in 2012, provides a comprehensive framework for the development of telecommunications and ICT in the country. It covers: targets; development strategies;

Key indicators for Viet Nam (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	5.9	10.0	13.6
Mobile-cellular sub. per 100 inhab.	128.0	98.9	101.5
Fixed-broadband sub. per 100 inhab.	9.6	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	46.6	47.4	52.2
3G coverage (% of population)	77.3	87.6	85.0
LTE/WiMAX coverage (% of population)	5.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	2.6	3.2	5.2
Fixed-broadband prices (% GNI pc)	1.7	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	2.0	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	3.2	5.4	6.8
Percentage of households with computer	23.5	37.8	46.6
Percentage of households with Internet access	25.9	45.5	51.5
Percentage of individuals using the Internet	46.5	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	91.3	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

legal, regulatory, institutional and human resource aspects and international cooperation mechanisms; organization responsibilities; and a list of eight key projects with budgets. Targets are quite conservative, calling for between 35 and 40 per cent broadband penetration in households and Internet usage to reach 55 to 60 per cent of the population by 2020.

**Conclusion:** Viet Nam's unique model of competition by state-owned enterprises has driven a high level of mobile access including in rural areas. The recent launch of LTE networks should drive pent-up demand for higher-speed broadband.

## Yemen

***Yemen has gone through political instabilities and turbulences over the past few years, which has affected the overall economy, affordability, infrastructure, and ICT development. The prices for telecommunication services are above the average prices in the region.***

**Mobile services:** Mobile cellular penetration is below the regional average and mobile broadband uptake is low as the country lacks the availability of 3G and LTE services. The mobile cellular prices level is one of the highest in the region. However, the level of competition in the mobile cellular market is very high with four cellular market players; Sabafon, MTN Yemen, Yemen Mobile, and Yemen telecom. The Yemen cellular market has been competitive since 2001 when Sabafon and MTN Yemen (previously known as Spacetel Yemen) launched cellular services. Prior to 2001, TeleYemen was the sole operator in the cellular market, and provided cellular services through its analogue network. In 2004, Yemen Mobile took over TeleYemen cellular network and replaced its analogue services with CDMA services. The country's rural nature and mountainous geography has also been a factor in the low mobile and fixed penetration rates. The introduction of 3G and LTE services is essential for the development of ICT sector, subject to the return of political stability and subsequent international financial support.

**Fixed services:** Fixed broadband is limited in Yemen. In 2012, the Public Telecommunication Company (PTC) began to install a national WiMAX network to improve the availability of Internet access. While competition has been introduced into the mobile sector, there is no competition in fixed lines and very little in Internet provision. The fixed voice market is monopolized by the government owned PTC. For its part, the Internet market is served by two government players: Yemen Net and Y-Net.

**Government policy:** The Yemen Ministry of Telecommunications and Information Technology (MTIT) regulates the telecommunication market. The MTIT is responsible for the following tasks: formulating policies and plans to encourage investment in the sector, managing the frequency spectrum, licensing, and maintaining the national numbering plan. With the formal acceptance into the World Trade Organization in mid-2014, further

Key indicators for Yemen (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	4.5	7.7	13.6
Mobile-cellular sub. per 100 inhab.	62.9	107.1	101.5
Fixed-broadband sub. per 100 inhab.	1.6	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	6.0	45.2	52.2
3G coverage (% of population)	88.9	81.9	85.0
LTE/WiMAX coverage (% of population)	0.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	6.2	4.3	5.2
Fixed-broadband prices (% GNI pc)	7.7	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	7.3	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	14.2	5.5	6.8
Percentage of households with computer	7.0	43.3	46.6
Percentage of households with Internet access	5.9	45.3	51.5
Percentage of individuals using the Internet	24.6	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	5.5	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

progress is expected towards liberalization in the telecommunication sector in the future. However, the current conflict will hamper progress. There is also need to establish an independent regulator to develop regulatory framework in the country. The humanitarian situation in Yemen has resulted in the creation of a global organization called the Emergency Telecommunications Cluster (ETC) that helps to improve telecommunication services. ETC has been operating in Yemen since April 2015 and has provided basic security telecommunication services, Internet hubs, and power charging stations.

**Conclusion:** The ICT market in Yemen is currently an unpredictable market. Significant parts of its telecommunication infrastructure are no longer operational. The recent conflict has put a halt to much of the progress in the telecommunication sector, resulting in satellite and radio communication becoming important technologies for service delivery.

## Zambia

***The landlocked Southern African nation has been making significant strides in building its national backbone in order to access Internet bandwidth in neighbouring countries.***

**Mobile services:** There are three mobile operators. MTN Zambia Limited, a subsidiary of South Africa's MTN is the leader, with a 45.2 per cent market share at the end of June 2017, which entered the market through the purchase of TELECEL, which had been operating since 1995. Airtel Zambia Limited, a subsidiary of India's AIRTEL, had the second largest market share of 39.2 per cent. The company launched its operations on the market in 1997 initially trading as Celtel Zambia and subsequently Zain Zambia. The State-owned incumbent, Zambia Telecommunications Company Ltd. (ZAMTEL), had the lowest market share, at 15.3 per cent, despite progressive gains in its customer base. ZAMTEL launched its mobile phone service offering in 1994 as the country's first mobile operator. The 2015 survey on access and usage of ICTs among households and individuals found that 65 per cent of households had a mobile phone including 85 per cent in urban homes and 50 per cent in rural ones.<sup>512</sup> MTN Zambia launched its 3G offering in 2011, followed by AIRTEL and ZAMTEL in 2012. Mobile LTE was introduced by MTN in 2014 using the 1 800 MHz frequency while ZAMTEL and Airtel Zambia launched their LTE offerings in 2016 and 2017 respectively. Mobile Broadband Limited trading as Vodafone Limited, Hai Telecommunications Limited and Microlink Limited, which previously were traditional ISPs, extended their service offering since last year to provide LTE mobile Internet services.

**Fixed services:** ZAMTEL is the main provider of fixed-telephone services using PSTN technology. It also offers fixed-broadband over capped ADSL and fibre-optic connections, and fixed wireless LTE-TDD (the latter since 2014). Vodafone also launched a fixed wireless LTE-TDD network using the 2 300 MHz band in 2016. While there are a number of other ISPs, most are small, with the top four (including mobile operators) accounting for more than 80 per cent of the market. Access to Internet services in the country increased by 2.9 percent from a total of 5.7 million Internet users reported at the end of June, 2016 to 5.9 million users reported at the end of June, 2017.

Key indicators for Zambia (2016)	Africa	World	
Fixed-telephone sub. per 100 inhab.	0.6	1.0	13.6
Mobile-cellular sub. per 100 inhab.	74.9	74.6	101.5
Fixed-broadband sub. per 100 inhab.	0.2	0.4	12.4
Active mobile-broadband sub. per 100 inhab.	32.2	22.9	52.2
3G coverage (% of population)	53.0	59.3	85.0
LTE/WiMAX coverage (% of population)	5.8	25.7	66.5
Mobile-cellular prices (% GNI pc)	5.7	14.2	5.2
Fixed-broadband prices (% GNI pc)	19.5	39.4	13.9
Mobile-broadband prices 500 MB (% GNI pc)	7.8	9.3	3.7
Mobile-broadband prices 1 GB (% GNI pc)	10.2	17.7	6.8
Percentage of households with computer	8.1	9.6	46.6
Percentage of households with Internet access	14.3	16.3	51.5
Percentage of individuals using the Internet	25.5	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	3.9	51.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

The fixed Internet services market remains highly concentrated despite having over 25 licensed operators. Zamtel, Africonnect, Zamnet and Microlink accounted for close to 90 percent of the subscribers for the fixed wireless Internet services.

Five companies have built out fibre networks, especially critical for ensuring access to submarine cables for the landlocked country. The largest is that of Fibrecom, a subsidiary of the Zambia Electricity Supply Corporation (Zesco), whose network reaches all 10 provincial capitals and stretches to about 6,000 km. The fibre network infrastructure is built on the electricity pylon. Fibrecom has direct connections to undersea cables through Tanzania, Malawi, Zimbabwe, Namibia, and Botswana. CEC-Liquid Telecom has also deployed metropolitan and national fiber networks via underground cable and in some cases overhead. MTN and AIRTEL collaborate on an underground metropolitan network in the capital Lusaka. ZAMTEL also has an extensive network with access to several international submarine cables. These links have enabled access to undersea fibre-optic cables since 2011. The Zambia IXP became operational in 2006.

**Government policy:** The Ministry of Transport and Communications has responsibility for sector policy. The current ICT policy was adopted in 2006, and is currently undergoing review. The three core areas of the current policy are capacity building, a competitive and efficient ICT sector, and an effective legal and regulatory framework. A national broadband strategy has been under development for the last few years, given the importance attached to ICT in the country's National Development Plan. The President

launched the SMART Zambia initiative in 2015 aimed at advancing the country into a digital and knowledge based society. The government, in August 2017, introduced a new licensing framework for the ICT sector aimed at supporting convergence in ICT services as well as deepening competition in the sector. The Zambia Information and Communications Technology Authority (ZICTA) is the sector regulator for postal and electronic communications, deriving its mandate from the Information and Communications Technologies (ICT) Act No. 15 of 2009, the Postal Services Act of 2009 as well as the Electronic Communications and Transactions Act of 2009. The Authority also administers the country code top-level domain (.zm) and the Universal Access Programme.

**Conclusion:** Recent high-level government support for ICT, coupled with improved bandwidth availability from cross-border fibre-optic connections, provides a platform for the development of the sector.

## Zimbabwe

***Despite its landlocked situation in Southern Africa, Zimbabwe has a vibrant backbone market, with cross-border connections to several submarine cables.***

**Mobile services:** Zimbabwe has long had competition in the mobile sector, with three operators. Net-One is the mobile arm of the incumbent, and launched in 1997. ECONET, a local company, successfully challenged the incumbent's monopoly to launch its GSM network in 1998. ECONET has since evolved into a mobile group, with headquarters in South Africa and operations in a number of countries. TELECEL launched in 1998; it has gone through several ownership changes and now is majority owned by a government investment holding. Household penetration is relatively high. In 2014, 89 per cent of homes had mobile phones, including 97 per cent of urban ones and 84 per cent in rural areas.<sup>513</sup> Mobile-broadband coverage has been growing, following the launch of 3G by all mobile operators. ECONET and Net-One also have LTE networks.

**Fixed services:** TELONE is the State-owned incumbent operator. It provides fixed-telephone service using copper landlines and CDMA wireless local loop. Though penetration is low, the number of subscriptions is high compared with other sub-Saharan African nations. TELONE offers fixed Internet through capped and uncapped ADSL, with speeds up to 4 Mbit/s, optical fibre with speeds up to 50 Mbit/s, and via satellite. There are several other fixed-broadband providers offering fixed wireless and fixed fibre-optic connections, as well as resell of TELONE'S ADSL. Backbone connectivity is a challenge for Zimbabwe due to its landlocked situation. There are several backbone operators in the market. The leading ones include TELONE, Liquid Telecom and POWERTEL, which have developed fibre-optic routes throughout the country and to the borders of neighbouring countries. POWERTEL is notable as a subsidiary of the Zimbabwe Electricity Supply Authority, and it offers retail broadband services. The national fibre-optic backbone connections to Mozambique and South Africa enable access to the SEACOM, WACS and EASSy undersea fibre-optic cables.

**Government policy:** The Ministry of Information Communication Technology, Postal and Courier Services is responsible for sector oversight.

Key indicators for Zimbabwe (2016)	Africa	World
Fixed-telephone sub. per 100 inhab.	2.0	1.0 13.6
Mobile-cellular sub. per 100 inhab.	83.2	74.6 101.5
Fixed-broadband sub. per 100 inhab.	1.1	0.4 12.4
Active mobile-broadband sub. per 100 inhab.	43.4	22.9 52.2
3G coverage (% of population)	55.3	59.3 85.0
LTE/WiMAX coverage (% of population)	22.6	25.7 66.5
Mobile-cellular prices (% GNI pc)	18.8	14.2 5.2
Fixed-broadband prices (% GNI pc)	20.9	39.4 13.9
Mobile-broadband prices 500 MB (% GNI pc)	27.9	9.3 3.7
Mobile-broadband prices 1 GB (% GNI pc)	48.8	17.7 6.8
Percentage of households with computer	12.9	9.6 46.6
Percentage of households with Internet access	22.1	16.3 51.5
Percentage of individuals using the Internet	23.1	19.9 45.9
Int. Internet bandwidth per Internet user (kbit/s)	9.1	51.0 74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

The importance of ICT for the Government is recognized in the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim-ASSET), identifying ICTs as one of the pillars for national socio-economic development. The Cabinet approved Zimbabwe's second National Policy for Information and Communication Technology in 2016. The overall objectives of the policy framework are to (a) use ICTs to facilitate delivery of Zim-ASSET and other national developmental goals; (b) enable and foster access to and increased use of ICT across all sectors of the economy; (c) bridge the digital divide and provide broadband for all; (d) manage challenges resulting from ICT development to ensure sustainability; and (e) lead, improve and adapt to the changing ICT environment through innovation and partnership. The Postal and Telecommunications Regulatory Authority of Zimbabwe is the sector regulator, guided by the 2000 (and amendments) Postal and Telecommunications Act, as well as supporting regulations. The Authority is also responsible for managing the universal service fund.

**Conclusion:** Zimbabwe has long had a competitive mobile market, resulting in a relatively high level of access. More recently, a competitive backbone market has developed, lowering costs and facilitating access to cross-border submarine cables.



## Other economies

## Hong Kong (China)

**Hong Kong (China) has one of the most sophisticated and competitive telecommunications markets in the world.**

**Mobile services:** For its size, Hong Kong (China) has one of the most competitive mobile markets in the world. There are four operators: China Mobile Hong Kong, Hong Kong Telecommunications (HKT) (CSL brand and 1010 brand), Hutchison (operating under the 3 brand) and SmarTone, all publicly listed on the local stock exchange. Hong Kong (China) was one of the first economies in the world to launch mobile number portability in 1999, which has helped to promote competition. It has one of the highest mobile penetration rates in the world, at 234 per cent in 2016. 3G mobile broadband was launched in 2004. All four mobile network operators have deployed LTE services, first launched in 2010, and have upgraded to LTE-Advanced with some networks reaching download speeds of up to 600 Mbps using carrier aggregation. Some 90 per cent of mobile subscriptions are for 3G/LTE services with 86 per cent of the population aged 10 and over having a smartphone in 2016.<sup>514</sup>

**Fixed services:** The fixed telephone market is fully liberalized and around 80 per cent of households can choose from among three operators for services. Fixed telephone subscriptions continue to remain popular as a result of bundled services. Fixed broadband is available in practically all office buildings and households. Technologies include ADSL, FTTP and coaxial cable, and fixed wireless LTE is also available. Fixed broadband services are available at speeds of up to 10 Gbps, and around 93 per cent of households have a fixed broadband service. Free public Wi-Fi service is available in most public places.

Hong Kong (China) is a major telecommunications and Internet hub in the region. It has eight submarine cable landing stations and is connected to ten regional and transcontinental undersea fibre-optic networks. It is also connected to mainland China by 20 overland cables. The Hong Kong Internet Exchange (HKIX), launched in 1995, has over 200 members and is the biggest in Asia in terms of traffic volume.

**Government policy:** The telecommunications market is completely liberalized, with no foreign

Key indicators for Hong Kong (China) (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	58.6	10.0	13.6
Mobile-cellular sub. per 100 inhab.	238.8	98.9	101.5
Fixed-broadband sub. per 100 inhab.	35.7	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	104.6	47.4	52.2
3G coverage (% of population)	99.0	87.6	85.0
LTE/WiMAX coverage (% of population)	99.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.2	3.2	5.2
Fixed-broadband prices (% GNI pc)	0.6	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.3	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.7	5.4	6.8
Percentage of households with computer	81.0	37.8	46.6
Percentage of households with Internet access	82.0	45.5	51.5
Percentage of individuals using the Internet	87.3	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	4,906.0	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

ownership restrictions. The Communications Authority (CA) is the regulatory body overseeing the broadcasting and telecommunication sectors. The Communications and Creative Industries Branch of the Commerce and Economic Development Bureau is responsible for policy matters on broadcasting, film, and telecommunications. The *Digital 21 Strategy* has existed since 1998 as the roadmap for ICT development in Hong Kong (China). It is revised regularly in line with technological evolution. The current strategy establishes the agenda for leveraging new technologies for socio-economic development. The strategy features initiatives within four themes: i) empowering citizens by building platforms for the public and businesses to accomplish their goals; ii) igniting business innovation to enhance research and development and provision of open data; iii) supporting the ICT industry to facilitate overseas expansion of local companies; and iv) transforming public services to develop intuitive, personalized and multi-platform e-services.

**Conclusion:** The Government has overseen sector development through a forward-thinking regulatory approach and through appropriate strategies to stimulate competition resulting in low prices and high levels of access. ICT is seen as a complement to the other attributes that make the economy a leading regional business hub.

## Macao (China)

***The island economy has a high level of access to both fixed and mobile high-speed services and is one of the three cities in the world with 100 per cent fibre-optic broadband coverage.***

**Mobile services:** For a small economy, there is a high level of competition, with four mobile operators: the incumbent Telecommunications Company of Macau (CTM); Hutchison, a subsidiary of Hutchison Telecommunications Hong Kong Holdings Limited; China Telecom, owned by the mainland operator; and SmarTone, a subsidiary of a Hong Kong telecom group. Mobile is practically ubiquitous with 96 per cent of the population aged 15 years and older used a mobile phone.<sup>515</sup> All subscriptions are technically broadband capable, as 2G was phased out in June 2016. LTE was launched in 2015 following the award of four licences, and by the end of 2016 LTE accounted for 46 per cent of all mobile subscriptions. LTE download speeds of up to 225 Mbps are achieved using carrier aggregation technology.

**Fixed services:** There are two fixed line operators, the incumbent CTM and MTEL, which was licensed as the second operator in 2013. CTM was formerly jointly owned by Portugal Telecom and Cable & Wireless. In 2013, CITIC Telecom International, whose ultimate shareholding is from mainland China, purchased the company (1 per cent is held by Macao Postal Savings). In the fixed broadband segment, ADSL subscriptions have been falling as users switch to optical fibre. CTM introduced fibre to the home (FTTH) in 2010 and has fully covered Macao (China) with more than 52 000 kilometres of fibre-optic cable. In 2016, 89 per cent of households had a fixed broadband subscription and by December 2016, 61 per cent of fixed broadband subscriptions were for optical fibre.<sup>516</sup> There are more than 2 000 Wi-Fi hotspots in Macao (China). Macao (China) has been connected to the SeaMeWe-3 submarine cable since 1999 and in addition has several terrestrial fibre-optic cable links to mainland China.

**Government policy:** The Secretariat for Transport and Public Works is responsible for sector policy. The Directorate of Postal and Telecommunications Services is the sector regulator. The 2001 *Basic Telecommunications Law*, supplemented by subsequent regulations, is the applicable legislation for the sector. The main policy thrust

Key indicators for Macao (China) (2016)		Asia & Pacific	World
Fixed-telephone sub. per 100 inhab.	23.9	10.0	13.6
Mobile-cellular sub. per 100 inhab.	332.1	98.9	101.5
Fixed-broadband sub. per 100 inhab.	30.0	11.3	12.4
Active mobile-broadband sub. per 100 inhab.	332.1	47.4	52.2
3G coverage (% of population)	n.a.	87.6	85.0
LTE/WiMAX coverage (% of population)	99.0	73.6	66.5
Mobile-cellular prices (% GNI pc)	0.1	3.2	5.2
Fixed-broadband prices (% GNI pc)	0.1	14.5	13.9
Mobile-broadband prices 500 MB (% GNI pc)	0.1	2.7	3.7
Mobile-broadband prices 1 GB (% GNI pc)	0.7	5.4	6.8
Percentage of households with computer	77.9	37.8	46.6
Percentage of households with Internet access	88.6	45.5	51.5
Percentage of individuals using the Internet	81.6	41.5	45.9
Int. Internet bandwidth per Internet user (kbit/s)	252.9	48.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).

has been to maintain a high level of competition in the mobile market with gradual liberalization of the fixed market, in line with CTM's Concession Agreement.

**Conclusion:** Fixed broadband penetration in Macao (China) is among the highest in the world. With four operators, the mobile market is one of the most competitive in the world, given Macau's small population and land area. As a result, the very latest mobile broadband technologies are available with high take-up.

## Palestine\*

\*Note: Palestine is not an ITU member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

### ***Palestine has a good ICT services market, taking into account the challenges facing the Palestinian Authority (PA), and the telecommunication sector, due to restrictions over allocation of frequency spectrum.***

**Mobile services:** Mobile cellular penetration in the West Bank and Gaza (WBG) is below the average penetration in Arab States region and globally. The level of competition is limited between the two licensed operators: Paltel Group with its mobile branded services Jawwal; and, Wataniya Mobile (one of Ooredoo group companies), which was granted a licence to operate in Palestine in 2006 and started operations in the West Bank in 2009. 3G and LTE services are not offered yet in the West Bank and Gaza, and mobile services are limited to GSM services. The frequency bands offered to mobile operators in the 900 MHz are limited and some of them are shared with Israeli operators. Palestinian operators are facing competition from Israeli operators, who are offering 3G and LTE networks that Palestinian operators cannot provide. Israeli operators presently cover 80 per cent of the territory of the West Bank and estimates suggest these operators capture between 7 per cent and 30 per cent of the West Bank market (World Bank, 2016). In 2016, the Palestinian Ministry of Telecommunications and Information Technology (MTIT) signed a final agreement with Israel to allow Palestinian telecommunication companies to provide 3G services in the West Bank governorates and to allow Wataniya Mobile to operate a 2G mobile system in Gaza.

**Fixed services:** Palestine has limited fixed-broadband penetration. PalTel owns the fixed line and fixed broadband infrastructure, and is the dominant operator in the Palestinian market. PalTel and its subsidiary, Hadara, offers to its customers both ADSL and Internet access, as well as access to its Internet facilities to more than 20 Internet service providers (ISPs). Hadara controls about 66 per cent of the access to data infrastructure market, and the other ISPs control the remaining third of the market. In addition many of the ISPs lease capacity from Israeli broadband operators.

Key indicators for Palestine* (2016)		Arab States	World
Fixed-telephone sub. per 100 inhab.	9.3	7.7	13.6
Mobile-cellular sub. per 100 inhab.	79.6	107.1	101.5
Fixed-broadband sub. per 100 inhab.	6.9	4.7	12.4
Active mobile-broadband sub. per 100 inhab.	0.0	45.2	52.2
3G coverage (% of population)	0.0	81.9	85.0
LTE/WiMAX coverage (% of population)	0.0	33.8	66.5
Mobile-cellular prices (% GNI pc)	5.0	4.3	5.2
Fixed-broadband prices (% GNI pc)	9.3	10.1	13.9
Mobile-broadband prices 500 MB (% GNI pc)	4.7	4.5	3.7
Mobile-broadband prices 1 GB (% GNI pc)	5.9	5.5	6.8
Percentage of households with computer	70.4	43.3	46.6
Percentage of households with Internet access	56.5	45.3	51.5
Percentage of individuals using the Internet	61.2	41.8	45.9
Int. Internet bandwidth per Internet user (kbit/s)	0.0	39.0	74.5

Note: Data in italics are ITU estimates. Source: ITU (as of June 2017).  
\*Palestine is not an ITU Member State; the status of Palestine in ITU is the subject of Resolution 99 (rev. Busan, 2014) of the ITU Plenipotentiary Conference.

**Government policy:** Since its inception, the Palestinian National Authority (PNA) has been one of the major contributors to the growth of the ICT sector in Palestine. The Ministry of Telecommunication and Information Technology (MTIT) is responsible for regulating the ICT sector and licensing. As part of the Oslo Accords, Israel agreed through the 1995 Interim Agreement with the Palestine Liberation Organization (PLO) to release frequencies to the PNA on the basis of need. This obligation was included in Article 36 of Annex 3 of the Interim Agreement as the legal framework for the release of frequencies to the PNA through a joint Israel-Palestinian committee (JTC). The legal framework is defined by Telecommunications Law 3/1996 and by regulatory provisions under the Oslo Agreement (Annex 3). In 2009, the PNA issued a new Telecommunication Law, according to which the Palestinian Telecommunications Regulatory Authority (PTRA) was to be established, to provide professional, fair, transparent and independent regulation of the telecommunications industry. However, until the PTRA is established, the MTIT still acts as the regulator.

**Conclusion:** The Palestinian telecommunications sector is characterized by the presence of a private regulated monopoly. Increasing competition and efficiency in the telecommunication sector will have far reaching effects throughout on the Palestinian economy. Granting 3G and LTE frequencies for national operators is essential for developing the ICT sector in Palestine.

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# Annex 1

INDICATOR	DEFINITION
<b>SUBSCRIPTIONS AND NETWORK COVERAGE</b>	<b>The indicators in this category refer to the key indicators relating to subscriptions and network coverage.</b>
<b>Fixed-telephone subscriptions per 100 inhabitants</b>	<p>Fixed-telephone subscriptions refers to the sum of active analogue fixed-telephone lines, voice-over-Internet Protocol (VoIP) subscriptions, fixed wireless local loop subscriptions, Integrated Services Digital Network voice-channel equivalents and fixed public payphones. It includes all accesses over fixed infrastructure supporting voice telephony using copper wire, voice services using Internet Protocol (IP) delivered over fixed (wired)-broadband infrastructure (e.g. digital subscriber line (DSL), fibre optic), and voice services provided over coaxial-cable television networks (cable modem). It also includes fixed wireless local loop connections, defined as services provided by licensed fixed-line telephone operators that provide last-mile access to the subscriber using radio technology, where the call is then routed over a fixed-line telephone network (not a mobile-cellular network). VoIP refers to subscriptions that offer the ability to place and receive calls at any time and do not require a computer. VoIP is also known as voice-over-broadband (VoB), and includes subscriptions through fixed-wireless, DSL, cable, fibre optic and other fixed-broadband platforms that provide fixed telephony using IP.</p> <p>This indicator is calculated by dividing the number of fixed-telephone subscriptions by the population and multiplying by 100.</p>
<b>Mobile-cellular subscriptions per 100 inhabitants</b>	<p>Mobile-cellular telephone subscriptions refers to the number of subscriptions to a public mobile telephone service providing access to the public switched telephone network using cellular technology. It includes both the number of postpaid subscriptions and the number of active prepaid accounts (i.e. accounts that have been active during the previous three months). It includes all mobile-cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging, machine-to-machine (M2M) and telemetry services.</p> <p>This indicator is calculated by dividing the number of mobile-cellular telephone subscriptions by the population and multiplying by 100.</p>
<b>Fixed-broadband subscriptions per 100 inhabitants</b>	<p>Fixed-broadband subscriptions refers to fixed-subscriptions for high-speed access to the public Internet (a Transmission Control Protocol (TCP)/IP connection) at downstream speeds equal to or higher than 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. The total is measured irrespective of the method of payment. It excludes subscriptions that have access to data communications (including the Internet) via mobile-cellular networks. It includes fixed WiMAX and any other fixed wireless technologies, and both residential subscriptions and subscriptions for organizations.</p> <p>This indicator is calculated by dividing the number of fixed-broadband Internet subscriptions by the population and multiplying by 100.</p>
<b>Active mobile-broadband subscriptions per 100 inhabitants</b>	<p>Active mobile-broadband subscriptions refers to the sum of data and voice mobile-broadband subscriptions and data-only mobile-broadband subscriptions to the public Internet. It covers subscriptions actually used to access the Internet at broadband speeds, not subscriptions with potential access, even though the latter may have broadband-enabled handsets. Subscriptions must include a recurring subscription fee to access the Internet or pass a usage requirement – users must have accessed the Internet in the previous three months. It includes subscriptions to mobile-broadband networks that provide download speeds of at least 256 kbit/s (e.g. WCDMA, HSPA, CDMA2000 1x EV-DO, WiMAX IEEE 802.16e and LTE), and excludes subscriptions that only have access to GPRS, EDGE and CDMA 1xRTT.</p> <p>This indicator is calculated by dividing the number of active mobile-broadband subscriptions by the population and multiplying by 100.</p>

INDICATOR	DEFINITION
<b>3G network coverage</b>	This indicator is also referred to as percentage of the population covered by at least a 3G mobile network. It refers to the percentage of inhabitants who are within range of at least a 3G mobile-cellular signal, whether or not they are subscribers. This is calculated by dividing the number of inhabitants covered by at least a 3G mobile-cellular signal by the total population and multiplying by 100. It excludes people covered only by GPRS, EDGE or CDMA 1xRTT.
<b>LTE/WiMAX network coverage</b>	This indicator is also referred to as percentage of the population covered by at least an LTE/WiMAX network. It refers to the percentage of inhabitants living within range of LTE/LTE-Advanced, mobile WiMAX/WirelessMAN or other more advanced mobile-cellular networks, whether or not they are subscribers, and is calculated by dividing the total number of inhabitants covered by the aforementioned mobile-cellular technologies by the total population and multiplying by 100. It excludes people covered only by HSPA, UMTS, EV-DO and previous 3G technologies, and also excludes fixed WiMAX coverage.
<b>ICT PRICES</b>	<b>The indicators in this category refer to the key indicators relating to prices of ICT services.</b>
<b>Mobile-cellular prices (% GNI p.c.)</b>	<p>Mobile-cellular prices refers to the monthly usage price for 30 outgoing calls per month in predetermined ratios (on-net/off-net to a fixed line and for peak and off-peak times), plus 100 SMS messages. It is calculated as a percentage of a country's average monthly GNI p.c.</p> <p>The mobile-cellular prices are based on the prepaid prices operator with the largest market share (as measured by the total number of mobile-cellular subscriptions). Postpaid prices are used for countries where prepaid subscriptions make up less than 2 per cent of all mobile-cellular subscriptions.</p> <p>Prices refer to regular (non-promotional) plans and exclude promotional offers and limited discounts or user groups or any other discounts for services specifically based on type of phone or time of day usage.</p>
<b>Fixed-broadband prices (% GNI p.c.)</b>	<p>Fixed-broadband prices refers to the price of a monthly subscription to an entry-level fixed-broadband plan. This indicator is calculated as a percentage of a country's average monthly GNI p.c.</p> <p>For comparability reasons, the fixed-broadband prices are based on a monthly data usage of (a minimum of) 1 GB. For plans that limit the monthly amount of data transferred by including data volume caps below 1 GB, the cost for the additional bytes is added to the sub-basket. The minimum speed of a broadband connection is 256 kbit/s. Tariffs are collected from the ISP with the largest market share (as measured by the number of subscriptions).</p> <p>Prices refer to regular (non-promotional) plans and exclude promotional offers and limited discounts or user groups or any other discounts for services specifically based on type of phone or time of day usage.</p>
<b>Mobile-broadband prices 500 MB (% GNI p.c.)</b>	<p>Mobile-broadband prices 500 MB refers to the price of an entry-level handset-based mobile-broadband subscription with a validity of 30 days (or four weeks). It is calculated as a percentage of a country's average monthly GNI p.c.</p> <p>For comparability reasons, prices for handset-based mobile-broadband subscriptions are based on prepaid services with a minimum data volume allowance of 500 MB for one of the following technologies: UMTS, HSPA family, LTE family, CDMA EV-DO family and mobile WiMAX (IEEE 802.16e and 802.16m). Prices applying to WiFi or hotspots are excluded.</p> <p>Tariffs represent plans for residential customers, including taxes, and are based on the cheapest plan from the operator with the largest market share measured by the number of mobile-broadband subscriptions. Prices refer to regular (non-promotional) plans and exclude promotional offers and limited discounts or user groups or any other discounts for services specifically based on type of phone or time of day usage.</p>

INDICATOR	DEFINITION
<b>Mobile-broadband prices 1 GB (% GNI p.c.)</b>	<p>Mobile-broadband prices 1 GB refers to the price of an entry-level computer-based mobile-broadband subscription with a validity of 30 days (or four weeks). It is calculated as a percentage of a country's average monthly GNI p.c.</p> <p>For comparability reasons, prices for computer-based mobile-broadband subscriptions are based on prepaid services with a minimum data volume allowance of 1 GB for one of the following technologies: UMTS, HSPA family, LTE family, CDMA EV-DO family and mobile WiMAX (IEEE 802.16e and 802.16m). Prices applying to WiFi or hotspots are excluded.</p> <p>Tariffs represent prices for residential customers, including taxes, and are based on the cheapest plan from the operator with the largest market share measured by the number of mobile-broadband subscriptions. Prices refer to regular (non-promotional) plans and exclude promotional offers and limited discounts or user groups or any other discounts for services specifically based on type of phone or time of day usage.</p>
<b>ICT ACCESS AND USE BY HOUSEHOLDS AND INDIVIDUALS</b>	<b>The indicators in this category refer to the key indicators relating to the access and use of ICTs by households and individuals.</b>
<b>Percentage of households with computer</b>	Percentage of households with computer refers to the proportion of households with a computer at home. Data are based on surveys generally carried out by national statistical offices.
<b>Percentage of households with Internet access</b>	Percentage of households with Internet access refers to the proportion of households with Internet access. Data are based on surveys generally carried out by national statistical offices.
<b>Percentage of individuals using the Internet</b>	Percentage of individuals using the Internet refers to the proportion of individuals using the Internet in the past three months. Data are based on surveys generally carried out by national statistical offices or estimated based on imputations models which take into account variables such as the number of fixed and mobile-broadband subscriptions and GNI per capita.
<b>Used international Internet bandwidth, in kbit/s per Internet user</b>	<p>International Internet bandwidth refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbit/s). Used international Internet bandwidth refers to the average usage of all international links, including fibre optic cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). All international links used by all types of operators – namely fixed, mobile and satellite operators- are taken into account. The average is calculated over the 12-month period of the reference year. For each individual international link, if the traffic is asymmetric, i.e. incoming traffic is not equal to outgoing traffic, then the higher value of the two is provided. The combined average usage of all international links can be reported as the sum of the average usage of each individual link.</p> <p>This indicator is calculated by converting the international Internet bandwidth to kbit/s and dividing it by the number of Internet users.</p>

Note: For definition and other description of the indicators, see the *ITU Handbook for the Collection of Administrative Data on Telecommunications/ICT 2011*, available at <http://www.itu.int/ITU-D/ict/publications/hb/2011/index.html>, and the *ITU Manual for Measuring ICT Access and Use by Households and Individuals, 2014*, available at <http://www.itu.int/en/ITU-D/Statistics/Pages/publications/manual2014.aspx>.

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