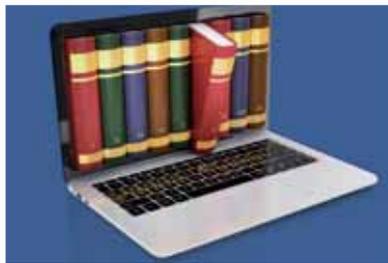# INTERNET BROADBAND
FOR AN INCLUSIVE DIGITAL SOCIETY
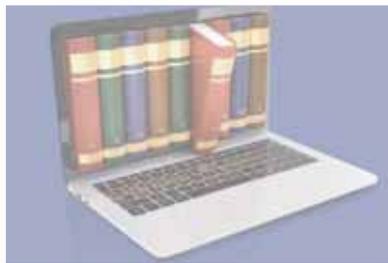
UNCTAD Current Studies on Science, Technology and Innovation. N°11

UNITED NATIONS

UNCTAD

INTERNET BROADBAND
FOR AN INCLUSIVE DIGITAL SOCIETY

Note

The United Nations Conference on Trade and Development (UNCTAD) serves as the lead entity within the United Nations Secretariat for matters related to science and technology as part of its work on the integrated treatment of trade and development, investment and finance. The current UNCTAD work programme is based on the mandates set at quadrennial conferences, as well as decisions of the United Nations General Assembly and the Economic and Social Council that draw upon the recommendations of the Commission on Science and Technology for Development, which is served by the UNCTAD secretariat. The UNCTAD work programme is built on its three pillars: research analysis, consensus-building and technical cooperation. It is carried out through intergovernmental deliberations, research and analysis, technical assistance activities, seminars, workshops and conferences.

This series of publications seeks to explore current issues in science, technology and innovation, with a particular emphasis on their impact on developing countries. The term "country" as used in this study also refers, as appropriate, to territories or areas; the designations employed and the presentation of the material 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 delineation of its frontiers or boundaries. In addition, the designations of country groups are intended solely for statistical or analytical convenience and do not necessarily express a judgment about the stage of development reached by a particular country or area. Mention of firms, organizations or policies does not imply endorsement by the United Nations.

The material contained in this publication may be freely quoted with appropriate acknowledgement.

All references to dollars are United States dollars.

List of Abbreviations

2G/3G/4G	second/third/fourth generation
A2K	access to knowledge
DSL	digital subscriber line
FTTH	fibre to the home
G3ict	Global Initiative for Inclusive ICTs
GDP	gross domestic product
ICT	information and communications technology
IPR	intellectual property right
ITU	International Telecommunication Union
LDC	least developed country
OECD	Organization for Economic Cooperation and Development
SME	small and medium-sized enterprise
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
VSAT	very small aperture terminal
WiMAX	Worldwide Interoperability for Microwave Access
WTO	World Trade Organization

Acknowledgements

Contents

Introduction

Internet broadband is shorthand for a range of capabilities enabled by the convergence of computers, the Internet, smart devices, high-speed wireline and wireless networks, and a plethora of innovative applications and services that these technologies make available. Compared with narrowband technologies such as dial-up telephone connections, which deliver a maximum data rate of 56 kilobits per second (kbps), broadband Internet refers to high-speed public Internet access. Although the boundary between narrowband and broadband is blurry, the International Telecommunication Union (ITU) describes broadband as Internet connections with downstream speeds of 256 kbps or more (ITU, 2010).

The precipitous growth of broadband networks and services over the past decade has been sparked by a combination of continuing rapid technological developments across the information and communications technology (ICT) landscape and the commensurate spectacular rise of popular applications and services that are made possible by broadband connectivity. These changes have also been increasing the socioeconomic development impact of broadband ICTs on various spheres, ranging from education to health care, and political and economic inclusion. Today, broadband ICT policies are increasingly becoming an integral part of national development plans and poverty reduction strategies to fight poverty and facilitate economic and social development. Hence, access to broadband ICT networks, services, and applications represents an increasingly essential requirement for achieving socioeconomic development goals in the twenty-first century.

Despite the rapid advances in the sector and the spread of its use in certain parts of the world, a digital divide in broadband connectivity, both between and within countries, has been growing. Of the roughly 588 million fixed broadband Internet subscribers in the world (2011), 315 million live in member countries of the Organization for Economic Cooperation and Development (OECD), while only 1 million live

in least developed countries (LDCs).[1] This has been noted in a variety of forums, including the Broadband Commission, the World Summit on the Information Society and the United Nations Educational, Scientific and Cultural Organization (UNESCO). Economic and Social Council resolution 2012/5 states that "there is a growing digital divide in the availability, affordability, quality of access and use of broadband between high-income countries and other regions, with least-developed countries and Africa as a continent lagging behind the rest of the world..."

All stakeholders have been called upon to maintain as a priority concern the bridging of the digital divide and to continue to focus on pro-poor ICT policies and applications, including access to broadband at the grass-roots level, with a view to narrowing the digital divide between and within countries. Innovative approaches that will encourage universal access to affordable broadband infrastructure in developing countries need to be devised. During its 2012 meeting, the Commission on Science and Technology for Development proposed to share and analyse policies and best practices intended to be comprehensive and inclusive, aimed at reducing the urban–rural gap in broadband access in developing countries and the digital divide throughout, especially in LDCs and landlocked developing countries.

The Commission also invited member States to use the multi-stakeholder approach in drawing up their national broadband plans and to develop a coherent policy and regulatory framework that promotes competition and investment in the ICT sector focused on achieving access to and affordability of broadband Internet.[2] Likewise, during the thirty-sixth session of the UNESCO General Conference, member States, in recognition of the importance of broadband Internet in development, passed resolutions with an emphasis on developing and fostering partnerships with the public and private sectors to narrow the digital divide and the gap between men and women, households, businesses and geographic areas at different socioeconomic

levels of the divide. The resolutions also took into account the needs of persons with disabilities and pointed out the importance of sharing and accessing open educational resources, promoting multilingualism and increasing developing countries' free access to open-source software and open standards (UNESCO, 2012).

The recent emphasis on broadband in ICT development arises from the emerging recognition that the nature and scope of interactive communications that can be accomplished by high-capacity data transmission and processing is fundamentally different from and exponentially more valuable than what was possible with older-generation voice and low-speed data connections.

For developed countries and affluent segments of the developing world, the advantages of broadband are well known. Apart from social networking, these include smart phones, tablets and an ever-growing cyberpresence. However, for most people in the world, they remain unknown or unavailable. The mobile telephone revolution has dramatically expanded access to basic voice telephone service across the world. Similarly, lower-speed Internet access (dial-up and second-generation (2G) mobile telephone technology) has made significant inroads among many lower- to middle-income populations. Nevertheless, the parallel explosive growth of the broadband universe has not yet sufficiently penetrated developing countries.

This study provides an overview of key issues relating to broadband ICTs in the context of international objectives for socioeconomic development. The discussion summarizes recent research, policy developments and practices associated with broadband ICTs around the world and offers a set of frameworks for considering and developing new public and private initiatives to promote broadband development.

The rest of this study is organized into four sections. Section 1 discusses the status and importance of broadband technology by examining the current broadband divide between developed and affluent segments of developing countries and the rest of developing countries, as the explosive growth of the broadband universe has

not yet sufficiently penetrated the latter group of economies. The section also reviews various ICT indicators across countries and discusses the potential benefits of broadband in invigorating economic development in countries and in improving social sciences, such as education, health care, and social and cultural services, as well as in facilitating the political engagement of the masses.

Section 2 introduces the current state of the broadband ecosystem. It describes how several layers of transmission networks, access facilities and end-user services are interconnected in the broadband infrastructure and summarizes recent developments in broadband technologies, end-user devices, and software and applications. In addition, section 2 describes the change in service providers in the sector – from State-owned enterprises to private suppliers in a competitive market. So far, however, this shift has not increased the need for outside financing in the sector, but the highly diverse and costly broadband world will eventually require innovative financing sources. The section also touches upon the people component of the broadband ecosystem, which requires skilled personnel on the supply side and educated customers on the demand side.

Section 3 deals with key policy challenges and opportunities in the broadband sector. Many countries, particularly developing countries, are facing significant challenges on the expansion of its existing broadband infrastructure, such as high capital costs of investment, the lack of financial resources and hurdles relating to the spread of broadband services, for example lack of skilled personnel and digital content in local languages. Therefore, overcoming these issues requires an enabling and supportive public policy environment. The section provides an overview of key elements of a successful ICT policy and regulations under rapidly changing market conditions and technological advances. It also emphasizes the importance of coordinating various ICT strategies and plans and obtaining the active participation of all stakeholders in devising coherent ICT policies. The final section provides a summary of the main findings and policy suggestions of the study.

1. Status and Importance of Broadband

Inclusiveness in the context of broadband development is manifested at several levels. At the global level, the issue is one of promoting equitable broadband development and related opportunities in all countries. The broadband divide exists at yet another level within countries – between urban and rural regions – widely prevalent not only in developing countries, but in developed countries as well. A lack of infrastructure and the slow expansion of high-speed networks to upgrade legacy services are leaving many rural areas further behind the wealthier, more densely populated urban and peri-urban communities, often compounding the dearth of other resources available in those areas. For development initiatives, the absence of broadband access makes delivering much-needed assistance more difficult, as programmes with digital components and communication are increasingly becoming essential elements of national and international support practices.

This study addresses the imperative of inclusive broadband development at both these levels – globally and within countries. Efforts to promote access to broadband may result in the enhanced physical installation of broadband services, but do not necessarily translate into reliable and long-lasting broadband access, which is essential if the benefits of broadband are to accrue.

1.1. Status of broadband development

Measurement of the status of broadband-related deployments, usage and activities, and research into the benefits and impacts of broadband for developing countries are very much a new field. Many governments in developing countries still do not closely track indicators of broadband, as opposed to traditional telephony and mobile phone penetration. However, more reliable and detailed data are increasingly becoming available. Recently, for example, the Broadband Commission for Digital Development,[3] under the sponsorship of ITU and UNESCO, compiled some of the most complete and useful data on broadband and Internet penetration throughout the world.[4]

Available data suggest significant growth over the past decade in broadband penetration in general, and a rapid increase in mobile broadband in particular since 2007 (ITU and UNESCO, 2012). The combined aggregate penetration levels are now above 25 per cent of the world's population.

Nevertheless, the rapid, substantial growth in broadband has not translated into significant increases in Internet access in LDCs, where only 6 per cent of inhabitants had access as of 2011. This proportion is expected to more than double by 2015, but by then, the absolute gap with higher-income countries is likely to grow even larger (ITU and UNESCO, 2012).

In addition to the digital divide in broadband penetration rates, significant disparities in the quality of broadband connection between developed and developing countries also exist. While slow broadband Internet connection reduces the range of services that can be accessed by users, high connection and monthly subscription charges significantly hinder the use of broadband services by end users. In 2010, the average European Internet user enjoyed about 80 kbps of bandwidth, as opposed to 1 kbps in Africa and 11 kbps in Asia and the Pacific and the Arab States (ITU, 2011a). Nonetheless, conventional broadband ICT indicators do not fully capture the digital divide in broadband connection. Recent studies have been trying to address this problem by incorporating quality aspects into broadband statistics.

Likewise, a number of academic and international institutions such as ITU have begun to formulate methods for comparative analysis of the role of the Internet and the digital economy in macro- and micro-levels of economic and social outcomes. Among the many challenges of studying the economic impacts of access to broadband, two stand out:

(a) Reliable empirical data are hard to find, since broadband is relatively new and only some developing countries have been fully exposed to it;

(b) Where some experience with broadband and development can be documented, the impacts are very difficult to separate from those of other concurrent initiatives and investments.

1.2. *Nature of the broadband divide*

The broadband divide has been widening not only between developed and developing countries but also among developing countries (see table). Many people in some developing countries and LDCs still lack sufficient access to broadband applications and markets, and advances in ICTs. Fixed broadband Internet subscriptions per 100 people have increased sharply in OECD member States, from 2.9 per cent in 2001 to 17 per cent in 2006 to 25.3 per cent in 2011. Developing countries have shown diverse paths. For example, countries in Europe, Central Asia, East Asia and the Pacific[5] boasted virtually no broadband penetration in 2001, but by 2011, penetration had risen to around 9 per cent, surpassing the world average. Broadband penetration in Latin America and the Caribbean made large strides in 2011, but was still below the world average. The Middle East, North Africa, and sub-Saharan Africa have so far not matched global trends in broadband Internet, as their statistics remain well below the world average.

The gap between telephony and broadband, and even narrowband or low-speed data and true broadband Internet, is perhaps far more significant in terms of potential socioeconomic impacts than earlier technological leaps. The digital divide is increasingly becoming a knowledge divide. The scope of information and of technical and socioeconomic know-how of educational, scientific, health and political resources available to one segment of society is virtually infinite, while the remainder of the population remains excluded from the information society.

In many ways, the broadband divide represents a specific intensification of the existing digital divide. Countries and people that are excluded from broadband risk not having access to an entire range of applications and benefits provided by the Internet.

ITU has developed a number of studies and measures of ICT development. Its ICT Development Index seeks to provide a comprehensive comparison of countries' ICT access, use and skills, incorporating 11 distinct statistical indicators, while allowing the examination of relative strengths and weaknesses along separate metrics.[6] Under this methodology, the top-ranking countries as of the end of 2011 are the Republic of Korea, Sweden, Denmark and a few other OECD economies. Those at the bottom of the rankings are nearly all in Africa. Overall, there is a correlation between country-income levels (gross national income) and their ICT Development Index results, notwithstanding a few notable exceptions (figure 1).

Within countries, especially developing countries, disparities between rural and urban regions in terms of ICT and broadband development are even more pronounced. Figure 2 shows the correlation between the percentage of urban population distribution compared with that of

Table. Fixed broadband Internet subscribers by region and development status, per 100 people			
	2001	**2006**	**2011**
Member countries, Organization for Economic Cooperation and Development	2.9	17.0	25.3
Europe and Central Asia*	0.0	2.6	9.2
East Asia and Pacific*	0.0	2.8	8.7
World	0.6	4.6	8.6
Latin America and the Caribbean	0.1	2.3	7.7
Middle East and North Africa	0.0	0.9	3.2
Sub-Saharan Africa	0.0	0.1	0.2
Least developed countries	0.0	0.0	0.1

*   *World Bank definition; excludes high-income countries*
Source: World Bank World Development Indicators, accessed 25 September 2013.

Figure 1.   ICT Development Index and gross national income per capita, 2011
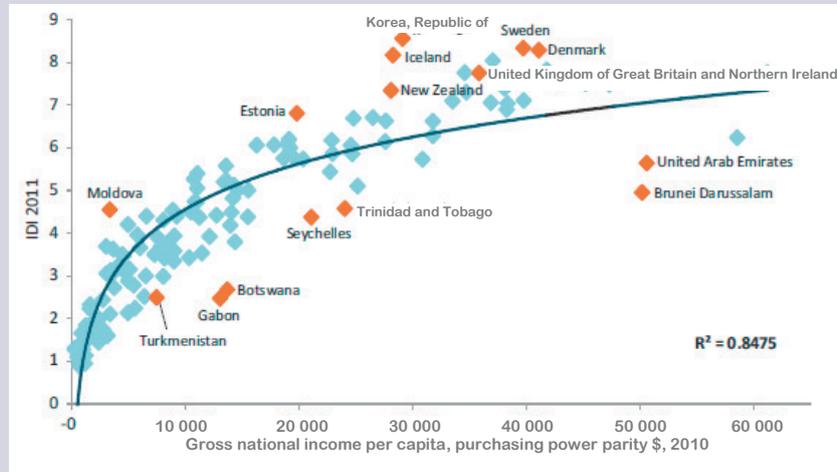
Source: Reproduced from ITU (2012a).

the rural population and the overall teledensity (fixed lines plus mobile telephones per 100 population), broken down by country income levels. This includes several Asian countries. In many parts of Africa and Asia, broadband connectivity is virtually non-existent outside main urban centres, and even basic (2G) mobile coverage is often limited.

Figure 2.   Correlation between teledensity and percentage of the rural population
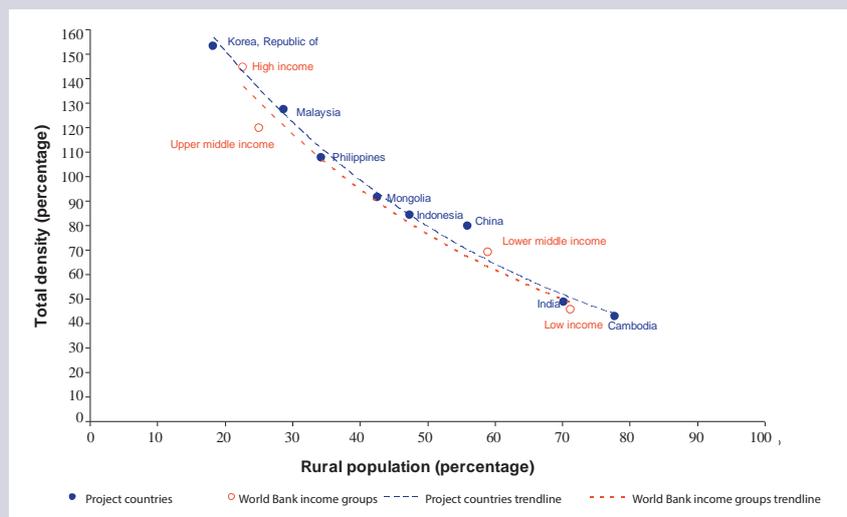
Source: Reproduced from UNCTAD(2013).

The advent of ICTs and Internet connectivity has been facilitating the sale or purchase of goods or services conducted over computer networks by methods specifically designed to receive or place orders, the so-called e-commerce. In 1999, an estimated 300 million users accessed the Internet, and approximately one fourth of them made purchases worth approximately $110 billion from electronic commerce sites (OECD, 2000). By 2013, this figure was expected to reach $1.25 trillion (World Trade Organization (WTO), 2013). There are numerous types of online commercial transactions conveniently labelled "business-to-business", "business-to-consumer", "business-to-government" and "mobile e-commerce". Business-to-business e-commerce, such as transactions between a manufacturer and a wholesaler, or between a wholesaler and a retailer, stood around $12.4 trillion – 90 per cent of global e-commerce at the end of 2012 (WTO, 2013). Such rapid sector growth has relied heavily on the spread of advanced telecommunications systems, particularly those that offer broadband and mobile broadband services at affordable prices for both consumers and producers.

Despite the surge in volume of e-commerce transactions, the digital divide in online trade has persisted. A sluggish diffusion of ICTs and Internet connectivity in certain developing countries has been marginalizing their businesses and consumers from rapidly growing global e-commerce markets. While North America, Asia and the Pacific, and Western Europe in 2012 captured 33.5 per cent, 30.5 per cent and 26.9 per cent of the world business-to-consumer e-commerce sales, respectively, the Middle East and Africa, and Latin America only accounted for 1.9 per cent and 3.4 per cent of the total, respectively. Among developing countries, only China managed to enter the top e-commerce sellers in the world. The United States of America is the largest e-commerce market, with a 31.5 per cent share and $343 billion sales in 2012, followed by Japan, the United Kingdom of Great Britain and Northern Ireland, and China (eMarketer, 2013). Eurostat (2012) firm-level data on European countries show significant variations in the share of companies making e-commerce sales, for example, from 4 per cent in Romania to 36 per cent in Norway. A similar variation can be observed in companies' e-commerce purchases as well: from

9 per cent in Romania to 71 per cent in Denmark. Likewise, there is an e-commerce divide among developing countries in company e-purchases; while more than half of Brazilian companies placed orders online in 2010, this figure falls below 5 per cent in 2009 in Egypt, Thailand and Azerbaijan (Fredriksson, 2013).

1.3. Impacts and benefits of broadband

Broadband offers significant benefits ranging from economic development to social inclusion when appropriate polices are applied. While empirical studies have identified substantial productivity and employment gains in enterprises, some country case studies have indicated significant improvements in access to education and health-care services even in LDCs when ICT and broadband policies were successfully incorporated into broader development strategies. Moreover, an increase in broadband penetration may generate positive externalities in sociocultural enrichment, as it can facilitate the participation of women and persons with disabilities in social and economic activities and access to arts, literature and indigenous cultures. It may also stimulate political participation and the spread of new ideas, both in developed and developing countries.

1.3.1. Economic development

The adoption of broadband at the company level has had positive effects on productivity and job creation (Katz, 2012). Most impacts to date have been realized through its adoption by larger, multinational firms, while the greatest potential for further growth remains for small and medium-sized enterprises (SMEs) to improve operating efficiency by better integrating broadband in production, sales, marketing and distribution processes (Nottebohm et al., 2012). The availability of reliable broadband infrastructure and services in rural areas in particular can build a strong foundation for businesses to locate and expand in these areas, helping reduce the pressures of excess urbanization.

Developing economies are also finding new opportunities in domestically produced software and online applications (UNCTAD, 2012a). Lower

labour costs and the efficiencies of storing and accessing data within domestically based servers can facilitate a cost-effective local software industry, while the benefits of customized solutions for domestic businesses and government can be extensive. Nevertheless, not all developing countries are reaping these benefits equally. The lack of skilled human resources, insufficient infrastructure, difficulties in accessing finance, as well as the absence of coherent and effective ICT and broadband policies, have been hindering the development of ICT-enabled services in many developing countries.

There is some research seeking to document a good evidence base of broadband's positive economic benefits. One widely cited World Bank study found that the average increase in gross domestic product (GDP) growth in developing countries was 1.38 per cent for each 10 per cent increase in broadband penetration (Qiang and Rossotto, 2009). These results have established an initial benchmark for broadband-related economic impact studies, as well as a strong incentive for governments to invest in broadband growth.

More recently, research and reports have sought to assess the link between broadband development and economic growth. An ITU-sponsored study in 2012 presented recent research on contributions of broadband to economic growth, productivity gains, employment and output, creation of consumer surplus and improvement of firm-level efficiencies (Katz, 2012). The study also included research findings indicating that the impacts and benefits of broadband increase after adoption reaches a critical mass of about 20 per cent of the population, a level that many developing countries have not yet come close to achieving (Koutroumpis, 2009). In terms of GDP effects, the ITU study suggests significantly lower positive effects than the aforementioned World Bank study, especially for developing countries. For example, in Brazil, the impact on GDP of a 1 per cent increase in broadband penetration can reach 0.008 per cent. For Latin America and the Caribbean as a whole, the average impact is 0.0158 per cent. Meanwhile, a study by the Inter-American Development Bank (Zaballos and Lopez-Rivas, 2012) found that a 10 per cent increase in broadband penetration in Latin America and the Caribbean corresponded with an average

per capita GDP growth of 3.19 per cent. Despite the difference in these estimates, the positive economic effects of broadband penetration call for a more systematic assessment of the factors that link broadband to higher economic growth.

A World Bank and African Development Bank study estimates the direct contribution of ICTs on Africa's GDP at around 7 per cent (World Bank and African Development Bank, 2012). Nevertheless, mobile technologies, in particular mobile broadband applications, offer significant benefits to Africa's social and economic development if they can be provided at affordable prices. Africa is the birthplace of an ingenious financial instrument called mobile money which, as of 2012, has been deployed in 56 sub-Saharan African and 5 Middle Eastern and North African countries out of a global total of 124 (WTO, 2013). Mobile broadband ICTs can facilitate a surge in these mobile services across Africa.

In a similar vein, a study prepared by McKinsey & Company reports significant gains for developing countries. According to the study, bringing broadband penetration levels in emerging markets to Western European levels could add $300 billion–$420 billion in GDP and 10–14 million jobs . The effect is relatively more noteworthy for African and Latin American counties, which are estimated to gain in the range of 0.7–1.6 per cent and 0.8–1.4 per cent, respectively (Bukktereit et al., 2009). The same study also emphasized the special importance of mobile broadband in stimulating economic growth in countries that lack adequate fixed-line broadband infrastructures, such as sub-Saharan Africa and North Africa. The study also highlights the importance of supportive regulatory regimes, particularly in poor and rural areas.

These anecdotal evidences, however, do not establish a definitive causal link between economic growth and ICT development. Developed countries tend to have better ICT development levels and high broadband penetration rates, but this does not imply the same contribution of ICTs to developing countries with resource-based industries. Moreover, unless proper policies are introduced, there is also very little evidence supporting the view that ICT activities will encourage or affect pro-poor economic growth (Batchelor et al., 2005).

1.3.2. Broadband in education

In developing countries, the goal to employ broadband in the classroom, especially at secondary- and higher-education levels, is tied directly to long-term social objectives, particularly the vital need for a technology-literate population and workforce. The lack of workers skilled in computer- and Internet-related technologies inhibits overall ICT-sector growth and the upgrading of functions in all other business and government realms. A recent study of the Broadband Commission (ITU and UNESCO, 2013a) highlights the tremendous gains being made in the deployment of advanced technologies in education and the continuing disparities in ICT access between students in developed and developing countries.

Some of the innovations driving educational transformation include the use of digital textbooks, Internet-based research and learning tools, audio-video presentation materials, interactive teaching and learning software, open access digital libraries and courseware, virtual science laboratories and museums, and all manner of remote distance-learning and online degree programmes. Many countries have introduced such programmes. Advances in ICTs and the spread of broadband connectivity

have encouraged many countries to begin exploring the possibility of provisioning tablet devices directly to students in lieu of textbooks. The Republic of Korea, Thailand and Turkey have recently announced large-scale programmes to gradually replace physical textbooks with digital textbooks, generally accessed from a tablet computer. Digital textbooks are not only easy to update but hold a potential for facilitating self-directed and customizable learning by offering rich content, and tools and resources that can be tailored to learners' abilities and interests. They are particularly useful for learners who are unable to attend regular school lessons for health and disability-related reasons, as well as for learners living in communities with a shortage of media-rich learning resources or school teachers. The initial findings concerning the Turkish case (box 1) have shown an increase in Internet penetration and literacy in the pilot areas.

1.3.3. Broadband in health care

Broadband networks can link doctors, clinics and treatment centres in rural areas to national medical resources, allowing access to remote consultations and diagnostics and tracking health conditions and epidemics much more effectively. The distribution of basic health information, such as pre-natal and maternal care, the prevention and

---

Box 1.   Turkey: ICTs for education FATIH project

In Turkey, the Ministries of Education and Transportation teamed up with Türk Telekom and several local companies to provide technology in the classroom. The nationwide project, Movement to Increase Opportunities and Technology (FATİH), aims to equip 42,000 schools and 620,000 classes with the latest information technologies and reach some 17 million students and 1 million teachers and administrators. The project is estimated to cost $8 billion, with 55 per cent of the funding coming from universal service funds (ITU and UNESCO, 2013a).

The aim of the project is to provide ICT equipment to classes in order to achieve ICT-supported teaching by the end of 2013 and reach completion by 2015. The project is part of a broader set of goals set out in policy documents of the Government of Turkey (Strategy Document on the Information Society, the Development Report, the Strategy Plan of the Ministry of Education and the ICT Policy Report). The principal goals are to ensure that Turkey makes the transition to an information society and achieves e-transformation.7

The pilot projects were launched during the 2010–2011 academic year.[8] In the Kocaeli municipality of Turkey, where the project served as a model for subsequent deployments throughout the country, 81,000 personal computers were distributed to classmates. This helped students and their families develop ICT literacy, as they are allowed to bring their computers home. Statistics show that the programme has increased digital subscriber line (DSL) subscriptions in Kocaeli, which now has the highest home DSL subscription rate in Turkey. Further, the education technology department found that 82 per cent of students reported that their siblings used computers, 55 per cent stated that their fathers used them and 33 per cent, that their mothers used computers (ITU and UNESCO, 2013a).

Source: UNCTAD.

treatment of malaria and other common diseases, first-aid practices and many other topics, can directly improve the quality of life for previously isolated communities. ICTs also facilitate the integration of health-related data into national databases and networks, which allows for more effective and efficient management of all aspects of a nation's health-care services. A range of existing and planned innovative e-health applications and services marks the beginning of dramatic changes in global health-care delivery (ITU, 2012b). The Government of Rwanda has initiated several projects in health care by integrating ICT projects into its broader development plans. The projects aims to automate health-care information systems and improve access to health care in remote areas (box 2).

1.3.4. Social and cultural enrichment

Broadband offers important social and cultural benefits with effects that may be realized over a longer time horizon. In many cases, broadband complements other developmental objectives in countries, while also creating new prospects for social inclusion and empowerment. Key examples of how broadband can help achieve these goals are described below.

Gender equity. In many countries, advocates of ICT development have recognized an opportunity for these technologies to play a leading role in overcoming historical inequities between men and women in employment, social roles and political empowerment. Through community facilities and individual devices, access to broadband can create channels of communication, knowledge sharing and mutual support for women isolated from mainstream social and economic structures. ICT technologies support women's entrepreneurial activities and make it easier to provide equal education opportunities for girls, including access to broader sources of learning and support for women's health and child bearing. (World Bank, 2006; infoDev and Price Waterhouse Coopers, 2010)

Persons with disabilities. ICT providers can enable persons with disabilities to participate more fully in society with the help of customized software, computer and phone equipment. In 2008, the Department of Economic and Social Affairs established the Global Initiative for Inclusive ICTs, also known by its acronym G3ict,[9] which has developed a virtual toolkit on e-accessibility policy, with support from a variety of public and private partners.[10] This and other similar initiatives are helping governments and companies make

---

Box 2.   Rwanda: ICT health-care initiatives

Rwanda was among the first African economies to make ICT an integral part of its development plans and poverty-reduction strategies to fight poverty and facilitate economic and social development. Rwanda sets precise, measurable targets for activities promoting the cross-sectoral use of ICT in its development plans (ITU, 2011b). In health services, the Government has launched several ICT initiatives such as the health insurance information system, the community health worker reporting and information system, and telemedicine. The Government initiated the health insurance information system project to improve the delivery of health services in Rwanda. The project will automate health insurance services that rely on paper-based authentication and claim processing. The new system, planned to be operational by the end of 2013, is expected to enable patient roaming, meaning that patients can receive treatment anywhere in the country and benefit from seamless health insurance claims processing and a unique patient identifier integrated with national identification documents (Rwanda Development Board, 2011).

The community health worker reporting and information system aims to improve reporting and information sharing by community health workers. This initiative will automate a paper-based reporting system containing maternal and child health statistics about patients.

Telemedicine is another project that aims at facilitating specialized health-care services in remote areas. The project will allow medical information to be transferred through audiovisual media and other technologies for purposes of diagnosing or treating patients. Telemedicine has been already in use in three teaching hospitals and two rural hospitals in Musanze and Kabgayi that are connected to King Faisal Hospital. The project should be expanded to include other health institutions across the country (Rwanda Development Board, 2011).

Source: UNCTAD.

rapid progress in empowering persons with disabilities to access education, jobs and other social amenities.

Arts and literature. Broadband plays a major role in distributing and enabling access to all forms of human artistic and cultural endeavours. It enables unlimited access to creative works in high-quality formats, including paintings, sculpture, architecture, music and books. New generations of artists are producing works using digital tools and the canvas of the Internet. millions of books are available for download, often free of charge. Programmes such as the Gates Foundation's Global Libraries initiative[11] are bringing yet more electronic resources and connectivity to remote populations.

Indigenous cultures. ICTs can also serve as a valuable resource to support and preserve the cultural heritage of indigenous peoples. In some respects, ICTs have often contributed to diminishing indigenous cultures by accelerating assimilation. More recently, however, movements have begun to embrace and highlight unique cultural features in many developing countries. Some of these efforts utilize broadband ICTs to connect disparate members of tribes and ethnic groups, share their stories and knowledge and strengthen dying languages or traditions. ICTs can also act as a preservation medium for arts, crafts, skills, mythologies and almost any other cultural memory. Through these efforts, numerous groups have been working not only to support indigenous peoples, but to expand awareness of their lives to others through educational initiatives (UNESCO, 2011).

1.3.5. Political engagement

Some the most significant and dramatic examples of the transformative potential of ICTs have been witnessed in recent years in the political arena. Expanding access to the ability to communicate ideas can contribute to increased political participation in developed and developing countries alike.

Information access. ICTs enable more knowledgeable and effective participation across the spectrum of political involvement. Bloggers have emerged as the front lines of investigative and activist political advocates in many countries, while traditional journalism has extended its reach by online reporting. Political

parties and other organizations have much more resources to connect with and influence voters, contributors, as well as politicians and government agencies. The presence of so many outside information sources also helps reinforce pressure on government to provide greater openness and transparency, allow access to all manner of internal records and data, investigate and publicize questionable practices and inform citizens in a politically neutral manner. ICTs – especially the social media – have also played a pivotal role in activist movements, contributing to political reforms around the world.

E-government. An essential contribution of ICTs in the public sphere has emerged in the form of e-government programmes. Many governments have recognized that there are a variety of opportunities to employ broadband ICT-based services and applications to improve and expand public services, and to encourage citizens to enhance the quality of their lives. Delivery of government services, including ICT capacity-building and public-awareness programmes, can be a vital means to enhance the value of ICTs for citizens and governments alike. Public ICT networks and services for rural communities provide other benefits for citizens, such as access to local government websites, documents, licences and tax records.

E-government initiatives can provide momentum for promoting open governance, transparency and the increased participation of citizens in democratic governance. The Open Government Directive issued by the Obama Administration, the Malmö Ministerial Declaration and the Digital Agenda for Europe highlight citizen participation and transparency in government and politics. Moreover, many Member States of the European Union have passed relevant legislation or are in the process of doing so while simultaneously developing new practices in e-government (Capgemini et al., 2011). These initiatives can alleviate certain problems associated with poor government services such as low levels of citizen trust, corruption, poor performance, low accountability and abuse of power by public officials. By allowing the public to access the business of government – from legislative meeting minutes and budget proposals to map-

based information – e-government also offers a panacea for these problems.(Godfrey et al., 2013)

Political activism. Advanced ICTs have also played a pivotal role in activism and even revolutionary movements, contributing an essential component to popular uprisings and political reforms around the world. Despite the best efforts of some regimes to suppress dissent, information-age means of communication are next to impossible to inhibit. The combination of Facebook, Twitter, texting, YouTube and other video channels, bloggers, and international media sources has allowed activists to share strategies and gain sympathetic support in numerous societies, including repressive regimes and open democracies. In several cases, including the recent Arab Spring uprisings in the Middle East, ICTs may have tipped the scales in favour of full-scale revolutionary change.

Broadband-enabled ICTs pose challenges to users and governments alike. The role of these technologies in various areas of political engagement may be skewed by those who can access information and whose viewpoints or interests are represented or disseminated. Moreover, broadband allows the rapid spread of social media among social masses, which can also be used for misinformation and propaganda purposes because of the anonymity of its participants. Since there is often no moderator to verify the reliability of its content, social media may used to rapidly spread rumours and false information (Comnios, 2011). For instance, during the riots in the United Kingdom in 2011, social media were used to mobilize the masses for non-democratic and non-progressive actions (BBC, 2011a). Some social media users spread false news and information over social networks during the Syrian conflict (BBC, 2011b).

2.   The Broadband Ecosystem

Access to broadband ICTs must be understood in the context of their evolution during the twenty-first century as a dominant medium of human interaction. Broadband implies not merely speed or capacity of network data transmission, but a wide array of capabilities, services and applications, as well as technology configurations and platforms, all of which depend upon high-capacity interconnectivity among their components. Thus, true access to broadband is measured by the usefulness of such access to end users – individuals, households, businesses and institutions – and the specific activities they are able to accomplish by utilizing broadband communications.

Therefore, it is important to recognize the features and components of what has been called the broadband ecosystem: the interrelated elements that must be in place at multiple levels for broadband services to deliver their potential. The following descriptions summarize the main components of this ecosystem, particularly in the context of a large number of developing countries where broadband is still far from widespread.

2.1.   Infrastructure and services

Broadband ICT infrastructure consists of several layers of transmission networks, access facilities and end-user services – part of the integrated ecosystem – all of which can be deployed in a variety of configurations. The broadband-based services obtained by end users are delivered over this infrastructure and are provided by a diverse group of related and competing suppliers. Some principal elements of broadband infrastructure and services are described below.

Backbone networks. Broadband interconnection depends upon very high-capacity international and national backbone transmission networks that utilize fibre-optic cables for most high-capacity intercity routes and international connectivity. Ultimately, all broadband networks and services must be interconnected with the global Internet as well as national public and private data networks. The transmission capacity required on these networks will increase as more users are connected to broadband services, as will the costs of the national backbone network. A typical fibre-optic network buildout to rural regions, for example, can cost around $5,000–$8,000/km.

Expanding broadband access beyond urban centres is one of the main challenges of achieving universal broadband. This requires adding capacity to reach hub locations that are close to rural population centres. Such broadband hubs might include wireless transmission and/or fibre optics – and sometimes satellite connections – all of which can be expensive to construct and maintain. These factors place significant constraints on the willingness of commercial operators to extend backbone networks deep into rural regions, where revenues from local broadband services may be low and unreliable.

Local broadband access networks. Completing the broadband connection requires wireline or wireless links between the backbone network and end users. These are often referred to as "the last mile". Traditional wireline telephone networks are widely used to provide dedicated broadband connections to businesses, institutions and homes in many countries, including via asymmetric digital subscriber line – ADSL – connections, coaxial cable television systems and fibre to the home, or FTTH. The costs of building such wired local access connections to homes in towns and villages depend heavily upon the density of the location, such that higher expected demand can drive down unit costs dramatically, from over $1,000 to less than $100 per connection.

All of these platforms are widely deployed in developed markets and are finding new openings in developing countries, at least within relatively dense and higher-income urban areas. Established incumbent telecommunications operators, along with a variety of new competitors, are seeking to expand the market base for broadband services

by delivering combinations of options known as multiplay packages that include local and long-distance telephone calling, high-speed Internet access and television entertainment.

Wireless broadband. The most significant trend contributing to the worldwide spread of broadband has been the rapid and dramatic increase in the capacity and functions of wireless telecommunications services. The mobile revolution was driven by the availability of flexible, convenient and increasingly affordable voice telephony. As basic mobile service upgraded to 2G, 3G and 4G technologies, together with fixed wireless such as Worldwide Interoperability for Microwave Access – WiMAX – or Wi-Fi, broadband followed a similar trajectory. More and more users worldwide, especially in rural areas, are gaining wireless broadband connections. Similarly, the cost structure of wireless networks continues to evolve rapidly as new innovations and growing demand drive down the costs of infrastructure and services, including for rural and remote networks. Some estimates foresee mobile communications services reaching a price threshold as low as $1 per month for basic users. Even broadband prices are already decreasing to below $10 per month in some markets.

Retail broadband Internet services. In a broadband environment, infrastructure and retail end-user services that are delivered over broadband networks are not always the same. Services can be offered by multiple providers, including network operators as well as independent providers, such as Internet service providers, mobile virtual network operators, aggregators and resellers, and other third parties. The more diverse the service offerings, the more robust the broadband market and ecosystem. For many users in developing economies, especially rural regions, access to broadband is most likely to be available through public access Internet facilities that offer the use of computers, Internet, telephone and other ICT equipment and services. Typical models include government-sponsored telecentres, as well as private commercial cybercafes, along with ICT labs in schools, post offices, libraries and other public places. In some locations, public broadband access may be offered simply as a free wireless (Wi-Fi) signal, managed or funded by the local government.

Data storage and exchange points. For broadband, the massive amount of digital information and applications that must be stored and exchanged requires separate facilities and increasingly large investments. Companies and governments that deal in terabytes and petabytes of data require access to infinitely huge storage sites – data warehouses – along with ultra-high capacity transmission links and exceptionally reliable and secure power sources, physical premises and data protection protocols. The collective body of such facilities worldwide is referred to as the "cloud". However, there are great cost efficiencies to be gained from retaining locally produced and consumed data within the boundaries of individual markets, including both domestically produced content, and local pockets of major global applications (OECD et al., 2013). Such a strategy can be achieved by establishing designated Internet exchange points, which keep domestic data within the national network, as well as local data warehouses and domestic cloud arrangements.[12]

2.2. End-user devices

The advances involved with broadband require far more sophisticated equipment for end users than what was necessary to benefit from traditional telephone services. Like the underlying networks and transmission technology, the broadband revolution has been driven by an ongoing mass transformation in the market for end-user devices that connect to these networks. The separation between computers and phones is becoming entirely obsolete, and the range of consumer and business equipment that now qualifies as smart – that is to say, that can connect to the Internet and other devices and perform multiple interactive functions – continues to expand.

Smart phones and tablets have become the fastest growing elements of the hardware market. Personal computers and laptops remain vital, especially in the business world, but even these tend to merge with the mobile and tablet domain. Meanwhile, a host of other devices are signing up for the Internet of things, from smart televisions, game consoles and countless other consumer toys, to security devices, automobiles and nearly all links in the chain-of-business processes.

As the scope of hardware choices continues to expand rapidly, the cost of such equipment has been constantly declining, which creates increasingly flexible options for utilizing broadband services. In developing markets, most users favour smaller, more affordable mobile devices, while larger, more robust computers are more often found in offices, schools and access centres. Even with cost reductions, however, the price of such equipment still represents a significant challenge in the development of the local broadband market for developing countries. Rapidly changing standards and obsolescence compound the challenge, as customers are unlikely to be able to replace or upgrade devices very often.

2.3. Software, applications and content

The value and appeal of broadband services are fundamentally dependent on software platforms and operating systems, multimedia applications and the wealth of information content that is made available through broadband connectivity. For many users in developing countries, the nature of information that can be obtained with the Internet, e-government networks, mobile broadband applications and other sources may not yet be as comprehensive as for customers in more developed markets. Scope-of-information applications and available content continue to expand without limit, and in the context of the social networking revolution, users themselves are becoming the most significant source of such content. As developing countries become more connected to the global information society, their interests and needs will necessarily have to be more reflected in the knowledge bases that they can access and to which they can contribute.

Already, the rapid emergence of broadband networks and advanced consumer devices has yielded an explosion in new "killer apps": ICT applications that have become virtually ubiquitous. The most prevalent of these are in the realm of social media and constitute the interactive, user-driven phase of Internet development known as Web 2.0. Facebook, the single most widespread online application, was launched only recently – in 2004 – and in less than a decade has grown to over a billion users, half of whom primarily use mobile devices to access the service. Numerous other such services, from Twitter and Google+ to Chinese Qzone and Sina Weibo, reach hundreds of millions of users worldwide. Other types of social media allow limitless sharing of videos (YouTube), photos (Flickr), and ideas (weblogs). Virtually all of these infinitely popular Internet applications were created in the mid-to-late 2000s, concurrently with the spread of broadband communications.

The newest wave of applications operating through mobile phones has heavily augmented, and to a large extent, displaced, conventional online computer-oriented applications. These new applications can offer highly innovative features unique to mobile broadband, further reinforcing demand for wireless services and devices.

2.4. Intellectual property rights

Intellectual property rights (IPRs) aim to stimulate the creation of new ideas, designs and products by protecting the inventor against unfair competition and the unauthorized disclosure of trade secrets. The mounting importance of technology and creative works in the modern economy has been increasing the value of intellectual property assets relative to physical assets.[13] In e-commerce, for example, intellectual property plays a crucial role, as many products involved in e-commerce possess intellectual property such as music files and software; the system that facilitates e-commerce also uses IPR-protected assets such as Internet networks, software, chips, routers and switches.[14] A firm's capacity to absorb knowledge and apply it to innovation is mainly determined by the extensive and complementary relationship between firms and the knowledge system, which includes organizations such as universities, financial institutions, industrial infrastructure and entrepreneurial associations in which they are embedded (Gehl Sampath, 2007). In LDCs, however, certain features of their institutional framework in which learning and knowledge generation is embedded might limit the role of IPRs in inducing innovation. For example, in Bangladesh, an UNCTAD study (Gehl Sampath, 2007) found that 50 per cent of the agro-processing firms, 96 per cent of pharmaceutical

firms and 55 per cent of textile and ready-made garment manufacturers surveyed considered that technology transfer from external sources and the presence of IPRs in the local context did not play a role, either as a direct incentive for innovation or as an indirect incentive enabling knowledge spillovers. Therefore, coherent national policies that focus strategically on enabling innovation in the three sectors will play a key role in transforming the sectors into more competitive modes and enable local firms to deal with any potential harmful effects of intellectual property protection.

Intellectual property also poses challenges to developing countries that may wish to promote broadband e-infrastructure and participate in the knowledge economy. Due to scarce financial and human resources, many LDCs have also faced difficulties in increasing educational attainment and spreading literacy. The fact that developed countries are the main producers of knowledge goods and existing IPR regimes is a current and potential deterrent to learning in the developing regions (Patel, 2010). Moreover, today's international intellectual property laws are a significant barrier to reform, as multilateral and bilateral trade treaties are increasingly introducing protective measures and limiting the policy space of domestic policymakers (Shaver, 2010).

Initiatives have been launched to overcome these barriers to global knowledge goods. One such initiative, access to knowledge, is also known as A2K. It covers a host of policy issues, including patent and copyright policy, media openness, access to ICTs and government information, open-access scholarship, spectrum allocation, interoperability standards and the preservation of traditional knowledge.[15] The A2K campaign particularly recognizes the need for strengthening economic development in the South through educational resources, in particular curricular resources in primary, secondary and tertiary education. It aims to limit the barriers imposed on access to knowledge by current and forthcoming intellectual property policy and widen the horizons of access by positively licensing knowledge goods. The success of these initiatives also depends on ICTs, including broadband. These technologies make possible the widespread low-cost distribution of high-quality intellectual property. For example, the open-source movement initially

took place in computer software but was later applied to intellectual property related to teaching and learning activities such as open-education resources, open courseware and open knowledge (Patel, 2010).

Innovative capacity within local firms is very low across all three sectors. The study finds that the presence of IPRs in the local context does not play a role, either as a direct incentive for innovation or as an indirect incentive enabling knowledge spillovers (through various technology transfer mechanisms such as licensing, imports of equipment and government–firm technology transfer). Within a country, IPRs tend to benefit transnational corporations operating in the local market, as local firms are not sufficiently specialized to protect their innovations under the current IPR regime.

2.5. *Financial sector*

The multiple facets of the broadband ecosystem require a considerable degree of financial investment and economic support. In the past, the build-up of telecommunications services was financed initially by public funds in most countries, as telephone operators were State-owned enterprises. The shift to private, competitive market structures and the rapid rise of the mobile industry did not dramatically expand the role of outside finance in the sector, as most large telecommunications operators have the means to self-finance their capital investments in this profitable and healthy market.

The new, highly diverse and costly components of the broadband world are creating a greater need for innovative financing sources and wider contributions to ICT-sector investment. It is thus important to recognize that financial institutions, funding mechanisms and a range of public and private actors play a vital role in the ecosystem. Expanded participation in the financial side of the ICT sector can be a healthy side benefit of broadband development. Diversification of investment sources, asset ownership, revenue streams and business relationships across a larger portion of a nation's economy can help strengthen economic ties in general and ensure greater

public and private commitment to the growth of the information society.

In most developing countries, the private financial and banking sector has been largely on the sidelines of ICT-industry investments. However, new financial instruments, such as domestic venture capital funds, could be established to allow private and institutional investors to participate in the medium- to long-term prospects of broadband development. Similarly, smaller entrepreneurs, start-up ventures and partnerships may be in a better position in the broadband market to contribute to, and benefit from, market growth, especially with incentives from public broadband policies.

In addition, the growth of broadband and mobile ICTs has helped to enable new initiatives within the financial sector. These technologies expand citizen access to banking, money transfer and a growing trend of mobile money services. By partnering with ICT companies, financial firms can have a stronger impact on sector development, and their own contribution to society can expand as well. For such expansion to continue, and in particular for robust e-commerce services to take hold in developing countries, the financial services industries will need to become even more deeply committed to integrating their industry with the ICT revolution.

2.6. Human skills and tacit know-how

Finally, beyond all the technical facilities, infrastructure, equipment, software, and other components, an equally critical element of the broadband ecosystem involves people in virtually every sphere of activity. This includes skilled personnel on the supply side, from business managers and employees, to public officials and users on the demand side. It is especially difficult for markets with a low supply of technical workers to enhance the labour force needed to expand highly technical services, especially in remote

locations, where installation, maintenance, technical support and customer service will be especially important.

As many users are unfamiliar with computers, the Internet and other advanced ICTs, local broadband providers will need to reinforce their operations with significant customer assistance, training and outreach to encourage demand and ensure good market responses. All of this implies a far greater level of local human resource responsibility than is necessary for basic telephone services. Key personnel may be part of the staff of a local telecentre or telecommunications service provider, or engaged through schools, libraries and local government offices to help support community ICT development. They may also contribute actively to the creation and dissemination of local information content, in cooperation with rural users, community groups and businesses.

Human skills are also important for improving the supply capacity of enterprises, particularly SMEs, in developing countries. The lack of a workforce with sufficient training in ICT and mobile technology is hindering SMEs from diversifying or branching out into e-commerce (WTO, 2013). Without sufficient awareness in ICTs or a skilled workforce in the private sector, developing countries will not harvest the full benefits of accessing new ICTs and increasing broadband penetration.

Human capital improves innovation capacity of an economy as well. OECD data show wide disparities in innovation output between OECD regions. Human capital is the strongest determinant of the outcome, almost double the impact of research and development (OECD, 2010). Trade in capital goods, participation in global production networks and foreign direct investments can lead to technology spillovers to local firms, either directly through licensing and technology transfer or indirectly through tacit know-how passed on to local personnel (UNCTAD, 2012b). Nevertheless, in the absence of skilled personnel, a country's technology absorption capacity will be weak, and local innovation output will deline rapidly.

3.   Key Policy Challenges and Opportunities for Broadband Development

The preceding sections highlight the wide scope of interrelated trends and interests that are part of the rapidly evolving broadband development landscape. While most governments, industry participants and international institutions recognize the importance of expanding and accelerating broadband and its benefits in developing economies, a range of complex challenges hinders such growth. Current challenges spread across the full spectrum of ecosystem components are as follows:

(a)   High costs of capital investments in infrastructure;

(b)   Lack of financial mechanisms and investor interest in marginal areas;

(c)   Low revenue potential from low-income, low-demand users;

(d)   High costs for broadband devices, compared with simple phones;

(e)   Lack of awareness, skills and training in the use and value of broadband;

(f)   Insufficient supporting infrastructure – electricity and roads – in many locations;

(g)   Inadequate ICT training and knowledge among government officials;

(h)   Lack of digital content in local languages and cultures;

(i)   Harnessing the benefits of broadband infrastructure.

3.1.   Information and communications technology policy and regulation

Laws, regulations and government oversight need to adapt to the rapidly changing dynamics of the broadband market. Policy regimes that were established to address more traditional communications and information industry conditions may prove inadequate to support the transition to an integrated broadband setting. Some key concerns are summarized below.

Converging regulation. Most countries have a separate telecommunications regulatory agency responsible for licensing, economic regulation and frequency management relative to a defined group of legacy telecommunications operators. However, other broadband and ICT-related activities may be regulated under separate broadcasting authorities, cable television and satellite rules, media and information content authorities, business and corporate regulations, and a variety of other regimes. Some countries have begun considering converged media or ICT regulators to address the overlap of these issues, while others have emphasized light regulation, focused mainly on fair competitive practices. Regardless of the approach, the implications of all multifaceted regulatory practices need to be understood and accounted for.

Facilitating market entry. Virtually all countries that have achieved high levels of broadband access have emphasized competitive, coherent, market-oriented policies as a foundation for ICT market growth and innovation. Market-based technology-neutral policies help ensure that investors and customers keep up with rapidly changing technologies and applications, while vigorous competition ensures that cost savings are passed on to users. Even in rural areas, there is an increasing array of solutions that can deliver commercially viable broadband services to many locations and user groups, given the flexibility to deploy cost-effective technology and targeted service options. Effective rural broadband development policies thus tend to facilitate market entry and competition in the delivery of network infrastructure and services at all levels.

This is accomplished, for example, by issuing multiple licences and using a relatively open regime that allows new competitors to establish service and build networks wherever they perceive a market opportunity. Such licensing policies also involve a robust and strategic allocation of the frequency spectrum among different operators

and platforms, including 3G mobile, WiMAX, very small aperture terminal, commonly known by its acronym VSAT, and other broadband wireless options. In some cases, leaving new spectrum available on an unlicensed basis, as typically applies to Wi-Fi technologies, can help accelerate deployments with minimal barriers.

For rural markets in particular, open-market entry policies can also help promote targeted local investment in these areas by new investors where established national operators might have less interest or incentives. In the context of broadband services, this is a relatively new model, particularly for developing countries, although the precedent of smaller, rural telephone companies has been followed in a number of countries. With declining costs of broadband wireless access and innovative new microcell architectures, this concept of independent local communications operators is gaining interest as an option in a number of countries.

Ensuring competitive access. Effective broadband market development depends upon fair and equal opportunities for all competitors. This requires that those investing in new telecommunications networks and services be able to interconnect with existing networks on equitable terms. More broadly, the efficient provision of network access can be facilitated by measures to encourage shared use of common passive infrastructure, such as cell towers, telephone poles, underground conduit and dark fibre.

Many countries have adopted forms of local open-access obligations, including local loop unbundling, which require owners of last-mile networks to allow the interconnection of such competing service providers to their access facilities. Non-discriminatory, cost-based access obligations for sharing backbone networks and passive infrastructure, such as towers and telephone poles, are also frequently adopted as part of a pro-competitive regime.

The regulator must ensure that pricing or cost-sharing arrangements between network operators are fair and equitable. In the case of rural communications infrastructure, this is especially important, as the costs to build into rural areas can be high, and interconnection to the national backbone should be as affordable as possible to encourage rural investments.

3.2. National broadband strategies and plans

Many countries have recently embarked upon the creation of a comprehensive framework for promoting broadband development. These initiatives may appear as a national broadband strategy or plan, and sometimes as a national ICT strategy or plan, although the latter may address a wider set of issues. Such a strategy or plan differs from a broadband, telecommunications or ICT policy in that it goes beyond policy foundations to identify specific tasks, activities, targets, responsibilities and time frames to achieve tangible results. For example, stimulation strategies can be oriented to ensure coordinated broadband demand so that consumers adopt the technology and benefit from broadband access. The World Bank infoDev programme has produced the *Broadband Strategies Handbook*, (Kelly and Rossotto, 2012) and the online Broadband Strategies Toolkit,[16] which provide in-depth discussions and recommendations on the development of such strategies.

Governments of developing countries across different regions are putting in place such ICT policies and national broadband plans. For example, Rwanda's vision is to transform the country into a knowledge-based country by 2020. To achieve this, improvements were put forward in the business and regulatory environment, as well as in the ICT infrastructure. A 2,500 km fibre-optic backbone connects 30 districts of the country and 9 major border points. A metropolitan network covers 3 districts of the capital, Kigali, and government offices. Several ICT initiatives, in areas such as health, financial services, e-government and agriculture, have already had a significant impact on Rwandans. E-health solutions have led to a vast improvement in both quality and access to health care. E-procurement has increased government efficiency in Rwanda by stimulating good governance and promoting accountability and transparency.

Effective broadband and ICT development policies are based on a strategic policy framework involving multiple agencies, which is actively endorsed at the highest level of government. Policy leadership may be asserted by the relevant ministry of communications or of ICT, by the national telecommunications regulatory

authority, or by a specialized ICT agency through close coordination with and participation of other offices. Key participating agencies generally include ministries of education, health, local affairs, culture, and more, as well as State and local governments. There may be a national coordinating committee to develop policy goals and allocate implementation responsibilities. In addition, some countries have developed broadband stakeholders groups, consisting of private sector operators and suppliers, user groups, academic and research institutions, and non-governmental organizations, among others.

A coordinated national broadband policy framework incorporates a comprehensive vision of broadband as a critical contributor to national socioeconomic development, as well as a range of specific goals and action items, such as the following:

(a) Objectives for broadband expansion, including numerical targets for penetration within defined time periods, to create incentives and momentum for growth;

(b) Implementation strategy for key components of the policy, including priority activities such as infrastructure funding, licensing and government networks;

(c) Stakeholder roles and allocation of responsibilities, for both public agencies and private sector operators;

(d) Funding sources, mechanisms and amounts to be channelled to specific activities;

(e) Public relations strategy to engage citizens in contributing to the planning and implementation process, and to promote awareness and demand for broadband.

3.3. Other incentives for harnessing broadband for inclusive development.

Governments need to ensure that the broadband network infrastructure does indeed lead to economic development and social inclusion. To overcome the challenges they face in developing inclusive broadband ICTs, governments should work in collaboration with ICT-sector stakeholders,

development advocates, and citizen and community groups in pursuing a host of policy and strategy initiatives aimed at spreading the benefits of broadband as widely and equitably as possible.

Expanding beyond the market. Even where market-based development is fully encouraged, practical conditions may limit the willingness of private firms to invest in broadband, especially in certain rural areas where likely returns will not cover costs. These conditions may arise from a combination of high costs to deploy infrastructure, as well as low incomes and sparse populations that may not be likely to generate sufficient revenue. Broadband services, equipment and software may not be affordable to many rural users, further suppressing demand, even where there may be interest in obtaining these services.

Many governments, together with the private sector and other stakeholders, have developed a range of policies to help expand broadband beyond these near-term market boundaries. Direct or indirect financial interventions to promote such expansion or universal access are common components of nearly all broadband development policies. They include a variety of forms of public–private partnerships, in which government funding helps underwrite some of the costs or risks of private investment to the benefit of both, as well as the use of universal service funds to stimulate supply and demand in unserved and underserved locations. For example, the Australian Government used over $200 million from its Universal Service Obligation and Fund and spent over $1 billion via its Connect Australia programme to extend broadband fixed and mobile networks to rural areas. Similar funds have been established and programmes initiated in the Republic of Korea, Malaysia and Chile (box 3).

Choice of broadband technology may also affect costs of connecting subscribers in remote areas. Satellite technology plays a key role in overcoming inaccessibility and lack of terrestrial infrastructure. Although the total cost of satellite broadband connectivity per subscriber is high, the marginal costs of connecting an additional subscriber are relatively low. Given that nearly almost half of the world's population lives in hard-to-reach rural regions, satellite technology can facilitate access to broadband services in those areas (ITU and UNESCO, 2013b).

Box 3.	Promoting Internet access in rural areas: Country cases

In Australia, the national administration and regulatory authority have sponsored an extensive series of programmes to support rural broadband access, including the Universal Service Obligation and Fund, which has generated over $200 million, the Connect Australia programme, which has allocated over $1 billion for extending broadband fixed and mobile networks to rural areas, and a new national broadband network initiative to create a new national wholesale fibre backbone.

The Korean broadband success story has also been aided by strategic public investments and partnerships. The Informatization Promotion Fund was used to finance projects, with contributions from the Government (39 per cent) and the private sector, through spectrum-licensing fees, operators levees and earnings from Fund loans. The Fund was jointly managed and administered by the then Ministry of Information and Communication and Institute of Information Technology Advancement. A $900 million project, Korea Information Infrastructure, invested in the national high-speed public backbone, the development of ICT applications, and the promotion of research and development and information technology pilot projects. Private sector carriers, both Korea Telecom (now KT Corporation) and others, were contracted by the Broadband Planning Division of the aforementioned Ministry of Information and Communication, with Government funds leveraging private investment (World Bank, 2009).

In Malaysia, the Government established a national broadband initiative to promote the expansion of broadband services throughout the country and achieve 50 per cent household penetration of fixed or mobile broadband by 2010. Some $4.2 billion were allocated from the Universal Service Provision Fund to finance ICT access for hundreds of rural schools, libraries and clinics. Public access community broadband centres and other telecentre projects have also become a successful component of the Malaysian strategy. Over 220 community broadband centres provide broadband access, ICT training, and online business or website development. The Government has also allocated $305 million from the Fund to provide free personal computers to qualified students and households, and discounted broadband subscription prices of $6 per month for rural subscribers.[17]

Chile was a pioneer in promoting rural telecommunications access through its Telecommunications Development Fund, which used open, competitive tenders and achieved rapid expansion of rural networks and establishment of infocentros (information centres). In 2008, the Chilean Government announced a new programme to provide mobile broadband in underserved rural areas by using a hybrid method that established minimum service conditions for broadband access and a ceiling on prices. The Government offered subsidies amounting to more than $100 million through a reverse auction to develop about 1,500 municipalities in rural areas. As a result of the programme, broadband coverage is expected to increase to 90 per cent of Chile's population (World Bank, 2012).

Source: UNCTAD.

Policy support for greater access. Market incentives are often insufficient to ensure the availability of goods and services to those that need it most but do not have the ability to pay. Express governmental support to promote access to broadband to the poor, particularly in rural areas, is required. This can take the form of additional financial incentives for greater penetration into rural areas, direct governmental provision of broadband infrastructure to rural areas and network access partnerships that facilitate broadband access to the poor at lower rates, among others.

Promoting relevant ICT content. Policies that promote the development of relevant ICT content, especially with a focus on the interests of less advantaged users, can help reinforce broadband demand. They can also contribute to the creation of ICT-based businesses and jobs, including software companies, business process outsourcing and online services. Such policies encourage the growth of domestic content that is of value to diverse groups of citizens and communities, while emphasizing awareness, training and economic opportunity.

Support for programmes focusing on local content and application development can be provided through various government initiatives that include partnerships with educational institutions, private corporations, non-governmental organizations, other public funding programmes and activities within local communities. ICT content in developing countries that addresses the interests of non-traditional users, from farmers and rural residents to indigenous peoples, and reflects local community values and social conditions can include the following components:

(a)   Content that is available in local languages and addresses indigenous cultures and traditions;

(b)   Applications focusing on ICT use in agricultural, fishing, forestry, tourism and other country-specific economic sectors;

(c)   Customized social networking services and programmes that encourage user-generated local content;

(d)   Mobile applications adapted to the devices and capacity levels of typical local users;

(e)   Applications and services aimed at specific disadvantaged or special groups, such as women, the elderly, disabled persons and non-literate users;

(f)   Business management and support software for local SMEs;

(g)   Entertainment content, including music and television programming, reflective of national values and interests.

Promoting use of ICTs and broadband technologies in local production. The high cost of relevant software, applications and hardware, such as computers, servers and parts, can be unaffordable for enterprises, particularly SMEs in developing countries. High tariffs or inconsistent tariff regimes can lead to high prices of ICT products (WTO, 2013) and may discourage SMEs to take up e-commerce and thus hinder their development and expansion into new markets.

Broadband also allows enterprises to connect internally as well as with other national and international producers. A firm can participate in global value chains when it has access to well-developed ICT infrastructure involving broadband networks that provide integrated and uninterrupted information flow across companies and countries (OECD, 2013).

Local government roles and responsibilities. Local and regional policies and rules can be at least as influential as national standards on broadband growth opportunities. Local government can bring valuable perspectives to ICT planning and implementation, whereas their opposition or exclusion can often lead to unforeseen impediments. Some key roles and functions

played by local governments in the process of promoting rural ICT development include issuing permits and fees for infrastructure rights of way, local taxes, providing e-government services and facilities, direct participation in community access projects and contributions to local ICT educational and awareness campaigns.

Bridging the gender gap in broadband divide. Policymakers need to address another problem: gender digital divide. Inclusive broadband ICT policies should consider the accessibility, affordability and digital literacy of discriminated groups in society. Therefore, policies need to promote content catering to the interests and needs of women, including content focusing on education, health, jobs, economic empowerment, and family and community life. Moreover, policies should encourage women and girls to embrace technology for their own empowerment, study and choose careers in this sector and engage passionately in the future of broadband (ITU and UNESCO, 2012).

Promoting open educational resources. Open educational resources also hold significant potential to accelerate free access to knowledge and facilitate the adaptation of content to local needs and languages (ITU and UNESCO, 2013a). Therefore, online educational materials, applications and services can be provided with local content and in local languages free of charge by governments and public organizations. Collaboration between developed and developing countries, as well as among the latter, would facilitate closing the broadband ICT divide. Individual institutions also play an important role in this initiative. In 2001, the Massachusetts Institute of Technology announced the release of nearly all its courses on the Internet for free access. In April 2012, the World Bank launched the Open Knowledge Repository, an online collection of World Bank publications released under Creative Commons licensing, which includes more than 9,200 research works.[18] The content of the open resource materials is crucial in maximizing its benefits. Another open educational resource, launched by the Delft University of Technology in the Netherlands, is particularly important for developing countries, as it offers courses on clean water technology for developing countries and updated information on water treatment processes from various regions.[19]

4. Conclusions

This study discussed recent trends in broadband ICTs and the nature of the broadband divide, a significant obstacle to the development of inclusive digital societies. It also described policy practices in some developed and developing countries. Major advances in broadband technologies and improved connectivity are not only facilitating the spread of new and existing popular applications and services but also reshaping the social and economic spheres across the globe.

Many studies document the contribution of broadband penetration and deployment to economic and social development. There is evidence that economic gains occur at the macrolevel in terms of GDP growth stemming from broadband expansion, while benefits can also accrue at the microlevel in terms of productivity gains, employment and firm efficiencies. The literature suggests that broadband ICTs offer socioeconomic gains to economies in the areas of e-commerce, education, health care, culture and political inclusion.

However, the precipitous growth of the sector and rise in broadband Internet penetration in various parts of the world has not helped to bridge the Internet divide. On the contrary, the benefits of broadband applications and markets, as well as advances in ICTs, have been unevenly shared among countries, thereby in many ways intensifying existing inequalities. In particular, many people living in LDCs still do not have sufficient access to these technologies and services. A broadband divide also exists between urban and rural areas, and between higher- and lower-income populations, even in developed countries. The broadband divide has been hindering private sector online commercial activities in many developing countries. While North America, Asia-Pacific and Western European countries together account for more than 90 per cent of e-commerce sales from producer to consumer, Middle Eastern, African and Latin American companies combined constitute only about 5 per cent of the total.

Several factors explain these gaps. Some of the main barriers to broadband ICT development are the high prices of the Internet, the lack of an enabling policy environment, elevated infrastructure costs, low revenue potential and low digital literacy rates. Moreover, intellectual property also poses challenges to developing countries that seek advances in broadband e-infrastructure and wish to participate in the knowledge economy. Certain features of their institutional framework in LDCs, in which learning and knowledge generation is embedded, might limit the role of IPRs in inducing innovation.

Empirical studies have found broadband technology to have positive effects on productivity and job creation. Although most impacts have been realized through its adoption by larger, multinational firms, SMEs also hold great potential for improving operating efficiency by better integration of broadband in production, sales, marketing and distribution processes. Moreover, some country case studies have reported significant advances in various areas such as access to education, online health services, and social, cultural and political inclusion. Improvements in ICTs and broadband technologies have been transforming the conventional education system by facilitating the spread of digital textbooks, Internet-based research, interactive teaching, open access to digital libraries and so forth. In health care, these new technologies are linking patients, doctors, hospitals and treatment centres – even in remote areas – to national health-care systems. Furthermore, broadband technologies promote social inclusion and the empowerment of women and persons with disabilities, facilitate the spread of local artistic works and indigenous cultures and contribute to increased political participation in developed and developing countries alike.

To close the broadband divide and maximize the benefits of ICT and broadband technologies, governments need to devise comprehensive strategy frameworks for national broadband development that include tangible shared objectives. Such frameworks should be

established, planned and implemented using a multi-stakeholder approach. Coherent and holistic national policies and plans with clear targets and strong government commitment, clear regulatory frameworks and coordinated demand strategies can help governments maximize the benefits of broadband access. Providing an enabling regulatory and policy environment focusing on open markets and fair competition is crucial to ensure the benefits of broadband ICTs as well.

Literacy, including traditional and digital literacy, plays a decisive role in the penetration and use of broadband access. Therefore, investment in education, with a focus on ICT-oriented curricula, is also critical to benefit from broadband development.

In addition, local content development can strengthen knowledge in communities and can be used as a platform to reach new markets. In this regard, the development of an appropriate model of broadband infrastructure is essential to realizing the benefits of ICTs. The surge in mobile money deployments in Africa has shown that when the right technologies and products are introduced at affordable prices, they can lead to significant benefits in LDCs. Thus, new mobile technologies, in particular mobile broadband applications, offer significant social and economic development gains if they can be provided at reasonable prices. Nonetheless, financing is still a major obstacle in countries, and new business models are required to capitalize on available opportunities.

References

Batchelor S, Scott N and Woolnough D (2005). Good practice paper on ICTs for economic growth and poverty reduction. *The DAC Journal 2005*. 6(3):27–96.

BBC (2011a). England riots: Government mulls social media controls. 11 August. Available at http://www.bbc.com/news/technology-14493497 (accessed 7 November 2014).

_____ (2011b). Gay girl in Damascus: Tom MacMaster defends host blog. BBC News Scotland. 13 June. Available at http://www.bbc.co.uk/news/uk-scotland-13747761 (accessed 7 November 2014).

Buttkereit S, Enriquez L, Grijpink F, Moraje S, Torfs W and Vaheri-Delmulle T (2009). Mobile broadband for the masses: Regulatory levers to make it happen. McKinsey & Company.

Capgemini, IDC, Rand Europe, Sogeti and the Danish Technological Institute (2011). 2011 eGovernment benchmark pilot on open government and transparency: Measuring the potential of eGovernment to foster open government and transparency in Europe. July. Available at http://ec.europa.eu/digital-agenda/sites/digital-agenda/files/finalreport_open_government_transparency_pilot.pdf (accessed 6 November 2014).

Comninos A (2011). Twitter revolutions and cyber crackdowns: User-generated content and social networking in the Arab spring and beyond. Association for Progressive Communications.

eMarketer (2013). Ecommerce sales topped $1 trillion for first time in 2012. 5 February.

Eurostat (2012). Share of turnover from e-commerce stable at 14% in 2009 and 2010. *Statistics in focus*. No. 18. Eurostat. European Commission.

Fredriksson T (2013). E-commerce and Development: Key Trends and Issues. Presented at the WTO Workshop on E-commerce, Development and Small and Medium-sized Enterprises. Geneva. 8–9 April.

García Zaballos A and López-Rivas R (2012). *Socioeconomic Impact of Broadband in Latin American and Caribbean Countries*. Technical Note No. IDB-TN 471. Inter-American Development Bank. Institutions for Development. November.

Gehl Sampath P (2007). *Intellectual Property and Innovation in Least Developed Countries: Pharmaceuticals, Agro-Processing and Textiles and RMG in Bangladesh*. UNCTAD. The Least Developed Countries Report 2007. Background Paper No. 9. Available at http://unctad.org/sections/ldc_dir/docs/ldcr2007_shree_en.pdf (accessed 5 November 2014).

Godfrey CJ, Bernal C, Knepper, HJ and Spence D (2013). Openness and transparency: Is e-government learning to listen? *PA Times Online*. Available at http://patimes.org/openness-transparency-e-government-learning-listen/ (accessed 5 November 2014).

*info*Dev and PriceWaterhouseCoopers (2010). Information and Communication Technology for Education in India and South Asia: Essay IV, Gender Equity and the Use of ICT in Education. Available at http://www.infodev.org/infodev-files/resource/InfodevDocuments_887.pdf (accessed 5 November 2014).

International Telecommunication Union (2010). Definitions of world telecommunication/ICT indicators. March. ITU. Geneva.

_____ (2011a). *Measuring the Information Society 2011*. ISBN 92-61-13801-2. ITU. Geneva.

_____ (2011b). *National e-Strategies for Development: Global Status and Perspectives 2010*. ITU. Geneva.

_____ (2012a). *Measuring the Information Society 2012*. ISBN 978-92-61-14071-7. ITU. Geneva.

_____(2012b). In focus: eHealth opportunities and challenges. ITU Telecom World 2012. Available at . http://www.itu.int/ITUTELECOM/world2011/email/focus/focus_5.html?WT.mc_id=focus5 (accessed 10 November 2014).

ITU and UNESCO (2012). *The State of Broadband 2012: Achieving Digital Inclusion for All*. ITU–UNESCO Broadband Commission. ITU. Geneva.

_____ (2013a). *Technology, Broadband, and Education: Advancing the Education for All Agenda*. Broadband Commission Working Group on Education. UNESCO. Paris.

_____ (2013b). *The State of Broadband 2013: Universalizing Broadband*. Broadband Commission for Digital Development. Geneva.

Katz R (2012). *The Impact of Broadband on the Economy: Research to Date and Policy Issues*. Impact of Broadband on the Economy Broadband Series. ITU. Geneva.

Kelly T and Rossotto CM, eds. (2012). *Broadband Strategies Handbook*. International Bank for Reconstruction and Development/International Development Association or the World Bank. Washington, D.C.

Koutroumpis P (2009). The economic impact of broadband on growth: A simultaneous approach. *Telecommunications Policy*. 33(9): 471–485.

Nottebohm O, Manyika J, Bughin J, Chui M and Syed AR (2012). Online and upcoming: The Internet's impact on aspiring countries. McKinsey & Company. Available at http://www.mckinsey.com/client_service/high_tech/latest_thinking/impact_of_the_internet_on_aspiring_countries (accessed 6 November 2014).

Organization for Economic Cooperation and Development (2000). *OECD Economic Outlook*. No. 67. OECD. Paris. Available at http://www.oecd-ilibrary.org/docserver/download/1200671e.pdf?expires=1415626322&id=id&accname=ocid195767&checksum=13A481182F06E6B91AA16FFCE08F0752 (accessed 10 November 2014).

_____ (2010). Higher education in cities and regions: Human capital, capacity-building, sustainability, innovation. Programme on Institutional Management in Higher Education. Available at http://www.oecd.org/edu/imhe/42440961.pdf (accessed 10 November 2014). .

_____ (2013). Interconnected economies: Benefiting from global value chains – Synthesis report. Available at http://www.oecd.org/sti/ind/interconnected-economies-GVCs-synthesis.pdf (accessed 6 November 2014).

Organization for Economic Cooperation and Development, United Nations Educational, Scientific and Cultural Organization and the Internet Society (2013). The relationship between local content, Internet development, and access prices. OECD Digital Economy Papers. No. 217. OECD Publishing.

Paris. Available at http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/local_content_study.pdf (accessed 5 November 2014).

Patel A (2010). New models for NREN's and universities in era of broadband and Web 2.0 applications and innovations. Proceedings and report of the third UbuntuNet Alliance annual conference. pp. 15–24.

Qiang CZW and Rossotto CM (2009). Economic impacts of broadband. In: *Information and Communications for Development 2009*: *Extending Reach and Increasing Impact*. Pp 35–50. World Bank. Washington, D.C.

Rwanda Development Board (2011). National ICT Strategy and Plan NICI – 2015: Accelerating Service Development. Rwanda Ministry in charge of ICT. Office of the President.

Shaver L (2010). The right to science and culture. *Wisconsin Law Review*. 2010 (1):121–184.

UNCTAD (2012a). *Information Economy Report 2012*: *The Software Industry and Developing Countries*. United Nations publication. Sales No. E.12.IID.14. New York and Geneva.

_____(2012b). *Technology and Innovation Report 2012: Innovation, Technology and South–South Collaboration*. United Nations publication. Sales No. E.12.II.D.13. New York and Geneva.

_____(2013). *Internet Broadband for an Inclusive Digital Society*, Commission on Science and Technology for Development, Report of the Secretary-General, E/CN.16/2013/3, Geneva.

United Nations Education, Scientific and Cultural Organization(2011). *ICTs and Indigenous People*. Policy Brief. UNESCO Institute for Information Technologies in Education. Moscow. June.

_____ (2012). *Resolutions*. Volume 1. Records of the General Conference. 36th session, 25 October–10 November 2011. Paris.

World Bank (2006). ICT & gender equality. Gender Development Briefing Notes. Gender and Development Group. Available at http://siteresources.worldbank.org/INTGENDER/Resources/GenderICTBriefingNoteOct06.pdf (accessed 10 November 2014).

_____ (2009). Broadband Policy Development in the Republic of Korea. Ovum Consulting. A report for the Global Information and Communications Technologies Department of the World Bank.

_____ (2012). *2012 Information and Communications for Development: Maximizing Mobile*. Washington, D.C.

World Bank and African Development Bank (2012). *The Transformational Use of Information and Communication Technologies in Africa*. Washington, D.C. and Tunis-Belvedère.

World Trade Organization (2013). Electronic commerce, development and small, medium-sized enterprises. WT/COMTD/W/193. 14 February.

Endnotes

[1]   World Bank World Development Indicators Database, accessed 24 September 2013.

[2]   See E/CN.16/2013/3, Internet broadband for an inclusive digital society, Economic and Social Council, Geneva, 25 March 2013.

[3]   www.broadbandcommission.org.

[4]   The Commission publishes annual reports as well as case studies on broadband Internet that include statistics and information on broadband national plans, mobile and fixed broadband penetration rates, percentage of Internet users and broadband market shares by technology. The statistics are mainly based on ITU databases but they also include figures from national ministries, public and private institutions and private companies.

[5]   Regional groupings are based on World Bank definitions. Country groups marked by * exclude high-income countries according to the World Bank definition but not necessarily developed countries according to the United Nations definition.

[6]   The ICT Development Index is divided into three subindices: The access subindex includes five infrastructure and access indicators on ICT readiness (fixed-telephone subscriptions, mobile cellular telephone subscriptions, international Internet bandwidth per Internet user, percentage of households with a computer and percentage of households with Internet access); the use subindex includes three indicators on ICT intensity and usage indicators (percentage of Internet users, fixed (wired)-broadband subscriptions and active mobile broadband subscriptions); and the skills subindex includes three indicators on ICT capability or skills (adult literacy, gross secondary enrolment and gross tertiary enrolment).

[7]   Turkish Ministry of Education website on FATIH project. http://fatihprojesi.meb.gov.tr/tr/index.php, accessed 3 November 2014.

[8]   Ibid.

[9]   g3ict.com, accessed 4 November 2014.

[10] www.e-accessibilitytoolkit.org/, accessed 4 November 2014.

[11] www.gatesfoundation.org/What-We-Do/Global-Development/Global-Libraries, accessed 4 November 2014.

[12] See, for example, Africa's future data architecture beginning to fall into place – exchange points and data centres, *Balancing Act*, Issue No. 625, 5 October 2012, (http://www.balancingact-africa.com/news/en/issue-no-625/top-story/africa-s-future-data/en, accessed 4 November 2014).

[13] http://www.wipo.int/sme/en/e_commerce/index.htm, accessed 4 November 2014.

[14] Ibid.

[15] Yale University Access to Knowledge Initiative: http://www.yaleisp.org/access-knowledge, accessed 4 November 2014.

[16] http://broadbandtoolkit.org/en/home, accessed 4 November 2014.

[17] http://www.skmm.gov.my/Sectors/Broadband/National-Broadband-Initiative.aspx, accessed 4 November 2014.

[18] https://openknowledge.worldbank.org/about, accessed 4 November 2014.

[19] http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-educational-resources/what-are-open-educational-resources-oers/, accessed 4 November 2014.