Background Report

Road to 2030: Information and Communications Technology in ADB's Corporate Strategy and Operations

Project TA-8974 REG:
Helping Transform Asia and the Pacific: Support for ADB's New Corporate Strategy (ICT Policy and Strategy)

This report was prepared by Andreas Sommer (International ICT Consultant, a.sommer@sec-sommer.com), Sameer A. Kamal (Young Professional, ADB, skamal@adb.org) and Olivier Serrat (Principal Knowledge Management Specialist, ADB, oserrat@adb.org).

LIST OF ACRONYMS AND ABBREVIATIONS

3G	–	3rd generation mobile network
4G	–	4th generation mobile network
5G	–	5th generation mobile network
ADB	–	Asian Development Bank
ADF	–	Asian Development Fund
AfDB	–	African Development Bank
APT	–	Asia-Pacific Telecommunity
CAPEX	–	capital expenditure
CWRD	–	Central and West Asia Regional Department
DMC	–	developing member country
EARD	–	East Asia Regional Department
EC	–	European Commission
ESCAP	–	Economic and Social Commission for Asia and the Pacific
EU	–	European Union
Gbps	–	gigabits per second
GDP	–	gross domestic product
ICT	–	information and communications technology
ICTD	–	information and communications technology for development
IDI	–	ICT Development Index
IoT	–	internet of things
IT	–	information technology
ITS	–	intelligent transport systems
ITU	–	International Telecommunication Union
IXP	–	internet exchange point
LDC	–	least developed country
M2M	–	machine to machine
Mbps	–	megabits per second
NOC	–	network operations center
NRI	–	Networked Readiness Index
O&M	–	operation and maintenance
OECD	–	Organisation for Economic Co-operation and Development
OPEX	–	operational expenditure
PPP	–	public–private partnership
PARD	–	Pacific Department
PRC	–	People's Republic of China
QoS	–	quality of service
RFID	–	Radio-Frequency IDentification
SAP	–	SAP AG, German Software Company
SARD	–	South Asia Regional Department
SDCC	–	Sustainable Development and Climate Change Department
SDGs	–	Sustainable Development Goals
SERD	–	South East Asia Regional Department
SIDS	–	small island developing state
TA	–	technical assistance
USO	–	universal service obligation
WEF	–	World Economic Forum

NOTE

In this report, "$" refers to US dollars.

CONTENTS

BOXES, FIGURES, TABLES

EXECUTIVE SUMMARY

Information and Communications Technology in Asia and the Pacific

Today, information and communications technology (ICT) is increasingly a part of daily life and a driver of inclusive economic growth, social stability, and sustainable development. While the ICT sector in Asia and Pacific has seen unprecedented growth, particularly in terms of mobile communications in the Asian Development Bank (ADB's) developing member countries (DMCs), a significant portion of the population remains "offline", and developing Asia lags behind other regions in terms of ICT policies and strategies, infrastructure, regulations, skills, and individual usage.

While the private sector has and will invest in ICT infrastructure and services where there is a strong business case, public investment is required to ensure affordable access and connectivity, particularly in remote and rural areas. DMC governments must also prepare for the impact of upcoming ICT developments on the labor market, pursue reforms to bring greater competition to telecommunications markets, and promote public–private partnerships. These require investing on the scale of billions of dollars in the years to come, and are likely to become increasingly important as ADB's DMCs move towards middle-income and upper middle-income status.

DMCs demand ICT to strengthen domestic sectors and keep pace with regional and global development and competition. But, they face major challenges that include (i) building missing gaps in international, regional, and national backbone infrastructure; (ii) removing policy and regulatory restrictions on, for example, licensing and market entry, and promoting universal access to affordable broadband internet; (iii) enhancing ICT security and public awareness on security; (iv) aggregating demand and scaling up e-services and applications; (v) building skills and competitiveness; and (vi) promoting ICT for trade and regional integration.

Opportunities for ADB

Between 2000 and 2015, ADB supported 402 ICT-related loan, grant, and technical assistance (TA) projects worth $11.91 billion, which is a mix of stand-alone ICT projects (8% of total financing) and ICT-component projects (92%), and sovereign (89% of total financing) and non-sovereign (11%) financing. Among ADB management and staff, there is a clear recognition of the importance of ICT. However, there is a broad consensus that ADB is falling behind in this area, that it should do much more, and that a clear institutional support structure for ICT is needed. There is also recognition that ADB may not be in a good position to gauge demand for ICT, because ADB's ICT engagement has remained fragmented and largely focused on sector-related ICT.

To date, ADB's engagements in ICT have been more opportunistic than strategic in nature. In comparison, some other international financing institutions have had a more strategic and coordinated focus on ICT.

There is no doubt that ICT will play an increasingly important role in development, and in enabling the world to achieve the Sustainable Development Goals (SDGs). The needs of ADB's DMCs in ICT, and thus opportunities for ADB, can be categorized in three priority areas: (i) ICT policies and strategies, (ii) ICT infrastructure, regulations, and skill building, and (iii) sector-related e-services and applications.

ICT policies and strategies are the first successive priority for ICT development, and are a prerequisite for successful projects. A number of ADB's DMCs will need to develop or update

their ICT policies and strategies in order to prepare and position themselves to take advantage of ICT-related opportunities now and in the coming years, which present opportunities for ADB.

Strong growing demand for internet capacity requires regular upgrades of international and regional ICT infrastructure, including fixed line networks (e.g. fiber optic cables for submarine and backbone connectivity, and last mile connectivity), mobile networks (e.g. base stations and telecom towers), satellites and data centers. ICT regulations, including standardization and security, need to be implemented and regularly updated to keep pace with changing technologies and increasing globalization. ICT skill building and literacy, covering both technicians and users, is also important, particularly as it pertains to data security and operations and maintenance.

There is also much space for ADB's support to sector-related e-services and applications, including turn-key solutions, to support sectors like education, energy, finance, health, transport, urban and water, and also governance and disaster risk management. By enhancing connectivity within and across countries and regions, ICT is a critical part of the regional cooperation and integration agenda. As a technology that can improve energy efficiency and reduce transportation-related costs, and also as a growing consumer of energy, ICT is also important for the climate change agenda.

There are numerous opportunities for investments in ICT across ADB's DMCs. Case studies from Indonesia, India, the Pacific Islands, the Philippines, and other DMCs illustrate the differentiated and diverse needs of ADB's DMCs, and highlight opportunities for ADB's investment and intervention in the short and medium term. In Indonesia, ADB can consider investments to build on its TA for the preparation of the $23 billion Indonesia Broadband Plan (2014–2019). In India, ADB can explore investments in domestic connectivity (submarine cables and telecommunications towers), smart cities, and entrepreneurship. In the Pacific islands, ADB can continue to build on its ongoing engagement across the full spectrum of ICT, from strategy to infrastructure to sector-related e-services and applications. In the Philippines, the upcoming preparation of an updated national broadband plan presents an opportunity for ADB to become involved at the planning stage and to identify future opportunities.

Recommendations

Looking ahead to 2030, it is clear that there will be strong demand from DMCs for investments in ICT. The question is how ADB will strategically position itself to respond. This paper proposes a gradual, judicious scaling up of ADB's ICT operations, positioning ADB so it may develop a reputation as a preferred partner for ICT in Asia, with a robust investment pipeline, in the medium to long term. This will be a natural extension of ADB's experience in ICT so far, including its successful engagements in the Pacific.

Given its limited internal ICT technical skills and human resources, ADB's focus in the **short term (2016–2017)** should be on the most promising opportunities in countries where ADB has good on-the-ground knowledge and relationships. In such countries, ADB should support updating and formulating national broadband plans and strategies, where possible. ADB should also take immediate steps to strengthen ICT components in sector operations, provide ICT training to staff, and further build its own experience in ICT procurement, ICT security, and cross-sector collaboration.

In the **medium term (2018–2019),** an ICT sector group should be established. To date, ADB's ICT activities (encompassing loans, grants, TAs, and other support) have been organized and conducted through different parts of the institution, without a clear focal point. An ICT sector group could be tasked with overall responsibility for preparing an ADB operational plan for ICT

and supporting the operations departments in integrating ICT in sector strategies and operations. Such a group would need to be dynamic, open and collaborative to be successful. It is proposed that ADB successively and gradually build up this sector group, starting with the recruitment or teaming of 3–4 ICT experts, and building up further based on demonstrated demand and success. In parallel, ADB should continue to recruit and work with consultants on specialized topics, including through a dedicated expert pool, and through strategic partnerships.

In the **long term (2020–2030),** ADB should be positioned as a recognized and noted development partner in ICT, with engagements and experience cutting across the ICT priority areas. In the long term, to meet its suggested duties, responsibilities, and objectives, the proposed ICT sector group would have a diverse pool of 10–15 ICT experts (mostly in the operations departments) whose experience and skills cut across all of the key areas in the ICT sector.

I.   INFORMATION AND COMMUNICATIONS TECHNOLOGY IN ASIA AND THE PACIFIC

A.   Current State of Information and Communications Technology in ADB's Developing Member Countries

1.   **Information and communications technology (ICT) is increasingly part of daily life and a driver of inclusive economic growth, social stability, and sustainable development.** ICT has no borders between countries, regions, cultures, and sectors. It is global and cross-sectoral. Increased access to ICT, particularly high-speed internet services (broadband), helps to deliver improved financial services, as well as social services, such as health and education. It brings efficiency and reduces the cost of these services, and in turn enables an environment conducive to private sector investment. Moreover, ICT has creates or enables significant employment opportunities for both women and men in many countries around the world by enabling firms to access an increasingly global client base.

2.   **The basis for ICT is connectivity through high-speed internet access (broadband).**[1] Broadband connectivity accelerates economic growth, improves labor productivity, creates job opportunities, enhances quality of life, and reduces energy consumption and greenhouse gas emissions. A number of recent studies have considered the role of broadband in the economy, as well as its social and economic impacts. These are summarized in Box 1 below.

Box 1: The Role of Broadband
- Every 10% increase in broadband penetration accelerates economic growth by 1.38% in developing countries and 1.12% in developed countries.[a]
- 10% higher broadband penetration in a specific year correlates to 1.5% greater labor productivity growth over the following 5 years.[b]
- Countries with higher internet penetration reap up to 25% more benefit from cross-border data flows than those with limited internet penetration.[c]
- There is a disparity between male and female internet users. Bringing 600 million more women online could increase global gross domestic product (GDP) by $12–18 billion.[d]
- Digitization can boost productivity, create jobs, and enhance quality of life. If emerging markets could double the digitization index score for their poorest citizens over the next 10 years, the result would be a global $4.4 trillion gain in nominal GDP, an extra $930 billion in the cumulative household income for the poorest, and 64 million new jobs for today's socially and economically most marginal groups.[b]
- The use of broadband can reduce greenhouse gas emissions by up to 25%. Mobile technology could lower greenhouse gas emissions by 2% by 2020.[d]
- E-commerce could lower energy consumption by 30% over traditional retails.[d]

[a] The World Bank. 2016. *World Development Report 2016: Digital Dividends*. www.worldbank.org/en/publication/wdr2016
[b] Booz & Company. 2009. *Digital Highways The Role of Government In 21st-Century Infrastructure*. http://www.strategyand.pwc.com/media/file/Digital_Highways_Role_of_Government.pdf
[c] McKinsey & Company. 2016. *Digital Globalization: The New Era of Global Flows*. www.mckinsey.com/mgi
[d] Broadband Commission for Digital Development. 2012. *The Broadband Bridge: Linking ICT with Climate Action for a Low-Carbon Economy.* www.broadbandcommission.org/Documents/publications/BD-bbcomm-climate.pdf

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3.   **Currently, only about 40% of the world's population has access to basic (slow) internet, while only 15% has affordable access to broadband (high-speed) internet.** Use of mobile phones, reaching almost three-quarters of the world's population, provides the main form of internet access in developing countries. But the lives of more than 2 billion people remain

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[1]   High-speed internet (broadband) includes the total number of fixed-line broadband subscriptions (such as DSL, cable modems, fiber optics), and the total number of 4G/LTE mobile subscriptions, minus a correcting factor to allow for those who have both types of access. 4G = fourth-generation, DSL = digital subscriber line, ICT = information and communications technology, LTE = Long Term Evolution.

largely untouched by ICTs, and half a billion live outside of areas with a mobile signal. Asian countries with large offline populations include India (1,063 billion), People's Republic of China (PRC) (755 million), Indonesia (213 million), Pakistan (165 million), Bangladesh (148 million), the Philippines (63 million), Myanmar (53 million), Vietnam (52 million), and Thailand (48 million).[2] In OECD countries, fixed-line networks came first, and now form the backbone for internet access. But most developing countries jumped straight to mobile networks without investing first in fixed line backbone connectivity. The consequence for many users in developing countries is an internet that is slow, expensive, and rarely "always on." For example, a 2014 survey by the Indonesian mobile operator Indosat Ooredoo found that 91% of young Indonesians said they did not spend as much time online as they would have liked, due to poor connectivity.[3] The Philippines, including its capital Manila, has one of the slowest average broadband speeds in Asia and in the world.[4]

4.   **While timely and reliable global analyses relating to ICT is difficult, because of the fast-moving nature of the sector, some recent analyses give an indication of how ADB's developing member countries (DMCs) perform relative to other countries.** For example, the World Economic Forum (WEF) Networked Readiness Index (NRI) provides a snapshot of ICT development including market conditions and the state of connectivity in different countries.[5] The Digital Adoption Index, a metric developed by the World Bank as part of its 2016 World Development Report titled "Digital Dividends," attempts to benchmark digital adoption by business, governments, and people across 130 countries globally.[6] While countries' positions on such indexes can vary significantly from year-to-year, they help to provide a snapshot of ICT development in a given year or before.

5.   **With a few exceptions, ADB DMCs rank in the bottom 55% in terms of networked readiness.[7]** Table 1 below shows the ranking and NRI of Asian countries for 2015 and 2010, relative to 143 (2015) and 139 (2010) economies around the globe. NRI values are measured on a 1 (low) to 7 (high) scale and are based on four sub-indexes (and 10 pillars):

(i)   environment sub-index (pillars: political and regulatory, business and innovation);
(ii)   readiness sub-index (pillars: infrastructure, affordability, skills);
(iii)   usage sub-index (pillars: individual, business, government); and
(iv)   impact sub-index (pillars: economic, social).

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[2]   The World Bank. 2016. *World Development Report 2016: Digital Dividends*. http://www.worldbank.org/en/publication/wdr2016

[3]   L. Cosseboom. 2014. *Indonesian Government Launches High-Speed Internet Initiative.* TechInAsia. https://www.techinasia.com/indonesia-high-speed-internet-2014-2019-broadband-plan

[4]   Y. Gonzales. 2015. *PH Internet 2nd Slowest in Asia One of the Most Expensive*. Inquirer.net. http://technology.inquirer.net/42293/ph-internet-2nd-slowest-in-asia-one-of-the-most-expensive

[5]   The World Economic Forum (WEF): "The Global Information Technology Report 2015 - ICTs for Inclusive Growth", 2015. http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf
      The World Economic Forum (WEF): "The Global Information Technology Report 2010-2011 – Transformations 2.0", 2011. http://www3.weforum.org/docs/WEF_GITR_Report_2011.pdf

[6]   World Economic Forum. 2015. *The Global Information Technology Report 2015: ICTs for Inclusive Growth*. 2015. http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf

[7]   These exceptions are: Singapore; Japan; the Republic of Korea; Hong Kong, China; Taipei,China; Malaysia; and the PRC.

Table 1: Networked Readiness Index of Asian Countries

Country	Place 2015 (2010)	Value 2015
Singapore	1 (2)	6.0
Japan	10 (19)	5.6
Korea	12 (10)	5.5
Hong Kong, China	14 (12)	5.5
Australia	16 (17)	5.5
New Zealand	17 (18)	5.5
Taipei,China	18 (6)	5.5
Malaysia	32 (28)	4.9
China, People's Republic of	62 (36)	4.2
Sri Lanka	65 (66)	4.1
Thailand	67 (59)	4.0
Philippines	76 (59)	4.0
Indonesia	79 (53)	3.9
Viet Nam	85 (55)	3.9
Bhutan	88 (-)	3.7
India	89 (48)	3.7
Lao People's Democratic Republic	97 (-)	3.6
Kyrgyz Republic	98 (116)	3.5
Bangladesh	109 (115)	3.3
Cambodia	110 (111)	3.3
Pakistan	112 (88)	3.3
Tajikistan	117 (112)	3.2
Nepal	118 (131)	3.2
Timor-Leste	134 (136)	2.8
Myanmar	139 (-)	2.5

Note: Other Asian and Pacific countries were not considered in the Network Readiness Index, because no data was available
Source: World Economic Forum. 2015. *The Global Information Technology Report 2015: ICTs for Inclusive Growth*. 2015. http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf

6.   **Relative to other regions, emerging and developing Asia lags behind in many dimensions of ICT, and particularly in terms of infrastructure, skills, and individual usage.[8]** Figure 1 illustrates the performance of different regions in terms of NRI, and also highlights global best and worst performing countries, across its ten pillars. It is worth noting that countries in both emerging and developing Asia (which would include most DMCs in ADB's East Asia, Southeast Asia, and South Asia regions) and the Commonwealth of Independent States (which would include most DMCs in ADB's Central and West Asia region) compare more favorably relative to other developing regions in terms of affordability, business usage and government usage. Even though internet access is generally affordable and well-utilized by businesses and governments in some of ADB's DMCs, significant investments are still needed to improve ICT infrastructure in line with policies and regulations, skills, and use by individuals.

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[8]   For the NRI, "Emerging and developing Asia" includes most DMCs in ADB's East Asia, Southwest Asia and South Asia regions.. Central and West Asia DMCs are largely covered under the Commonwealth of Independent States. Most Pacific countries were not assessed as part of the NRI.

Figure 1: Global Performance Overview: Networked Readiness Index
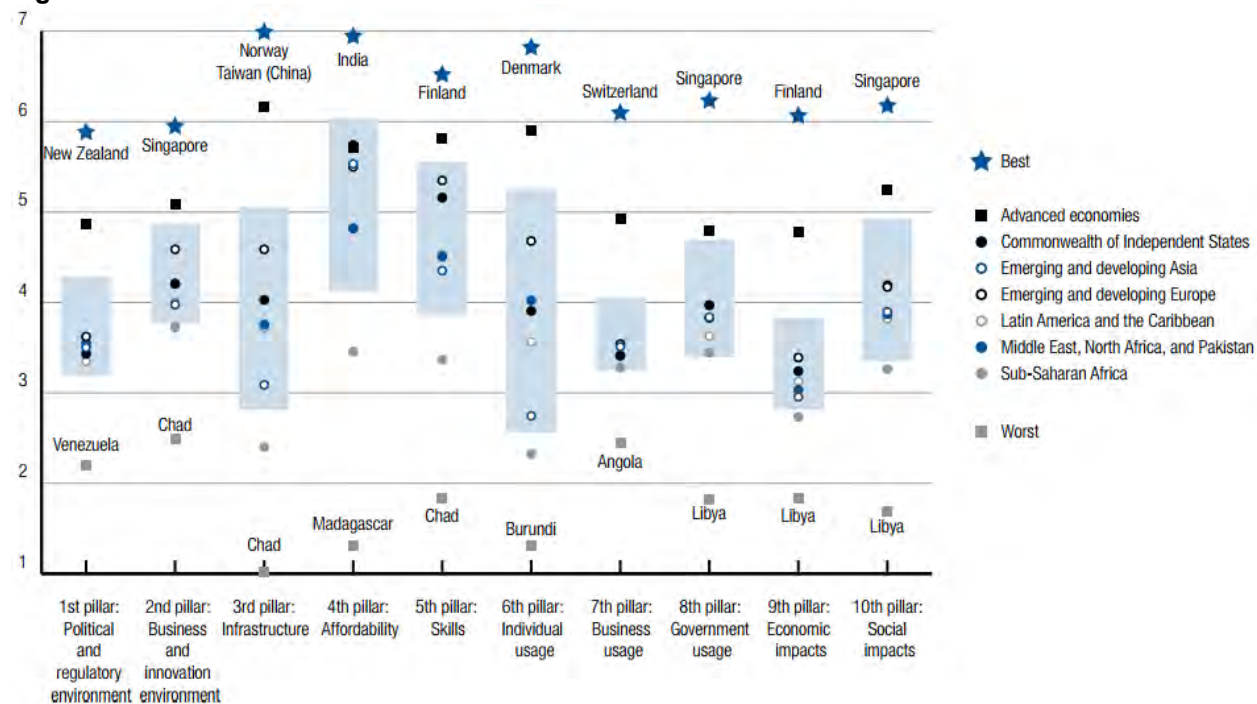
Source: The World Economic Forum (WEF): "The Global Information Technology Report 2015—ICTs for Inclusive Growth", 2015

7.   **Adoption of digital technologies by citizens in ADB's DMCs may be less than in other parts of the world.** A quick analysis of a subset of the 18 ADB DMCs[9] out of the total of 130 countries considered and indexed in the World Bank's 2016 Digital Adoption Index is summarized in Table 2.[10] The results should be seen as indicative. The lower values for the Digital Adoption Index for citizens are consistent with the low scores for the region in NRI's pillar on individual usage and on ICT skills. Meanwhile, digital adoption of business and governments in ADB DMCs appears to be more consistent with global trends, the same trend suggested by the NRI's pillars on business usage and government usage.

Table 2: Average GDP per Capita and Digital Adoption Index Values for Developing Member Countries and Global Dataset

	GDP per Capita (constant 2005 $) 2012	Digital Adoption Index		
		Business	Governments	People
Global Average (130 countries)	4,317	0.39	0.56	0.67
DMC Average (18 countries)	4,106	0.34	0.55	0.57

Source: World Bank 2016. *World Development Report 2016: Digital Dividends.*

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[9]   Armenia, Bangladesh, Brunei Darussalam, Cambodia, the PRC, India, Indonesia, the Republic of Korea, the Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Tajikistan, Thailand, Uzbekistan, and Vietnam.

[10] The World Bank. 2016. *World Development Report 2016: Digital Dividends*. http://www.worldbank.org/en/publication/wdr2016

8.   **Many of ADB's DMCs cannot keep pace with global ICT development and regional integration due to a lack of investments in and attention to (i) ICT policies and strategies; (ii) ICT infrastructure; (iii) ICT regulations and standardization (including ICT security); (iv) ICT skills development; and (v) e-services and applications.** Generally speaking, these key areas, which are listed in successive order from more "upstream" investments to more "downstream" investments, must be addressed successively in order to develop ICT and unlock its development potential.

9.   **Each country's situation is different and unique, and must be considered individually based on actual available data.** For example, Table 3 below shows how key measures of the state of a country's ICT development, such as broadband infrastructure, affordability, and competitiveness of telecommunications markets, vary across selected countries in the Central and West Asia region.[11] Two countries in the same region and with similar per capita gross domestic products (GDPs), such as Azerbaijan and Turkmenistan, can have significant differences in terms of the level of their broadband infrastructure development, international bandwidth per capita, and competitiveness of telecommunications markets.

Table 3: The State of Broadband Infrastructure in Central Asian Countries

	GDP per Capita, Year End 2012 ($)	International Bandwidth Per Capita (Kbps)	International Connectivity	Domestic Connectivity	IP Transit Price	Competitiveness of Telecom Market	Fixed and Mobile Broadband Infrastructure	Annual1 Mbps Broadband Subscription + Installation as % of Nominal GDP per Capita
Azerbaijan	$ 10,800	22.4	Moderate	Adequate	Reasonably Priced	Somewhat Competitive	Relatively Strong	Reasonable
Kazakhstan	$ 14,000	16.5	Moderate	Relatively Strong	Reasonably Priced	Somewhat Competitive	Relatively Strong	Reasonable
Kyrgyz Republic	$ 2,400	0.893	Weak	Limited	Very Expensive	Somewhat Competitive	Limited	Very Expensive
Tajikistan	$ 2,300	0.313	Weak	Limited	Very Expensive	Somewhat Competitive	Very Limited	Very Expensive
Turkmenistan	$ 9,600	0.125	Weak	Limited	Very Expensive	Not Competitive	Very Limited	Very Expensive
Uzbekistan	$ 3,500	0.259	Weak	Limited	Very Expensive	Somewhat Competitive	Limited	Very Expensive

Source: ESCAP: "An In-Depth Study of Broadband Infrastructure in North and Central Asia", January 2014.

B.   Upcoming Information and Communications Technologies and Applications

10.   **The world has never been more deeply connected by commerce, communication, and travel than it is today.** However, the pattern of globalization is shifting. Trade was once dominated by tangible goods and was largely confined to advanced economies and their large multinational companies. Today, global data flows are surging, while digital platforms allow more countries and smaller enterprises to participate in the global economy.[12] This allows firms to enter new markets, reduce transaction and communication costs, and improve business

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[11]   United Nations Economic and Social Commission for Asia and the Pacific. 2014. *An In-Depth Study of Broadband Infrastructure in North and Central Asia*. http://www.unescap.org/resources/depth-study-broadband-infrastructure-north-and-central-asia

[12]   J. Manyika et al. 2016. Digital Globalization: The New Area of Global Flows. *McKinsey Global Institute.* http://ma.mckinsey.com/practicecrm/MGI/MGI_Digital_globalization_Full_report_March_2016.pdf

efficiency, ultimately contributing to inclusive economic growth. As shown in Figure 2, global data flows are soaring while global flows of trade and finance are flattening.

Figure 2: Development of Global Trade, Finance, and Data (1980–2014)
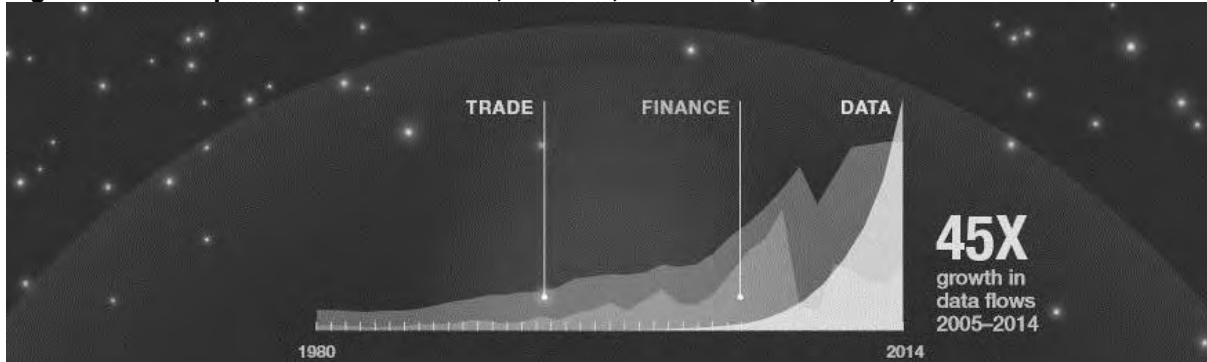
Source: McKinsey Global Institute: "Digital Globalization: The New Area of Global Flows", March 2016.

11. **There are two key trends in upcoming ICT technologies that will have a significant impact on the development of countries globally, including ADB's DMCs.** These are 5G mobile networks and the internet of things (IoT).[13]

12. **From 2020 onwards 5G mobile networks will provide a major boost in global ICT development.** At present, peak speeds of 4G mobile networks are at 150 Mbps, 5G will be capable of transmitting data 100 times faster at up to 20 Gbps. It is expected that 5G mobile networks will become a multi-billion dollar business around the globe with new business opportunities for network infrastructure, devices, services, applications and gadgets.[14] Given that mobile communication are the main source of connectivity in many DMCs, the development of 5G mobile networks will bring significant opportunities for their people, businesses, and governments.

13. **Recent estimates from McKinsey & Company suggest that the IoT has a total potential economic impact of $3.9 trillion to $11.1 trillion a year by 2025.[15]** At the top end, that level of value, including the consumer surplus, would be equivalent to about 11% of the world economy. Meanwhile, Ericsson forecasts a total of 26 billion connected devices by 2020, of which almost 15 billion will be phones, tablets, laptops, and PCs. Cisco forecasts that there will be 3.2 billion machine to machine (M2M) connections alone by 2018, connected via macro-cells. Adding in other devices and connectivity technologies, Cisco forecasts almost 25 billion connected devices by 2019. Gartner predicts 1 million new IoT devices will be purchased every hour of every day in 2021.[16] Unless countries can adapt to these developments, the proliferation

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[13] The World Bank. 2016. *World Development Report 2016: Digital Dividends*. http://www.worldbank.org/en/publication/wdr2016

[14] Source: European Telecommunications Standard Institute (ETSI)

[15] The internet of things (IoT) is the network of physical objects (devices, vehicles, buildings and other items) embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit; when IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing internet infrastructure. (J. Manyika et al. 2015. Unlocking the Potential of the Internet of Things. *McKinsey & Company*. http://www.mckinsey.com/business-functions/business-technology/our-insights/the-internet-of-things-the-value-of-digitizing-the-physical-world)

[16] H. Levy. 2015. Gartner Predicts Our Digital Future. *Gartner*. http://www.gartner.com/smarterwithgartner/gartner-predicts-our-digital-future

and growth of IoT may even introduce a new form of the digital divide, in terms of who has and who has not access to which connected devices.[17]

14. **Other trends that will impact on global development include smart cities, smart grids, self-driving vehicles, big data, cloud computing, 3D printing, artificial intelligence, and robotics, among others.** The use of video, requiring significant bandwidth, will also experience further growth. More detailed information on upcoming ICT technologies and global trends, as well as top 10 Gartner predictions in this respect for 2016, are presented in Appendix 1.

15. **With these developments, further growth of global electronic information traffic is expected, and quality of service will be of high importance.** Globally cross-border used bandwidth has grown 45 times larger over the past decade (2005 to 2014), with an annual growth rate of 52%. Over the next 5 years, total internet protocol traffic is projected to triple, while cross-border used bandwidth is projected to post a nine fold increase.[18] The dependency on ICT will grow in nearly all sectors and for most businesses and resiliency and redundancy of network infrastructure will become increasingly important.[19]

16. **A first wave of rapid growth in ICT access, in DMCs, particularly mobile communications, will be increasingly leveraged by a second wave of transformational initiatives, revolving primarily around electronic services (e-services) and applications.** Existing and upcoming broadband infrastructure will be leveraged by aggregating demand and scaling up e-services in the public sector through e-government, e-business, e-health, e-education, e-agriculture and others, and applications for subjects such as customs.

17. **E-services and applications will help to make various sectors more efficient.** E-government initiatives can improve transparency and efficiency of public services, for example by making information on key government processes and services available to the public. Smart city initiatives enable city managers to collect and process data in real-time to better manage its assets. Intelligent transport systems can help to improve road safety and contribute to reduced carbon footprint. Smart grids can help to maximize energy efficiency and efficient use of renewable energy resources while reducing carbon dioxide emissions. E-learning applications can help to individualize and personalize learning, and provide a platform for adapting high-quality content from different sources.

18. **E-services and applications can also radically improve access to services, across sectors.** Applications also improve access to certain services, improving equity of access. For example, strong e-health platforms have the potential to significantly transform the lives of patients in remote areas (such as in the Pacific islands and others), where patients would otherwise incur high travel costs to access specialized health care that is not available locally. Similarly, mobile financial services can help the poor access banking services, while e-agriculture services can provide farmers access to regular information about the weather and the market, and facilitate product tracing for food safety and disease control.

19. **The sharing economy, which enables communities to share their personal assets with others as a means of income, will grow with increasing connectivity.** In a 2014 global survey conducted by Nielsen, 81% of respondents from Asia and Pacific were receptive to

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[17] Broadband Commission for Digital Development. 2015. *The Actual State of Broadband Annual Report 2015.* http://www.broadbandcommission.org/publications/Pages/SOB-2015.aspx

[18] H. Levy. 2015. Gartner Predicts Our Digital Future. *Gartner.* http://www.gartner.com/smarterwithgartner/gartner-predicts-our-digital-future

[19] Redundancy refers to alternate/backup network connections and other network infrastructure such as facilities.

renting items through a sharing community.[20] How governments can facilitate or leverage this willingness for the public good will be an interesting area of work in the future. For example, governments can support sharing of multi-use parking lots, by providing subsidies to residential owners to create public parking spaces; or can facilitate access to services (e.g. transportation) for the elderly through the shared economy (e.g. such as car or accommodation sharing). Support for the sharing economy, also called "collaborative consumption", is particularly strong amongst 21 to 34 year olds.

C.   Recent and Upcoming Challenges in Information and Communications Technology

20.   **There are substantial deficits in ICT infrastructure in many countries and regions, and these are expected to grow with time.**[21] In addition to the provision of international, regional, and domestic infrastructure for improving connectivity to existing services, particularly for "last-mile" connectivity in rural and remote areas, additional infrastructure investments will be required to cater for increasing global data flows and upcoming ICT technologies such as 5G mobile networks. In addition, sustainable operations and maintenance (O&M) will be critical.

21.   **The private sector has and will invest in ICT infrastructure and services where there is a strong business case and where profits can be made. To ensure affordable access and connectivity, public investment in ICT infrastructure is needed in areas where the private sector has no interest to invest such as remote and rural areas.** Public investments are required for example in setting strong policies and regulation, for government ICT infrastructure, and for the provision of government services in a range of sectors such as education, transport, urban, water, and health. Robust and conducive policy and regulatory frameworks need to be in place to encourage investment and foster competition. There is also scope of public–private partnerships (PPPs) to give the private sector added confidence in a project's viability.

22.   **Major issues with regard to infrastructure include expanding financing for ICT investments, ensuring high-quality and affordable service, sustainable O&M, and power supplies that are sustainable and environmentally friendly.** Key considerations in this respect are:

(i)   financing for capital expenditure (capex) requirements for investments, considering for example public–private partnership);

(ii)   ensuring coverage, availability, quality of service (QoS) (e.g., call drops, slow internet caused by congestion or operational issues, hotlines, time for repair), security, and affordability;

(iii)   ensuring ICT policies and regulations keep pace with, and provide sufficient space for, the needs of ICT infrastructure development;

(iv)   sustainable O&M with adequate financial resources for O&M expenditures (opex) and trained staff; and

(v)   sustainable and environmental friendly power supply.

23.   **National governments and policymakers must ensure that ICT legal and regulatory frameworks meet present and future needs for a modern society.** Historically, and

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[20] The Nielsen Company. 2014. *Is sharing the new buying? Reputation and trust are emerging as new currencies.* http://www.nielsen.com/content/dam/nielsenglobal/apac/docs/reports/2014/Nielsen-Global-Share-Community-Report.pdf

[21] ICT infrastructure in a wider definition includes: submarine cables and backbones (international, regional, and domestic), fiber optic cables, last mile access, infrastructure sharing between sectors, mobile networks including towers, data centers including national/regional cloud infrastructure, satellites, universal service obligation (USO) funds, internet exchange point (IXP), network operations centers (NOCs), call centers, etc.

especially in developing countries governments have had difficulties in developing modern legal and regulatory structures and meeting their responsibilities in this regard. Country-related issues such as illiteracy, poor governance, red tape, or unreliable legal systems are all factors that prevent progress in ICT development.

24.   **Major weaknesses of governments and policymakers with regard to ICT development include weak strategies and vision, limited financial resources, and limited technical capacity.** More specifically, these issues include:

(i)   No or weak vision and lack of strategic directions because of the absence of ICT master plans, e-strategies, and national broadband plans for bridging the digital divide and to support urban, remote, and rural development.

(ii)   Limited financial resources (ministries in many DMCs do not even have funding for a website).

(iii)   Lack of availability of human capacity and low general security awareness. Especially the public sector often has the problem to attract and retain skilled ICT staff because their salaries and other benefits are part of the government compensation systems and are not comparable with those in the private sector globally. Weak security awareness of staff for physical security (e.g., for data centers, server rooms, desktops) and data security (e.g., viruses through data from insecure sources via USB stick or unauthorized software download, weak or not changed passwords) slow down government IT systems and open doors for abuse (e.g., from hackers).

25.   **A major and growing area of concern is cybersecurity. Weak cybersecurity can result in significant costs to business, and also pose privacy, public safety, and national security risks.** A world that runs increasingly on data flows is also one that is increasingly vulnerable to cyberattacks. Globally, there are several million cyberattacks per day, most of them automated. Cyberattacks can jeopardize ICT infrastructure such as data centers and networks but also infrastructure that is managed by ICT such as smart grids, smart cities, power plants, hospitals, harbors, and airports. One study has estimated that cybercrime costs the global economy some $400 billion in annual losses; these can include consumer data breaches, financial crimes, market manipulation, and theft of intellectual property. [22]

26.   **Recent high-profile cybersecurity incidents in ADB's DMCs illustrate the damage cybersecurity failures can cause.** In February 2016, unknown hackers stole about $80 million from Bangladesh's Central Bank and just a typo helped to prevent a nearly $1 billion heist.[23] In March 2016, the Philippines' Commission on Elections (COMELEC) database was hacked, the incident exposed records of more than 55 million voters; it is the biggest government-related data breach in the country.[24] The exposed records included personal and passport information and fingerprint data, and not all of these records were encrypted. Such incidents are typically caused by a mixture of lack of skills and awareness, weak O&M processes, outdated systems, missing updates, and poor implementation of security measures.

27.   **Alongside cybersecurity, governments will need to address increasingly complex issues around data privacy.** Regulators need to mandate standards for securing consumer data, and public agencies need to take additional steps to safeguard their own assets. Complex

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[22]   McAfee. 2014. *Net Losses: Estimating the Global Cost of Cybercrime.* http://www.mcafee .com/us/resources/reports/rp-economic-impact-cybercrime2.pdf

[23]   S. Quadir. Reuters. 2016. *How a Hacker's Typo Helped Stop a Billion Dollar Bank Heist.*http://www.reuters.com/article/usa-fed-bangladesh-hacking-typo-idUSKCN0WC0TJ

[24]   P. Paganini. 2016. *Anonymous Philippines hacked the COMELEC. It is the biggest government related data breach.*https:// securityaffairs.co/wordpress/46085/data-breach/anonymous-philippines-data-breach.html

issues around data privacy and security will continue to grow in almost every sphere as attempts increase to realize the full economic value of cloud services, big data analytics, and the IoT, which are predicated on collecting and sharing data. Governments will also have to make choices about data collection, access, usage, and consent, especially for data generated in public spaces. The dangers that hackers could create in physical settings have to be carefully considered and guarded against; policy makers can help to address security issues by creating frameworks for liability.[25]

28.   **E-services (ICT-enabled services) and applications can provide significant opportunities in a range of sectors, but implementation of these services—particularly in countries with weak infrastructure, policies and regulations—will remain a significant challenge.** All e-services and applications require having a reliable, secure, and well-managed infrastructure in place for providing quality of service (QoS) and high-speed connectivity for the users. In addition to the major issues with regard to infrastructure (discussed previously), there are a number of emerging challenges with respect to e-services and applications:

(i)   Although evidence is limited, various estimates from surveys of government officials, audit reports, and country cases suggest that about 30% of e-services and applications-related projects are total failures, with projects abandoned before completion. Another 50–60% are partial failures, with significant budget and time overruns and only a limited number of the project objectives achieved. Fewer than 20% are considered to be fully successful.[26]

(ii)   Limited financial and human capacity for development and O&M is a major impediment to the use of ICT across sectors. Most governments have interest in the use of ICTs for innovative solutions. However, they often lack financing and technical expertise; most ministries have just a small number of ICT experts, if any.

(iii)   Workflow processes are often outdated, and not in line with developments in ICT.

(iv)   Cross-connection to or from other databases (of other sectors) is not provided (e.g., no standardization of protocols).

(v)   Goals of national and regional strategies and sustainable development are not considered.

(vi)   Sector-related and ICT-related policies and regulations are not in place e.g. for data privacy and security standards for data transmission and data storage. Cooperation with other areas (energy, logistics, medical care, etc.) is limited.

(vii)   E-services and application development often relies on overseas developers who do not understand the local context or leave without transferring the needed skills.[27] To be accepted by users, e-services and applications must especially focus on accessibility, ease of navigation, efficiency, information and content, reliability, personalization, security and privacy, and responsiveness. Given the high proportion of populations that access the internet through mobile communication, ensuring access to e-services through low-technology mobile devices is critical.

(viii) Today, only an estimated 5% of the world's languages are present on the internet. Given the importance of local content and linguistic diversity, it is vital to

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[25] McKinsey Global Institute. 2016. *Digital Globalization: The New Area of Global Flows*. http://ma.mckinsey .com/practicecrm/ MGI/MGI_Digital_globalization_Full_report_March_2016.pdf

[26] The World Bank. 2016. *World Development Report 2016: Digital Dividends*. http://www.worldbank.org/ en/publication/wdr2016

[27] Association of Southeast Asian Nations. 2011. *Masterplan on ASEAN Connectivity*. http:// www.asean.org/master-plan-on-asean-connectivity-2/

increase the online representation languages, especially for regions and countries with high linguistic diversity such as Southeast Asia and India.[28]

29.   **Governments must also prepare for the impact of upcoming ICT developments on the labor market.** In some cases, ICT developments will augment the existing labor market, in terms of complementing skills of workers by improving efficiency and connectivity. In other cases, these trends can lead to greater automation—particularly in routine jobs that rely on manual labor—and may significantly transform or replace jobs.[29] Adapting to these developments would require a broader shift in education to emphasize skills such as logical reasoning, critical thinking, creativity and communication, as well as specific training and skills development in emerging ICT technologies. Efforts to ensure basic functional literacy, which is a prerequisite to digital literacy, must be addressed with renewed urgency.

30.   **In summary, to deliver universal digital access, investment in infrastructure and pursuing reforms are required that bring greater competition to telecommunications markets, promote public–private partnerships (PPPs), and yield effective regulation.** The full benefits of the information and communications transformation will not be realized unless countries continue to improve their business climate, invest in people's education and health, and promote good governance.[30] Refer to Appendix 2 for a more detailed discussion on key issues and challenges related to (a) connectivity and infrastructure; (b) governments, policy makers, and regulators; (c) e-services and applications; (d) human resources; (e) O&M; (f) risks; and (g) emerging technologies.

II.   OTHER DEVELOPMENT AGENCIES' INFORMATION AND COMMUNICATIONS TECHNOLOGY INITIATIVES

31.   **Other development agencies such as the World Bank, the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD), and the African Development Bank (AfDB) place significant emphasis on ICT infrastructure (connectivity, access to broadband).** ICT infrastructure development is typically developed alongside ICT policies and regulations, and is based on ICT strategies. Other focal areas of the agencies include ICT skill building, service delivery of the government sector (good governance), and stimulating the private sector for the use of ICT. A recent study by the AfDB noted that each dollar invested in ICT infrastructure projects leveraged $10 on average from external sources, and that the bank's investments gave comfort and acted as a catalyst for private investment into the broadband market (including missing regional and national backbone networks).[31]

32.   Between 2000 and 2015, the World Bank Group supported 379 ICT-related projects with financing of about $20 billion around the globe.[32] During the same period, the European Investment Bank (EIB) supported 272 global projects in the telecommunications sector with about $35 billion in financing, including about $25 million for countries in the Pacific region.[33] As of 31 August 2015, the European Bank for Reconstruction and Development (EBRD) had

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[28]   The Broadband Commission. 2015. *The Actual State of Broadband Annual Report 2015*. http://www .broadbandcommission.org/publications/Pages/SOB-2015.aspx

[29]   The World Bank. 2016. *World Development Report 2016: Digital Dividends.* http://www.worldbank.org/ en/publication/wdr2016

[30]   The World Economic Forum. 2015. *The Global Information Technology Report 2015 - ICTs for Inclusive Growth: 2015*. http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf

[31]   African Development Bank. 2012. *Review of the Bank's ICT Operations Strategy & Work Plan for the Medium Term 2012–2014*. http://www.afdb.org/en/documents/document/review-of-the-banks-ict-operations-strategy-and-action-plan-for-the-medium-term-2012-2014-27119/

[32]   World Bank. Projects & Operations by Sector. http://www.worldbank.org/projects/sector?lang=en&page

[33]   European Investment Bank. Finance Contracts Signed, Breakdown by Sector. http://www.eib.org/projects/ loans/sectors/index.htm?start=2000&end=2015

supported a total of 164 ICT-related projects with a cumulative investment of about $3.8 billion.[34] The ICT division of the AfDB was established in mid-2013 and no official figures for financing of ICT-related projects are available. Intergovernmental agencies, such as the Asia-Pacific Telecommunity (APT) and the International Telecommunication Union (ITU) also work with and support their member governments in ICT. Bilateral development agencies and other partners also provide some support, largely in capacity building and financing for small-scale projects.

33.   **These intergovernmental and multilateral agencies have ICT infrastructure as a key agenda for ICT development, while skill development and private sector stimulation are the other most common focus areas.** Table 4 summarizes the focus areas of selected agencies active in ICT. Sample initiatives from some of these agencies, which cut across sectors and regions in Asia and Pacific and illustrate the breadth of investments in the ICT space, are presented in Appendix 3. These sample investments include examples of projects that focus on regulatory and policy issues, regional connectivity, use of ICT for government services, and ICT-enabled applications in the finance and transport sectors.

Table 4: The ICT Focus of other Development Agencies

Agency[35]	Focus Area
African Development Bank (AfDB)	▪ Extend access to **ICT infrastructure** for poverty reduction and economic growth through direct financing of broadband infrastructure (national and regional backbones) and enabling policy and regulatory environment. ▪ Stimulate **private sector** investment. ▪ Enhance **good governance**, the efficient delivery of public services like education, health, and agriculture.
Asia-Pacific Telecommunity (APT)	▪ Foster the development of **telecommunication services and information infrastructure** throughout the region with a particular focus on the expansion thereof in less developed areas. ▪ Promote the expansion of **telecommunication services and information infrastructure** and the maximization of the benefits of ICT for the welfare of the people in the region. ▪ Develop **regional cooperation** in areas of common interest, including radio communications and standards development. ▪ Undertake studies relating to developments in **ICT infrastructure technology** and policy and regulation in coordination with other international organizations, where pertinent. ▪ Encourage **technology transfer, human resource development**, and the exchange of information for balanced development of telecommunication services and infrastructure. ▪ Facilitate regional **coordination** to strengthen the region's international position.

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[34]   European Bank for Reconstruction and Development. What we do in ICT. http://www.ebrd.com/what-we-do/sectors-and-topics/ict/overview.html

[35]   African Development Bank. Bank Group Strategy. http://www.afdb.org/en/topics-and-sectors/sectors/information-communication-technology/bank-group-strategy/
    Asia-Pacific Telecommunity. Objectives of the APT. http://www.apt.int/APT-Objectives
    European Bank for Reconstruction and Development. What we do in ICT. http://www.ebrd.com/what-we-do/sectors-and-topics/ict/overview.html
    European Investment Bank. Digital Economy. http://www.eib.org/projects/sectors/digital-economy/index.htm?lang=en
    International Finance Corporation. http://www.ifc.org/wps/wcm/connect/Industry_EXT_Content/IFC_External _Corporate_Site/ TMT/Priorities_TMT
    ITU. Activities in Asia Pacific. http://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Pages/Activities.aspx
    World Bank. World Bank Group Announces New Focus on Using ICT for Greater Development Impact. http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:23247661~pagePK:34370~piPK:34424~the SitePK:4607,00.html

European Bank for Reconstruction and Development (EBRD)	▪ Support improving access to communications and information in particular by increasing the **penetration of broadband** in regional centers and more remote locations. ▪ Support **privatization** by assisting the incumbent telecom operators and governments to transform operators into commercially oriented, privatized companies where investment is required primarily to develop the network. Foster a **knowledge economy**.
European Investment Bank (EIB)	▪ Finance and technical expertise for **mobile networks, fixed broadband access networks, transmission networks for national and international connectivity** (fiber optic, satellite, submarine cables). ▪ Finance and technical expertise for **ICT applications and services** (automotive, electricity, healthcare, e-government, e-health, e-business), including investments in data center facilities and associated hosted services such as cloud. ▪ Finance and technical expertise for **RDI** (research and development across the ICT domain) in **ICT infrastructure**, equipment, and in **semiconductor industry**, including investments in the manufacturing of handsets, network equipment, software, audio-visual equipment, displays (e.g., LCD), and **chip manufacturing** (nano-microelectronics). RDI activities include the research and development of **broadband infrastructures**, such as next generation networks, satellites.
International Finance Corporation (IFC)	▪ **Broadband development** to increase broadband connectivity. ▪ **Infrastructure sharing** to reduce companies' costs, to create stronger competition, and minimize environmental impact. ▪ **Mobile networks** helping mobile operators expand networks and upgrade services to reach all areas and population groups, especially in challenging environments. ▪ **Financial technology** supporting the development of new technologies that contributes to greater access to financial services.
International Telecommunication Union (ITU)	▪ Address the unique ICT needs of least developed countries, small island developing states, and landlocked developing countries to a) improve **infrastructure** and enhanced access to affordable **ICT services**, b) improve enabling environment for **ICT development**, c) implement appropriate national, sub-regional, and regional frameworks for **cybersecurity,** and d) enhance **skills**. ▪ Support members in all phases of **disaster management**, through ICT solutions supporting disaster preparedness including early warning, disaster response/relief, and rehabilitation of telecommunication networks. ▪ Facilitate the **transition from analogue to digital broadcasting** including digital broadcasting master plans and conversion from analogue to digital archives. ▪ Facilitate the development of **broadband infrastructure** and support access in urban and rural areas including ICT applications that can support multilingualism and address local needs, skills enhancement, and addressing deployment and operational challenges. ▪ Strengthen and **policy and regulatory frameworks**.
World Bank (IBRD/IDA)	▪ Transformation: Making development more open and accountable, and improving **service delivery**; for instance, by facilitating citizen feedback to governments and service providers. ▪ Connectivity: Scaling up affordable **access to broadband**, including for women, disabled citizens, disadvantaged communities, and people living in remote and rural areas.[36] ▪ Innovation: Developing competitive **IT-based service industries** and fostering **ICT innovation** across the economy, with a focus on job creation, especially for women and youth.

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[36] As part of its corporate scorecard, the World Bank will begin tracking "People reached with ICT", starting in 2016. http://www.worldbank.org/en/about/results/corporatescorecard

III. ADB'S INFORMATION AND COMMUNICATIONS TECHNOLOGY INITIATIVES AND LESSONS LEARNED

34. **During 2000–2015, ADB supported 402 ICT-related projects and technical assistance worth $11.91 billion.**[37] These consist of 53 stand-alone ICT projects (8% of overall financing) and 349 projects with ICT-components (92% of overall financing). Of the 402 projects, 390 were sovereign projects totaling $10.59 billion (89% of overall financing), while 12 were non-sovereign projects totaling $1.32 billion (11% of overall financing). ADB has supported ICT-related projects in almost all of its DMCs, including significant investments in PRC, India, Viet Nam, Sri Lanka, Mongolia, Afghanistan, Bangladesh, Myanmar and others. Since at least 2003, ICT has been a priority sector for ADB in the Pacific region, recognizing the disadvantages of the region's economic geography, and also the potential gains offered by links to the global market.

35. **During 2000–2015, ADB financed 53 stand-alone ICT projects (loans, grants and TAs), amounting to $994.2 million.**[38] This consisted of 45 sovereign projects (4 loans totaling $47.9 million; 6 grants totaling $52.9 million; and 35 TAs totaling $20.4 million); and 8 non-sovereign projects (8 private sector loans and equity investments totaling $873 million).[39] A little under half of these stand-alone projects were regional projects.

36. **During the same period, ADB financed 349 ICT-component projects totaling $10.91 billion.** These projects consisted of 345 sovereign projects (80 loans, totaling $9.04 billion; 34 grants totaling $0.39 billion; and 231 TAs totaling $1.03 billion) and 4 non-sovereign projects (4 private sector loans and investments totaling $0.45 billion). Key ICT-enabled sectors for ADB include public sector management (the most by project, 76 projects) and energy (the most by financing, about $4.2 billion). As shown in Figures 3 and 4, there have also been a significant number of ICT-related loans in the transport, industry and trade, education and finance sectors.

Figure 3: Breakdown of ADB's ICT-Related Projects by Sector (2000–2015)
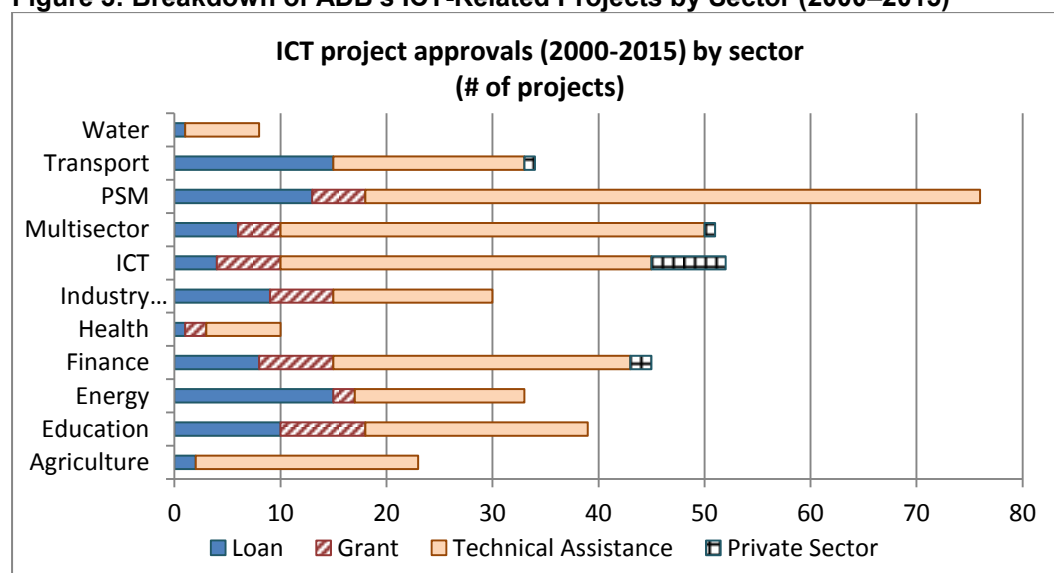
Source: Asian Development Bank

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[37] These figures are based on 2016 estimates from the Sustainable Development and Climate Change Department (SDCC), and include projects where ICT is the main outcome and/or is listed as a major project output. The projects captured based on these criteria are less than the $17.67 billion worth of projects currently listed on ADB's website http://www.adb.org/sectors/ict/overview , which are based on broader criteria.

[38] A stand-alone ICT project is any project (loan, grant, TA, or equity investment) that is classified under the "ICT" sector or as an ICT sub-sector in ADB's project classification system (PCS). An ICT-component project is any project where ICT is included as one of the outputs.

[39] Based on 2015 estimates SDCC.

Figure 4: Breakdown of ADB's ICT-Related Financing by Sector (2000-2015)
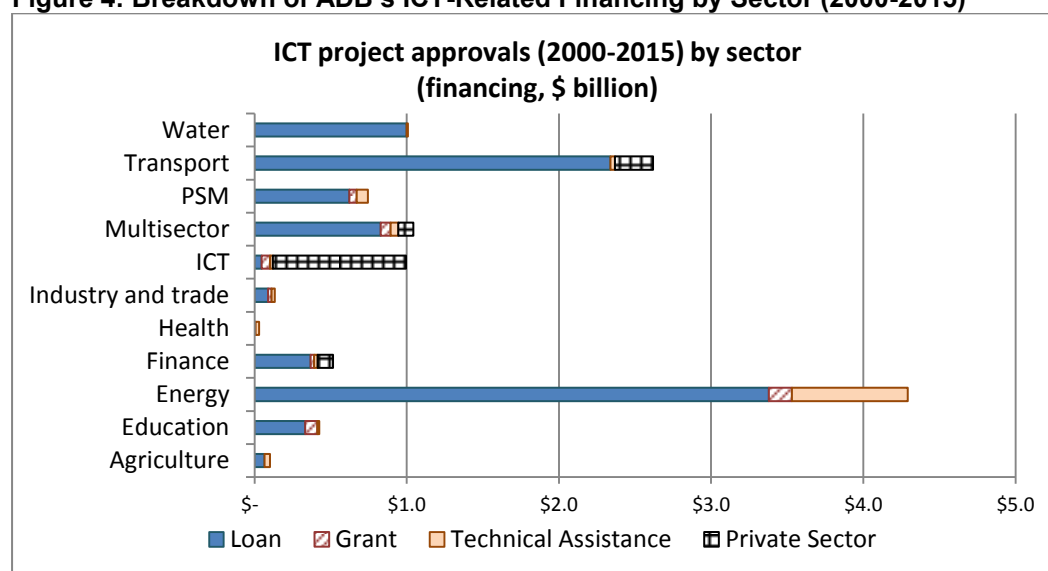
Source: Asian Development Bank

37.   **ADB's support has covered ICT infrastructure; ICT-enabled industries; ICT-enabled services; and ICT policy, strategy, and capacity development.** To date, ADB has helped develop and maintain:[40]

(i)   ICT infrastructure (e.g., telecommunications networks, mobile and wireless network, broadband cable networks, data centers, last-mile internet connectivity);

(ii)   ICT industries (e.g., ICT centers of excellence, research/computer laboratories; ICT-enabled industries such as business process outsourcing, knowledge process outsourcing, software parks, ICT incubators);

(iii)   ICT-enabled services (e.g., ICT applications for governance, education, health, finance);

(iv)   ICT policy, strategy, and capacity development (e.g., ICT policy and strategy, telecommunications policy reform, universal access and service, ICT road maps (national and local), ICT regulations and laws, ICT skills training and capacity building).

38.   **Recent assessments of ADB's ICT operations have noted that while ICT components of ADB projects at project completion have generally been a success, implementation of these has been hampered by considerable delays.** Depending on the sector, the delays were attributed to reason related to lack of e-readiness (weaknesses in ICT infrastructure, inadequate policies and strategies), lack of qualified technical staff to maintain and support systems, project management related issues (including procurement delays), lack of leadership (including slow decision-making at critical project stages), and lack of ownership (including resistance from staff).[41]

39.   **Delays could have been avoided through better planning, better monitoring and control, better comprehension of complexity of ICT projects, and a better understanding of demand, patterns, and user behavior.** Other issues were insufficient attention to system-

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[40]   ADB.   2014.   ADB's   Work   to   Improve   Access   to   Information   and   Communication. http://www.adb.org/sectors/ict/overview

[41]   ADB.   20104.   Promoting   Information   and   Communication   Technology   in   ADB   Operations. http://www.adb.org/sites/default/files/publication/42673/promoting-ict-adb-operations.pdf

manuals and training, and insufficient resources to cover internet costs after project completion. Lack of government commitment to allocate sufficient resources for operations and maintenance of the ICT systems, as well as human capacity development, have affected project sustainability.

40.   **In terms of e-solutions supported by ADB in public sector management, more than half did not fully achieve their expected results.** In addition, the vast majority of e-governance projects experienced substantial completion delays. Some of the reasons cited for partly successful or unsuccessful projects related to poor e-readiness (including poor ICT infrastructure, unsupportive policy and regulatory frameworks, frequent power outages and lack of backup power source in remote areas), lack of ownership and foresight, limited financial and in-house technical capacity of DMCs, scarcity of local ICT consultants and vendors, a limited understanding of the complexity of ICT systems, and poor project design and management. Another key issue was inappropriate implementation arrangements, including those that had an overreliance on ICT but overlooked the importance of institutional change and human resource development.

41.   **These challenges have highlighted some key lessons for ADB in terms of its support to sector-based ICT interventions.** These include the need to:

(i)   facilitate development of a conducive ICT policy environment;
(ii)   carefully consider the political and institutional environment for ICT initiatives;
(iii)   adopt a holistic approach rather than a fragmented one;
(iv)   invest in building organizational capacity and change management;
(v)   tailor e-solutions to the local context;
(vi)   identify the total cost of ownership of e-solutions in early stages, including sustainable O&M after project completion;
(vii)   adapt project design to fast-changing technologies and local condition; and
(viii)   support ICT champions within government and in key institutions.

42.   **Other key lessons learnt include the importance of regular monitoring and evaluation after completion of the project to guarantee sustainability.[42]** Beside customer and user satisfaction surveys, contribution of projects to improved service delivery and national development goals should be assessed. Project relevance, efficiency, effectiveness, and sustainability (e.g., funding, O&M, skills development) should also be part of the evaluation. Regular third party security audits are especially recommended for critical e-services and applications like, for example, e-health, e-finance, and smart grids. With regard to ownership, projects where the contributing party has to invest at least partially own funds are the most successful in long term. Waiving tax on import of ICT equipment and waiving fees for permits are other aspects for appropriate government contribution.

43.   **Other important issues not fully considered in ICT-related projects concern security, standardization, and O&M.** Data security (applications, data transfer, storage), physical security (networks, data centers, server rooms, submarine cable landing stations), standardization of systems (hardware, software, protocols, e.g., for exchange of data between systems), and sustainable O&M (skills, funds, spare parts) are all areas that are often not considered fully in ICT projects.

44.   **Among ADB management and staff there is an overwhelming recognition of the importance of ICT and its contribution to achieving the region's development goals.** This includes both stand-alone ICT interventions (ranging from strategy to policy and regulation to ICT infrastructure) and also ICT sector applications. There is a broad understanding that

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[42]   Includes personal experience of the author of this document, including in Asia and Pacific.

increasing access to ICT can introduce new opportunities for the poor and other under-represented groups, including women, by increasing access to information, jobs and income generation opportunities, and allowing these groups to participate as citizens, producers, and consumers.[43] The midterm review of Strategy 2020 also drew attention to the role that ICT can play in making ADB's assistance more innovative, inclusive, and integrated. This included ICT's impact on improving access to finance, improving project management, promoting e-governance, meeting education needs of growing and modernizing economies, and making service delivery more efficient.[44]

45.   **At the same time there is a broad consensus that ADB is falling behind in this area, that it should do much more, and that a clear institutional support structure for ICT is needed.** Based on consultations conducted in early 2016 for the preparation of this paper, there is an overall impression is that ICT has so far no "home" and leadership in ADB, and that the impact of ICT on the development of countries, regions, and sectors may be less than fully understood and somewhat underestimated. At the same time, many staff view the ICT sector as an important sector where ADB can scale-up its support and financing.

46.   **To date, ADB's ICT activities (encompassing loans, grants, TAs, and other support) have been organized and conducted through different parts of the institution, and there is no clear focal point.** At present there is no Sector or Thematic Group (STG) specifically for ICT. ADB's ICT activities have been organized in the operations departments (particularly the Pacific Department [PARD]) and by various sector and thematic groups including the transport sector group, the finance sector group, and the governance thematic group.[45] A recent analysis by the Sustainable Development and Climate Change Department (SDCC) found that ICT features in the operational plans of some of the sector and thematic groups, such as education, health, finance, and disaster risk management, but not in others.[46]

47.   **As a result, ADB's approach to ICT has been largely opportunistic, rather than strategic, in nature.** There is recognition that ADB may not be in a good position to gauge demand for ICT, as ADB's ICT engagement is fragmented and largely focused on sector-related ICT. With some exceptions, such as in the Pacific, DMCs may not actively approach ADB for a holistic assessment and response to meeting all their ICT needs because of a perception that ADB's expertise and focus is elsewhere, such as infrastructure development in traditional sectors. At the same time, ADB has not taken steps to develop deep expertise and experience in ICT as there is a perception that there is insufficient demand from DMCs for ICT. In most

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[43] Recent initiatives by ADB on using ICT to address gender equity include work in Myanmar and Central Asia.
ADB. 2015. Myanmar: Nationwide Telecommunications Project. http://www.adb.org/projects/49116-001/main#project-overview
ADB. 2014. Information and Communication Technologies for Women Entrepreneurs. http://www.adb.org/publications/ information-and-communication-technologies-women-entrepreneurs

[44] ADB. 2014. Midterm Review of Strategy 2020: Meeting the Challenges of a Transforming Asia and Pacific (R-Paper). http://www.adb.org/documents/midterm-review-strategy-2020-meeting-challenges-transforming-asia-and-pacific-r-paper

[45] A full list of DMCs by region and operations department is given next:
Central and West Asia Department (CWRD) covers operations in Afghanistan*, Armenia*, Azerbaijan, Georgia*, Kazakhstan, Kyrgyz Republic*, Pakistan*, Tajikistan*, Turkmenistan, and Uzbekistan*; Pacific Department (PARD) covers operations in Cook Islands, Republic of Fiji, Kiribati*, Marshall Islands*, Federated States of Micronesia*, Nauru*, Palau*, Papua New Guinea*, Samoa*, Solomon Islands*, Timor-Leste*, Tonga*, Tuvalu*, and Vanuatu*; South Asia Department (SARD) covers operations in Bangladesh*, Bhutan*, India, Maldives*, Nepal*, and Sri Lanka*; Southeast Asia Department (SERD) covers operations in Brunei Darussalam, Cambodia*, Indonesia, Lao People's Democratic Republic*, Malaysia, Myanmar*, Philippines, Singapore, Thailand, and Viet Nam*; andEast Asia Department (EARD) covers operations in the People's Republic of China; Hong Kong, China; Republic of Korea; Mongolia*; and Taipei,China.
*Asian Development Fund (ADF) countries (concessional lending)

[46] ADB. 2016. *Ramping up ADB's role in Information and Communications Technology for Development—ICTD Team Work Plan, 2016–2017*. Manila.

DMCs, ADB is not in contact with the right stakeholders, like ICT ministries and responsible departments within the ministry of telecommunications, regulators, and ICT sector associations. ADB also cannot hold complex technical discussions with DMC stakeholders if it itself does not have the expertise across the complex ICT ecosystem, and a strong technical understanding of the sector and related dependencies. Please see Appendix 4 on staff views on these issues.

48.   **Outside of the Office of Information Systems and Technology staff, whose mandate is related to ADB's internal IT systems, ICT expertise in ADB is weak, consisting of only a few individuals most of whom focus on strategy or ICT sector-related knowledge.** ADB's ICT staff lack strong practical experience along the full spectrum of the complex ICT ecosystem and end-to-end dependencies, encompassing strategy, policies, regulations, infrastructure, e-services and applications, security, and O&M, including respective planning, project management, implementation, and risk elements. This lack of practical expertise is a bottleneck to further expanding ADB's role in the ICT sector.

49.   **ADB has recently recognized ICT as a sector in its own right, on a par with other sectors.** Since 2014, ICT has been identified by ADB as a separate sector in its project classification system, whereas previously it was considered a subsector under "Transport and ICT".[47] ADB's ICT priority areas are identified in Box 2, which includes largely stand-alone ICT areas (Priorities 1 and 2) and areas that cut across sectors (Priority 3).

IV.   FUTURE OPPORTUNITIES FOR ADB

50.   **Global dependency on ICT will further grow in the coming years and ICT will play an increasingly important role in development, and in enabling the world to achieve the Sustainable Development Goals (SDGs).** ICT contributes to development in many ways, including by facilitating information and data flows, improving productivity and efficiency, and improving access to information and services. As such, it plays a significant role across the 17 SDGs, from achieving food security (under Goal 2) and the management of water (under Goal 6), to ensuring affordable, reliable, sustainable and modern energy for all (under Goal 7), to taking urgent action on climate change (under Goal 13). ICT can also be considered to be directly referenced in four of these goals, namely on inclusive and equitable quality education (Goal 4); gender equality and empowerment of women and girls (Goal 5); infrastructure and innovation (Goal 9); and strengthening implementation and global partnerships (Goal 17) (Footnote 49). ICT is also important for ADB's safeguards, for example, it can support improved monitoring (including environmental monitoring), facilitate access to information, and promote gender inclusion.

51.   **There are many present and future opportunities for ADB's ICT interventions.** Most ADB DMCs have similar weaknesses in their respective ICT sectors.[48] Furthermore, as ADB's DMCs increasingly reach upper middle-income status, their demands for ICT solutions, for

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[47] ADB. 2014. *Project Classification System: Final Report.* http://www.adb.org/documents/project-classification-system-final-report

[48] The World Economic Forum. 2015. The Global Information Technology Report 2015 - ICTs for Inclusive Growth. http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf
  The Broadband Commission. The Actual State of Broadband Annual Report 2015. plus additions. http://www.broadbandcommission.org/publications/Pages/SOB-2015.aspx
  ESCAP. 2014. An In-Depth Study of Broadband Infrastructure in North and Central Asia. http://www.unescap.org/resources/ depth-study-broadband-infrastructure-north-and-central-asia
  The World Bank. 2016. World Development Report 2016: Digital Dividends. http://www.worldbank.org/en/ publication/wdr2016
  ADB. 2014. Promoting Information and Communication Technology in ADB Operations. http://www.adb.org/publications/ promoting-information-and-communication-technology-adb-operations

example to enable increased productivity, develop new products, provide more sophisticated and complex services, and develop new markets, will grow.

52.   **ICT opportunities for ADB in DMCs can be categorized in three priority areas, covering (i) ICT policies and strategies, (ii) ICT infrastructure, regulations and skill building, and (iii) sector-related e-services and applications (refer to Box 2).** Broadly, these priority areas are relevant across ADB's DMCs and regions. Strong policies and strategies should underpin development of ICT infrastructure, regulations, and skills. Similarly, sector-related e-services and applications should be considered and developed when the infrastructure, regulatory environment, and skill levels are sufficient to support such e-services and applications. For a more detailed description of these areas, refer to Appendix 2.

Box 2: Priority Areas for ADB in ICT
- Priority 1: ICT/broadband policies and strategies (including sector-related, national, and regional) and ICT sector reforms;
- Priority 2a: ICT infrastructure (submarine cables, fiber optic cables, mobile networks, data centers including national/regional cloud infrastructure, satellites, last mile access, infrastructure sharing between sectors, universal service obligation (USO) funds support, internet exchange points (IXPs), network operations centers (NOCs), call centers, etc.) at the international, regional, and domestic levels; including sustainable O&M;
- Priority 2b: ICT regulations, ICT standardization, ICT security (cybersecurity etc.), ICT legal; national and regional;
- Priority 2c: ICT skill building, capacity building and awareness programs covering both technicians and users; and
- Priority 3: E-services and applications for various sectors and topics, including sustainable O&M.

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53.   **Furthermore, there is scope for cross-sector collaboration (e.g., ICT sector with energy sector, transport sector) through common standards, policies, and multi sector-infrastructure sharing (roads, rails, grids).** In most countries there is only very limited cooperation between ICT regulator and stakeholders of the transport and energy sector, and, as a result, such opportunities are not utilized.

54.   **In the fast growing and changing global ICT sector, ADB's engagement at the strategic level is critical to ensure that its analysis and proposals are based on current information.** In the ICT sector, published statistics and information are just snapshots, and the state of ICT development of countries and regions can change substantially in a very short period, for example by setting-up the first international high-speed connection (e.g., submarine cable or landline), by capacity upgrades (e.g., redundant connections), or through new competitors in the market. To access up-to-date developments and understand what is currently planned or already under implementation, ADB must always source actual and timely information and knowledge from the right stakeholders such as ICT and sector-related ministries and regulators, ICT and sector-related associations, and other multilateral organizations active in the sector. For this reason, ongoing engagement with all relevant stakeholders at the policy and strategy level should be considered by ADB as its first priority.

   A. **Priority 1: Information and Communications Technology Policies and Strategies**

55.   **ICT policies and strategies are the first successive priority for ICT development, and are a prerequisite for successful projects, be they stand-alone ICT projects or sector-related e-services and applications.** ICT/broadband policies and strategies (including sector-specific, national, and regional) need to be prepared and updated by DMCs every few years. In addition, ICT sector reforms with regard to telecommunications laws, regulation, competition, technology, liberalization, etc. are required on a continual basis to meet future demand.

56.   **ADB's first priority should be to support the preparation of national ICT and broadband plans, ICT policies, and strategies.** During the preparation of these plans, ADB will get actual and detailed information about the state of the ICT development of the respective country, including cross-border linkages. This includes activities in the domestic ICT sector and ICT-related priority areas (including various sector-related) for the next years. It will also give an opportunity for ADB to develop relationships with the most relevant stakeholders of the ICT sector and to identify areas for intervention in the future. ADB needs to immediately establish, follow-up and keep regular contact with such stakeholders.

57.   **A number of ADB's DMCs will need to develop or update their ICT policies and strategies in the coming few years, which present opportunities for ADB.** Table 5 lists the status of ICT policies for ADB's DMCs. Several of ADB's DMCs do not have national broadband policies (which includes national broadband plans and national policies that contain broadband targets). In other cases, existing broadband policies that were adopted some years ago will need to be updated. For example, the Philippines broadband plan ("The Philippine Digital Strategy, Transformation 2.0: Digitally Empowered Nation"), adopted in 2011, is due to be updated.[49] By supporting preparation and updating of such national (or regional) broadband plans, ADB can identify areas of intervention for the coming years, and build relationship with the right stakeholders. In countries where updated plans are already available, these should inform ADB's ICT interventions.

Table 5: National Broadband Policies[50]

Country/Region	ICT Policy available	ICT Policy adopted	Title/Details
Afghanistan	Y P	2011 N	Optic Fiber Network Backbone Expansion Project - 2011-2013 (ICT Policy for Afghanistan, A digital agenda for development and social change 2015-2024) – only Draft available
Armenia	Y	2008	Government of Republic of Armenia Decree No35, on Approving The Information Technology Sector Development Concept Paper Road Map For "Real-Time" Armenia: e-government, e-security, e-commerce
ASEAN	Y	2011	ASEAN Connectivity Plan
Australia	Y	2009	The National Broadband Network
Azerbaijan	Y	2014	"Azerbaijan 2020: Look Into The Future". National Strategy for Information Society Development in Azerbaijan for 2014-2020
Bangladesh	Y	2009	Broadband National Policy Act 2009
Bhutan	Y	2008	National Broadband Master Plan Implementation Project
Brunei Darussalam	Y	2014	National Broadband Policy
Cambodia	Y	2014	Cambodia's ICT Master Plan 2020
China, People's Republic of	Y	2011	Telecom Industry Development Plan 2011-2015
Fiji	y	2011	National Broadband Policy
Georgia	N		
India	Y	2011	National Telecom Policy 2012 and National Optical

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49   TeleGeography. 2016. *Philippines' government corrals agencies to formulate new national broadband plan*. https://www.telegeography.com/products/commsupdate/articles/2016/04/22/philippines-government-corrals-agencies-to-formulate-new-national-broadband-plan

50   The Broadband Commission. The Actual State of Broadband Annual Report 2015. plus additions. http://www .broadbandcommission.org/publications/Pages/SOB-2015.aspx

Country/Region	ICT Policy available	ICT Policy adopted	Title/Details
			Fibre Network Plan
Indonesia	Y	2014	Indonesia Broadband Plan 2014-2019
Japan	Y	2014	Japan Revitalization Strategy
Kazakhstan	Y	2010	Programme of ICT Development
Kiribati	N		
Korea, Republic of	Y	2009	Ultra-Broadband Convergence Network
Kyrgyz Republic	Y	2006	Regional Arrangement concerning the planning of the digital terrestrial broadcasting service and the digital Plan (GE06)
Lao People's Democratic Republic	N		
Maldives	N		
Malaysia	Y	2010	National Broadband Initiative
Marshall Islands	Y	2011	National ICT Policy
Micronesia, Federated States of	N		
Mongolia	Y	2011	National program on Broadband Network up to 2015
Myanmar	N		
Nauru	Y	Not available	Nauru ICT Policy
Nepal	Y	2004	Telecommunication Policy, 2060 (2004)
New Zealand	Y	2015	Ultra-fast broadband initiative, Five Point Government Action Plan for faster broadband
Pakistan	Y	2007	National Broadband Programme 2007
Palau	P		
Papua New Guinea	Y	2011	National ICT Policy and PNG LNG Fibre cable project
Philippines	Y	2011	The Philippine Digital Strategy, Transformation 2.0: Digitally Empowered Nation
Samoa	Y	2010	Broadband Spectrum Plan
Singapore	Y	2005	Intelligent Nation 2015
Solomon Islands	P		
Sri Lanka	Y	2012	e- Sri Lanka
Taipei,China	Y	2002	National InfoComm Development Plan: Broadband Enabling Strategies 2002-2011
Tajikistan	N		
Thailand	Y	2010	The National Broadband Policy
Timor-Leste	P		
Tonga	Y	2011	Tonga-Fiji Connectivity Project: Pacific Regional Connectivity Program
Turkmenistan	N		
Tuvalu	N		
Uzbekistan	N		
Vanuatu	Y	2013	National Information and Communications Policy
Viet Nam	Y	2010	Master Plan of Viet Nam, from 2010 to 2015; Prime Minister's Decree 1755 on the approval of a National Strategy on Transforming Viet Nam into an advanced ICT country

ASEAN = Association of Southeast Asian Nations, LNG = Liquefied Natural Gas, N = No, P = Planned, PNG = Papua New Guinea, Y = Yes.
Source: The Broadband Commission: "The Actual State of Broadband Annual Report 2015" plus additions.

B. Priority 2: Information and Communications Technology Infrastructure, Regulations, and Skill-Building

58. **Based on and consistent with national ICT policies and strategies, ADB should formulate and determine its investments in ICT infrastructure, regulations, and skill-building.** These three areas are considered under the same priority area because ICT developing ICT regulations (2b) and skill-building (2c) in parallel to ICT infrastructure (2a) is essential to ensure that infrastructure is effective and/or sustainable. ICT infrastructure includes submarine cables, fiber optic cables, mobile networks, data centers including national/regional cloud infrastructure, satellites, last mile access, infrastructure sharing between sectors, universal service obligation (USO) funds support, internet exchange points (IXPs), network operations centers (NOCs), call centers, etc. These investments could be international, regional, and/or domestic in nature, and should include adequate measures for sustainable O&M. While the private sector has and will invest in ICT infrastructure and services where there is a strong business case, public investment is required to ensure affordable access and connectivity, particularly in remote and rural areas. There is much space for PPPs. ICT regulations includes those relating to legal aspects, standardization, security (including cybersecurity) and other aspects, at both the national and regional level. ICT skill building includes capacity building and awareness programs that cover both technicians as well as users.

1. Information and Communications Technology Infrastructure

59. **Strong growing demand for internet capacity requires regular evaluation of international connectivity and upgrades of international and regional ICT infrastructure.** International connectivity infrastructure includes land lines, submarine cables, and in exceptional cases with serious limitations, satellites. For such infrastructure aspects, issues relating to resiliency, redundancy (e.g., alternate/backup routings of international connections), and regional (e.g., for strengthening regional integration) and international routing (most services are hosted in the United States and other developed countries) must also be considered.

60. **National ICT infrastructure (fixed line networks, mobile networks) must be implemented and upgraded regularly to meet present and future requirements.** National fiber-optic backbone networks are especially limited in most rural areas and mobile towers are required for better coverage. Support is needed in such areas when there is insufficient incentive for private sector investment. This will help promote private sector participation and enhance redundancy triggering higher ICT availability and lower prices for consumers. There is scope for cross-sector collaboration to share communications networks used in the energy and transport sector.

61. **Electricity is critical for ICTs, and cross-sector partnerships involving both the energy and ICT sectors can accelerate the deployment of electricity and connectivity to rural areas.** Given the often significant impact of ICT infrastructure and devices on energy consumption and emissions, renewable energy should be considered wherever possible.

62. **Mobile broadband networks are crucial to ICT development in the Asia and Pacific region, particularly as these are set to become faster with increased adoption of 4G and 5G networks.** Mobile broadband is already far more prevalent than fixed. However, the predominant 3G technology used in the region falls short of matching the quality of fixed broadband networks. The latest 4G technology and upcoming 5G technology provides performance equivalent to basic and high speed fixed line broadband with benefits for consumers across a range of applications. Many developing economies in the region have yet to launch such networks and, in those that have, coverage is generally restricted to a few cities. Assistance is needed to establish suitable regulatory frameworks, including leveraging the

frequencies made available from moving to digital broadcasting, in order to ensure adequate spectrum is available for deploying 4G and future 5G networks. This includes sector advice on attracting the needed investment and ensuring that the benefits of fast 4G and upcoming superfast 5G technologies are available throughout DMCs.

63.   **There is a need to extend access for rural and disadvantaged communities, including through mechanisms such as universal service obligation (USO) funds.[51]** A number of countries in the region lack a USO. Even when such a fund exists, there may be policy and technical limitations; many countries with the fund do not support mobile or broadband. Further, there remains a significant urban-rural divide in terms of ICT access. Support for disadvantaged users such as the disabled or elderly is also limited. Therefore, there is considerable scope to enhance universal service programs from the point of view of strengthening inclusiveness in accessing mobile and broadband services. An example of an intervention is support for expanding mobile broadband coverage and telecenters for community access. Improved access to ICT can help revitalize rural communities by providing opportunities to expand incomes, develop new livelihoods, and enhance well-being through online education, health, and social networking applications.

64.   **For internal use and for providing public services, secure government networks need to be implemented and upgraded regularly.** Today most governments still have only scattered ICT infrastructure, O&M, and security, which are mostly weak caused by very limited skilled resources and lack of availability of budget for operations. In addition, data is often not transferrable between IT applications because of lacking standardization. To improve accessibility, transparency, and efficiency of public services, ICT infrastructure needs to be consolidated and expertise pooled (such as for shared ICT infrastructure and services), security needs to be strengthened, standards for interoperability between systems need to be agreed upon and implemented, and ICT policies need to be suitably adapted and updated.

2.   Information and Communications Technology Regulations

65.   **ICT regulations, including standardization and security, need to be implemented and regularly updated to keep pace with changing technologies and the globalization in ICT.** Key areas where legal and regulatory frameworks are necessary include security (e.g., cybersecurity, privacy, etc.), quality of service (QoS), spectrum frequency management, convergence, competition, multi-sector infrastructure sharing, and universal service. Legal advice is essential to modernize existing laws and introduce new laws governing the ICT sector to create a favorable investment environment. Capacity building is also important for policymakers to understand and effectively manage key technological issues impacting the sector. Regional dimensions of such ICT regulations are critical, given the global nature of ICT. For example, all data that is stored on servers outside the country, such as storage in clouds, email services, and social media, are subject to laws and regulations of the country where the data is stored and not of the country where it was created.

3.   Information and Communications Technology Skill-Building

66.   **With growing connectivity and associated risks ICT skill building and ICT literacy/awareness programs covering both technicians and users need to be implemented and regularly updated; data security and O&M should be priority areas.** This encompasses both skill building with respect to specific infrastructure and investments (for example, relating to hardware and software upgrades or renewal, O&M aspects, network

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[51]   The telecommunications industry of a country pays a part of their net earnings into a universal service obligation (USO) fund and with this fund the government tenders for example telecommunications infrastructure development in rural and remote areas where the private sector has no interest to invest in.

management and monitoring, and security) and general ICT skills that can be applied in different jobs or contexts (programming, design, mobile application development, cyber and digital security, etc.). There is also a need for training programs targeted at those involved with ICT project preparation, management and implementation, as well as application design, particularly for secure real-time (and cloud-enabled) data collection, sharing and analysis.

67.   **The private sector, especially entrepreneurs and small- and medium sized enterprises (SMEs), need to be stimulated for the use of ICT.** Assistance is needed to develop policies and strategies in this area including incorporating ICT in national development plans, diagnosing strengths and weaknesses, identifying opportunities, and designing appropriate human resource development programs.

C. Priority 3: Sector-Related E-Services and Applications

68.   **Prerequisites for all sector-related e-services and applications are adequate national strategies, ICT and sector-related policies and regulations and compliance with internationally accepted open standards, especially for software development, security, and transmission.** These standards include encryption for hosting and data transfer with the users, and interfaces and protocols for data exchange between systems to avoid isolated solutions. Resilient infrastructure (including data centers, computer rooms, servers, networks, sustainable energy supply) is required that allows secure, fail-safe, and robust hosting and transmission of services. The users must have secure and high speed access (e.g., coverage, quality of service (QoS), affordable capacity) and of course suitable devices such as computers, notebooks, tablets, mobile or smart phones or GPS enabled devices to use and benefit from e-services and applications. For sustainable use of e-services and applications, related workflow processes and organizational structures must be adopted. Regular updates of databases with information from reliable sources, and ICT literacy for O&M including handling of associated security risks, are other important topics to be considered. Of course e-services and applications must be available in local languages, consider cultural aspects and should be accessible for people with disabilities.

69.   **Once these prerequisites are developed and/or assured, there is much space for ADB's interventions by supporting the deployment of turn-key and the development of individual sector-related e-services and applications.** These sector applications include but are not limited to applications in education, energy, finance, health, transport, urban and water, finance, agriculture, and governance. Key areas where ICT interventions are and will be relevant for each of these sectors are discussed below. It is worth noting that ADB has relevant experience already in many of these areas, such as intelligent transport systems, smart grids, public transport management systems and cashless ticketing systems, GIS-based urban planning, and delivery of financial services. For a more comprehensive discussion of e-services and applications in key sectors, refer to Appendix 2.

70.   **ICT is already deeply embedded in energy sector, and most solutions in the energy sector already include ICT-related components, especially for monitoring and management purposes.** ICT is used for improving the functioning of the electricity grid (including through smart grids and smart meters for power distribution and monitoring) and promoting generation from diverse sources (by facilitating planning, metering, and adjustments to peak supplies). ICT related e-services and applications play a key role in improving energy efficiency, which in turn reduces carbon dioxide emissions from power plants, and lowers electricity bills. ICT also facilitates energy savings in buildings, including through automated energy management and monitoring systems. Other opportunities include infrastructure sharing between the ICT sector and the energy sector, especially related to towers and facilities, and critical infrastructure protection, which relates to the preparedness of energy infrastructure

(including power plants, grids and node points) to deal with serious incidents or natural disasters. Furthermore, today, almost all power grids are implemented with fiber optic cables for the monitoring and management of the power grid. These fiber optic cables can also be utilized for telecommunications. However, in most countries, there is very limited cooperation between ICT regulators and energy regulators, with the result that such opportunities are fully utilized.

71.   **In the transport sector, ICT has been utilized for traffic management, reducing energy consumption, and improving road safety.** One major area is Intelligent Transport Systems (ITS), which concerns the exchange and analysis of information across systems for improved performance and safely of transport systems. This includes stand-alone applications such as traffic management systems, information and warning systems installed in individual vehicles, as well as cooperative ITS (C-ITS) applications involving vehicle to infrastructure and vehicle-to-vehicle communications.[52] ICT has also been utilized for toll systems and harbor, border, and airport logistics. Looking ahead, there are significant ICT opportunities in urban transport, including applications for real-time routing (to ease traffic congestion), electronic fare collection, bus information systems, and road safety applications that record and report accidents. Furthermore, the use of different types of data facilitated by ICT, such as mobile data (e.g., for traffic studies) and GIS/satellite data (e.g., for road alignments), continues to be explored. (A key related issue is on data privacy, as the effectiveness of many of these systems would depend on how many vehicles and drivers are connected to the system, while the willingness of drivers to connect may depend on their perception of how securely the data they contribute to the system would be handled.) There are opportunities for cross-sector infrastructure sharing between the ICT and transport sectors, especially related to ducts for fiber optic cables along roads and railways, and should continue to be identified. In most countries, however, there is very limited cooperation between ICT regulators and stakeholders of the transport sectors; as a result, such opportunities are often not utilized.

72.   **ICT brings significant opportunities for cities to enhance quality, performance, and interactivity of urban services, to reduce costs and resource consumption and to improve contact between citizens and the government.** Utilizing cloud-based services, mobile phones, sensors, big data, data analytics, and other technologies, "smart cities" can improve quality of life by using technology to increase the efficiency of services and meet residents' needs, and allow for the integration of multiple ICT solutions in a secure fashion to manage a city's assets. These assets include, but are not limited to, local departments information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. Geographical Information Systems (GIS) are being increasingly utilized for urban planning; and Management Information Systems (MIS) for urban management and governance. Through the use of sensors integrated with real-time monitoring systems, data collected from both citizens and physical objects can be processed and analyzed. It is important to note that such ICT-based solutions will not be successful unless key skills, expertise, and systems in relevant government departments are also developed

73.   **ICT plays an important role in enabling management of water and natural resources.** ICT systems can enable water service providers to automate a significant portion of their operations, monitor water use, optimize water pressure and energy use, identify and reduce non-revenue water and improve bill collection. They can also enable real-time responses to other challenges relating to service delivery, computerized billing and collection, public safety, taxation, public transport, and waste collection. In terms of water resources and natural resources management, ICT plays an important role in modeling, monitoring, and reporting on natural resources, including by enabling analysis of data gathered from different sources such

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[52]   Australian Government. Intelligent Transport Systems. https://infrastructure.gov.au/transport/its

as satellites and sensors. In these and other ways, ICT contributes to Goal 6 of the SDG (on availability and sustainable management of water and sanitation for all), as well as Goal 14 (on conservation and sustainable us of oceans, seas, and marine resources) and Goal 15 (on protection, restoration, and promotion of ecosystems).

74. **ICT plays an important role in extending formal financial services to excluded and underserved populations through digital finance**. Globally, 2 billion adults remain unbanked; South Asia (625 million), and East Asia and the Pacific (490 million) together account for more than half the world's unbanked adults. Countries such as India, PRC, and Indonesia account for a significant share of the world's unbanked adults, at 21%, 12%, and 6% respectively.[53] Ensuring financial inclusion of these unbanked populations in the formal economy is a critical contribution to poverty reduction, reduction of inequality, and inclusive growth.[54] Financial inclusion means that households and small businesses can gain access to savings, credit, insurance, remittances, and payment services. These can be accessed through e-finance applications, including those for online banking and/or mobile banking. E-finance allows for financial activities to be carried out electronically, for example over the internet or between devices, provided that users have access to computers, mobile or smart phones, or tablets with secure and good internet and/or mobile connectivity. A correct mix of technical, financial, and policy support can assist in scaling up sustainable branchless and mobile financial services that reach especially the poor in low-income countries. These include providing risk capital directly to private sector providers for developing financial technology ("fintech") solutions and bringing these to underserved and hard-to-reach markets, supporting central banks in establishing an enabling environment (including the legal and regulatory framework and policies) for branchless and mobile services, and facilitating market and client research to develop financial products and services that target low-income and rural households.

75. **ICT can play an important role in governance, and e-government initiatives can improve accessibility, transparency, and efficiency of public services.** E-government is used for government internal administration (e-administration) and for the benefit of citizens and businesses. Governments need support in defining national e-government strategies. Well-managed secure government networks and ICT infrastructure are additional prerequisites for handling sensitive internal data and data on citizens and businesses. Around the world, e-services and applications have been employed for hundreds of government initiatives, including for public service administration and for e-governance. Such initiatives can facilitate governments' interactions with businesses (e.g., business registration, taxes, licenses, government procurement, statistical information services, etc.) as well as citizens (taxes, identification and biometric services, taxes and financial services, property information and land maps, online billing, SMS alerts including for disasters, citizen feedback and crowdsourcing, etc.) across sectors. The use of ICT for government services can also promote transparency in important government processes, such as procurement.

76. **In the agriculture sector, ICT can help to gather, analyze, store, and communicate information related to weather, markets, productivity, and risks, among others.** E-agriculture is the conceptualization, design, development, evaluation and application of ICT in the rural domain, with a primary focus on agriculture.[55] Information and communication have always played an important role in agriculture. Ever since people have grown crops, raised live-

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[53] The World Bank. The Global Findex Database 2014: Measuring Financial Inclusion around the World. https://media.worldbank.org/secure/global-findex-2014/Global-Findex-2015-Report.pdf

[54] The United Nations Capital Development Fund (UNCDF) considers that financial inclusion is achieved when all individuals and businesses have access to and can effectively use a broad range of financial services that are provided responsibly, and at reasonable cost, by sustainable institutions in a well-regulated environment. http://www.uncdf.org/en/mm4p

[55] E-agriculture: http://www.e-agriculture.org

stock, and caught fish; they have sought information from one another. By facilitating such information, ICT-enabled services will be critical in enabling the 70% increase in food production required to feed a growing global population that is expected to reach 9 billion by 2050. One important area concerns preparing and adapting to weather-related events. Even in resource constrained environments, providers can use satellites or remote sensors (to gather temperature data), internet (to store large amounts of data), and mobile phones (to disseminate temperature information to remote farmers) to prevent crop losses and mitigate effects from natural adversities. Other applications in the agriculture sector include those relating to different aspects of the supply chain (including product tracing via RFID [Radio-Frequency Identification] and other technologies such as mobile, for food safety and disease control), market information, financial management, land administration and information, farmer productivity, and other areas. For such measures to be successful, they must be developed as part of a broader national e-agriculture strategy, to prevent such projects from being implemented in isolation, and to develop efficiency gains from intra sector and cross-sector synergies.

77.   **ICT has far-reaching consequences for the education sector, both in terms of how learning methods, delivery, and monitoring in the sector can be improved (e.g., though e-learning), but also in terms of the types of skills and experience that will become increasingly important for the jobs of the future.** ICT is critical for Goal 4 of the SDGs, namely, helping to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." By facilitating access to education services and content, ICT can provide cost-effective and equitable pathways to just-in-time learning through various devices such as the mobile. E-learning, also known as online learning and computer-based learning, refers to the practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources.[56] Turn-key e-learning solutions or individual developed solutions can be implemented across the education sector, including basic education, technical vocational education and training, and higher education. The focus should be on adapting high-quality content from different sources, as well as improving teaching and learning, boosting collaborative research, and developing the capacities of teachers, all in line with national ICT for education strategies.[57] Local context is important, and the advantages of an e-learning solution in a particular context (such as flexible schedules, reduction in travel time and costs, individualized and dynamic learning plans) must be weighed against disadvantages (such as frustration associated with poor connectivity, risk of learners with low motivation falling behind, and social isolation). Moving forward, cooperation and partnerships with major knowledge and innovative technology providers will become increasingly important. For example, ADB is partnering with MathCloud,[58] a turn-key solution which provides individualized learning plans, under pilot initiatives in Sri Lanka and Bhutan.

78.   **ICT can enable e-health (healthcare practice supported by electronic processes and communications) and make the provision of health services more accessible, efficient, and affordable.** ICT will play an important role in contributing to Goal 3 of the SDGs, namely, helping to "ensure healthy lives and promote well-being for all at all ages." Remote areas, especially islands (e.g., Pacific islands) can benefit from e-health solutions as many patients in such areas can be treated locally, saving costs associated with transport. E-health is also relevant in cases where hospitals and other health facilities can become inaccessible due to flooding or other natural calamities. Applications of e-health include, for example, electronic health records (enabling the communication of patient data between different healthcare professionals); computerized entry of tests, treatment and prescriptions; telemedicine (diagnosis, treatment, and monitoring of patients at a distance); health knowledge management (including

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[56]   As defined by the Association for Educational Communications and Technology (AECT)
[57]   ADB. 2016. *Ramping up ADB's role in Information and Communications Technology for Development—ICTD Team Work Plan, 2016–2017*. Manila.
[58]   MathCloud: http://company.mathcloud.net and http://www.mathcloud.net

use of big data for health insurance); and m-health (the use of mobile devices for data collection, information dissemination, and direct provision of care). Looking ahead, key areas include developing health data systems that enable data exchange, including between health insurance providers and hospitals, and between different countries and regions. For e-health solutions, cloud services for secure data storage can be utilized, but security for hosting and data transmission of confidential data to patients and cloud services are major issues to be considered. Furthermore, secure interoperability between systems based on international accepted standards must be provided (e.g., between various health systems, and with medical devices, central statistic offices, national and regional health insurances, the World Health Organization (WHO), etc.). Development and implementation of e-health solutions must also involve key national stakeholders such as ICT and health sector regulators.

79.   **ICT can have both positive and negative impacts on climate change.** The positive effects of ICT with respect to climate change stem from systemic efficiency improvements, improved energy and resource (metals, minerals, paper, etc.) efficiency in production and use, applications for monitoring and management, and substitution of transport and travel, e.g., through telework.[59] Negative effects can arise from energy consumption and the materials used in the production, distribution, and use of ICT equipment and devices. For example, as discussed in Box 5, the telecommunication tower industry in India is the second largest consumer of diesel in the country. With growing mobile networks and new technologies, the numbers of mobile towers and mobile base stations will rapidly grow in all countries. ICT-supported intelligent solutions that allow for monitoring and managing a mix of diesel generation and renewable energy can make energy use more efficient and also contribute to reducing carbon emissions. ICT-enabled technologies and computing power also play an important role in climate modeling and weather forecasting.

D. Case Studies

80.   **Case studies from Indonesia, India, the Philippines, and the Pacific islands illustrate opportunities for ADB's investment and intervention in the short and medium term.** These case studies are examples of "low hanging fruit" where ADB can support urgent and high-profile needs in ICT in the short term, while developing the depth and breadth of experience to scale-up its engagement in the medium to long term. These case studies cover interventions across the three priority areas identified previously, namely (i) ICT policies and strategies, (ii) ICT infrastructure, regulations and skill building, and (iii) sector-related e-services and applications. These case studies, as well as the case studies of other development agencies' initiatives in Appendix 3 help to illustrate a few of the many types of opportunities that exist for ICT investments across ADB's DMCs, and to give a sense of the differentiated and diverse needs of ADB's DMCs. Other opportunities for intervention in the ICT sector are available, for example, in Bhutan, Myanmar, Sri Lanka, Mongolia and Tajikistan, where ADB already is in contact with relevant stakeholders.[60]

1.   Case Study: Indonesia

81.   **In Indonesia, ADB has supported the preparation of the Indonesia Broadband Plan (2014–2019), which was launched by the Government of Indonesia in September 2014 with an investment of \$23 billion for the next 5 years.** Through participating in the

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[59]   ADB. 2016. *Ramping up ADB's role in Information and Communications Technology for Development—ICTD Team Work Plan, 2016–2017.* Manila.

[60]   SDCC has conducted country diagnostics in Indonesia, Mongolia, Tajikistan, and Sri Lanka as part of background work for the ICTD Team Work Plan 2016–2017. Of course, there are numerous other "low hanging fruit" across ADB's DMCs; the intention here is to highlight some opportunities where there is strong demand from DMCs and where ADB may already have a good information base and/or an ongoing engagement with DMCs.

preparation of the broadband plan, ADB has developed a good overview and understanding of the ICT development requirements of Indonesia and established a relationship with the relevant stakeholders.

82.   **About 80% of the $23 billion is to be covered by financing the private sector[61] with government investment anticipated to make up the remaining $4.5 billion.** It is worth noting that while the IFC has invested significantly in e-commerce in Indonesia (about half of its $600+ millions of investments in 2015); the Private Sector Operations Department of ADB had not yet done any deals in this area.[62] As explained in Box 3, Indonesia requires financial and technical support in several areas related to implementation of the broadband plan. These areas include the following:

(i)   implement policy and regulatory reforms, and build the new institutional capacities needed to oversee the ICT sector, if the private investment envisaged for extending and expanding broadband capabilities is to be enabled;

(ii)   assist the government with the more detailed implementation planning, monitoring, and evaluation of the various components of the Indonesia Broadband Plan;

(iii)   assist government through policy, regulatory, and technical support to develop core e-governance infrastructure (i.e. common government networks, data centers, information sharing, cybersecurity, common application software, and ICT networks); and

(iv)   continue to provide ICT development support in key areas such as financial inclusion, e-procurement, and smart-cities.

Box 3: Case Study on ICT Opportunities in Indonesia

ICT has a special role to play in Indonesia because of the nation's unique geographic and socio-economic characteristics. Indonesia is an archipelagic country comprising some 17,508 islands, of which 6,000 are populated, and has a population of 252 million persons residing in 34 different provinces. With a geographic area of 1.9 million square kilometers, Indonesia is the world's 15th largest country in terms of land area and the world's 7th largest country in terms of combined sea and land area. Indonesia's youth are leading Indonesia's telecommunication's revolution. The average age of population in Indonesia is 24 years. 60% of the population is under 39. Indonesia's young population and especially those in the rapidly growing urban middle class are early and avid adopters of mobile telephony and internet technology. This, in turn, has fueled rapid growth in the telecommunications sector. Between 2000 and 2013, the average growth rate of Indonesia's telecommunications sector was 23% per year.

If Indonesia can put the necessary enabling environment in place, it could harness the power of new technology to drive productivity improvements, combat corruption, and substantially improve delivery of public services. Mobile banking could help to expand financial inclusion. Telemedicine could help in delivering health care services to remote areas, and digital learning tools could be used to improve the quality of education and teacher training across the archipelago. Use of ICT to collect and analyze big data, to draw on networks of sensors embedded in objects that connect via the internet (i.e. the internet of things), and leveraging cloud computing could substantially boost productivity in many sectors of the Indonesian economy. Linking small businesses to e-commerce opportunities could provide access to markets, technology, and business partners.[63]

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[61]   A large portion of this will be covered by PT. Telekomunikasi Indonesia Tbk, the largest telecommunication services company in Indonesia, which is about 51% state-owned but considered private.

[62]   Information from ADB Indonesia Country Director. The Private Sector Operations Department noted that investments in IT-related services were not currently part of its strategy or mandate.

[63]   ADB. 2015. Promoting Information and Communications Technology in Indonesia. http://www.adb.org/publications/promoting-ict-indonesia

In September 2014, the government launched a $23 billion Indonesia Broadband Plan (IBP) which is to be implemented between 2014 and 2019. [64] The preparation of the IBP was supported by ADB. Under this plan, the government aims to provide fixed broadband access to all government offices, hospitals, schools and public facilities throughout all of Indonesia by 2019, and with an internet connection speed of at least 2 Mbps. The plan also aims to bring broadband access to 80% of all rural institutions, half of all rural households, and to 71% of all urban households by 2019.

The Indonesia Broadband Plan identifies initiatives needed to improve the supply of ICT infrastructure and enhance the government's use of ICT for e-governance, e-education, e-health, e-procurement, and e-logistics. The plan aims at contributing to economic growth and competitiveness, building human capacity and providing services to under-served regions. In big cities like Jakarta and Surabaya, or popular islands like Bali, ICT coverage and bandwidth is quite good, but outside and everywhere else in the country, especially in the east, ICT infrastructure is weak or absent. So e-services and applications can currently only be used partially. [65]

80% of the $23 billion is to be covered by the private sector (a large portion will be covered by PT. Telekomunikasi Indonesia Tbk, which is about 51% state owned but considered private), with the remaining $4.5 billion to be covered by government. This includes, beside e-services, for example, fiber optic cables (including connecting public services), domestic submarine cables (connecting islands), mobile networks (including telecom towers) and core data centers (including for government and cloud infrastructure to be used by businesses).

It is worth noting that the preparation of the Indonesia Broadband Plan (IBP) for the period beyond 2019 will probably start in 2017/2018. ADB could consider also participating in the preparation of the new plan, which will support the early identification of new opportunities for intervention.

2. Case Study: Pacific Islands

83. **ICT is a top priority for Pacific island countries, allowing them to access world markets and global knowledge despite their geographical remoteness.[66]** While the Pacific region has made significant progress in basic ICT connectivity and some initial ICT applications, including with support from ADB and other partners, significant investment and reform needs remain in a number of areas (the list also applies to other countries in Asia). These include:

(i)   leveraging regional and international connectivity;
(ii)   enhancing the mobile integration ecosystem;
(iii)   strengthening competition;
(iv)   fostering e-learning and digital skills;
(v)   using ICTs for public service delivery;
(vi)   supporting ICT enabled agricultural services;
(vii)   improving data collection and monitoring the health of the ICT sector;
(viii) stimulating e-health;
(ix)   boosting tourism impacts; and
(x)   making ICT access universal.

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[64] Jakarta Post. 2014. Indonesian Govt launches 23b Broadband Access Plan. http://jakartaglobe.beritasatu.com/ business/indonesian-govt-launches-23b-broadband-access-plan/#show-hide

[65] A. Sommer. 2015. Indonesia ICT Sector Assessment Outlook. *Jakarta Post.* http://www.thejakartapost .com/news/2015/11/02/indonesia-ict-sector-assessment-outlook.html

[66] In September 2015, the Pacific Islands Forum leaders identified five regional priorities, including information and communications technology (ICT). See: Pacific Islands News Association. 2016. *Framework for Pacific regionalism: Update on the implementation of regional priorities.* http://www.pina.com.fj/?p=pacnews&m=read&o=204659209656b913f7ee0db20fbb0b
Pacific Islands Forum Secretariat. 2015. 46th Pacific Islands Forum Communique. http://pidp.eastwestcenter.org/ pireport/2015/September/pif-comm.htm

84.   Eventually, as dependencies on ICT grow, the islands will also need submarine cable connections with alternate/backup routings for redundancy.

85.   **ADB's experience in the Pacific islands, which cuts across the full spectrum of ICT from strategy to infrastructure to ICT sector applications, provides a strong case study of how ADB can build up a strong reputation and a robust investment pipeline in ICT.** As described in Box 4, strong ICT expertise in PARD and management attention to ICT has allowed ADB to participate in and engage in complex technical discussions with both national stakeholders, as well as development partners like the World Bank, and the Government of New Zealand. This experience also demonstrates how basic ICT connectivity (e.g., submarine cables) creates demand and opportunities for many other ICT-related projects in DMCs and in the region. Such opportunities are not unique to the Pacific islands, other DMCs offer similar opportunities. However, these can be identified and evaluated only if ADB has the relevant ICT expertise and management support.

Box 4: Case Study on ICT Opportunities in the Pacific Islands

The total population of Pacific Islands is about 3 million (Australia, Guam, Hawaii, New Zealand, Papua New Guinea not included).[67] Liberalization of the telecommunications sector, strongly supported by development partners, has driven competition especially in the South Pacific leading to increased network rollout and falling prices. This, in turn, has dramatically impacted ICT access. Average mobile coverage in Fiji, Samoa, Solomon Islands, Tonga, and Vanuatu jumped from less than half the population in 2005 to 93% in 2014, and penetration of cell phones in households rose from 49% in 2007 to 86% in 2013. Recent connectivity to submarine cables has resulted in an explosion of capacity. International internet bandwidth jumped over 1,500% between 2007 and 2014 rising from less than 100 Mbps to over 1 Gbps (excluding Fiji which had already connected to submarine cable in 2000). The region is still coming to grips with the novelty of abundant bandwidth, enhanced coverage, and cheaper tariffs. There is considerable scope for widening internet take-up across the Pacific Islands and boosting mobile penetration. While fixed and mobile voice had some indirect economic impact, the bulk of impact is likely to stem from mobile broadband. Tourism and remittances systems, which contribute significantly to GDP, are now making better use of ICT. Limited financial and especially technical human capacity is a major impediment to the use of ICT across different sectors. The region needs to leverage growing ICT access by introducing a second wave of transformational initiatives primarily revolving around e-services and applications as well as sustaining sector liberalization. Several interventions have crosscutting elements that merit strengthening, with assistance from development partners. These mainly revolve around capacity development and include (i) reinforcing institutions within government agencies involved with the regulatory and policymaking areas of ICT as well as those responsible for coordinating public service delivery; (ii) developing basic digital literacy among the general public; and (iii) elevating ICT skills for creation of relevant applications and e-services and to participate in the ICT-enabled employment sphere which is now possible with the arrival of submarine cables in the area.[68]

ADB's initial focus in the Pacific Islands has been putting in place the infrastructure (largely submarine cables) where this does not exist, and supporting sector management and regulatory environment reform. This has been done in partnership with World Bank in some instances. Examples are:
-   Tonga–Fiji Submarine Cable Project (ADB $9.7 million, World Bank $16.5 million)
-   Samoa Submarine Cable Project ($25 million grant from ADB and cumulative co-financing of more than $30 million from World Bank, Australia, the Samoa Submarine Cable Company and the Government of Samoa.
-   North Pacific Connectivity Project ($25 million loan from ADB to Palau for a submarine cable to be connected to the SEA-US submarine cable system; after ADB and World Bank co-financed project activities during the planning phase the Federated States of Micronesia (FSM) island

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67   Wikipedia.   List   of   Oceanian   Countries   by   Population.   https://en.wikipedia.org/wiki/ List_of_Oceanian_countries_by_population
68   PRIF. 2015. Economic and Social Impact of ICT in the Pacific. http://www.theprif.org/components/ com_jomcomdev/files/2015/10/40/124-PRIF%20Pacific%20ICT%20Report%202015.pdf

Yap will be connected in a similar way, financed by a World Bank grant of $25 million)

For the remaining countries or remote islands of connected main islands of Pacific countries where cables do not currently make economic sense technical assistance from various agencies is available to assess options and support access to "Other 3 Billion" (O3B) low level satellite. ADB is providing advisory services to Nauru and Kiribati to assess its connectivity options via Federated States of Micronesia (FSM) in cooperation with World Bank.

ADB is increasing focus on supporting use of ICT for development, predominantly applications for education (north Pacific), health services (Papua New Guinea [PNG] and Samoa), human resources (Republic of the Marshall Islands [RMI]), and public finance (Kiribati, RMI and possibly others). This is an interesting new line of business and ADB is learning across sectors on these. This also offers significant co-financing opportunities. Support for use of ICT to other areas, e.g., social protection, private sector could be looked at.

Other planned projects include the Cook Islands submarine cable project (in cooperation with the Governments of New Zealand, Niue, and French Polynesia) and Tonga ICT for health project.

3.   Case Study: India

86.   **In India, massive investment in ICT is needed, ranging from submarine cables and telecommunication towers (including switching to renewable energy to reduce emissions) for enhancing domestic connectivity to developing smart cities, and supporting entrepreneurship.** The Indian government, under Prime Minister Narendra Modi, has launched several digitization initiatives like "Made in India" and "Digital India." The myriad opportunities in the sector can be explored through discussions with the right national stakeholders, for example the Department of Telecommunications (DoT), the Telecom Regulatory Authority of India (TRAI), and the Cellular Operators Association of India (COAI). As shown in Box 5, there are significant opportunities both in terms of stand-alone ICT interventions as well as sector-related e-services and applications, which can be explored and developed. With enhanced ICT expertise, ADB will be well positioned to tackle complex challenges that cut across sectors. For example, the fact that telecommunications towers are the second largest consumer of diesel in the country means that related interventions would require expertise in ICT, energy, and climate change.

Box 5: Case Study on ICT Opportunities in India

With a population of 1.3 billion, India is currently the second-largest telecommunication market in the world and has the third highest number of internet users in the world. Between 2007 and May 2015, India's telephone subscriber base expanded at a compound annual growth rate of 19.5% to about 1 billion subscribers; about 97% are wireless. India's mobile subscriber base had crossed approximately 500 million subscribers by the end of 2015. It is predicted that India will overtake the United States as the second-largest smartphone market globally by 2017 and will maintain a high growth rate in the market over the next few years as more people switch to smartphones and gradually upgrade to 4G. Availability of affordable smartphones, along with a rise in the security level of mobile transactions, is expected to boost growth of transactions conducted via phones, with the overall transaction value having already tripled between 2013 and 2014. The Indian telecom sector is expected to generate 4 million direct and indirect jobs over the next 5 years according to estimates by Randstad India. The employment opportunities are expected to be created due to combination of government's efforts to increase penetration in rural areas and the rapid increase in smartphone sales and rising internet

usage. India will emerge as a leading player in the virtual world by having 700 million internet users of the 4.7 billion global users by 2025, as per a Microsoft report.[69] But, as of 2015, the offline population in India, according to the World Bank, was still 1,063 billion.[70]

Under the digitization initiatives like "Made in India" and "Digital India," there are several projects, such as:

1) India's vision of creating 100 smart cities will require an investment of over $150 billion over the next few years, with private sector being a significant contributor. According to Deloitte, nearly $120 billion of will come from the private sector.[71] The government has already initiated two programmes with an initial outlay of $7.513 billion for "Smart Cities Mission" and the "Atal Mission for Rejuvenation of Urban Transformation (AMRUT)" for the upgradation of 500 existing cities.

2) As a pilot initiative, the European Union just launched the Startup Europe India Network (SEU-IN) to connect the European and Indian Startup ecosystems for catalyzing growth and investments.[72] While Europe has one of the leading startup ecosystems in the world, India has one of the fastest emerging startup ecosystems—great dynamism to bring together. SEU-IN is focused on ICT, particular disruptions and evolutions happening in the intersection of ICT with other industries. Finance, cybersecurity, intelligence (machine to machine (M2M) communications, artificial intelligence, big data), education, agriculture, smart cities, healthcare, automotive, waste management, and government and business are of particular interest.

3) India's government plans to roll out a new fiber-optic submarine cable linking the mainland with the remote Andaman and Nicobar Islands to improve connectivity to that strategically important archipelago—which lies between the Bay of Bengal and the Andaman Sea.[73] The cost estimate of the Telecommunications Regulatory Authority of India (TRAI) for connecting this group of islands and Lakshadweep island group on India's west coast is approximately $360 million. The private sector including the incumbent operator BSNL is not keen to expand their networks to all the inhabited islands and villages because these operations are commercially unviable. Financing might be through the Universal service obligation Fund (USOF) or other instruments. Similar steps will also be taken to connect small islands such as Neil, Little Andaman, Kamorta and others.

4) According to Ericsson, India currently has 425,000 mobile towers and 850,000 base transceiver stations for mobile networks, most of them backed up by diesel generators.[74] Total power consumption is approximately 16.5 Billion Kilowatt Hours (BkWh). On average, 70% mobile towers face electrical grid outages in excess of 8 hours a day. The telecom tower industry consumes over 2.5 billion liters of diesel annually making it the second largest consumer of diesel in the country. Diesel consumption emits 6.6 million metric tons of CO_2 annually, making diesel generators both environmentally and economically unattractive. Energy costs alone account for 30% in urban and up to 50% in rural of total network operating costs, affecting the profitability of the telecommunications operators and affordability for consumers. The mobile subscriber base is crossing 1 billion marks. This growth may require approximately 1,000,000 more telecom towers to ensure network availability. Therefore, it becomes critical to devise a balance between demand and supply side equation while also exploring alternate energy sources. With new technologies such as 5G mobile networks energy requirements will increase further.

[69] India Brand Equity Foundation. 2016. Telecom Sector in India. http://www.ibef.org/industry/telecommunications.aspx

[70] The World Bank. 2016. World Development Report 2016: Digital Dividends. http://www.worldbank.org/en/publication/wdr2016

[71] Press Trust of India. 2016. Over $150 billion investments required for smart cities: Study. http://www.india.com/business/over-150-billion-investments-required-for-smart-cities-study-906020/

[72] Project website: http://startupeuropeindia.net

[73] Sanjib. 2016. Andaman to Get Submarine Optical Fiber Cable Connectivity in 2–3 Years. *Andaman Sheekha.* http://www.andamansheekha.com/2016/01/03/andaman-to-get-submarine-optical-fibre-cable-connectivity-in-2-3-years/
The Hindu. 2014. TRAI Suggests Rs. 2,400-cr Plan for Andaman and Nicobar, Lakshadweep Island Chains. http://www.thehindu.com/business/trai-suggests-rs2400cr-plan-for-andaman-and-nicobar-lakshadweep-island-chains/article6238405.ece

[74] Ericsson. 2016. A Perspective on Energy Performance Standardization – Today & 5G. Presentation held by Ericsson in New Delhi, India. February.

4. Case Study: The Philippines

87. **In the Philippines, preparation of an updated national broadband plan, which will identify key areas for government initiatives, presents an opportunity for ADB.** The plan will consider areas where the government will directly support infrastructure, where the government will provide subsidies, and where the private sector would freely compete in the market. ADB's engagement at an early stage can help to identify potential opportunities for ADB, including for PPPs, and develop a strong understanding of the political economy around ICT in the country. Given recent high-profile cybersecurity incidents, potential investments in this area can also be explored.

Box 6: Case Study on ICT Opportunities in the Philippines

The government of the Philippines is looking to pull together a number of relevant institutions as it introduces an interim broadband plan to improve the country's underdeveloped internet access market. With high speed data services seen as key to the development of industry—both for large companies and for micro, small- and medium sized enterprises (MSMEs)—the government has requested the National Telecommunications Commission (NTC), the National Economic and Development Authority (NEDA), and the Information and Communications Technology Office (ICTO) to consider how the industry can move forward.

The National Broadband Plan is being drafted by NTC and proposes: (i) where the government should put up infrastructure; (ii) where the government should subsidize; and (iii) where the private sector can freely compete in the market.

The NTC review will take particular care in ensuring that areas seen as less economically appealing to operators are not overlooked. The country's two dominant service providers—Philippines Long Distance Telephone Company (PLDT) and Globe Telecom—are spending an average P80 billion ($1.7 billion) per annum to develop their broadband (fixed and mobile) networks, but their focus is largely limited to urban and suburban rollouts. To put up infrastructure in rural areas, investments of about P30 billion to P100 billion are required. Mobile broadband connection is intermittent in rural areas, and some home broadband services are also not being offered by telcos to certain areas in the provinces.[75]

V. RECOMMENDATIONS

A. Strategic Options

88. **Looking ahead to 2030, it is clear that there will be strong demand by ADB's DMCs for investments in ICT.** These demands cut across policies and strategies; infrastructure, regulations and skill building; and sector-related e-services and applications. ADB's DMCs must not only ensure connectivity and affordable access for its citizens, but also prepare for upcoming developments including the move to new technologies such as 5G mobile networks, the internet of things (IoT), and increasingly complex issues around cybersecurity and privacy. DMCs must always have a global view on ICT-related topics such as international hosting and cloud solutions, trans-regional and trans-continental submarine and land cables, centralized global remote operations and monitoring, international ICT standardization, global cybersecurity threats, and global privacy-related issues.

89. **ADB's experience across the ICT spectrum has provided many lessons to build on.** With almost $11.91 billion of loans, grants, and TAs in 2000–2015, of which $994 million have

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[75] TeleGeography. 2016. Philippines' government corrals agencies to formulate new national broadband plan. https://www.telegeography.com/products/commsupdate/articles/2016/04/22/philippines-government-corrals-agencies-to-formulate-new-national-broadband-plan

been for stand-alone ICT projects, ADB has a relevant experience base in the sector. For example, ADB's experience in the Pacific Islands, where it has built a robust portfolio in ICT and developed a strong reputation, demonstrates the importance of strategically engaging across the three priority areas outlined in this report, namely, (i) ICT policies and strategies, (ii) ICT infrastructure, regulations, and skill building, and (iii) sector-related e-services and applications).

90. **Moving forward, three possible strategic options can be considered for how ADB can respond to DMCs demands and needs in ICT.** The first scenario is a status quo scenario, where ADB continues identifying and investing in readily available opportunities as and when it is able to do so, gradually developing a reputation as a preferred partner for ICT in some DMCs and regions. The second scenario is one where ADB can engage in more proactive pipeline development and successive scaling up of its ICT operations, aiming to provide support strategic and operational across all three priority areas, and develop a strong reputation as a preferred partner for ICT across Asia, in the medium to long term. The third scenario is an immediate scale-up of ADB's engagement in pipeline development and ICT strategy and operations in all three priority areas, aiming to develop a strong reputation as a preferred partner for ICT across Asia in the short to medium term. The implications, benefits, and risks of each of these scenarios are summarized in the table below.

Table 6: Strategic Options for ADB in ICT

Strategic Option	Benefits, Risks, and Implications
1. Status quo ADB identifies and invests in readily available opportunities as and when it is able to do so.	Benefits: Using existing resources, ADB can focus on readily available opportunities in the short and medium term. ADB can respond to opportunities across sectors and regions as and when it is able to do so, slowly building up a pipeline and reputation in ICT, and gradually building on successful engagements in individual DMCs and regions. Risks: ADB's existing capacity will limit its ability to respond to growing demands for ICT-related support from DMCs as they try to keep pace with regional and global developments in ICT. With limited resources, it will be very difficult for ADB to maintain regular contact and be responsive to all relevant stakeholders. Without systematic engagement and investments in underlying ICT strategies, policies, infrastructure, regulations, and skills, it may be difficult for ADB to design appropriate and sustainable solutions for DMCs' sector-specific needs. In particular, ICT-related O&M in DMCs is likely to remain weak unless there is coordinated action and support across the ICT spectrum. By remaining as is, ADB will miss many opportunities for financing and supporting ICT in DMCs. Implications: No immediate organizational change or significant investments will be required. In the long term (2020–2030), depending on progress and demand, an ICT sector group can be established, and additional ICT staff can be hired, either directly or through an ICT expert pool.
2. Gradual scaling-up of ICT operations In addition to readily available opportunities, ADB proactively develops new business and provides support across priority areas.	Benefits: Through providing support across ICT priority areas, from strategy and planning to infrastructure to sector applications, ADB will become increasingly recognized as a partner for ICT, and demand for support from other DMCs would gradually grow as a result. By working at the strategic level, ADB can proactively explore and develop future opportunities, even while it invests in readily available opportunities. A gradual scale-up also has the benefit of expanding ADB's ICT engagement and investment subject to evidence of performance and demand. Risks: With a gradual scaling-up of ICT, ADB will need to prioritize opportunities, and would still miss out on some short and medium term opportunities, given the fast-moving nature of global ICT developments. Implications: Some organizational development and gradual increases in staff and

	capacities will be required, starting with a modest increase in ICT staff and establishment of an ICT expert pool in the short term, a further staffing increase and establishment of an ICT sector group in the medium term, and a full complement of staff and expertise (both internal and external) in the long term.
3. Immediate scaling-up of ICT operations ADB immediately develops the in-house expertise needed to scale-up activities across all priority areas.	Benefits: An immediate scale-up will give ADB the capacity to pursue and leverage multiple opportunities for financing and supporting ICT in DMCs immediately, work across all priority areas, and offer comprehensive support to DMCs for a large majority of their ICT demands in the short term. ADB will immediately be seen as a serious and preferred partner for ICT, and be well positioned to rapidly develop a new line of business. Risks: An immediate scale-up would require quick and sizeable organizational and staffing changes. It will be difficult to so quickly integrate a larger number of new staff in ADB's organizational structure and to manage a completely new and expanded team. A mismatch between the scale and timing of ICT-related demand from DMCs, and the scale and timing of ADB's scale-up, could result in poor utilization of ADB's staff and resources. Implications: Substantial initial organizational change and investments in staffing and capacity will be required. ADB would need to set up an ICT sector group and bring in significant expertise (a combination of new staff and experts from a rapidly-established expert pool) in the short term (2016–2017). A full complement of ICT staff and expertise would be recruited by the medium term (2018–2019).

B. Proposed Option: Gradual Scaling Up of Information and Communications Technology Operations

91. **A gradual scaling-up of ICT operations (Scenario 2), with a corresponding gradual increase in expertise and establishment of an ICT sector group in the medium term (2018–2019), strikes the right balance between benefits and risks.** There are sufficient near-term and medium-term opportunities and demand to justify a gradual scale-up (refer to Chapter IV). In addition, there is significant potential to proactively develop new business opportunities across the three ICT priority areas. In gradually building up the ICT sector group and scaling up ICT operations, ADB can learn from its recent experiences in operationalizing its other sector and thematic groups, and also from experience of peer institutions.

92. **In line with ADB's future opportunities and ICT priority areas, and a scenario for gradually scaling up ADB's ICT operations, strategic activities are proposed for the short, medium, and long term.** The proposed approach would gradually grow ADB's expertise and experience in ICT, starting with engagement at a strategy and policy level and on concrete and promising opportunities.

1. Short-Term Activities (2016–2017)

93. **In the short term (2016–2017), ADB should continue to concentrate on the most concrete and promising opportunities in countries and regions where ADB has good on-the-ground knowledge and relationships with relevant stakeholders.** These could include the Pacific island countries and countries such as Indonesia, Myanmar, Sri Lanka, Mongolia, Tajikistan, and Bhutan, where ADB has had recent dialogue, TA, operations and/or conducted ICT sector diagnostics. Depending on skill requirements, staffing and expertise can be improved through staff training, new direct hires or through an expert pool, supplementing ADB's limited internal ICT skills and expertise at present. With the existing and new ICT staff, and the ICT expert pool, ADB should maintain regular contact with different DMC stakeholders.

94. **ADB should support ICT strategy and policy development in its DMCs, and engage with updating and formulating national broadband plans and strategies where possible.** As noted previously, engagement at the policy and strategic level will allow ADB to contribute to DMCs' formulation of their national broadband plans, develop relationships, and develop a view on upcoming investments in the medium and long term. ADB should engage in national planning processes around ICT, particularly in countries where broadband plans are already scheduled to up be updated in the near future (see Table 5).

95. **ADB should begin to more comprehensively and systematically assess ICT readiness of countries and regions as the basis for sector-related e-services and applications.** For sector-related e-services and applications, existing sector-related ICT experts should more carefully consider compliance with national or regional ICT strategies (if available) and standards (such as protocols for data exchange); evaluate if target users have required infrastructure (e.g., coverage, high-speed connectivity); and make secure and professional hosting of equipment and sustainable O&M a part of every project.

96. **ADB should take immediate steps to strengthen its capacity in ICT procurement, ICT-related security, and cross-sector collaboration.** As noted earlier in this report, ADB's lack of expertise in ICT-related procurement has been a key constraint that impacts not only stand-alone ICT projects but also ICT applications across sectors and regions. Staff trainings and knowledge dissemination on specific topics can be organized. ADB should also begin to develop experience and expertise in ICT security, which is a critical area for DMC governments and a potentially interesting new line of business. Lastly, there is scope for promoting cross-sector collaboration (e.g., energy sector, transport sector) through policies, regulations, and multisector-infrastructure sharing (roads, rails, grids).

97. **ADB should develop strategic partnerships, and bring in external expertise, to get more exposure and experience to the full spectrum of ICT.** ADB should explore developing partnerships across the spectrum of organizations working on or supporting ICT (refer Appendix 5), including knowledge partnerships and opportunities for co-financing. External consultants, be they individual consultants or specialized companies, should be hired for supporting ADB experts in developing and implementing projects. ADB can initially focus on ensuring availability of resources and monitor and evaluate implementation. The external consultants supporting the projects should be briefed to identify further opportunities for ICT intervention. ADB staff should promptly follow-up on the identified opportunities.

98. **ADB's interventions should be based on the identified priority areas, the expertise available, and the development status of a DMC.** Initially, the focus should be on a small subset of relatively high-profile or promising opportunities that will establish a strong platform and investment pipeline for the medium term. ADB should also continue to explore opportunities to integrate ICT solutions into sector operations, and conduct effective e-readiness assessments for these solutions.

99. **ADB is already planning to conduct most of these short-term activities.** The 2016–2017 Work Plan of the ICTD Team, situated in the Social Development, Governance, and Gender (SDGG) division of SDCC, focuses on four outcome areas, namely: (i) ICT options in ADB's operations are identified; (ii) ICT portfolios in ADB's operations are diversified; (iii) ADB's capacity for ICT operations is developed; and (iv) knowledge partnerships in ICT are leveraged.[76]

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[76] ADB. 2016. *Ramping up ADB's role in Information and Communications Technology for Development—ICTD Team Work Plan, 2016–2017*. Manila.

2.   Medium-Term Activities (2018–2019)

100.   **In the medium term (2018–2019), ADB should further strengthen its ICT expertise and establish an ICT sector group, moving towards a more strategic and systematic approach to ICT across its operations.** The ICT sector group would be patterned on existing sector and thematic groups, with a small number of core staff operating from a Secretariat based in SDCC, with most other ICT-related staff based in the operations departments. The terms of reference and key responsibilities for the ICT sector group are discussed further in Section C. Given the nature of ICT, such a group would need to be dynamic, open and collaborative in order to be successful.

101.   **With growing ADB internal ICT-related expertise resources and building on the experience and relationships developed in the short term, ADB should continue to concentrate on the most concrete and promising areas ("low hanging fruits") in the medium term (2018–2019).** ADB's ICT experts should, together with the country directors and sector groups, identify and explore further opportunities for intervention in countries and regions. ADB experts should continue to build relationships with relevant stakeholders, maintain regular contacts and reply to requests on short notice. ADB sector groups should continue to be supported for e-services and applications as well as ADB ICT procurement. Support from external consultants should continue.

102.   **ADB should continue to gradually develop and expand its experience in the ICT priority areas: (i) ICT policies and strategies, (ii) ICT infrastructure, regulations, and skill building, and (iii) sector-related e-services and applications.** Building on experience in the short term, investment opportunities in these areas should continue to be identified, and promising opportunities further developed. Initial staffing could focus on staff that, among them, would meet needs for a helicopter vision across the sector (who could lead the secretariat), would coordinate cross-region and global ICT infrastructure projects, would support ICT and broadband plan and strategy development (and reforms), would help DMCs develop ICT policies, regulations, and standardization (including relating to security), and would be able to handle ICT-related procurement across ADB. Depending on requirements, some of this expertise can be developed by recruiting staff in the operations departments, in other sector/thematic groups, and/or through the expert pool. With an active sector group and key staff in place, ADB can offer more strategic and comprehensive support for sector operations.

103.   **Based on upstream work during the short term, ADB should aim to deliver at least one or two high-profile, flagship initiatives in ICT in the medium term.** Such initiatives will give ADB stronger visibility in the ICT sector, which will lead to future business opportunities. ADB's experience in the Pacific has demonstrated the important role such flagship initiatives can play in establishing ADB as a key player in the sector, and in catalyzing other opportunities in the region.

3.   Long-Term Activities (2020–2030)

104.   **Over the long term (2020–2030), ADB would fully adopt and mainstream a strategic approach to ICT operations, bringing ICT on a par with other important sectors of ADB. ADB would be positioned as a recognized and important development partner in ICT, with experience cutting across the three ICT priority areas.** With full staffing resources, ADB's ICT-related expertise in the long term (2020–2030) should strategically and comprehensively cover the three ICT priorities. ADB should be well-positioned to support ADB sector groups for e-services and applications, and fully cover ADB ICT procurement, using scaled up in-house resources as well as external consultants (including through the ICT expert pool).

105. **Over the long term, ADB should be regularly identifying opportunities for intervention in interested DMCs and regions, and continue to build strong relationship with stakeholders.** This will allow ADB to have a continuing and expanding portfolio of ICT-related projects in DMCs. In the long term, it in envisioned that ADB's internal expertise would gradually become less and less of a constraint, and ADB will be able to more fully respond to countries' development priorities across the ICT spectrum.

106. **In the long term, through its ICT experts, ADB would proactively share best practices in ICT for development in international and regional conferences and in ICT-related working groups.** Examples are conferences organized by the ITU, the Pacific Telecommunications Council, and country specific events.

C. Implications for ADB's Organization and Staffing

107. **If ADB is to become a credible and strong partner in the Asia and Pacific ICT for development sector, some world class ICT experts including engineers and experts with substantial implementation and O&M experience will have to be recruited.** In the long term, a critical mass of expertise in ICT will be required to allow ADB to engage with DMCs on the full spectrum of the ICT ecosystem. However, it will be challenging for ADB to attract, hire, and retain such world class experts because (i) these experts are expensive and in high-demand; (ii) Manila is not an ICT hub like Singapore, South Korea or Japan; (iii) ADB does not presently hold a reputation as an employer of choice for ICT experts; (iv) ADB's internal hierarchical structure and bureaucracy do not match with the more flat hierarchical and quite casual, non-bureaucratic ICT culture; (v) the fast-changing nature of ICT necessitates speed and flexibility in terms of skill enhancement and (vi) restrictions or limits on mission travel outside Asia are contrary to the global nature of ICT.

108. **A dedicated expert pool can be used to recruit and work with consultants on specialized topics.** Such a pool can be a means of bringing in specialized expertise in key areas until such time that ADB can build a critical mass in-house, and of bringing in targeted, short-term support in uncovered areas (for example, on specific technologies, policy aspects, standardization, implementation or O&M) to complement ADB's own support. Candidates for such a pool could include consultants with substantial practical ICT experience. ADB should also look for ways to leverage partnerships to strengthen expertise for its projects, be it through partners in the private sector, ICT institutions, NGOs, bilateral agencies, intergovernmental institutions, or other international finance institutions (please refer to Appendix 5).

109. **The proposed ICT sector group would be established as a network that draws on existing and evolving in-house ICT expertise to provide strategic operational support, facilitate knowledge management, facilitate talent management for ICT, and carry out specific ICT-related tasks, such as trans-regional and trans-continent related ICT infrastructure projects and operations.** Such an ICT sector group would be patterned on existing sector and thematic groups, with core staff based in a Secretariat hosted by SDCC, and other staff located across different departments but mostly in the operations departments. The bulk of ICT operations, be they stand-alone ICT operations or ICT-component operations, would continue to be led by staff who are based in the operations departments and, at the same time, are also active members of the ICT sector group. The cross-country, trans-region, and cross-sector nature of many ICT projects, and the need for active surveillance of the complex ICT ecosystem (and end-to-end dependencies), means that continuous central coordination by the ICT sector group is critical.

110. **Recognizing that ICT inherently cuts across borders, regions, and sectors, the ICT sector group would also play a role in providing leadership in developing and**

implementing ADB's ICT strategy and operational plan. This initiative would be led by the ICT sector group's Secretariat, which will work and coordinate with all staff in the sector group. The ICT sector group will provide technical support and guidance across all stages of the project cycle. This would include ICT infrastructure projects as well as strategies, policies, capacity building, and other relevant projects and programs. Furthermore, the ICT sector group shall assist ADB sector and thematic groups in developing e-services and shall support ADB's ICT procurement. For all activities, international ICT standards, implementation and sustainable O&M shall always be an important area of focus. To note, the fast-growing scope and reach of ICT—and the workload this entails—may require that the ICT sector group be staffed with a larger complement than other sector and thematic groups as explained below.

111. **The ICT sector group would focus on ICT stand-alone topics such as ICT/broadband strategies and sector reforms, infrastructure, policy, and regulations (including cybersecurity), and skill building.** More specifically, this would include:

(i) ICT/broadband strategies (including sector-related, national, and regional) and ICT sector reforms;

(ii) ICT infrastructure (submarine cables, fiber optic cables, mobile networks, data centers including national/regional/trans-continental cloud infrastructure, satellites, last mile access, infrastructure sharing between sectors, universal service obligation (USO) funds support, internet exchange points (IXPs), network operations centers (NOCs), call centers, etc.); international, regional and domestic; all including O&M and risk assessment.

(iii) ICT policy and regulations, ICT standardization, ICT security (cybersecurity etc.), ICT legal; and

(iv) ICT skill building, capacity building and awareness programs covering technicians and users.

112. **The ICT sector group would also have a cross-cutting function to support the operations departments and sector and thematic groups for any ICT-component or ICT-enabled projects.** In this function, the ICT sector group shall, for example, give support for ensuring that ICT components are appropriate given the state of e-readiness, policies and regulations of countries and regions, and that issues such as security and O&M are sufficiently covered. It will also play a central function in terms of guiding and facilitating ICT-related procurement. Other areas of focus would include:

(i) sector-specific underlying ICT infrastructure;

(ii) ICT policies and regulations in connection with sector-related policies and regulations (e.g., for multi sector infrastructure sharing);

(iii) e-services and applications for various sectors, including security and O&M; and

(iv) ICT procurement (as a central function).

113. **Suggested duties, responsibilities, and objectives of the ICT sector group would include:**

(i) Provide overall leadership for ADB's strategies in ICT development and lead policy dialogue and discussions with DMCs, and other development partners. Promote cross departmental collaboration.

(ii) Support the operations departments by providing overall leadership for policy dialogue with DMCs to advance reforms in the ICT sector, especially in the areas of strategy, planning, projects, and programs; ICT policy and regulatory frameworks; governance; infrastructure development; asset management; O&M; security; and private sector participation;

(iii) Assist countries, regions, and other ADB sector and thematic groups in carrying out analytical and sector work, applying latest technologies and thinking on sector and thematic issues, and developing monitoring and evaluation capacity;

(iv) Coordinate the development of a robust pipeline of projects, programs, and analytical work through identification and preparation activities;

(v) Coordinate the supervision and implementation of projects and programs, and monitor and ensure the overall performance of the ICT sector group's project portfolio, operational effectiveness, and development impact;

(vi) Maintain and develop partnerships with development partners, nongovernment organizations, think tanks, research institutions, and civil society organizations operating in ICT; and promote collaborative initiatives including co-financing;

(vii) Ensure that the recruitment, deployment, and training of professional staff within the ICT sector group maintain a mix and level of skills appropriate to the evolving operational needs of ADB;

(viii) Develop the ICT sector group's operational plans and objectives, identifying activities and assessing the resources required to implement the plans;

(ix) Publicize ADB's ICT activities through various media, websites and reports; and

(x) Lead or participate in high level missions to DMCs, and represent ADB at international and regional conferences.

114. **In the long term (2020–2030), to meet its suggested duties, responsibilities and objectives, the ICT sector group would require a diverse pool of about 10–15 staff/experts whose experience and skills would cut across some key ICT-related areas.** These staff should have strong experience in engineering, project management, implementation, and O&M. Some staff may be able to cover multiple topics, and each staff member should have at least one other staff member as a backup. The key skills and focus of these staff would be:

(i) 1–2 persons who should clearly have a helicopter vision of the entire complex ICT ecosystem and the dependencies end-to-end. One of these persons should be leading the ICT sector group secretariat;

(ii) 2 persons for ICT strategic and ICT sector reform related topics;

(iii) 2 or more persons for all ICT infrastructure related topics;

(iv) 2 persons for ICT policy and regulations, ICT standardization, ICT security topics;

(v) 2 persons for ICT skill building, capacity building, and awareness programs covering both technicians and users. Such topics might be covered by or in cooperation with the education sector;

(vi) 2 or more persons for e-services and applications (e.g., solution architects), for various sectors, including O&M, depending on requirements. Such topics might be covered by, or in cooperation with, the various sectors and thematic groups;

(vii) 1–2 persons for financial aspects of ICT;

(viii) 1 person for ICT procurement;

(ix) 1 person for ICT legal; and

(x) 1–2 persons for administration and ICT research.

115. **Most staff belonging to the ICT sector group would be based in the operations departments, while a core staff would be based in the group's Secretariat based in SDCC.** As is the case with other sector groups, the Secretariat would be led by a Technical Advisor, who would be a staff member with a helicopter vision of the ICT ecosystem. The Secretariat's role would include developing a strategic vision for ICT at the ADB, work planning, preparation of sector policies and operational plans, coordination of ICT initiatives across regions and globally, knowledge management, innovation, partnerships, co-financing, and support to talent acquisition (both staff and consultants). As such, a subset of the 10-15 staff proposed, perhaps

4-5 staff, could be based in the Secretariat, subject to further discussions.[77] In addition, the ICT expert pool, based with the Secretariat, can be used as a flexible tool to source consulting services in areas where it is not practical (or desirable, given the global nature of ICT) to recruit specialists for every operations department, such as ICT security, regulations, legal, procurement, and standardization. It is critical to ensure that the structure of the ICT sector group allows it to be dynamic, open and collaborative.

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[77] Typically, the Secretariat of a STG in ADB is full-time, based in SDCC, led by a Technical Advisor (Level 7-9), and comprises 2-3 international staff and 1 national staff.

SOME RECENT TRENDS IN INFORMATION AND COMMUNICATIONS TECHNOLOGY

1.   For instance, from 2020 onwards, **5G mobile networks** will bring another major boost in the global digital development. 5G mobile network standards are currently developed by the global 3GPP initiative under the European Telecommunications Standards Institute (ETSI). 5G will be the successor of 2G, 3G, 4G mobile networks. A 5G pilot will be available during the 2018 South Korea Winter Olympics; the global rollout is expected successive after 2020. According to ETSI, global traffic will continue to increase dramatically over time (est. 1000x by 2020), connected devices will increase dramatically over time (10–100x by 2020), new device types will significantly contribute to that increase (e.g., probes, sensors, meters, machines, etc.), new sectors will bring new priorities (e.g., critical infrastructures), 5G will be optimized for latency sensitive solutions such as Internet of Things (IoT) and machine to machine communication (M2M). Peak speeds of 4G are at 150 Mbps, 5G will be capable of transmitting data 100 times faster at up to 20 Gbps. 5G standards are communicated by ETSI to the International Telecommunication Unit (ITU) and global standardization authorities like ARIB and TTC (both Japan), TTA (South Korea), CCSA (China) and ATIS (North America) already contribute to the development. TSDSI (India) has just joined as well. It is expected that 5G mobile networks will become a multi-billion $ business around the globe with new business opportunities for network infrastructure, devices, services, applications, and gadgets. International and domestic backbone infrastructure must be ready for the new technology, ICT policies and regulations must be adapted respectively.

2.   As another sample, **IoT**, sensors, and actuators connected by networks to computing systems, has received enormous attention over the past few years. A McKinsey Global Institute report attempts to determine exactly how IoT technology can create real economic value.[1] The central finding is that the hype may actually understate the full potential, but that capturing it will require an understanding of where real value can be created and a successful effort to address a set of systems issues, including interoperability. To get a broader view of the IoT's potential benefits and challenges across the global economy, McKinsey Global Institute analyzed more than 150 use cases, ranging from people whose devices monitor health and wellness to manufacturers that utilize sensors to optimize the maintenance of equipment and protect the safety of workers. McKinsey Global Institute's bottom-up analysis for the applications sizes estimates that the IoT has a total potential economic impact of $3.9 trillion to $11.1 trillion a year by 2025. At the top end, that level of value, including the consumer surplus, would be equivalent to about 11% of the world economy.[2] Ericsson forecasts a total of 26 billion connected devices by 2020, of which almost 15 billion will be phones, tablets, laptops, and PCs (excluding simple sensors and RFID). Cisco forecasts that there will be 3.2 billion M2M connections alone by 2018, connected via macro-cells. Adding in other devices and connectivity technologies, Cisco forecasts 24.4 billion connected devices by 2019 (although this estimate excludes RFID). Indeed, the growth of the IoT may even introduce a new form of the digital divide, in terms of who has access to which connected devices.[3] Because more intelligence will be moved from end user devices to the network, quality, availability, and performance of network infrastructure and services will become more important.

3.   There is no universally accepted definition of a **Smart City**. The conceptualization of Smart City varies from city to city and country to country, depending on the level of development,

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[1]   McKinsey & Company. 2015. The Internet of Things: Mapping The Values Beyond The Hype. http:// www.mckinsey.com/business-functions/business-technology/our-insights/the-internet-of-things-the-value-of- digitizing-the-physical-world

[2]   McKinsey & Company. 2015. Unlocking the Potential of the Internet of Things. http://www.mckinsey .com/insights/business_technology/the_internet_of_things_the_value_of_digitizing_the_physical_world

[3]   The Broadband Commission. 2015. The Actual State of Broadband Annual Report 2015. http:// www.broadbandcommission.org/publications/Pages/SOB-2015.aspx

willingness to change and reform, resources, and aspirations of the city residents. The core infrastructure elements in a Smart City would include:

(i)   robust and secure IT connectivity and digitalization;
(ii)   sustainable electricity supply (smart grid);
(iii)   adequate water supply;
(iv)   sanitation, including solid waste management;
(v)   efficient urban mobility and public transport (M2M - intelligent transport systems [ITS]);
(vi)   affordable housing, especially for the poor;
(vii)   good governance, including e-governance and citizen participation;
(viii) sustainable environment;
(ix)   safety and security of citizens, especially for women, children, and elderly; and
(x)   health and education.

4.   This is not a complete list and cities are free to add more services and applications.

5.   For instance, the Indian government's vision of creating 100 Smart Cities will require an investment of over \$150 billion over the next few years according to a recent study. The government has already initiated two programs with an initial outlay of \$7.5 billion for the upgrade of 500 existing cities.[4]

Top 10 Gartner Predicts for 2016[5]
1. By 2018, 20% of all business content will be authored by machines.
2. By 2018, 6 billion connected things will be requesting support.
3. By 2020, autonomous software agents outside of human control will participate in 5% of all economic transactions.
4. By 2018, more than 3 million workers globally will be supervised by a "robo-boss."
5. By year-end 2018, 20% of smart buildings will have suffered from digital vandalism.
6. By 2018, 50% of the fastest-growing companies will have fewer employees than instances of smart machines.
7. By year-end 2018, customer digital assistance will recognize individuals by face and voice across channels and partners.
8. By 2018, 2 million employees will be required to wear health and fitness tracking devices as a condition of employment.
9. By 2020, smart agents will facilitate 40% of mobile interactions, and the post-app era will begin to dominate.
10. Through 2020, 95% of cloud security failures will be the customer's fault.

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[4]   The Times of India. 2016. Modi's smart cities need over \$150 billion investment: Study. http://timesofindia.indiatimes.com/india/Modis-smart-cities-need-over-150-billion-investment-Study/articleshow/50792711.cm
[5]   Gartner. Gartner Reveals Top Predictions for IT Organizations and Users for 2016 and Beyond. http://www.gartner.com/newsroom/id/3143718

THE INFORMATION AND COMMUNICATIONS TECHNOLOGY ECOSYSTEM AND RELATED ISSUES

A.   Connectivity/Infrastructure

1.   Connectivity needs to be available where the users are in urban, rural, and remote areas. Coverage, availability, quality (performance, quality of service (QoS), latency), security, and affordability are the major issues. Connectivity compromises international and domestic infrastructure providing sufficient capacity for the transfer of digital information and the secure and sustainable operation and maintenance (O&M) of the infrastructure. Among others, infrastructure comprises cables, manholes, ducts, poles, data center, internet exchange points (IXPs), exchanges, towers, telecoms equipment (hardware and software), power supply, security (physical and data), and satellites. All infrastructure development needs to go in line with the adoption of information and communications technology (ICT) policies and regulations. Adequate financing for infrastructure investments (capex) and sustainable O&M (opex) are required. Furthermore, for reliable O&M, well trained staff is mandatory and well thought-through processes need to be adapted. Cross sector infrastructure sharing (e.g., manholes, ducts, poles, telecom towers, cables, poles, facilities), which must be well regulated, will bring down infrastructure costs and so increase affordability. Traditional power supply through a combination of power grid, diesel generators, and batteries shall be exchanged though green solutions such as solar, wind, fuel cell, or a mix wherever possible (e.g., telecom towers).

2.   Driven through strong increasing number of global users, latency sensitive new technologies, redundancy (backup) requirements, and strong increase regarding capacity requirement, several more international submarine cables are under construction or construction will be initiated in near future. The project duration for a new submarine cable is usually up to 5 years (including financing, permits and licenses, national security approvals, implementation) and a submarine cable usually has a lifespan of 25 years up to 40 and more years. For a comprehensive overview of current submarine cables and submarine cables under implementation, refer to the TeleGeography Submarine Cable Map: http://www.submarinecablemap.com. Another good source is Greg's Cable map: http://www.cablemap.info

3.   International cross-border connectivity on land and domestic backbone networks, including domestic submarine cables, also need long term and well thought-through planning to meet today's and future requirements regarding availability, performance, resiliency, redundancy, security, and latency.

4.   A major weakness in developing countries is the telecommunications fixed line access network, the "last mile." Capacity needs to be transported to the user via the domestic fiber optic network ("backbone") of the telecom operators to the user. Old copper cables and oxidized cable connections for the access network from the telecom operator exchange to the termination point at the user premises slow down the speed and limit availability of connectivity. Same issues are well-known for campus cabling or in-house cabling. These old copper cables need to be re-engineered or better exchanged by fiber optic cables or other technologies such as fourth generation (4G)/Long Term Evolution (LTE) mobile coverage or television (TV) whitespace to meet future high speed and quality requirements. Cable theft and vandalism are other well-known issues related to cable related infrastructure.

5.   Major topics for connectivity/infrastructure:

Affordability	Network operations centers (NOCs)
Access networks (copper, fiber, microwave, mobile, satellite, television whitespace)	Open access
Broadband network	Operation and maintenance (O&M)
Budgets (capex, opex, universal service obligation (USO) fund)	Performance
Call center	Power supply
Convergence (IP based voice, data, video, TV)	Project management (involvement of all stakeholders)
Coverage	Public–private partnership (PPP)
Equipment (hardware and software)	Quality of service (QoS)
Facilities (data center, exchanges, internet exchange points (IXPs))	Renewable energy (solar, fuel cell, wind)
Fixed line networks (data over cable service interface specification (DOCSIS) 3.0, fiber, copper, fiber to the x (FTTx) (x= cabinet, building, home, node, premises), very high speed digital subscriber line (VDSL) vectoring)	Redundancy (diverse routing, no single point of failure)
Financing (business case/plan, investment financing (capex), O&M financing (opex))	Satellite
Green information technology (data centers)	Security (physical and data security)
Infrastructure sharing (multi sector), e.g., cables, data center, ducts, facilities, manholes, poles, towers, special equipment (e.g., barge for submarine cable repairs)	Spectrum management
Internet exchange points (IXPs)	Storage (national or international cloud, data center)
Latency	Submarine cables (cable landing station, environmental study, interconnection agreements, licensing, NOC network operations center, O&M, permits)
Mobile networks (2G, 3G, 4G/LTE)	Wi-fi
Microwave	

B.   Governments, Policy Makers, and Regulators

6.   Major topics for governments, policy makers, and regulators:

E-Readiness Assessment

Competition	Pricing/tariffs
E-leadership	Regulator
Human resources (salary schemes, skills, training)	Sector analysis (ICT industry, ICT users)
Infrastructure (national and international connectivity)	Standardization
Laws, regulations, and policies	Statistics

National ICT/Telecom Sector Reform and Strategies

ASEAN Connectivity Plan	National associations (role of)
Brand development	National broadband strategy (action/implementation plan)
Cache server/data centers	National connectivity (infrastructure in remote, rural, and urban areas)
Capacity building	National ICT policy
Competition	National interests
Connectivity (international and domestic)	National security
Disaster management plan (cyber-attacks, backup, disaster recovery)	Privacy
ICT entrepreneurship development	Priority sectors
ICT impact (how technology complements climate change adaptations? Technological obsolescence and how to factor these in financial and economic terms?)	Privatization
ICT sector performance monitoring (connectivity, competition, data bases, e-readiness, growth, hurdles (taxation, working permits), ICT industry, ICT users, quality of service (QoS), statistics)	Processes
ICT sector stimulation (academic, public, private sectors)	Public–private partnership (PPP)
ICT sector strategy (ICT sector reform, future ICT sector development, action/implementation plan)	Quality control
Infrastructure sharing (multi sector)	Standardization (infrastructure, quality of service (QoS), services, technologies such as Ipv6, 5G, M2M)
International and regional connectivity (infrastructure, permits, strategy)	Strategic alliances and partnerships with multilateral and bilateral institutions (e.g., ADB, ASEAN, EU, ITU, UNDP, UNESCO, World Bank)
Legal and regulatory frameworks	Trade barriers
Linguistic diversity of the internet	

ICT Policy, Law, and Regulation

National ICT policy	Telecommunications regulator (strong, independent)
Telecommunications law	Telecommunications regulations
To be covered in law, regulation, policies:	
Acceptable use policy	Key performance indicators (KPIs)
Child online protection	Lawful interception
Cloud computing	Licensing (including fees)
Code of conduct	Net neutrality
Consumer protection	Non-discriminatory access
Computer emergency response teams (CERTs)	Numbering scheme
Cybercrime	Open access policy
Cybersecurity	Quality of service (QoS)

Data protection	Privacy
Data retention	Public and private networks
Data security	Radio spectrum and spectrum management
Data storage	Roaming (international)
Dispute resolution	Satellite coordination
Domain	Service level agreements (SLAs)
Email	Tariffs/pricing
Encryption	Tax on telecommunications services (corporate tax)
Harassment	Type approval equipment
Hosting	Universal access and services
Infrastructure sharing (multi sector)	Value added services
Intellectual property rights	Voice over IP (VoIP)
Interconnection agreements	Virtual private networks (VPN)
Internet governance	

7.   Sample: In the global connected world regulators must consider international data traffic and related security. For example, all data that is stored on servers outside the country, such as cloud storage, email services, and social media are subject to laws and regulations of the country where the data is stored and not of the country where it was created. In the United States, where several service providers host most of their servers (e.g., Amazon, Apple, Dropbox, Google including Gmail, Facebook including WhatsApp, Instagram, Microsoft including YouTube and Skype, Twitter, Yahoo) the US National Security Authority (NSA)/Team Telecom has full access to all traffic and stored data by law . Same applies for all communication via submarine cable or satellite touching US territory such as Guam (there are several from Asia) or Hawaii (e.g., O3b satellite base station, submarine cables from Pacific islands).

C.   E-Services and Applications

Budget	Local content and local languages
Cross-sectoral considerations	Operation and maintenance (O&M) (of software and technical infrastructure)
Data bases (data base performance, data base software development, data collection, data quality, data up-to-date, security)	Project topics (implementation, ownership, planning, processes (workflow), project management, stakeholder involvement, testing)
E-Services (e-agriculture, e- or m-banking/e-finance/e-currency/e- or m-payment/e-wallet, e-filing, e-commerce, e-communication (audio/video conferencing systems), e-customs, e-filing, e-governance, e-government, e-health (health cloud, telemedicine), e-ID, e-learning/distance learning, e-logistics, e-procurement)	Skills (education, regular training)
Applications (supporting: anticorruption, border control, climate change, customs, disaster risk management, emergency services (e.g., disaster management, earth quake warning, tsunami warning, typhoon warning), energy, fishery, food security, gender equity, national security, natural resource management (e.g., geo-graphic	

information systems), public finance, public service delivery, rural development, tourism, urban development, social protection, water and sanitation)	

8.   Some more details about opportunities in selected sectors are presented below.[1]

9.   **E-government** refers to services and applications to improve the accessibility, transparency, and efficiency of public service. E-government is used for government internal administration (e-administration) and for the benefit of citizens and businesses. Governments need support defining national e-government strategies. Well managed secure government networks and ICT infrastructure are additional prerequisites for handling sensitive internal data and data of citizens and businesses. Around the world, e-services and applications for hundreds topics in governments are implemented, some samples are:

(i)   government websites;
(ii)   public service administration (intranet, payroll, human resources management system, accounting, asset management, etc.)
(iii)   e-governance applications;
(iv)   border control;
(v)   disaster risk management;
(vi)   tsunami monitoring and warning systems;
(vii)   natural resources management (e.g., geo-graphic information systems);
(viii)   etc.

a.   For businesses:
(i)   business registration;
(ii)   business name database;
(iii)   tax application;
(iv)   tax payment online;
(v)   licenses applications;
(vi)   regulatory information;
(vii)   government procurement;
(viii)   real estate database;
(ix)   labor department services;
(x)   statistical information systems;
(xi)   etc.

b.   For citizens:
(i)   licenses online (e.g., professional licensing, fish and game licenses);
(ii)   business and employment services;
(iii)   education and library services;
(iv)   employment services;
(v)   environmental services;
(vi)   health and safety services;
(vii)   legislative services;
(viii)   motor vehicle and boating services;
(ix)   taxes and financial services
(x)   biometric identification cards;
(xi)   electronic toll collection;

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[1] For a presentation of opportunities in ICT across ADB's sectors and themes, refer: ADB. 2016. *Ramping up ADB's role in Information and Communications Technology for Development—ICTD Team Work Plan, 2016–2017*. Manila.

(xii) SMS alerts (confirmation, information, warnings in case of emergencies such as earthquake, tsunami, typhoon);

(xiii) polling;

(xiv) online petitions;

(xv) property information;

(xvi) online billing (utility bills, rates and taxes for property); etc.

10. Issues and opportunities for e-services and applications in some key sectors such as health (e-health), education (e-learning), finance (e-finance), agriculture (e-agriculture), energy, transport, and urban development are discussed below.

11. **E-health,** which means healthcare practice supported by electronic processes and communications. Especially islands (e.g., Pacific islands) and remote areas can benefit from e-health solutions, because many patients can be treated locally and so costs can be saved for transport (e.g., many Pacific islands are flying out patients for treatment). Often hospitals and other health facilities can become inaccessible due to flooding during the rainy season. For e-health, solutions cloud services for secure data storage can be utilized, but security for hosting and data transmission of confidential data to patients and cloud services are major issues to be considered. Furthermore, secure interoperability between systems based on international accepted standards must be given (e.g., between various health systems, with medical devices, central statistic offices, national and regional health insurances, between hospitals and health insurances, World Health Organization (WHO), etc.). Development and implementation of e-health solutions must go in line with national stakeholders such as ICT and health sector regulators. Forms of e-health are for example:[2]

(i) electronic health records: enabling the communication of patient data between different healthcare professionals (general practitioners, specialists etc.);

(ii) computerized physician order entry: a means of requesting diagnostic tests and treatments electronically and receiving the results;

(iii) e-prescribing: access to prescribing options, printing prescriptions to patients, and sometimes electronic transmission of prescriptions from doctors to pharmacists;

(iv) clinical decision support: providing information electronically about protocols and standards for healthcare professionals to use in diagnosing and treating patients;

(v) telemedicine: physical and psychological diagnosis and treatments at a distance, including tele-monitoring of patients' functions;

(vi) consumer health informatics: use of electronic resources on medical topics by healthy individuals or patients;

(vii) health knowledge management: e.g., in an overview of latest medical journals, best practice guidelines or epidemiological tracking;

(viii) virtual healthcare teams: consisting of healthcare professionals who collaborate and share information on patients through digital equipment (for transmural care); and

(ix) m-health: includes the use of mobile devices in collecting aggregate and patient level health data, providing healthcare information to practitioners, researchers, and patients, real-time monitoring of patient vitals, and direct provision of care (via mobile telemedicine).

12. ICT has far-reaching consequences for the education sector **(e-education)**, particularly e-learning. E-learning**,** also known as online learning and computer-based learning is defined by the Association for Educational Communications and Technology (AECT) as "the study and ethical practice of facilitating learning and improving performance by creating, using, and

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[2] Wikipedia. e-Health: https://en.wikipedia.org/wiki/EHealth

managing appropriate technological processes and resources." Turn-key e-learning solutions or self-developed solutions can be implemented for the whole education sector including, but not limited to basic education, technical vocational education and training, and higher education. The focus should be on adapting high-quality content from different sources, as well as improving teaching and learning, boosting collaborative research, and developing the capacities of teachers, all in line with national ICT for education strategies.[3] For example, South Korea's MathCloud is a turn-key solution already supported by ADB.[4] It provides individualized learning paths to address each student's individual needs.

13.   Advantages of e-learning are for example:[5]
      (i)   class work can be scheduled around work and family;
      (ii)   reduces travel time and travel costs for off-campus students; students can stay in their villages or on their islands for all levels of education;
      (iii)   students may have the option to select learning materials that meets their level of knowledge and interest;
      (iv)   students can study anywhere they have access to a computer and internet connection;
      (v)   self-paced learning modules allow students to work at their own pace;
      (vi)   flexibility to join discussions in the bulletin board threaded discussion areas at any hour, or visit with classmates and instructors remotely in chat rooms;
      (vii)   instructors and students both report e-learning fosters more interaction among students and instructors than in large lecture courses;
      (viii) e-learning can accommodate different learning styles and facilitate learning through a variety of activities;
      (ix)   develops knowledge of the internet and computers skills that will help learners throughout their lives and careers;
      (x)   successfully completing online or computer-based courses builds self-knowledge and self-confidence and encourages students to take responsibility for their learning; and
      (xi)   learners can test out of or skim over materials already mastered and concentrate efforts in mastering areas containing new information and/or skills.

14.   E-learning also has disadvantages, as for example:
      (i)   learners with low motivation or bad study habits may fall behind;
      (ii)   without the routine structures of a traditional class, students may get lost or confused about course activities and deadlines;
      (iii)   students may feel isolated from the instructor and classmates;
      (iv)   instructor may not always be available when students are studying or need help;
      (v)   slow internet connections or older computers may make accessing course materials frustrating;
      (vi)   managing computer files and online learning software can sometimes seem complex for students with beginner-level computer skills; and
      (vii)   hands-on or lab work is difficult to simulate in a virtual classroom.

15.   **E-finance,** as a general heading, covers for example online banking also known as internet banking, m-banking, e-currency, e- or m-payment, and m-wallet. Financial activities are carried out electronically, as for example, over the Internet or electronically between devices. For

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[3]   ADB. 2016. *Ramping up ADB's role in Information and Communications Technology for Development—ICTD Team Work Plan, 2016–2017*. Manila.
[4]   MathCloud: http://company.mathcloud.net and http://www.mathcloud.net
[5]   ResearchGate.
      https://www.researchgate.net/post/What_are_the_advantages_and_challenges_of_online_learning_and_teaching
      eLearning Industry: http://elearningindustry.com

utilization, users need computers, mobile or smart phones, or tablets with secure and high-speed internet and/or mobile connectivity. Security and usability are major issues that need to be considered for all e-finance solutions in line with policies and regulations. According to United Nations Capital Development Fund (UNCDF), a correct mix of technical, financial, and policy support can assist in scaling up sustainable branchless and mobile financial services that reach especially the poor in very low-income countries.[6] These include providing risk capital directly to private sector providers for developing financial technology ("fintech") solutions and bringing these to underserved and hard-to-reach markets, supporting central banks in establishing an enabling environment (including the legal and regulatory framework and policies) for branchless and mobile services, and facilitating market and client research to develop products and services that target low-income and rural households.

(i)   service providers and financial service agents require financial and technical support;

(ii)   central banks need assistance to create enabling environment for branchless and mobile financial services; and

(iii)   market and client research is needed to develop products and services that reach especially low-income and rural households and to bring large scale users into the branchless and mobile financial services system.

16.   Globally, about 2 billion adults remain unbanked; South Asia, East Asia, and the Pacific together account for more than half the world's unbanked adults. South Asia, home to about 625 million adults without an account, has about 31% of the global total; East Asia and the Pacific, with 490 million unbanked adults, accounts for about 24%. India is home to 21% of the world's unbanked adults and about two-thirds of South Asia's. The People's Republic of China accounts for 12% of the worlds unbanked and Indonesia for 6%; together they account for three-quarters of the unbanked in East Asia and the Pacific.[7] Including the poor in the formal economy is a critical contribution to poverty reduction, reduction of inequality, and inclusive growth. For UNCDF, financial inclusion is achieved when all individuals and businesses have access to and can effectively use a broad range of financial services that are provided responsibly, and at reasonable cost, by sustainable institutions in a well-regulated environment. Increased levels of financial inclusion—through the extension of savings, credit, insurance, and payment services—contributes significantly to sustainable economic growth. Capital and technical support through inclusive finance programs is needed to ensure that more households and small business gain access to financial services that expand opportunities and reduce vulnerabilities. Providing risk capital directly to the private sector is helping bring new financial products to underserved and hard to reach markets and spurring innovations. Through flexible grant and loan instruments, a wide range of providers (e.g., financial service providers, banks, cooperatives, money transfer companies, and mobile networks operators) and financial products and services (e.g., savings, credit, insurance, payment services, remittances) can be supported.

17.   **E-agriculture** is the conceptualization, design, development, evaluation, and application of innovative ways to use ICT in the rural domain, with a primary focus on agriculture.[8] Information and communications have always mattered in agriculture. Ever since people have grown crops, raised live-stock, and caught fish, they have sought information from one another. What is the most effective planting strategy on steep slopes? Where can I buy the improved seed or feed this year? How can I acquire a land title? Who is paying the highest price at the market? The growing global population, expected to hit 9 billion by 2050, has heightened the demand for food and placed pressure on already-fragile resources. Feeding that population will

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[6]   United Nations Capital Development Fund. http://www.uncdf.org/en/mm4p

[7]   The World Bank. 2014. The Global Findex Database 2014: Measuring Financial Inclusion around the World. https://media.worldbank.org/secure/global-findex-2014/Global-Findex-2015-Report.pdf

[8]   E-agriculture. http://www.e-agriculture.org

require a 70% increase in food production.[9] ICT-enabled services are useful to improving the livelihoods of poor smallholders. One example of these services is they can prepare for weather-related events. In resource constrained environments especially, providers use satellites or remote sensors (to gather temperature data), internet (to store large amounts of data), and mobile phones (to disseminate temperature information to remote farmers)—to prevent crop losses and mitigate effects from natural adversities. Other, more-specialized applications, are for example software used for:

(i)   supply chain;
(ii)   financial management;
(iii)   risk management;
(iv)   land administration and management:
(v)   market information;
(vi)   irrigation management;
(vii)   asset management;
(viii) monitoring (e.g., intruders, protecting water supplies, preventing break-ins, deterring theft, daily operations (feeding, milking), etc.);
(ix)   increasing farmer productivity (such as receiving information about animal's health by vets, keep a record of milk production);
(x)   accounting (that allows for example cooperatives to manage production, aggregation, and sales with increased accuracy); and
(xi) product tracing (via RFID and other mobile technology) for food safety, disease control and other benefits.

18.   Governments need support defining national e-agriculture strategies. An e-agriculture strategy can offer critical support to rationalizing of resources (financial and human), better harnessing of ICT opportunities, and addressing challenges in the agricultural sector. The existence of a comprehensive national strategy can prevent e-agriculture projects from being implemented in isolation and develops efficiency gains from intra sector and cross sector synergies.

19.   ICT can play an important role in the **energy sector** by, for example, rendering buildings more energy efficient or improving the functioning of the electricity grid. Today, most solutions in the energy sector already include ICT-related components especially for monitoring and management purposes. Nevertheless, the energy sector itself is responsible for carbon emissions which are rapidly growing and should be kept to a minimum. As part of the solution, ICT related e-services and applications can contribute improving energy efficiency. If energy is used more efficiently, it also reduces the harmful carbon dioxide emissions coming from power plants and reduces electric bills. Examples for e-services and applications are:

(i)   grid planning;
(ii)   energy savings through ICT-enabled (public) building automation system and energy management and monitoring system;
(iii)   e-meters, intelligent meters, smart meters;
(iv)   smart grid (includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources. Electronic power conditioning and control of the production and distribution of electricity are important aspects of the smart grid.[10]);
(v) critical infrastructure protection (power plants, grids, node points);
(vi) auctions and trading

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[9]   E-agriculture. 2011. ICT in Agriculture Sourcebook. http://e-agriculture.org/ict-agriculture-sourcebook
[10] Federal Energy Regulatory Commission. 2008. Demand Response & Smart Metering. http://www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf

      (vii)   power supply for (government) data centers ("Green IT"); and
      (viii)   e-billing for utility bill.

20.   A practical example is given in sample case 4 of Box 5. In India, the telecom tower industry consumes over 2.5 billion liters of diesel annually, making it the second largest consumer of diesel in the country. With growing mobile networks and new technologies, the numbers of mobile towers and mobile base stations will rapidly grow in all countries. ICT supported intelligent solutions monitoring and managing a mix of diesel generation and renewable energy can make energy use more efficient and contributes to reducing carbon emission.

21.   Other opportunities are cross sector infrastructure sharing between the ICT sector and the energy sector especially related to towers and facilities. Furthermore, today, all power grids are implemented with fiber optic cables for the monitoring and management of the power grid. These fiber optic cables can be utilized for telecommunications. In most countries, there is only very limited cooperation between ICT regulator and energy regulator, so that this opportunity is not regulated and utilized.

22.   ICT can support the **transport sector** through several e-services and applications having considerable impacts on energy consumption reductions and road safety. Examples are:

      (i)   intelligent transport systems (ITS) (the ITS technology applies to transport and infrastructure to transfer information between systems for improved safety including road safety, productivity, and environmental performance. This includes stand-alone applications such as traffic management systems, information and warning systems installed in individual vehicles, as well as cooperative ITS (C-ITS) applications involving vehicle to infrastructure and vehicle-to-vehicle communications, vehicle to infrastructure communications, vehicle to everything communications;[11]toll systems; and
      (ii)   harbor and airport logistics.

23.   Furthermore, the use of different types of data facilitated by ICT, such as mobile data (e.g., for traffic studies) and GIS/satellite data (e.g., for road alignments), should be explored.

24.   Other opportunities are cross sector infrastructure sharing between the ICT sector and the transport sector especially related to ducts for fiber optic cables along roads and railways. In most countries, there is only very limited cooperation between ICT regulator and stakeholders of the transport sector, so that this opportunity is not regulated and utilized.

25.   ICT can play an important role in **urban development**. An urban development vision is "smart cities" to integrate multiple ICT solutions in a secure fashion to manage a city's assets—the city's assets include, but not limited to, local departments information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. The goal of building a smart city is to improve quality of life by using technology to improve the efficiency of services and meet residents' needs. ICT allows city officials to interact directly with the community and the city infrastructure and to monitor what is happening in the city, how the city is evolving, and how to enable a better quality of life. Through the use of sensors integrated with real-time monitoring systems, data are collected from citizens and objects—then processed and analyzed. The information and knowledge gathered are keys to tackling inefficiency. ICT is used to enhance quality, performance, and interactivity of urban services, to reduce costs and resource

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[11]   Australian Government. Intelligent Transport Systems. https://infrastructure.gov.au/transport/its

consumption, and to improve contact between citizens and government. Smart city e-services and applications are developed with the goal of improving the management of urban flows and allowing for real time responses to challenges.[12] Geographical information systems (GIS) are being increasingly utilized for urban planning; and management information systems (MIS) for urban management and governance. More detailed examples for e-services and applications are:

(i)   urban planning, management, and monitoring;
(ii)   public transport management systems;
(iii)   cashless payment/e-ticketing systems for public transport; and
(iv)   optimization of public transport and waste collection routes.

D.   Human Resources

Capacity building	Organizational structure with high level skills description
E-learning/distance learning	Lifelong learning
Entrepreneurship	Public awareness programs/campaigns
Human resources availability/planning/requirements	Salary schemes (keeping trained staff in the country in the government)
ICT literacy	

E.   Operation and Maintenance

Audits (external service audits)	Network operations center (NOC)
Budget (continuous, sufficient)	Organizational structure
Business continuity (disaster management, backups)	Outsourcing
Call centers	Processes (inclusive documentation, fault handling, labelling, project management, reporting)
Hardware (upgrades, renewal)	Quality of service (QoS)
Human resources (capacity building, ownership, payment schemes, project management, training, skills)	Security (physical, data)
Insurance	Software (purchase, upgrades and licenses)
Legal support	Spare parts (inclusive logistics)
Maintenance and services/support contracts	Risk elimination/prevention
Network management and monitoring	

F.   Risks

Budget (availability of regular and sufficient)	ICT sector (competition, consumer protection, infrastructure sharing, operator interconnection)
Environmental (electromagnetic radiation, flooding, earth quake, landslide, sea quake, tsunami, typhoon, volcano)	Physical security (accidents, connectivity, explosions, fire, lightning, power feed)
Data security (copyrights infringement, cyberattacks, cyberwarfare, firewall,	Political (censorship and content filtering, cross border disputes, cultural, lawful

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[12]   Wikipedia. Smart Cities. https://en.wikipedia.org/wiki/Smart_city

phishing, trojan horses, viruses, worms)	interception, laws, policies, political disputes, land reclamation, regulations, strategic)
Human (awareness, espionage, expertise, hacking, intrusion, land ownership disputes, law infringement, leadership, ownership, phishing, sabotage, skills, training, theft, vandalism, terrorism)	Technical design risks (disaster recovery, diverse routing, redundancy, resiliency, single point of failure)

G.   Emerging Technologies

3D printing	M2M communications (Machine to Machine such as Intelligent Transport Systems (ITS), utility meters)
5G mobile networks	Robotics
Artificial intelligence (AI)	Smart cities/municipalities
Autonomous vehicles (AV) (self-driving cars)	Smart grid
Cloud computing	TV white space technology
Big data	Ultra-high definition IP TV
Internet of things (IoT)	

SAMPLE INFORMATION AND COMMUNICATIONS TECHNOLOGY INITIATIVES

A.   Assessment to Strengthen Internet Connectivity in Central Asia

1.   Mid of 2015, the **World Bank** and the **International Finance Corporation (IFC)** have started a joint initiative focused on improving connectivity within Central Asia and between Central Asia and other regions. As part of this initiative, the preparation of a thorough analysis of options to improve internet connectivity has been tendered. The assignment included: (i) a market assessment for **Tajikistan and the Kyrgyz Republic** mapping existing cable and satellite capacity, data pricing, market segmentation, demand and growth potential, and transit potential with neighboring countries; (ii) an engineering solution assessment to evaluate the strengths, weaknesses, and costs of various models to improve connectivity either utilizing existing country infrastructure or by linking the two countries to better connectivity options via **Pakistan and Afghanistan, the People's Republic of China, and/or Russia**. It was requested that the study should consider all feasible technical solutions including connecting existing cable links, a new cable, satellite solutions, or any other viable option; and (iii) basic project design for the preferable solution (cost, route, stakeholders). The initiative is still ongoing. World Bank had several similar initiatives around the globe.

B.   Master Plan on Asean Connectivity[1]

2.   As basis for further activities in 2011, the **Association of Southeast Asian Nations (ASEAN)** published the Master Plan on Asean Connectivity for the period 2011–2015. A robust information and communications technology (ICT) infrastructure in tandem with better human resources and regulatory environment is critical for enabling ICT as an engine of trade, economic growth, innovation, and better governance in the ASEAN region. A number of countries in the region are gaining global reputation in ICT infrastructure, ICT-based industries and services. However, the digital divide within ASEAN remains, especially between the lagging regions and the urban areas on the one hand, and between countries on the other hand. The digital divide needs to be reduced in order to narrow the development gaps within the region. The master plan includes the ASEAN Broadband Corridor (ABC) project that has two main objectives: (i) to provide the infrastructure backbones to enable ICT services to all communities in ASEAN; and (ii) to put in place the required enabling policies and legislation to attract businesses and investments to the region. The project will focus on development of the "next generation infrastructure" (which refers to both wired and wireless technologies) and set the minimum standards and quality of broadband connectivity in ASEAN. It will also identify and develop the locations in each ASEAN member state which offer quality broadband connectivity and enabling environment for the seamless usage and ICT applications across ASEAN, and enhance the development of ICT and other sectors (e.g., broadband to all schools), and promote the diversity of international connectivity among ASEAN members states. Further key actions were identified: (i) promotion of the diversity of international connectivity among ASEAN member states; (ii) establishing an ASEAN internet exchange network to facilitate peering among ASEAN internet access providers to reduce latency and increase speed as well as lower costs; (iii) promotion of network integrity and information security, data protection, and Computer Emergency Response Team (CERT) cooperation by developing common frameworks and establishing common minimum standards where appropriate, to ensure a level of preparedness and integrity of networks across ASEAN; (iv) review of universal service obligations (USO) and/or similar policies to ensure that infrastructure covered under these policies are broadband internet capable; (v) prioritization and expedition roll-out of broadband internet capable infrastructure to schools; and (vi) conducting feasibility study on developing an ASEAN single

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[1]   Association Of Southeast Asian Nations. 2011. Masterplan on ASEAN Connectivity. http://www.asean.org/master-plan-on-asean-connectivity-2/

telecommunications market, in the context of free flow of products, services, investments, and skilled human resources. The implementation of the items is not completed yet.

C.   Mongolia Information and Communications Technology-Related Public Service

3.   **Mongolia** is large, landlocked country that is mostly sparsely populated, but overpopulated in a few areas. Mongolia, with a population of 2.9 million (2014), has a strong growth in the ICT sector. The mobile penetration reached 150% in 2014, fixed lines reach about 40% of the population. Today, already more than a third of Mongolian citizens use smartphones and tablet devices and so have the basis to benefit from governments social and other services. The international bandwidth demand of Mongolia will grow from 34 Gbps in 2014 to forecasted 2.037 Gbps in 2024, which means a compound annual growth rate of 47%.

4.   In June 2014, the **World Bank** approved a $19.4 million standard International Development Association (IDA) **credit** to the Government of Mongolia with a repayment period of 25 years and of a 5 years grace period. The lending instrument used is an investment project financing credit. By law, all new loans and credits in Mongolia are reviewed by cabinet and subject to parliamentary approval. Parliamentary approval for the project and signed financial agreement was granted on 9 July 2015 and the project was declared effective on 17 August 2015. The development objective of the project (to be finalized by 31 December 2020) is to use ICT to improve accessibility, transparency, and efficiency of public service in Mongolia. The overall strategy of the project is to focus on key components of the ICT and open data ecosystem which will support Mongolia's Smart government initiative. Key areas being addressed by the project were developed through an earlier analytical activity and include (i) shared ICT infrastructure and services; (ii) citizen engagement; (iii) capacity building; (iv) policies related to open data; and (v) applications and co-creation of solutions. The credit will be used for technical assistance, investment support, and support for application development.

D.   Afghanistan Joint Transport and Information and Communications Technology Infrastructure Project

5.   **Afghanistan** is a large, landlocked country with a population of 31 million with mobile penetration of 75% (2014 figures). Afghanistan's mobile networks provide geographic coverage to approximately 90% of the population. Fixed lines reach is only about 4% of the population, which is among the lowest in the world. The international bandwidth demand of Afghanistan will grow from 20 Gbps in 2014 to forecasted 1.126 Gbps in 2024, which means a compound annual growth rate of 53%. In October 2015, the **World Bank** approved a $250 million International Development Association (IDA) grant to the Government of Afghanistan for the Trans-Hindukush Road Connectivity Project. **10% ($25 million) are allocated to telecommunications.** The project has become effective on 17 January 2016.

6.   Afghanistan suffers from significant transport infrastructure gaps in terms of connectivity and accessibility. These gaps result in relative isolation of parts of the country and negatively affect regional and internal integration and trade. The country is located at the intersection of Central Asia and South Asia and the existing highways provide international links to Iran, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. More than 90% of freight and almost 85% of intercity passenger transport are carried by road transport. The total length of Afghanistan's road network is about 123,000 kilometers but nearly 80% of the roads are not "all-season" roads. About 63% of the population is more than 2 kilometers away from an all-season road. An information and communications campaign will include the design and execution of Ministry of Public Works. The purpose is building public and stakeholder support for upgrading of the roads. This is especially important because the construction works will occasionally cause disruptions of the normal traffic patterns. The communications/outreach campaign is expected to include

ICT-based citizen feedback mechanisms (including a grievance redress mechanism) and will also promote road safety awareness among road users. Furthermore, the Baghlan to Bamiyan road will include fiber optic cables laid in ducts embedded in the road structure. The new fiber optic cable along this road will become part of the "data highway" for Afghanistan and provide a backup loop for the existing trans-Hindukush fiber optic cable along the Salang Pass road. It will facilitate the planned opening of the Afghan ICT market to private sector ICT service providers. The Afghan Ministry of Communications and Information Technology will come to contractual agreements with both public and private ICT service providers who will pay annual fees to install and keep their cables in separate ducts. This is part of the broader reform of the Afghan ICT market which is being opened up to competition between different service providers, public and private.

E.   Commercial Regulatory Issues Consultancy

7.   Under the **Timor-Leste** Department of Foreign Affairs and Trade - World Bank Strategic Partnership Trust Fund Telecommunications Technical Assistance Program, in 2015 the **World Bank** has tendered assistance for the Timor-Leste regulator Autoridade Nacional de Communicações (ANC). The ANC needs to develop, document, and establish regulatory functions for each of the following elements such that they integrate into and operate within the ANCs separately developed business systems, and to train ANC staff on use, maintenance, and development of these instruments and systems.

8.   The objectives of the assignment of telecommunications specialists included to work with the ANC to advise on and assist in the establishment of a comprehensive set of harmonized regulatory systems for: (i) telecommunications markets review, market power, and competition; (ii) interconnection, site sharing, and facilities access and; (iii) an infringement notice regime. And with relevant regulatory instruments, management and administration systems and provision of skills development in use and prospective system development for ANC staff.

9.   The scope of work for a market and competition specialist included a review of the markets set out in schedule two of the decree law and any other relevant markets, make proposals about market power of any one or more operators, provide strategic and practical advice to the ANC staff in the analysis of telecommunications markets, market power and competition in line with the scope and extents of the decree law. This included regulatory instruments, systems, and processes for the effective discharge of ANCs statutory functions and duties based on the requirements of the telecommunications decree law, best practices of modern telecommunications consumer protection arrangements, the current circumstances of the telecommunications industry of Timor-Leste, and the skill levels and resources of the ANC.

10.   The scope of work for the interconnection, site sharing, and facilities access specialist included providing strategic and practical advice to the ANC and its staff in the design and development of initially options suitable for the circumstances of Timor-Leste, and if the ANC chooses to proceed, with advice and assistance toward the introduction of the service. This included regulatory instruments (as necessary), systems and processes for the effective discharge of ANCs statutory functions and duties based on the requirements of the telecommunications decree law, best practices of modern universal access, the current circumstances of the telecommunications industry of Timor-Leste and the skill levels and resources of the ANC.

11.   The scope of work for the infringement notice regime specialist included providing strategic and practical advice to the ANC staff in the design and development of the infringements regime. This included regulatory instruments, procedure and process documentation including relevant confidentiality arrangements where appropriate, and

arrangements to ensure the earliest practicable closure of an infringement matter. Such systems are to enable discharge of ANC's statutory functions and duties based on the requirements of the telecommunications decree law, best practices of modern infringements regime practices, the current circumstances of the telecommunications industry of Timor-Leste, and the skill levels and resources of the ANC. This is just a sample of several similar initiatives of the World Bank.

F. European Union–India Cooperation on Information and Communications Technology Standardization, Policies and Legislation

12. Early 2015 **the European Union (EU)/European Commission/EuropeAid**, through its newly established partnership instrument, has decided to foster its cooperation with **India** (**Bhutan and Nepal** are invited to participate) on ICT standardization issues. India is a strategic economic partner for the EU and a key player both in the South Asia region and at global level. It maintains significant market access barriers in the ICT sector (e.g., based on alleged India specific security needs). There is a danger that additional India specific telecom and IT standards would result in further market access barriers, leading to substantial additional costs and administrative burden for international companies (e.g., additional testing, certification, and labelling requirements and resulting delays). Furthermore, India has little experience in ICT standardization and can benefit from such a project. With a population of more than 1.2 billion (India) and 508 million (EU) joint standards open business and trade opportunities for both sides and other countries and regions will follow these two big global players after the implementation of standards. To this aim, the project "EU-India co-operation on ICT-related standardization, policy and legislation" has been initiated by the EU with a funding of total app. $3.5 million for 2 phases (inception phase, implementation phase) to be carried out between 2015 and 2019.

13. In the first phase, the European Telecommunications Standards Institute (ETSI) and the recently established Telecom Standards Development Society of India (TSDSI) were identified as major stakeholders. ETSI and TSDSI are supported by the EU and the Government of India and all relevant stakeholders from the respective ICT sectors are members of these two standardization entities. Eurostat (Statistical Office of the European Union), and the Central Statistics Office (CSO, India) were identified as stakeholders for a separate statistics component of the project. In the first workshops, the following ICT supported topics (pilot initiatives) were identified for further collaboration: (i) 5G mobile networks, (ii) machine to machine (M2M) with a focus on intelligent transport systems (ITS), and (iii) network function virtualizations/software defined networks (NFV/SDN); including security as a cross-cutting theme. For the statistics component, statistical data and metadata exchange (SDMX) was identified as pilot initiative.[2] This is an international initiative sponsored by the Bank for International Settlements (BIS), the European Central Bank (ECB), Eurostat (Statistical Office of the European Union), the International Monetary Fund (IMF), the Organisation for Economic Cooperation and Development (OECD), the United Nations Statistical Division (UNSD), and the World Bank to foster standards for the exchange of statistical information and metadata.

14. In the second phase, the implementation phase, the project will strengthen the cooperation between ETSI and TSDSI, and Eurostat and CSO by supporting TSDSI and CSO for activities such as meetings, international expertise, trainings, analysis, studies, position papers, participation of Indian experts in international meetings, conferences, and workshops.[3] The standardization project supports current "Make in India" and "Digital India" initiatives and 5G mobile networks was part of agreements signed on an EU–India Summit in Brussels on 30 March 2016. The EU was represented by Donald Tusk, President of the European Council, and

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[2] Statistical Data and Metadata eXchange (SDMX). http://sdmx.org and Eurostat: SDMX: http://ec.europa.eu/eurostat/data/sdmx-data-metadata-exchange

[3] European Union. https://ec.europa.eu/digital-agenda/en/news/eu-india-cooperation-ict-standardisation and project website: http://www.indiaeu-ictstandards.in

Jean-Claude Juncker, President of the European Commission. The Republic of India was represented by Prime Minister Shri Narendra Modi.

G.   Mobile Money for the Poor

15.   In an ICT supported Mobile Money for the Poor (MM4P) initiative, **United Nation's** capital investment agency, the **United Nations Capital Development Fund (UNCDF),** aims to demonstrate how the correct mix of technical, financial, and policy support can assist in scaling up sustainable branchless and mobile financial services that reach the poor in very low-income countries. The total project costs are about $36 million.[4]

H.   Policy and Regulatory Harmonization for the Pacific Island Countries

16.   The **International Telecommunication Union–European Commission funded** project provided expert assistance and human capacity building to countries in the Pacific region particularly in the areas of ICT policy, numbering, international mobile roaming, cybersecurity, licensing frameworks, spectrum management, broadcasting, broadband, satellite coordination, pricing, and universal access and service.[5]

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[4]   Project website: http://www.uncdf.org/en/mm4p
[5]   ITU.   Regional   Initiatives   –   Asia   and   the   Pacific.   http://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2015/August-RDF2015/ASP_RIs_Brochure.pdf

SUMMARY OF STAKEHOLDER MEETINGS AT ADB

1.   Between 17 February 2016 and 2 March 2016, the authors of this document held about 30 meetings with a range of ADB sector and thematic group technical advisors, sector directors, country directors, DGs, and other staff.

2.   There is overwhelming recognition of the importance of information and communication technology (ICT), and almost everyone the authors spoke to felt that ADB is falling behind in this area and should do much more. ICT is already integral part of most of the projects but not identified as ICT related projects separately. The impression is that ICT has so far no home and leadership in ADB and its impact on the development of countries, regions, and sectors is underestimated.

3.   There is a general view that ADB should scale up its work in ICT in terms of ICT/broadband strategies, ICT policy and regulations, ICT capacity building, and IT applications for various sectors, as well as procurement support for ICT components. Private and public sector space needs to be clearly defined for the ICT sector.

4.   For ICT infrastructure, there were some mixed views. Some define ICT infrastructure just as cables, but ICT infrastructure in a wider definition includes submarine cables and backbones (international, regional, and domestic), fiber optic cables, last mile access, infrastructure sharing between sectors, mobile networks including towers, data centers including national/regional cloud infrastructure, satellites, universal service obligation (USO) funds, internet exchange point (IXP), network operations centers (NOCs), call centers, etc.

5.   Some staff, and especially those with a more profound understanding of the ICT sector, indicated that there is demand from the countries and regions and that there are good opportunities for ADB—if advertised and followed-up—to get involved in certain aspects of ICT infrastructure, and in certain contexts. For example:

(i)   Demand for submarine cables and ICT backbones is strong in the Pacific and archipelagic countries such as Indonesia and the Philippines where connectivity can have catalytic impacts and spillover effects on many sectors of the economy and where private sector investment may be limited.

(ii)   Demand for domestic ICT infrastructure that enable government services may be strong in countries where there is already basic connectivity and e-readiness.

6.   Because ADB's ICT engagement is fragmented and generally limited to sector-related ICT, ADB may not be in a good position to gauge demand for ICT. On the other hand, ICT infrastructure is required as basis for all sector-related ICT applications.

Some quotes from the consultations:

Information and Communications Technology in ADB
(i)   *"ICT – it's the way the world is moving and we can't ignore it."*
(ii)   *"ADB has no choice but to adopt ICT, without ICT you can't do anything."*
(iii)   *"ADB needs to scale up ICT dramatically."*
(iv)   *"A more strategic and corporate approach is needed for ICT. ADB should consider setting corporate targets for ICT."*
(v)   *"ADB is not fast enough for development in the ICT sector. ICT might bring some value, but the market is so fast."*

(vi)   *"ICT is infrastructure in a broader sense, similar to transport and electricity, and ADB is an infrastructure bank. So there is no doubt about ICT. ICT is also a cross-cutting sector."*

Development Case for Information and Communications Technology
(i)   *"Given the contribution of mobile coverage to GDP, there is a clear case for ADB to support the ICT sector."*
(ii)   *"Productivity and effectiveness grows with ICT."*
(iii)   *"ICT allows countries to leap-frog."*
(iv)   *"ADB must invest first: you have to generate demand. Let's learn from consulting firms like McKinsey & Company and PWC how to create demand."*

Business Opportunities
(i)   *"In the future, ADB can finance projects in less developed countries in areas such as next generation technology, connectivity, and cross-border inter-connectivity. In addition, ADB can continue to work in frontier markets for basic ICT infrastructure, and on last-mile connectivity in countries where large populations are still unconnected."*
(ii)   *"ICT for service delivery; there is substantial demand from countries and their people. There is no doubt about it at all."*
(iii)   *"[There is] Little potential for future ICT projects for the Private Sector Operations Department. It is hard to find projects that are left that are commercially viable but also demonstrate a strong and clear development impact."*
(iv)   *"Most important are ICT pilot projects to demonstrate ICT competence."*

Challenges
(i)   *"Countries have asked for ICT support but ADB has rejected projects because it has no expertise."*
(ii)   *"We have a chicken-and-egg problem in terms of organizing ADB's response. ADB's internal ICT capacity is way behind most of our DMCs."*
(iii)   *"ICT procurement is a problem in ADB; there is no ICT policy, no processes, no expertise."*

Information and Communications Technology in ADB's Institutional Structure
(i)   *"Not clear who "owns" ICT at ADB."*
(ii)   *"ADB needs to raise its ICT profile, there is no institutional anchor."*
(iii)   *"ICT projects have not, by default, been streamlined. Often one-off interventions."*
(iv)   *"ICT should be at least a thematic group in ADB advising other sectors and departments. For standalone ICT projects (ICT infrastructure, ICT skills, ICT regulations, e-government) a separate ICT department might be considered."*
(v)   *"[ADB needs] More ICT experts to support other departments/sectors and for standalone projects."*
(vi)   *"It will be extremely difficult to build up and keep ICT expertise in ADB, there are huge doubts that the construct of ADB allows this. Where any new ICT capacity is placed is critical, to ensure that ICT staff do not "burn out"."*
(vii)   *"It will be a major problem for ADB to hire world class consultants. 2–3 people make no sense, they will be lost in the organization."*

PARTNERING FOR ICT

1.   There are some interventions that might benefit from collaborating with **other institutions** active in the region to enhance their impact and sustainability. This should draw on the specific expertise that different institutions possess.[1]

(i)   The **private sector** could be for instance a partner for financial interventions that help expand access to rural and remote areas. One best practice is to have operators bid for subsidies to supply services in underserved areas. Also, though they may not be direct partners for some projects, operators would be involved indirectly in public–private partnerships such as operating and maintaining fiber backbone projects.

(ii)   Institutions **such as International Telecommunication Union and Asia Pacific Telecommunity** could be useful partners for projects involving human capacity development given their expertise in that area.

(iii)   Nongovernment organizations **and bilateral agencies are** typically involved in more narrowly focused assistance such as pilot projects and specific applications (e.g., e-agriculture, e-health, and e-government). Their support could be helpful for scaling up such activities. Cooperation can be important particularly in offering solutions that may be more relevant for countries given their level of development. Examples include offering technical advice for the design of universal service programs, integrating information and communications technologies in economic diversification strategies, and the development of e-services in sectors such as agriculture, education, and health.

(iv)   Interventions involving sector policy advice and regional integration might be strengthened in collaboration with **intergovernmental institutions** such as the Economic and Social Commission for Asia and the Pacific (ESCAP), Associate of Southeast Asian Nations (ASEAN), and the Pacific Forum.

(v)   Resources for large-scale interventions, particularly in the area of international and regional backbone networks, could be enlarged through collaboration with other **international financing institutions** such as the World Bank.

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[1]   See also: ADB. 2016. *Ramping up ADB's role in Information and Communications Technology for Development— ICTD Team Work Plan, 2016–2017*. Manila.

RECOMMENDED LITERATURE

1.   The following recommended reports and literature illustrate the strength and weaknesses of regions and countries (including Asian and Pacific) considering many factors and impacts. Furthermore, the reports provide a comprehensive comparison between the regions and countries for the state of their digital development. The reports contain descriptions of several actual digital development initiatives around the globe. Measures for further development and prioritization can be derived from these reports.

2.   The level of digital development varies greatly among Asian and Pacific countries. Every year, the **Broadband Commission** for Digital and Sustainable Development, launched by the International Telecommunication Union (ITU) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), publishes **"The State of Broadband Annual Report"** which reflects the development in many, including Asian and Pacific countries.[1]

3.   Since 2001 the **World Economic Forum (WEF)** in partnership with Cornell University and Institut Européen d'Administration des Affaires (INSEAD) yearly publishes the "**Global Information Technology Report"** which features the latest iteration of the Networked Readiness Index, which assesses the factors, policies and institutions that enable a country to fully leverage ICT or increased competitiveness and well-being. Many countries are covered, including Asian and Pacific countries.[2]

4.   In January 2016 the **World Bank** has published the **"World Development Report: Digital Dividends"**. The report concludes that the full benefit is of the ICT transformation will not be realized unless countries continue to improve their business climate, invest in people's education and health, and promote good governance. To deliver universal digital access, investment in infrastructure and pursuing reforms that bring greater competition to telecommunications markets, promoting public–private partnerships, and yielding effective regulation are required. Among other topics, the report especially focuses on agriculture, digital finance, education, e-health, smart cities, energy, and environmental management.[3]

5.   Another interesting document **"Economic and Social Impact of ICT in the Pacific"** published by the **Pacific Region Infrastructure Facility (PRIF)** in June 2015.[4]

6.   The **Organisation for Economic Co-operation and Development (OECD)** regularly publishes the **"Measuring the Information Society Report"**, which identifies key ICT developments and tracks the cost and affordability of ICT services, in accordance with internationally agreed methodologies. Its core feature is the ICT Development Index (IDI), which ranks countries' performance with regard to ICT infrastructure, use and skills. The report aims to provide an objective international performance evaluation based on quantitative indicators and benchmarks, as an essential input to the ICT policy debate in ITU Member States. For the 2014 report refer to: http://www.itu.int/en/ITU-D/Statistics/.../MIS2014_without_Annex_4.pdf

7.   The World Bank projects & operations website shows 186 projects in the ICT sector around the world with a total committed amount of about $1.25 billion in the period 1 January

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[1]   Broadband Commission for Digital Development. 2015. *The Actual State of Broadband Annual Report 2015*. http://www.broadbandcommission.org/publications/Pages/SOB-2015.aspx

[2]   World Economic Forum. 2015. *The actual Global Information Technology Report 2015*. http://reports.weforum.org/global-information-technology-report-2015/downloads/

[3]   World Bank. 2016. *World Development Report 2016: Digital Dividends.* http://www.worldbank.org/en/publication/wdr2016

[4]   Pacific Region Infrastructure Facility. 2015. *Economic and Social Impact of ICT in the Pacific.* http://www.theprif.org/components/com_jomcomdev/files/2015/10/40/124-PRIF%20Pacific%20ICT%20Report%202015.pdf

2010 until 31 December 2015. With 76 projects and a committed budget of total $750 million, telecommunications had the major share. Details can be found on (refer to Information and Communications): http://go.worldbank.org/KPMUDAVVT0

8.   The European Union (EU) is represented by the European Commission (EC). The EC's Directorate-General for International Cooperation and Development (DG DEVCO) is responsible for designing European international cooperation and development policy and delivering aid throughout the world. Under **EuropeAid** programs and projects are implemented around the world. ICT is part of the infrastructure sector. Refer to: http://ec.europa.eu/europeaid/home_en