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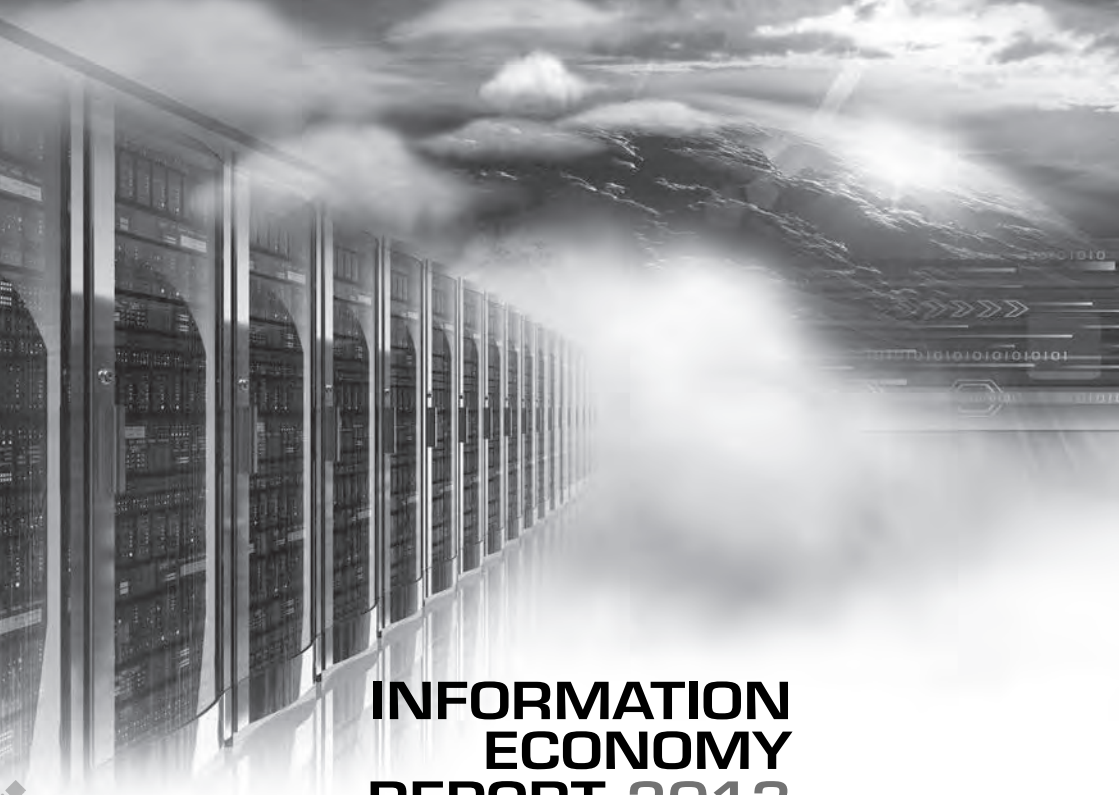
INFORMATION ECONOMY REPORT 2013

The Cloud Economy and Developing Countries

OVERVIEW



UNITED NATIONS



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NOTE

Within the UNCTAD Division on Technology and Logistics, the ICT Analysis Section carries out policy-oriented analytical work on the development implications of information and communication technologies (ICTs). It is responsible for the preparation of the *Information Economy Report*. The ICT Analysis Section promotes international dialogue on issues related to ICTs for development, and contributes to building developing countries' capacities to measure the information economy and to design and implement relevant policies and legal frameworks.

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PREFACE

Innovation in the realm of information technology continues its rapid pace, with cloud computing representing one of the latest advances. Significant improvements in the capacity to process, transmit and store data are making cloud computing increasingly important in the delivery of public and private services. This has considerable potential for economic and social development, in particular our efforts to achieve the Millennium Development Goals and define a bold agenda for a prosperous, sustainable and equitable future.

The *Information Economy Report 2013* marks the first time the United Nations is examining the economic potential of cloud computing for low- and middle-income countries, where rates of adoption are currently low. With governments, businesses and other organizations in the developing world considering whether to migrate some or all of their data and activities to the cloud, this publication is especially timely. I commend its information and analysis to all those interested in learning more about the benefits and risks of the cloud economy.

A handwritten signature in black ink, reading "Ki-moon Ban". The signature is fluid and cursive, with a long vertical stroke extending downwards from the end of the name.

BAN Ki-moon
Secretary-General
United Nations

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OVERVIEW

Cloud computing accentuates the quality dimension of the digital divide.

The differential between countries in access to and use of information and communication technologies (ICTs) – the digital divide – has long been a significant concern of Governments and the international community. Over time, its nature has changed. The gap in access to basic telephone services, once very substantial, is now significantly diminished and expected to shrink further in the next few years. In its place has come a gap in access to the Internet and, particularly, in access to broadband services. The digital divide in broadband capacity and quality leads in turn to a divide between countries and regions in the extent to which individuals, businesses, economies and societies are able to take advantage of new ICT innovations and applications.

Cloud computing is a recent manifestation of this evolving ICT landscape. Given its potential, it is becoming increasingly important for Governments and enterprises. In simple terms, cloud computing enables users, through the Internet or other digital networks, to access a scalable and elastic pool of data storage and computing resources, as and when required. Some predict that cloud technology will be among the most significant disruptive technologies over the next two decades, with major implications for markets, economies and societies. Against this background, the *Information Economy Report 2013* provides an objective analysis of the possible implications for developing countries of the evolving cloud economy.

Massive improvements in storage, processing and transmission capacity have paved the way for the cloud economy.

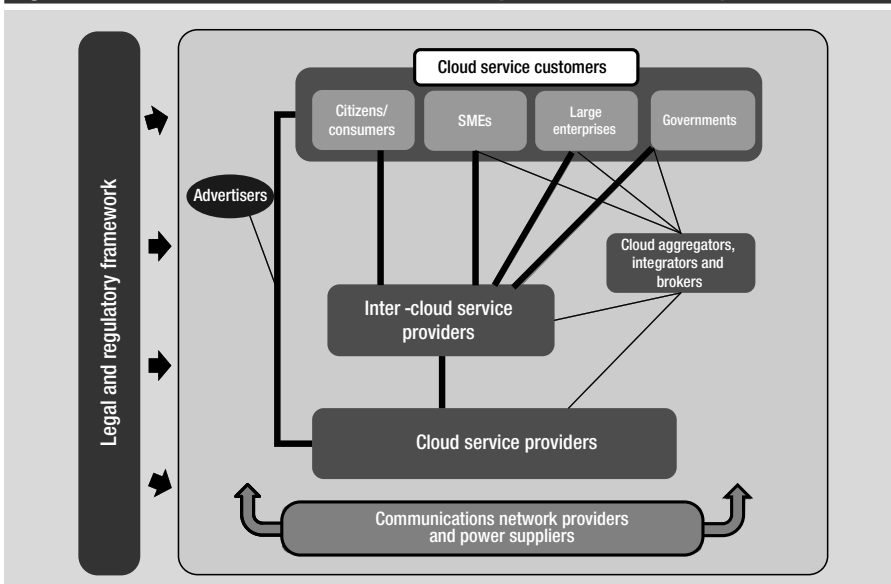
The metaphor of the “cloud” can be misleading. Rather than representing an amorphous phenomenon in the sky, cloud computing is well anchored on the ground by the combination of physical hardware, networks, storage, services and interfaces that are needed to deliver computing as a service. A key feature of cloud computing is that it often involves transferring data to a server controlled by a third party.

The shift that is taking place towards the cloud represents a step change in the relationship between telecommunications, business and society, and has been enabled by massively enhanced processing power, data storage and higher transmission speeds. For example, Intel’s 22-nanometre central processing unit is 4,000 times faster than that which the same company introduced in 1971, and

between 1986 and 2007 the world's "technological memory" roughly doubled every three years. Meanwhile, the fastest theoretical speed of a dial-up connection in 1993, the year the Internet browser was introduced, was 56 kilobits per second (kbit/s); as of 2013, consumer broadband packages of 2 gigabits per second (Gbit/s) are available, almost 36,000 times faster than dial-up. Major cloud service providers today have hundreds of thousands of servers located in massive data centres in different parts of the world.

According to definitions proposed in April 2013 by the International Telecommunication Union (ITU) and the International Organization for Standardization (ISO), cloud computing is a paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with on-demand self-service provisioning and administration. Cloud services are defined as services that are provided and used by clients on demand at any time, through any access network, using any connected devices that use cloud computing technologies. The implications of cloud computing and cloud services on wider economic development are discussed in this report in the context of the cloud economy (figure 1).

Figure 1. Main stakeholders and market relationships in the cloud economy



Source: UNCTAD.

The cloud economy comprises various cloud service categories and deployments.

However, the “cloud” and “cloud services” are not homogenous products but come in different shapes and configurations. Three categories of cloud services – infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS) – are commonly used to encompass the whole range of cloud service categories that are currently available. The defining characteristic of each of these variations of the cloud is the type of computing or information technology (IT) facilities that is made available remotely to a cloud service customer, on a rental or subscription basis, by a cloud service provider:

In the case of IaaS, the cloud provider’s processing, storage, networks and other fundamental computing resources allow the cloud customer to deploy and run software. The elasticity of IaaS allows an organization or enterprise to access computing infrastructure in a flexible and timely manner.

In the case of PaaS, the cloud customer deploys its own applications and data on platform tools, including programming tools, belonging to and managed by the cloud provider.

With SaaS, the cloud customer takes advantage of software running on the cloud-provider’s infrastructure rather than on the customer’s own hardware. The applications required are accessible from various client devices through either a thin client interface, such as a web browser (for example, web-based email), or a program interface.

Cloud services can also be deployed to users in a variety of ways, the most significant of which are summarized below:

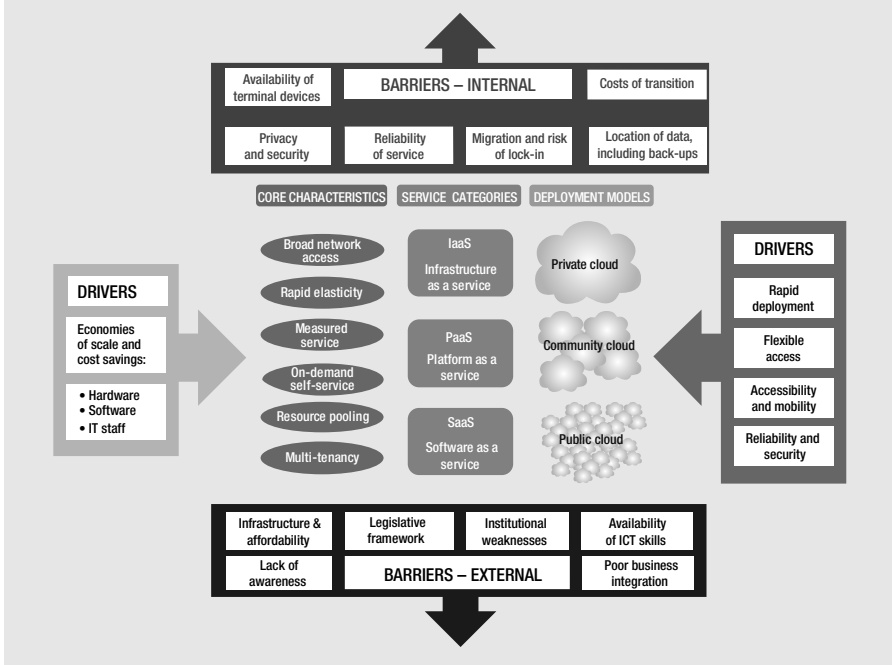
- **Public clouds:** open resources that offer services over a network that is open for public use. Many mass market services widely used by individuals, such as webmail, online storage and social media are public cloud services.
 - **Private clouds:** proprietary resources provided for a single organization (for example, a Government or large enterprise), managed and hosted internally or by a third-party.
 - **Community clouds:** resources/services provided for and shared between a limited range of clients/users, managed and hosted internally or by a third-party.
 - **Hybrid clouds:** a mix of the deployment models described above, for example, public and private cloud provision.
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Different cloud configurations offer both opportunities and risks for potential cloud service customers.

As a basis for the analysis, the *Information Economy Report 2013* uses the concept of the cloud economy ecosystem, which highlights the deployment and impacts of cloud computing and cloud services within the wider information economy and, thereby, their relevance to national economic development. The cloud economy ecosystem includes a complex set of relationships between technology and business, governance and innovation, production and consumption. It is how this ecosystem evolves, rather than the potential of the technology alone, that will determine the outcomes for developing countries.

As Governments, enterprises and other organizations in the developing world consider whether to migrate some or all of their data and activities to the cloud, they need to assess the potential advantages and risks of such a move (figure 2).

Figure 2. Drivers and barriers to cloud adoption



Source: UNCTAD.

Potential advantages include:

- Reduced costs for rented IT hardware and software compared to in-house equipment and IT management;
- Enhanced elasticity of storage/processing capacity as required by demand;
- Greater flexibility and mobility of access to data and services;
- Immediate and cost-free upgrading of software;
- Enhanced reliability/security of data management and services.

Potential risks or disadvantages include:

- Increased costs of communications (to telecommunication operators/Internet service providers (ISPs));
- Increased costs for migration and integration;
- Reduced control over data and applications;
- Data security and privacy concerns;
- Risk of services being inaccessible, for example, due to inadequate ICT or power infrastructure;
- Risk of lock-in (limited interoperability and data portability) with providers in uncompetitive cloud markets.

The cloud's potential to improve efficiency is a strong incentive for organizations in the private and public sectors to transfer activities to the cloud. At the same time, there are important trade-offs to be made, for example, between cost savings on the one hand and considerations related to data security and privacy on the other. Various cloud customers will assess the opportunities and risks associated with the cloud differently, therefore opting for different solutions. Some businesses, Governments and other organizations are better positioned to reap the benefits of a shift to the cloud, or can gain greater advantage than others because of the nature of their activities or business model. This is the case, for example, for those that have high fixed costs in maintaining in-house IT departments, recurrently need IT software and hardware, face large or unpredictable variations in demand for IT resources or can gain substantial added value from more efficient exploitation of data and market opportunities.

The cloud economy is expanding fast but is still small.

There are various estimates of the size of the market for cloud services. Fee-generated revenues from public provision of IaaS, PaaS and SaaS have been forecast to reach somewhere between \$43 billion and \$94 billion by 2015. To this can be added the revenue generated through advertising on cloud-enabled web applications that are available at no cost to the user. Such revenue is currently considerably larger than the fees generated from public cloud provision. Estimates of the value of private cloud services also vary greatly – from about \$5 billion to about \$50 billion. Discrepancies in projections reflect different methodologies, but most forecasts agree that cloud adoption will continue to expand rapidly over the next few years.

This is still very small compared with the revenue of the global ICT sector, which was estimated at about \$4 trillion in 2011. However, most segments of the ICT sector are in some way affected by cloud computing. The demand for bandwidth will drive telecommunication services revenue, although revenues from voice services could be affected as more people switch to cloud-based voice over Internet protocol applications. Demand for equipment and computer hardware, particularly data servers and network equipment, will rise as more services move to the cloud.

The shift to the cloud is generating considerable growth in data traffic. During an average minute in 2012, Google received two million search requests, Facebook users shared around 700,000 content items and Twitter sent out 100,000 tweets. In 2012, 60 per cent of such cloud traffic on the Internet emanated from Europe and North America. Asia–Pacific was responsible for another third while Latin America and the Middle East and Africa together accounted for only 5 per cent. However, the highest growth rates in the next few years are expected in the Middle East and Africa.

On the supply side, the cloud economy is currently dominated by a few very large cloud service providers, almost all headquartered in the United States. Their early entry into cloud computing gave them first-mover advantages, not least in terms of building large networks of users and massive data storage and processing capacity. The absolute levels of investment required for major cloud-computing estates are very high; it can cost more than half a billion dollars for a cluster of data centres.

While the cloud service provider market is likely to continue to be dominated by a small number of global IT businesses, some factors may favour national or regional players. Some Governments and enterprises are required (by law or corporate

policy) to locate their data within national jurisdictions, or prefer to do so for security or geopolitical reasons. Large corporations and Governments have hitherto shown a preference for private over public clouds, eschewing some cost saving to ensure a greater sense of security and control over their data and services. Recent international publicity concerning data surveillance may have reinforced such a preference.

Cloud adoption in developing countries has potential implications for both the supply and the user side of the cloud economy.

The most significant activities and potential supply opportunities for enterprises in developing countries are concerned with: (a) data-centre and related cloud provision; (b) the development and provision of local cloud services for groups of customers, including local businesses and individual citizens; (c) cloud aggregation, system integration, brokerage and related services. In addition to these explicitly cloud-based areas of activity, opportunities exist for national communications businesses (telecommunications operators and ISPs) which can gain from increased data traffic using their networks. Despite the advantages of global cloud service providers, there are some factors that offer scope for local or regional data centres to expand in developing countries, such as growing demand for private cloud solutions, national data-protection laws or corporate policies requiring data to be kept within national jurisdictions, and high costs of or unreliable international broadband connectivity.

There has been extensive adoption by individuals in developing countries of free cloud services such as webmail and online social networks. This is true in almost all countries, in particular those with higher levels of Internet use and cloud readiness. The most popular cloud-based applications are generally those provided at a global level. In low-income countries at a nascent stage of cloud readiness, IaaS is often the first category of cloud services to emerge. As the infrastructure situation improves and if the SME sector expands, the market for SaaS in developing countries will become more important and eventually dominant as it already is in developed countries.

Foreign affiliates in developing countries make extensive use of the cloud as part of their parent companies' global networks. With some wariness, Governments in developing countries are also moving towards the cloud. Some are developing systematic cloud strategies, as part of broader ICT strategies or sometimes alongside these. Where government departments and larger corporations are concerned,

there is so far a general preference for private over public cloud approaches. There is planned adoption of the cloud in domestic enterprises, although less extensive than anticipated by cloud advocates.

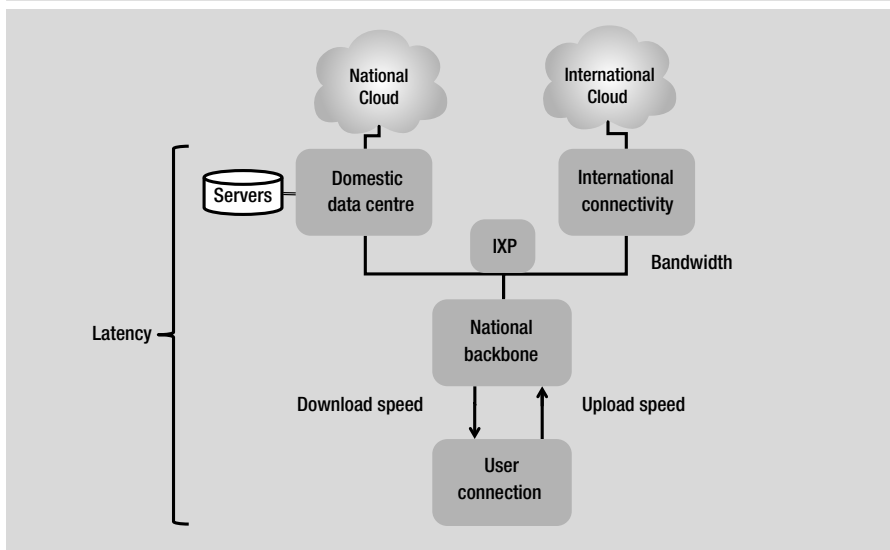
Experience of cloud computing in developing countries is too recent for there to be a strongly established evidence base on which to assess impacts. Businesses, Governments and other organizations should carefully examine the potential for cloud services to improve their management and service delivery. They should only migrate data and services to the cloud when they are confident that the cloud offers significant benefits and that attendant risks can be appropriately mitigated. Both public and private cloud solutions should be considered in this context, taking into account implications for data security and privacy.

Infrastructure deficiencies seriously hamper the uptake of and benefits from cloud computing in many developing countries.

For several reasons, the options for cloud adoption available in low- and middle-income countries look different from those in more advanced economies. Critical factors relate, among other things, to the availability and quality of cloud-related infrastructure, cost considerations and inadequate legal and regulatory frameworks to address data protection and privacy concerns.

As regards access to and availability of cloud-related infrastructure, and despite significant improvements in broadband connectivity in many developing economies, the gap between developed and developing countries keeps widening. Average fixed broadband penetration is now more than 28 subscriptions per 100 people in developed economies, 6 in developing countries and only 0.2 in the least developed countries (LDCs). In the case of mobile broadband, the gap is also significant. The average number of subscriptions in 2012 was about 67 per 100 people in developed countries, 14 in developing countries and below 2 in the LDCs.

In addition, in most low-income countries, mobile broadband networks are characterized by low speed and high latency and are therefore currently not ideal for cloud service provision, especially of the more advanced kinds. The net value of cloud-based solutions will be lower in countries with a heightened risk of communication- and power-network outages. The lack of supporting infrastructure, such as Internet exchange points (IXPs), reliable and inexpensive electricity and robust fibre-optic backbones (figure 3) also affect the deployment of national data centres. Indeed, as much as 85 per cent of data centres offering co-location

Figure 3. Getting to the cloud

Source: UNCTAD.

services are in developed economies. This “data centre divide” is reflected in the availability of servers; whereas there were in 2011 more than 1,000 secure data servers per million inhabitants in high-income economies, there was only one such server per million inhabitants in LDCs.

The cost of communication remains another critical obstacle for adoption of cloud services in many developing countries. The fees paid to cloud service providers and for broadband access and usage, charges by the ISP and the hardware and software costs incurred are likely to form a much higher proportion of the total costs of cloud provisioning than in advanced economies. The combination of few national data centres and high costs of international broadband communications further weighs on the net value of relying on cloud solutions.

The cloud raises legal and regulatory challenges, especially concerning data protection and privacy.

The rapid emergence of cloud computing has raised concerns about its legal and regulatory implications. Issues of data protection and security are among the concerns most frequently mentioned by potential cloud customers in both

developed and developing countries. Such concerns have intensified following the disclosure in 2013 of national surveillance programmes and reports on access by law-enforcement agencies to data hosted by global cloud service providers. Governments need to protect national interests and their citizens; service providers require a stable framework to facilitate innovation and investment; and users require assurance and trust to encourage the take-up of such services. Policy responses may range from a do-nothing attitude to the adoption of cloud-specific laws.

Public law is essential to secure the basic rights of end users. While there is no imperative to develop specific laws or regulations on cloud computing, areas requiring reform are relatively clear: privacy, data protection, information security and cybercrime. For Governments of developing countries, it is essential that appropriate laws and regulations are adopted and enforced in these areas. As of 2013, there were 99 countries with data-privacy laws. As far as is known, Mexico is the only country which has adopted cloud-specific provisions in relation to data protection. There is no international harmonized privacy framework regulating data transfers across borders, but developing countries could benefit from implementing strong domestic-privacy regimes.

In addition to public law, contractual agreements between cloud service providers and cloud service customers also greatly impact on the operation and effects of the cloud economy. In some circumstances, regulatory intervention in the freedom to contract may be necessary to protect the public interest. The placement of data in the cloud may require regulatory intervention to address concerns related to personal privacy, commercial secrecy or national security. For example, within data protection laws, imposing minimum responsibilities on the cloud service providers – to ensure the security of customer data and to notify its customers if there is a security breach – could help to provide greater transparency about vulnerabilities and to enable mitigation in a timely manner.

Where there are apprehensions on relying heavily on cloud services offered by providers based in a foreign jurisdiction, it may be difficult to address this market reality through regulatory intervention. An alternative policy response may be to encourage the establishment of domestic cloud services, either by offering foreign investors a favorable environment to invest in the building of local infrastructure (such as data centres) or encouraging domestic enterprises to enter the supply side of the cloud economy. Whereas such measures may involve regulatory components, such as imposing “localization” requirements, they would be designed to facilitate the provision of cloud services rather than to constrain them. Several Governments

of developing countries are building government clouds to serve the needs of the Government itself and sometimes others. In Europe, there have been calls for the development of a secure European cloud and some national cloud initiatives have been launched to offer an alternative source of cloud service provision.

Governments should facilitate benefits from the cloud economy but be aware of pitfalls.

Although cloud adoption is still at a nascent stage in developing countries, policymakers should waste no time in enhancing their understanding of how it may affect their economies and societies, in order to be able to make informed policy decisions. Government policies should be based on an assessment of the pros and cons of cloud solutions and be rooted in a thorough understanding of existing ICT and cloud use within countries. Governments need to recognize the diversity of business models and services within the cloud, the multiplicity of customers of cloud services, and the complexity of the cloud economy ecosystem. In view of its relevance for both public service delivery and business competitiveness, it is important to integrate any cloud strategy in the overall national development plan, and to plan for its execution, monitoring and evaluation. Policy approaches should be tailored to the circumstances of individual economies, and be consistent with the overall strategic framework for national economic development and for leveraging ICTs.

On the whole, Governments should broadly welcome and support the development of a cloud economy and the adoption of cloud services. In principle, there is no general case for government policy and regulation to discourage migration towards the cloud. Rather, policies and regulatory approaches should seek to create an enabling framework that supports firms and organizations that wish to migrate data and services to the cloud so that they may do so easily and safely. However, this does not mean that cloud-based solutions are always preferable to alternative approaches. In addition, there are multiple ways of making use of cloud technology – using public, private or hybrid clouds at national, regional or global levels. Governments should seek to facilitate those approaches that seem most likely to deliver wider economic benefits in their particular context.

A number of steps could be considered by Governments that wish to translate the potential of the cloud into tangible development gains. In terms of scope, at the national level policymaking would be advised to consider measures related to the following areas:

- **Assess the cloud readiness of the country.** Governments should start by carefully assessing the current situation in their countries, to identify bottlenecks and weaknesses that need to be addressed if the cloud is to be effectively exploited, and clarify what kind of cloud solutions are most propitious.
- **Develop a national cloud strategy.** Based on the readiness assessment, a national cloud strategy could be drafted either as a stand-alone policy document or as an integral part of the national ICT strategy.
- **Address the infrastructure challenge.** This would involve measures to improve the provision of reliable and affordable broadband infrastructure and to monitor regularly the quality of broadband services. Effective communications regulations are here of the essence. Attention should also be given to the role of IXPs and the provision of electricity.
- **Address relevant legal and regulatory issues related to cloud adoption to ensure that cloud-service users' interests are properly protected.** Key areas include the location of data, e-transactions and cybercrime. Efforts should be made to reflect international best practice in the development of new legislation.
- **Map opportunities in the supply side of the cloud economy.** Three key areas deserve particular attention: the development of national data centres, the potential for cloud aggregation services, and the development of new cloud services.
- **Address the need for human resources.** Skill areas that are likely to become increasingly important include those related to the IT and software skills needed to manage the migration and integration of cloud services; management and organizational skills to handle the reorganization and re-engineering of business processes; and legal and procurement skills.
- **Government use of cloud services.** Given their important role in the information economy in many developing countries, the role of Governments should be explored with regard to the establishment of national data centres, e-government systems and related public procurement.

Development partners should work with Governments in responding to the cloud economy.

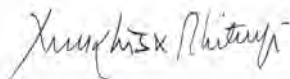
Addressing the many challenges that developing countries face in seeking to benefit from the evolving cloud economy will require both expertise in various fields and financial resources. Development partners could help in that respect,

by ensuring that cloud-related development challenges are incorporated in their agendas to reduce the risk that the move towards the cloud economy may result in a widening of the digital divide. They may also provide support at the country level in contributing to financing broadband infrastructure, establishing appropriate legal and regulatory frameworks, and building capacity in relevant areas.

International agencies could facilitate this assistance through some of their existing activities. UNCTAD and other international organizations can, for example, facilitate an exchange of experiences with regard to the policy challenges that developing countries face to derive benefits from the cloud economy and avoid pitfalls.

Another key area in which development partners can play a role concerns international standards for cloud services, which are essential to facilitate interoperability and to help customers understand what they are purchasing. Standardization forums should consider how to engage developing countries and their users to ensure that their specific needs and requirements are addressed. More research is also needed in a number of areas to allow for a more comprehensive assessment of the impact of different forms of cloud adoption. As the evidence base expands, it will become feasible to assess macroeconomic implications for economic growth, employment, productivity and trade.

As with other ICT areas, the pace of change in cloud technology and markets is rapid. The experiences described in this report relate to present circumstances. The nature of cloud services and of the cloud economy will continue to develop fast, and may be very different in five years' time. Governments, businesses and development partners need to bear these changes in mind, and to re-evaluate their policies and strategies concerning the cloud regularly to ensure that they continue to maximize potential benefits and minimize potential risks to their citizens, businesses and customers.



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