Unlocking the Benefits of Cloud Computing for Emerging Economies—A Policy Overview

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Executive Summary

The emergence of the Internet and the World Wide Web were technological triumphs. When this common architecture for digital information and communications became wedded to broadband networks, it melded previously distinct communications markets for data, voice and broadcast content. This also enabled a new generation of computer architectures embodied in the very large arrays of cheap data storage and processors that is popularly described as the "Cloud."

Cloud computing is scalable on-demand provision of remote computing and data storage. Its dramatic growth is captured in a 2011 study by Gartner Research, which predicted that by 2014 over 60% of the world's server workloads will take place on virtualized Cloud servers, up from 8% five years earlier. This growth emerges from the Cloud's economic advantages of scale and scope that lower costs, improve speed of service, expand operational flexibility for users and reduce risks in IT deployment. The Cloud also enables an eco-system of innovative information and communications technology (ICT) applications in low-and middle-income economies that can advance their economic growth and social goals.

This report addresses the movement towards a Cloud environment. The opening and closing essays examine the technological requisites for successful Cloud computing and then examine how the Cloud fits into global economic trends while highlighting key policy issues confronting utilization of the Cloud. Three additional essays document the Cloud's ample potential for helping India, Mexico and South Africa achieve their development goals and address the numerous challenges in achieving this potential.

The full benefits of the Cloud require three key technological capabilities: 1) broadband networks, 2) the unrestricted flow of information (including cross-border) between customer and service provider to meet customers' needs wherever they arise and with whatever data they need, and 3) the freedom to locate and operate (and scale) data centers on the basis of efficiency considerations. If these requisites are fulfilled, the country studies show that the Cloud has five implications for bolstering the well-being of lower-and middle-income countries:

1. The Cloud is central to being competitive in higher value-added products because both goods and services in the world economy are becoming more ICT intensive. The Cloud can allow emerging economics to tap the economic gains from the move to globalization of the design, production, distribution and support of goods and services over the last 30 years, and its growing ICT intensity.

2. Cloud ICT is vital to being competitive in South-South commerce, already the fastest growing share of world trade and investment and the future home to most of the world's middle class. The Cloud opens the way for lower and middle income countries to participate more fully in the world's switch to a "knowledge economy" as both consumers and creators of knowledge based products.

3. Cloud computing can greatly strengthen small and medium enterprises (SMEs), thereby stimulating job creation. The Cloud reduces the cost, the upfront investment and the operational complexities of using ICT to help build smaller businesses into larger ones. At the same time, both SMEs and individual users are relying on many "free" Cloud services that are in turn paid for by Cloud-enabled advertising, often delivered trans-border.

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4. The Cloud creates significant benefits for both individual users and governments. All three country studies demonstrate emerging changes in the capacity of government to deliver its core services more economically and effectively to the benefit of citizens.

5. The Cloud and the build-out of broadband infrastructures have strong synergies in developing economies. An effective Cloud infrastructure improves the economic case for creating broadband networks in lower income countries because Cloud services create new revenue opportunities for networks.

An additional implication of the country studies is the enormous benefit of experimentation and "learning by doing" in an environment driven by market competition and a national policy to invest in rapidly transforming digital capabilities. This approach will require the embedding of national experimentation and innovation in the context of global experimentation and innovation. Governments can play a positive role in reducing the uncertainty about the rules of road concerning questions about privacy, security and equity. But, just as the emergence of the Internet infrastructure and the sophisticated export sectors of developing economies benefited from more open markets, the Cloud will be most powerful where government rules restrain from detailed micro-management and encourage multi-stakeholder groups with sophisticated expertise to continuously refine detailed solutions.

Successful experiments and innovations already exist. For example, for years we have permitted personal financial information in the form of credit card systems (think Visa), link banks, merchants, support services (fraud detection services, for instance), and consumers in shared data systems running across national boundaries. We already utilize cross-border medical consultation (such as outsourced radiology readings) safely generating benefits in patient care, especially in areas with few medical resources. With proper care, and under minimal regulatory structure, transnational data need not be a sovereign risk.

A review of the studies of Mexico, India and South Africa highlight three clusters of policy issues.

1. *It takes a vision to achieve the potential of ICT for economic and societal goals.* Promoting a sound Cloud ecosystem should be considered an intrinsic part of a national ICT strategy that, at minimum, advances universal broadband build out, including all communities, urban and rural, makes human capital investments in digital skills and identifies how to use ICT to improve government services.

Building on the lessons from the advances made in promoting higher investment, lower prices and faster innovation since the introduction of competition in telecommunications and information service markets, sound decision-making processes are essential to making the markets work for the public interest. This suggests that *transparent rules and decision processes with multi-stakeholder participation are critical.* When possible, governments should rely on multi-stakeholder groups to craft many of the detailed policies necessary to maximize the benefits from the Cloud.

2. *It takes a global ICT network to achieve full national benefits*. A national approach to creating and using this ICT infrastructure foregoes much of its potential, and preventing the ability of global ICT infrastructures to provide local national services misses much of the Cloud's performance benefits. To do so, countries should embrace:

- *Free Flow of Information*: To achieve the full benefits of global interconnection governments should allow information to move freely and be stored globally.
- *Flexible placement of facilities*: Governments should not require that facilities or information be located in a specific country or region.
- *Open, competitive markets to encourage infrastructure development and services*: Encouragement of cross-border market access for investment in ICT (including broadband and Cloud facilities) and commerce (including trade in services) under transparent rules will be critical to achieving the potential of the Cloud and broadband.

3. *Reliance on the open, voluntary global system for Internet/Web standard setting to sort out questions of interoperability:* Standard setting organizations like the Internet Engineering Task Force and the World Wide Web Consortium successfully marry voluntary, commercially driven standard-setting with participation by all interested parties with the appropriate expertise.

   A national strategy for addressing legitimate policy concerns about the privacy of user information and security of information works best within a framework of global principles and policy approaches consistent with competitive markets and flexible implementation strategies that can cope with rapidly changing technology.

   - *Rejection of the premise of data sovereignty*: Some believe that government can only protect citizens' rights and national security if the data of its citizens remains exclusively within its borders. While issues of cross-border jurisdiction (what to do with Mexican data stored in Brazil) are perennial to many facets of international commerce and require resolution over time, their solution does not require locking data up within national borders.
   - *Global compatibility of privacy and data security rules*: National rules should be anchored in globally recognized principles (e.g., the APEC or OECD privacy guidelines) and should be crafted to assure commercial non-discrimination among providers of infrastructure and services. When possible, governments should offer mutual recognition of other countries' laws that achieve the same objective.
   - *Flexible location of data*: Data should be stored geographically depending on market and engineering considerations and governments should focus policy on functional goals for different types of data (e.g., personal medical data may have higher standards than merchant data and a transparent system for remedies in the case of violations of privacy protections.

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INTRODUCTORY ESSAY

The emergence of the Internet and the World Wide Web were technological triumphs of the late 20th Century. When this common architecture for digital information and communications became wedded to broadband fixed and mobile networks, it melded previously distinct communications markets for data, voice and broadcast content. This marriage also allows society to take full advantage of a new generation of computer architectures enabled by the very large arrays of cheap data storage and processors that are popularly described as the "Cloud." As the Cloud becomes fundamental to the world of information and communications technology (ICT), it will deliver major benefits for both low and high income countries. This report examines these benefits and the public policies needed to achieve them.

Cloud architectures permit users to decouple the main computing power and storage for applications from the capabilities of particular end users or even end user organizations. This both lowers the cost of information applications and allows them to operate ubiquitously, largely unconstrained by geography wherever broadband network capacity is available. (And, while reducing the potential power of applications, even narrowband networks can support some Cloud services.).

The Cloud's advantages for bringing ICT to low income countries are easy to grasp. There are both short and medium-term efficiencies with very large payoffs, as well as the possibility of medium and long-term expansion of local innovation capacity. Previously, for example, the purchase price of software was only a small component of the overall cost of ownership; the costs of hardware, upgrades, and supporting personnel often dwarfed the purchase price. Cloud computing shifts these costs to remote data centers which benefit from significant economies of scale and scope. It also allows significant flexibility in the choice of terminal device linking the user to information applications.[1] You don't need a PC to have data intensive applications in the middle of a farm field. This is why applications ranging from email to mobile enabled health care in developing nations are shifting to Cloud-based delivery. Doing so creates cost savings, improves speed of service, expands operational flexibility for users and reduces risks in information technology (IT) deployment. Beyond these operational efficiencies, the Cloud enables a new range of ICT service offerings supporting a new ecosystem of innovation of high-value applications in low-and middle-income economies that can advance economic growth and social goals.[2]

These Cloud benefits require the effective and efficient movement of Internet-based information between the customer and the Cloud service provider. This cannot occur without three key

[1] The form and mix of information processing, storage and gathering will continue to vary (including personal computers, tablets, smartphones, Internet enabled appliances and wireless sensor devices) as the "Internet of Things" emerges, but the Cloud will make the entire architecture dramatically more powerful, flexible, pervasive and less expensive.

[2] Many of these innovations will likely involve systems to better manage critical infrastructure and resources, such as water. (Chui, et al 2010) http://www.fastcompany.com/biomimicry/how-the-internet-of-things-is-turning-cities-into-organisms

technological capabilities. First, while some Cloud supported applications can be delivered on narrow band networks (such as simple, mobile enabled health applications), the biggest payoffs from the Cloud arise when high speed communications service (often called "Broadband") is available. Second, Cloud computing requires the unrestricted flow of information between customer and service provider. Third, Cloud data centers can only be fully effective if they achieve significant economies of scale and scope, and can respond dynamically to their customers' needs wherever they arise and with whatever data they need. This implies freedom to locate and operate data centers on the basis of efficiency considerations, and to scale data centers by handling cross-border data needs. And, as a surprising corollary, the deployment of an effective Cloud infrastructure improves the economic case for creating broadband networks in low-or middle-income countries by enabling the national broadband connection to provide global services almost the instant it is connected.

The report addresses the movement toward a Cloud environment. This essay defines the terms for our discussion, sets Cloud computing in the context of global economic trends, and highlights key policy issues. The next three essays illustrate the unfolding performance and potential of the Cloud in India, Mexico and South Africa in light of their national development goals. A concluding essay uses case studies to pinpoint issues about setting national goals for Cloud computing and broadband, anchoring this national ICT infrastructure into a global ICT infrastructure featuring flows of communication and information across borders and setting national policies to address issues of privacy and security of information in a manner compatible with tapping the advantages of the global ICT infrastructure.

1) The Dimensions and Economics of Cloud Computing

The US National Institute of Science and Technology, NIST, defines Cloud computing as "…a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."[3] Simply stated, the Cloud allows users to access computing resources on-demand and pay for only what they use.

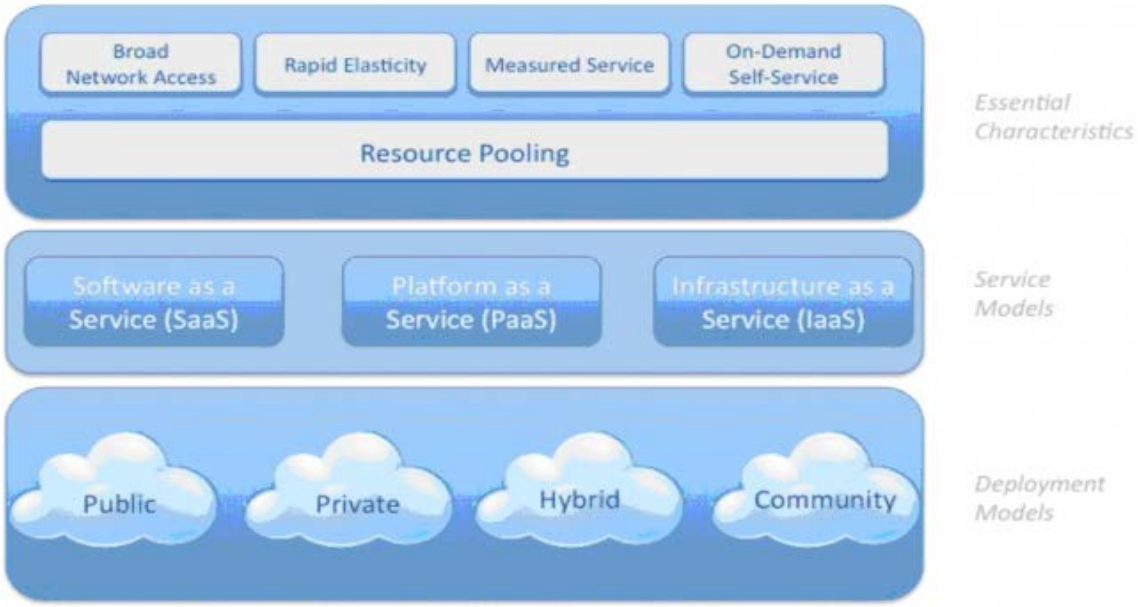
The key to the Cloud's architecture is the separation of suppliers and users and the dynamic allocation of ICT resources along with some form of metering for reporting and billing (NIST 2011). Given this architecture, the economics of the Cloud depend on the way it is deployed and the delivery model for its capabilities. (See Figure One).

The Cloud can be deployed in one of three configurations. It can be *the private capability of a single organization*, as in some global banks. It can be a *shared private resource of a consortium of users*, such as is found in parts of the utility industry. Or, it can be a public *commercial resource that is owned and managed by a private entity* and is available to any user on commercial terms. (Obviously, hybrid models are also possible) (NIST 2011). In theory, the largest economic savings derive from provision by a public commercial resource, which is not always feasible, thereby making hybrid strategies attractive (Centre for Economics and Business Research, 2010).

[3] In our view NIST has the best summary of the core elements of the Cloud. (Mell and Grance, 2011).

The other critical dimension of Cloud capabilities is the service model. *Software as a Service (SaaS)*, exemplified by Google Applications or Microsoft 360 email, is the most common service model used by end users. The user or user-organization does not manage or control the underlying infrastructure and does not create the basic application. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a dedicated program interface (e.g. Outlook). In contrast, with the *Platform as a Service (PaaS)* model, the end application is created by the user, leveraging the Cloud provider's offer, which includes software tools to help the user access the underlying hardware. Examples of software tools include programming languages, program libraries, services, and development and collaboration tools. In India, for instance, Naadhi's realized that they needed to move their project monitoring-and-reporting application to the Cloud to enable prospective customers to try it before they made a full commitment to the service. Finally, with *Infrastructure as a Service (IaaS)* the user can access machine and network resources dynamically and remotely and use them as needed. This is the lowest level of Cloud services. The user does not control the underlying infrastructure but controls what is loaded onto the infrastructure, such as operating systems and deployed applications.

Figure One: Alternative Deployment and Service Models for the Cloud



Source: NIST 2011

The scale of Cloud activity is becoming large and pervasive. In a study that is consistent with several analyses, Gartner Research (Anderson, et al, 2011) predicted the Cloud market will, by 2013, generate $150 Billion and by 2014 Gartner predicts that more than 60% of server workloads will take place on virtualized servers, up from 8% five years earlier. Table One summarizes its emerging engineering and economic characteristics.

Table One: The Engineering and Economic Characteristics of the Cloud Market

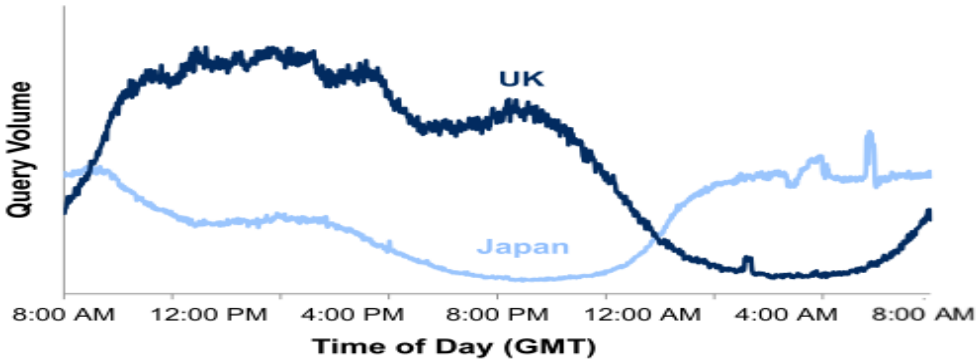
1. Dominated by a global "hub and spoke" network because of advantages for a. Economies of scale and scope b. Responding to characteristics of particular data management needs c. Peak load management
2. Growing diversification of facility locations and increasing array of competitive entrants both in large data centers and Cloud-enabled services a. Geographic distribution for response times, redundancy and peak load management b. Major ICT firms and specialized new entrants c. Growing role of firms from emerging economies

As our country studies illustrate, there is an emerging hub and spoke network for the Cloud. Smaller Cloud facilities may handle smaller, local service applications and particularly sensitive local data in national facilities, while data that are really large scale and inherently transnational is handled out of a network of regional hubs. Understanding the engineering and economic case for this arrangement is critical.

As a matter of engineering economics, the state of the art hub facilities work at major economies of scale and scope, and they will be located based on complex operational requirements (Armbrust, et al, 2010.) Put simply, the Cloud uses a lot of resources, space, power, cooling and machines. Apple's first major Cloud data center (its consumer product is called iCloud) is 500,000 square feet and is powered in part by 200 acres of solar panels. And that is only about a third of the size of the world's largest commercial data center, which is the @Tokyo Data Center in Tokyo that is large enough to have its own train station.

Moreover, the Cloud hubs need to work together to manage peak demand. Figure Two shows how AWS can reduce the total capacity necessary to handle peak demand by time shifting between its data centers in different time zones.

FIGURE TWO: How AWS makes the Cloud more cost effective by time shifting



Source: Microsoft – The Economics of the Cloud 2010

Moreover, the hubs are critical for data management that is both massive and inherently global in scope. Examples of large scale and inherently transnational data include the data operations of large global companies coordinating international operations or public sector problem-solving requiring the mixing of many national data streams, such as analyzing the vectors of infectious diseases or pollution patterns.

Much of the smaller scale work involved in Cloud services will be in spokes of local Cloud facilities. *But, even then, full effectiveness will require flexibility on the free and unrestricted movement and management of data across borders.* Tracking trucks and managing traffic, for example, often involves border crossings. The country studies in this study indicate that dynamic sharing among Cloud facilities to manage peak demand is already occurring even in government services.

Moreover, Cloud hosting is rapidly diffusing globally. The private Cloud infrastructures of governments and companies like Google, Ford and the major banks are already distributed around the world to improve service time and reliability. Massive data centers that are larger than Apple's also exist in Ireland, India and Wales; it is rumored that China is planning to build the largest in the world. Even smaller nations, such as Haiti, are studying the potential of Cloud hosting centers.

Unsurprisingly, as the global center for e-commerce, software and integrated hardware-service models (such as the iPod), the United States' major ICT firms (especially Microsoft, Google and Amazon) were the early leaders in Cloud infrastructure. However, the evolving Cloud infrastructure will not solely be controlled by giant ICT leaders. Many of the major Cloud centers are owned by new specialized companies that are carving out agile strategies as suppliers of all three Cloud service models. For example, the largest public data centers at the end of 2010 included Cloud offerings of Switch Communications, DuPont Fabros, Next Generation Data, Terremark, Quality Technology and Digital Reality. (Data Center knowledge, 2011) Also, many of the specialized services in the Cloud eco-system (such as video delivery) are provided by "middleware" companies (like Akamai), rather than traditional telecommunications carriers.

A hub-and-spoke system offers abundant opportunities for competitive entry for companies in emerging countries both as the owners of giant data centers and suppliers of many Cloud services. In India, HCL and E2E among others operate Cloud supporting data centers. In Mexico, both Amazon and Google are operating Cloud-serving centers, as well as a division of Telmex, the dominant telecommunications carrier. In South Africa Vodacom and Teraco operate several centers and a new firm, Pamoja, is beginning to offer what is planned to be a Pan-Africa Cloud service based out of South Africa, Kenya and other African nations. These Centers are continuing to grow; ABB (2011) estimates that 5.75 million servers are added annually. Thus, the economics of the Cloud allow new entrants in the industry and we expect strong regional players to do exactly that. However, the best returns come from Cloud networks that take full advantage of economies of scale and scope.

2) The Cloud and the Transformation of Emerging Economies

The Cloud is critical to the economic welfare of emerging economics because it is central to tapping the economic gains from the move to globalization of the design, production, distribution and support of goods and services over the last 30 years and its growing ICT intensity. If lower- and middle-income countries are to profit from the transition to the Cloud, they have to frame their policies in light of five implications of the Cloud for the world economy (summarized in Table Two).

Table Two: Five Implications of the Cloud for Emerging Economies

6. The Cloud is central to being competitive in higher value-added products because products in the world economy are becoming more ICT intensive. .
7. Cloud ICT is vital to being competitive in South-South commerce, which is already the fastest growing share of world trade and investment and the future home to most of the world's middle class.
8. Cloud computing can strengthen SMEs and employment in all economies.
9. The Cloud creates significant benefits for both individual users and governments.
10. The emergence of the Cloud and the build out of broadband infrastructures has strong synergies in developing economies.

1. *The Cloud is central to the next stage of the transformation of the world economy; a stage characterized by the growing share of ICT and services in its total value added.* Services now constitute 63% of global economic output and over 70% of this output in wealthier countries.[4] Traditionally, most services were local (the hospital, the beauty shop, or an accountant) and thus goods (manufactured and commodities) dominated global trade.[5] However, many services that were once local (such as medicine) are becoming, in part, cross-border in supply. In 2010, services constituted about 19% of all world trade and more than 30% of U.S. trade. Even this figure severely undercounted services as a share of the value added in trade. Software and information services play a growing role in manufactured goods. An automobile has a huge value added from software programming, for example. Moreover, the melding of ICT-enabled services with manufactured goods as a product offering is emerging as a central feature of a more information-intensive economy. In fact, manufacturing is the second largest user of Cloud computing (only surpassed by finance).

The growing scale and scope of ICT and services are central to the rapid evolution of sophisticated divisions of labor embodied in global supply chains. Economists call this the growth of a "trade in

[4] Based on 2011 GDP figures, the share of services in India, Mexico and South Africa are, respectively: 55.6%, 63.4%, and 65.9%. (CIA, 2011)

[5] Sweden is a model of an information and service intensive economy whose competitiveness in manufacturing depends on these inputs. As a smaller population, wealthy economy it has important lessons for the ultimate objectives of most lower income countries. National Board of Trade (2010)

tasks" (that also includes foreign investment) (Grossman and Rossi-Hansberg 2008). This growth has already created sophisticated national and regional sub-systems of production, distribution, professional services, and innovation tied to global networks. Countries wishing to thrive in this "trade in tasks" require state of the art ICT infrastructures. For example, Indian companies are busily converting traditional IT outsourcing systems into Cloud-based services with new offerings dubbed "business process as a service".

The growing dissemination of science-and technology-based innovation capabilities outside of the OECD countries will enable them to engage fully with the opportunities. China, India, Brazil, Mexico, and South Africa are, in total size of national R&D expenditures, numbers 2, 8, 11, 24, and 31, respectively (Battelle Institute, 2010.) When coupled with important milestones in realizing universal connectivity and computation access in all communities, but especially in universities and colleges at this stage of development, the era of reliance primarily on "me-too" products is ending in emerging economies is concluding.

2. The importance of South-South trade has grown dramatically, and it is becoming information-intensive. The expansion of trade, paired with investments in human capital, policies geared at macro-economic stability, and creation of appropriate social "safety nets," has allowed emerging markets to double their share of world exports (from 21 to 43%) from 1994 to 2008, while creating a sophisticated system of "South-South" trade and investment (Hanson 2012.) This shift has reduced the role of the United States as the hub of world commerce.

The growth in South-South commerce will be further propelled by the new middle class in less wealthy economies, which will make up more than 90% of the world's middle class by 2030. This sets the stage for new market demands and a further rapid shift in the demographics of income and wealth.[6] This opens the market for new designs from Southern countries attuned to these consumers' needs (Radjou, et al, 2012.) There is no reason, however, to think that these designs will be less information-and service-intensive than the mix for wealthier markets.

As South-South commerce rises, so does its sophistication. This means that successful emerging economies require global ICT and service infrastructures to support this commerce, just as the OECD nations have already demonstrated. The massive investments of India in international terrestrial and undersea fiber optic networks, which are among the largest in the world, are one sign of this realization. Just as significantly, Southern economies become more service-oriented in their trade and economic value-added as they become enmeshed in the world economy. The growth of bank, finance and business services is particularly ICT intensive.[7] Interviews for this study discovered that at least one major Indian ICT company is providing Cloud services to Africa from

[6] "The World Bank estimates that the global middle class is likely to grow from 430 million in 2000 to 1.15 billion in 2030. The bank defines the middle class as earners making between $10 and $20 a day -- adjusted for local prices -- which is roughly the range of average incomes between Brazil ($10) and Italy ($20)." This population in countries below OECD income levels is equal to 93% of the world middle class in 2030. (Quoted in Knowledge@Wharton 2008).

[7] In 2008 the World Bank estimated that China and Brazil grew business services at 15% annually from 1995 to 2005 while India grew these services at 25% per annum. (Reported in China MOFCOM web site on trade in services--http://tradeinservices.mofcom.gov.cn/en/f/2008-02-02/23536.shtml) CEBR (2010) provided details on ICT intensity of different services.

locations in India and Singapore. Similarly, Mexico and a number of Latin American countries are developing CLARA, an interconnected network of the major IT research and education centers in their countries in order to share data and optimize use of their computing capacity. (Casasus, 2008)

3. *Cloud computing will improve productivity and job creation, especially in small-and medium-sized (SME) enterprises, because it reduces barriers to new products and business models.* Studies of the EU by Etro (2009) and the CEBR (2010) identified key contributions of the Cloud. The Cloud lowers initial entry costs for new products and businesses (especially for SMEs), it permits faster expansion of the business while maintaining quality of services and it is cheaper to handle "peak demand" periods for ICT. Additionally, the Cloud increases productivity growth (a key contributor to wage improvement). Etro estimated that over a five year period in the mature – therefore, slower growing – EU market, the Cloud could boost cumulative GDP growth by 0.2% and create about one million new jobs, primarily through faster expansion of SME activity. Using a finer-grained analysis, CEBR estimated annual economic benefits in France, Germany, Italy, Spain, and the UK to reach more than 177 billion Euros annually by 2015 with about 445,000 net new jobs annually by that date. The share of benefits for each nation depends certain factors, such as the percentage of their economies involved in the most ICT intensive sectors (led by banking, finance, business services, followed by manufacturing, and then transport, communication, government, health and education services).[8] A similar analysis reported in our study on Mexico yielded equally strong results on stimulating SME growth and jobs.

To illustrate these dynamics, consider Amazon Web Services (AWS), a principal platform for numerous start-up firms that require Cloud services, ranging from simple web services to media streaming. In the past, these firms would have had to purchase servers, lease high speed network lines to their offices, have technology specialists to manage the servers and disk drives and constantly risk being under capacity if product realized rapid adoption as well as massive over investment. With Cloud services SMEs have no capital commitment and their Cloud resources grow dynamically. Detailed estimates for SMEs in India, for example, suggest a cost saving of at least one-third for IT capabilities. (Sharma, et al, 2010) This massive reduction in up front capital and operational execution risks mean that start-up firms and those facing significant growth have a much higher chance of survival and success. This translates to more start-ups, more jobs and more local innovation.

The cost and efficiency gains from the Cloud do not capture its long-term importance for innovation possibilities in emerging markets. The Cloud needs to be thought of as a two (or N-) way street. It is akin to the experience of the Apple and Android App stores. This is possible because the Cloud supports, and demands, the use of thin clients for product delivery which drives re-architecting many applications but perhaps more importantly opens up the market to a new class of developers, many of whom can emerge from developing countries with context specific knowledge that enables successful tailored solutions. The economics of the PC eco-system did not easily permit such inexpensive systems solutions for applications in specialized market niches. For example, in addition to lowering distribution costs, the Cloud creates a de facto global market overnight for service, content and program providers (the same way the App stores enable

[8] The most ICT intensive sectors spend up to 5.4% of total revenues on ICT. CEBR (2010), p. 22.

thousands of independent application developers to quickly reach millions of customers). These Cloud applications include many that might be thought of as social service applications, such as mobile health services. In support of such efforts Kenya is developing a network of data centers with hopes of becoming a regional Cloud hub.[9] As Cloud enabled service architectures blossom, many of the highly specialized engineering and skilled support services necessary for local innovation clusters can be supplied transnationally. This allows individual entrepreneurs with local expertise to innovate on a local, regional, and global scale.[10]

The Cloud also makes the value propositions and traditional winners tied to ICT subject to much easier disruption (Cowhey and Aronson, 2009). Apple's iTunes turned the profits in music into a commodity business while increasing margins on the hardware product and its "store", much to the surprise of the conventional wisdom of the day. Barriers to creating and distributing new applications (a form of software) decline while profits rise, bolstering companies innovating services for the new middle class of emerging markets.

4. *The Cloud provides significant benefits to non-business users, including consumers and governments.* The majority of the benefits from Cloud services are usually discussed in terms of business, but consumers benefit from the Cloud in a variety of ways, from convenience, to low cost (or free) services, to variety of on-line applications available. Of great significance, the Cloud enables the web advertising models that are critical to developing and providing the many information applications that are central to evolving global information markets. The size of this digital ad market is large and growing rapidly. Gartner estimates that revenue "derived from [Cloud-based] advertising services that is then used to deliver other IT services" was $36.5 billion in 2010, projected to grow to $77.1 billion in 2015. (Anderson, Ed, et al. 2011) These revenues are an important indicator of the value of advertising revenue for enabling 'free' Cloud delivered services such as data storage (Dropbox and Box.Net), photo sharing (Flickr), collaboration (any meeting) or email applications (Hotmail). Because of the business benefits of Cloud services a number of offerings can be made available for free (at the basic level) for consumers. Crucially, both the downloading of data and applications, and their uploading, can be done without the barrier of requiring personal computers or servers controlled by users.

As the case studies in this report document, Cloud computing is significantly reducing the cost and improving the reliability of traditional government services. Thus, it has direct benefits for governments as users of ICT to fulfill core functions. For example, the Cloud is essential to the design of Mexico's new "Angel Network", the largest social service system in Latin America. Even more interestingly, the Cloud enables new hybrids of social and commercial services that are often provided by business models, made possible by the Cloud infrastructure, that charge little or nothing. Students worldwide access the Khan Academy educational videos over Cloud-based YouTube (which Google hosts in multiple locations across the world, including Asia, Africa and

[9] The Cloud also enables changes because it reduces the cost of terminals connected to high bandwidth networks and provides networked intelligence capabilities critical to reliability and cost management of remote monitoring, management and billing systems and marketing and sales support.

[10] In its early stages it is impossible to predict the precise changes that will be induced by Cloud computing. On why the large transformational impacts of a "general purpose technology," such as electricity or cloud computing, plays out differently across countries and markets, see: David and Wright, 1999.

Oceana as well as the US and Europe). In Ethiopia and India, rural healthcare is delivered with the assistance of mobile-enabled applications hosted on Cloud servers in the US, and of equal import these applications and services are also being created in emerging markets. Many of these health services combine an element of traditional public health service (now delivered more ubiquitously at a lower cost). . For example, social enterprise models where "community knowledge workers" use a micro-finance model to provide supplementary follow-up for tiny fees. (Grameen Foundation, 2010)

5. *The emergence of the Cloud and the buildout of broadband has strong synergies in developing countries*. While many Cloud services are designed to cope with narrowband networks, especially mobile networks, they will achieve their full potential if broadband is available. Additionally, the deployment of Cloud infrastructure can actually accelerate the broadband buildout by increasing the value of such networks to the users and thus their adoption, improving the economic returns for network operators.

The buildout of broadband is uneven, but a largely foregone conclusion over time for wealthier countries. OECD reported in June of 2011 an average of 25% wired broadband take-up across its members, with a high of almost 40% in the Netherlands, and close to 48% for wireless broadband with Korea over 90%. These numbers are driven by significant growth rates year on year, ranging from under 5% in already well served nations to over 25% in newer markets.

The importance of broadband is now so broadly agreed upon that even the economic analysts of international financial institutions endorse its significance. For example, broadband service is now considered key to economic growth and development banks, such as the Inter-American Development Bank (2012) and World Bank, which have programs promoting broadband as does much of Africa (with South Africa targeting at least 80% broadband availability by 2020[11]). What is little understood is that the Cloud can accelerate the economic feasibility for expanding broadband build out because it radically saves costs for network providers (including last mile providers) in delivering a broader range of products/services to customers than they could on their own, thereby significantly expanding the ability of users in any location.

For example, there is a developing Cloud effort in Africa to ring the continent and bring services to the different markets; the Cloud could permit even small carriers to be offering a wide product range that can generate enough revenues to justify their investments in new network infrastructure. The new connections in East Africa were made possible because new submarine cables have reduced by over 50% the historic costs of connectivity[12], while bringing multi-terabit speed services to nations along their routes. Cable landing stations with hosting center space, terrestrial fiber and dedicated national data centers exist or are being built across the region, with South

[11]http://7thspace.com/headlines/414180/south_africa_indaba_wants_80_of_africans_having_broadband_by_2020.html

[12] The open access East Africa SEACOM system was the first to stimulate price drops, followed by new capacity and major new cables such as WACS on the West Coast. Collectively they increased total capacity from Africa to Europe by more than 10 times and created a competitive supply market for raw bandwidth and high quality IP services. http://mg.co.za/article/2012-01-06-broadband-price-drop-expected; http://www.bandwidthbar.co.za/articles/seacom.php

Africa and Kenya[13] creating hundreds of thousands of feet of space. But all of this connectivity in the nation assumes unfettered broadband access to the resources available all across the global Internet. No nation contains all of the on-line resources or services used by its citizens solely within their national borders. Interference with broadband connectivity would slow the growth of Cloud services adoption in affected nations and regions, effectively isolating them from the benefits of or markets created for them by the two-way nature of Cloud.

3) The Policy Implications

A global Cloud infrastructure raises significant issues that need to be addressed on a national and even corporate or individual level. To reiterate, the prerequisites for a Cloud infrastructure are:

These benefits of the Cloud require the effective and efficient movement of Internet based information flow between the customer and the Cloud services provider. This cannot occur without three key technological capabilities. First, while some Cloud supported applications can be delivered on narrow band networks (such as mobile health data bases), the biggest payoffs from the Cloud will arise when high speed communications service (often called "Broadband") is available. Second, Cloud Computing requires the unrestricted flow of information between customer and service provider. Third, Cloud data centers can only be effective if they achieve significant economies of scale and scope, and can respond dynamically to their customers' needs wherever they arise and whatever data they need. This implies freedom to locate and operate data centers on the basis of efficiency considerations, and to scale data centers by handling cross-border data needs. And, as a surprising corollary, the deployment of an effective Cloud infrastructure improves the economic case for creating broadband networks in lower or lower middle income countries.

For these conditions to emerge it will require prudent public policy that is supported by appropriate complementary action in civil society. A review of the country studies of Mexico, India and South Africa suggest that there are three critical issues for this nexus of government and civil society policy and action. Here, we preview the issues that our final essay explores in full.

4. *It takes a vision to achieve the potential of ICT for economic and societal goals.* In all three countries there is a clearly articulated vision, with varying degrees of success in execution, for the growth of national broadband systems. This includes complementary investments in human capital investment to create populations that can take full advantage of broadband at work and at home. But all three countries have only haltingly envisioned what it would take to take full advantage of the benefits of Cloud computing. Yet, if this essay is correct, Cloud computing is an essential complementary capability to broadband; indeed, there are synergies in the economics of their deployment.

5. *It takes a global ICT network to achieve full national benefits*. A national approach to creating and using this ICT infrastructure foregoes much of its potential. For example, South Africa's domestic broadband build out will go faster if integrated into cross-border broadband investments. And preventing the ability of global ICT infrastructures to provide local national

[13] http://www.kictanet.or.ke/?p=7995; http://allafrica.com/stories/201109141049.html; http://www.teraco.co.za/live/content.php?Item_ID=24

services misses much of the Cloud's performance benefits. Even in a country with a major Cloud infrastructure, the diversity of data, applications, and peak capacity needs will require relying on services from Cloud infrastructure in other countries.

6. *A national strategy for addressing legitimate policy concerns about the privacy of user information and security of information, which Cloud computing brings into sharp focus, works best within a framework of global principles and policy approaches consistent with competitive markets and flexible implementation strategies that can cope with rapidly changing technology*. Our experience with ICT is that allowing both specialization and diversity in problem solving is an important part of creating a dynamic technical ecosystem that can grow and adapt to market needs and social goals quickly. Detailed prescriptions from the top down, especially those imposing uniform technical practices, are counter-productive.

   There is an emerging international consensus that countries and civil society should adopt high level, compatible principles for strengthening both privacy and security (OECD, 2011; Aspen Institute, 2012). Indeed, as APEC (2005) recognized in its work of Privacy, effective national measures to advance privacy protection and information security in a world with a global ICT infrastructure requires compatible national policy approaches.[14] The details of national policies may be fine-tuned to individual national sensibilities but the approach of each nation should conform to the general principles.

   We have, for years, permitted personal financial information in the form of credit card and other financial transactions to transit numerous national jurisdictions and have done so without major harm to national interests. This example, and others, suggest with proper care and under minimal regulatory structure, transnational data need not be a sovereign risk.

The closing chapter of this report returns to these policy issues in greater depth in light of the case studies on India, Mexico, and South Africa.

[14] On implementation of the APEC framework see: http://ibmprivacy.com/2011/11/17/the-promise-of-the-apec-cross-border-privacy-rules/

India and the "Cloud"

Jessica Seddon

The Cloud is changing the playing field for several aspects of India's development aspirations. It is shaking up the IT and IT-enabled services industry, India's international "headline industry," by changing the market for services and the nature of competition. Existing IT giants are expanding offerings from their traditional bases of strength and finding their niche in the expanding global market.[15] New, smaller IT companies are seizing the opportunity to leverage low-cost common Cloud platforms to provide various services to an increasingly varied and generally growing worldwide market. The Cloud is also opening up new possibilities for achieving domestic development goals. Global pooling of IT infrastructure and the Cloud-enabled potential to access international pools of innovation has lowered IT costs for small business, NGOs and other new entrants in the socio-economic arena. It has also enabled new business models for companies seeking to bring health care, telecommunications, education, financial access, and other services to poorer and more remote areas. From worker payrolls to tax administration, private Clouds have begun to change the way that IT is developed and integrated to support public policy implementation.

India faces several hurdles, however, before these opportunities can be seized. It must improve its policies on data protection, including government access to data and clarifying its stance on cross-border data flows. Its privacy policies are weak by international standards and the country's recent history of blocking Cloud-based services has disregarded its own due process. India must also develop its domestic broadband infrastructure; just 6% of the country's 250 million households have access to broadband.[16]

Momentum for overcoming these challenges is building. Recent policy statements emphasize that the country will pay particular attention to improving data protection and other regulatory policies that foster the expansion of Cloud services in India, as well as strengthening domestic broadband access to Cloud services. Implementation, however, will be a test for the political and administrative system.

This paper reviews the declared intent of government, the gains that could come with successful implementation of policy and infrastructure development intentions, and the obstacles that will need to be tackled to realize the economic and social potential of the Cloud. It is cautiously optimistic: the obstacles are neither trivial nor terminal. There is broad-based industry demand for policies that help the IT sector compete, wider consumer demand for Cloud-enabled services and advances in wireless technology. These factors may make it easier (if still costly) to rapidly expand broadband services even if India's handicaps in building physical infrastructure persist.

[15] NASSCOM (2012) documents this pattern among existing IT companies.

[16] Data from TRAI (2012). Broadband defined as download speed of >256kbps.

The Policy Intent

The National Telecom Policy 2012 affirms promotion of the Cloud infrastructure when it states that India will take "new policy initiatives to ensure rapid expansion of new services and technologies at globally competitive prices by addressing the concerns of Cloud users and other stakeholders including specific steps that need to be taken for lowering the cost of service delivery." It advocates lowering barriers to Cloud development by "identifying areas where existing regulations may impose unnecessary burdens and to take consequential, remedial steps in line with the best international practices for propelling a nation to emerge as a global leader in the development and provision of Cloud services" (10.2 & 10.3). The (draft) National IT Policy (pending approval at the time of writing), envisions the Cloud playing a critical role in more than tripling India's IT/IT-Enabled Services (ITES) revenues by 2020. The draft policy also emphasized the "objective to gain significant global market share in emerging industries and services."[17]

The move to establish a legal and regulatory framework for data protection appears to be gathering momentum. NASSCOM, India's IT Industry Association, recently called on its members to "step up and take the lead in driving Cloud mainstream" and to "collaborate to proactively drive development of robust standards for security, data and risk management to alleviate customers' concerns." (NASSCOM, 2012, p.7) The recent appointment of a high-level committee on Cloud Computing, chaired by a leading industry figure, further signals intent to develop a more detailed policy framework that will "promote Cloud computing service in and from the country."[18]

As Cowhey and Kleeman note, achieving the full benefits of Cloud computing depend on deploying broadband access to the Cloud. Here, too, the Government has ambitious objectives. The Telecom Regulatory Authority of India's proposed[19] National Broadband Plan targeted 45 million subscribers by 2012 and intended to double that amount by 2014 (75 million and 160 million total including mobile broadband). The 2012 Telecom Policy envisions providing "Broadband on Demand" and discusses "working toward a Right to Broadband" (1.2). The specific targets are 175 million connections with a minimum download speed of 2 Mbps by 2017 and 600 million by 2020.[20] The policy also proposes enabling high speed and high quality broadband for all village

[17] Information based press reports about the draft policy, such as S. Ronendra Singh, "Ministry Seeks Cabinet Nod for National IT Policy," *Business Line*. May 9, 2012. Available at: http://www.thehindubusinessline.com/industry-and-economy/info-tech/article3401261.ece, accessed July 24, 2102. The Minister of Communications had told participants at the Confederation of Indian Industry Cloud Summit 2012 that the policy would be tabled before the Cabinet in mid-July, but it had not been approved as of the time of writing in end July 2012.

[18] Gulshan Rai, Indian Computer Emergency Response Team and a member of the Committee. Quoted in Press Trust of India (2012). "Infosys's Gopalakrishnan to head govt's cloud computing panel," *The Hindu* July 8, 2012.

[19] The National Broadband Plan was circulated for discussion in 2009, for execution by 2013. It was reportedly cleared by the Department of Telecoms in April 2011, and expected to be cleared by the Cabinet in August 2011, but appears to still be under consideration.

[20] Available at http://www.dot.gov.in/ntp/NTP-06.06.2012-final.pdf.
The proposed minimum download speed is 2 mbps by 2015 and 100 mbps on demand.

panchayats (village government offices) by 2014 and expanding from this core to make connections available to all villages and habitations[21] by 2020.

Public discussion also emphasizes practical applications. In particular, India's policymakers see the Cloud as the next big solution for service provision and public management. "Cloud computing will significantly speed up the ability to design and roll out services, enable social networking and participative governance and m-Commerce at scale [sic], which were not possible through traditional technology solutions," notes India's recently published National Telecoms Policy (June, 2012) (NTP, para 8). Kris Gopalakrishnan, Chairman of the Cloud Computing Panel notes that, "Cloud computing is the way forward to bring affordable services in areas like healthcare, education, e-governance and banking to masses."[22]

Finally, the government has also slowly strengthened historically weak data and privacy protection in an initial response to the policy questions involving privacy and security that are essential to get right for Cloud deployment. Data privacy is still relatively limited; there is no data protection regulator and the existing privacy rules apply only to the private sector and do not follow international practices, such as the EU Data Protection Directive or the APEC Privacy Framework. However, the Gopalakrishnan Committee is expected to look closely at further strengthening of data protection.

In light of this positive policy context, it is not surprising that many observers project that Cloud computing in India is about to take off. Zinnov (2011) estimates that over 8% of IT expenditure will be on Cloud-based services by 2015, more than quadruple the 2011 proportion.[23] The report estimates that the Indian Cloud market will be worth $4.5 billion by 2015, of which the private Cloud market would account for $3.5 billion. NASSCOM - Deloitte (2012) foresees an Indian market of $15 to 18 billion by 2020. The number of Cloud deployments submitted for the 2012 PCQuest Best IT Implementation Awards doubled from previous years.[24]

In addition to the expansion of the big multinationals (such as Microsoft and Google) in India, a dense ecosystem of Indian players in the Cloud is emerging, with some building on existing IT strengths. A recent report from the Indian IT/ITES industry association identified "Business Process as a Service," or BPOs run on a Cloud infrastructure as an important niche, for example. However, Domestic IT and communications giants Tata Consulting Services, Infosys, Wipro, Reliance Infocomm, Airtel, Netmagic and others are entering international markets for mainstream Cloud services, often in partnership with international providers. Smaller startups, such as Wolf Frameworks (Mumbai) and Orangescape (Chennai), have a growing presence as platform providers enabling small businesses and NGOs to develop and test niche software. MAIA Intelligence, for

[21] Clusters of homes smaller than villages.
[22] Quoted in Press Trust of India (2012). "Infosys's Gopalakrishnan to head govt's cloud computing panel," The Hindu July 8, 2012.
[23] In spite of the breathless hype, not every company seems to be sold. Zinnov (2011) reported that 42% of the "150 Top Cloud Computing Companies" were not focusing on India.
[24] Most of these were for private cloud deployments rather than the more often discussed SaaS or IaaS, indicating that companies may still be most comfortable keeping their data on their own servers.

example, paid close attention to local market features and took off after it secured the unique ability to integrate with Tally, a ubiquitous Indian accounting package.[25]

More so than the next Indian export phenomenon, the Cloud could be an important infrastructure for solving some of India's deeper challenges. Nearly all assessments of India's development prospects for the next decade agree that the country will have to tackle three deeper structural factors: education, infrastructure and the distribution of economic opportunity. The Cloud's combination of scalability, flexibility and pay-for (even small)-use could contribute significantly to India's ability to successfully tackle several aspects of these key challenges.

1. Cloud-based software, platforms and infrastructure services could significantly lower the cost of providing high quality secondary, vocational and higher education by enabling the country to access global stores of content as well as create and disseminate indigenously-developed material. Rapid improvements in education will be essential if India is to reap its much-touted "demographic dividend."
2. The Cloud could enable governance and public management reforms required to deliver growth and inclusion-enabling infrastructure and services.
3. The Cloud could create new opportunities for entrepreneurs and small businesses as well as those located outside of the current centres of economic growth.

However, the ultimate contribution of the Cloud will depend heavily on India's ability to overcome several policy and implementation challenges, particularly on the extension of access to broadband. While physical infrastructure is the immediate bottleneck to leveraging the Cloud, India must also develop clearer policies on data protection, privacy, liability for data loss and other regulations that would help set the stage for private investment in and use of Cloud services. These variables shape the alternative scenarios for the Cloud that conclude this essay.

2. Exploiting Cloud Economics For National Development Goals.

Educating the "Demographic Dividend"

More than half of India's population is currently younger than 25, and 13% are younger than 6 years old. A million people will enter the labor force every month for the next 20 years, many of without sufficient training for current jobs much less the jobs of the future.[26] India would need a million more teachers to meet the teacher-pupil ratio specified in the Right to Education Act, and as many as 600,000 of the current teachers in the public school system are untrained.[27]

Numerous policy initiatives have sought to overcome these gaps by developing more digital content and establishing the infrastructure to deliver this to rural educational institutions.

[25] Integration with legacy systems is one of the biggest perceived obstacles to Cloud adoption in India, according to Zinnov research cited in NASSCOM (2012).
[26] The current higher education capacity is a fifth of what it will need to be by 2030, and many of the areas with the fastest growing labour forces are the least well served by the current system. (Teamlease (2009, 2012). India Labour Report, various years.) As many as half of the faculty positions in State Universities in some poorer states are vacant. (Government of India, Planning Commission. Approach Paper to the Twelfth Plan.) Poor facilities and a severe shortage of teachers constrain primary and secondary education.
[27] Government of India, Planning Commission. *Approach Paper to the Twelfth Plan.*

The government's National Mission on Education through ICT began in January 2009 with a three-year budget of just under US$1 billion to "provide high quality personalized and interactive knowledge modules over the internet/intranet for all the learners in Higher Education Institutions in anytime, anywhere mode."[28] This is likely to be expanded in the next Five Year Plan. The National Knowledge Network (www.nkn.in) was launched in 2010 with a ten-year budget of about US$1.3 billion to establish a high-speed data network between all higher education institutions in the country and to develop applications in development-relevant subjects, such as agriculture, education, health, e-governance and grid computing.[29]

More recently, the Minister of Human Resource Development, Kapil Sibal, Advisor to the Prime Minister Sam Pitroda, and the Prime Minister himself have been advocating for "meta-universities," or consortia of universities (potentially including both Indian and non-Indian providers) coming together to develop joint virtual degrees.[30] Course materials that would be accessible throughout the country via data centres set up as part of the plans to build a national optical fibre network. The University Grants Commission's recent decision to allow government universities to collaborate in course offerings with foreign universities may also signal a growing appetite for international content.

Educational institutions have also turned to the Cloud to lower costs. The All-India Council on Technical Education (AICTE) became Microsoft's largest Cloud customer in April 2012, with a contract to deploy Live@edu for more than 10,000 technical colleges (7.5 million students) throughout India.[31] AICTE plans to roll out other Cloud-based collaboration and productivity software (Office 365, Sharepoint, etc) over the year as part of its efforts to support inter-institutional collaboration and monitor quality of education in the institutes it oversees. Individual institutions have also turned to the Cloud to reduce costs of existing IT infrastructure, to support global and regional collaboration and to provide facilities for advanced, computationally intensive research. For example, IIT-Delhi moved most of its facilities to a private Cloud in 2011 and other institutions are expected to follow suit. Development platforms, such as Zoho, are an increasingly common part of classroom projects.

Accelerating Infrastructure and Service Improvements

[28] Letter D.O. No. F 16/3-2009-DL, dated January 9, 2009, from Shri N.K. Sinha, Joint Secretary, Ministry of Human Resource Development to faculty of various higher education institutions. Available online at http://www.ignouonline.ac.in/sakshatproposal/default.aspx

[29] It appears to be running behind schedule – the initial goal was to connect 1500 institutions within 2-3 years of launch, but just 681 institutions had been connected to the NKN as of March 2012. As announced on the website of the Government of India, Ministry of Communications and IT. http://mit.gov.in/content/national-knowledge-network, accessed June 20, 2012.

[30] PM's Speech at the National Innovation Council, November 15, 2011

[31] http://www.microsoft.com/en-us/news/press/2012/apr12/04-12AICTEPR.aspx

There are many contributors to India's notoriously poor infrastructure, but most analysts concur on the obstacles that divided authority among numerous agencies, limited information sharing, and rudimentary public planning and expenditure management systems create for infrastructure and service development. Urban transport planning, for example, can involve as many as 14 agencies across three levels of government that may or may not communicate.

Cloud-enabled and Cloud-like management of resources for e-governance hold enormous potential for helping the State become more effective in delivering goods and services. The Cloud is not a cure-all but it could lower the cost of coordination and information flow across Ministries and levels of government and open doors for small public management initiatives to scale for national impact.

Most estimates of the size of the government market for Cloud services in India are driven by the assumption that the State will seize this opportunity to support inter-agency collaboration, but cost-cutting and management of variable demand will likely be the key immediate drivers. Virtualization of servers, for example, has reduced the cost of running the Unique Identification numbers database (which will eventually cover over 1.2 billion people) that will be critical for managing the distribution systems for subsidies, worker payments, financial services and other public and private programs. Taking advantage of its reliability to vary scale on demand, India is using the Cloud to maintain service quality for e-governance applications that have significant seasonal variance. The Tamil Nadu government, for example, recently moved much of its data to a private Cloud to cope with short-term spikes in transactions, such as requests for registration in employment databases, requests for education certificates and tax payments.[32] The same provider (C-DAC) has also supported Cloud deployment of applications for the Governments of Kerala and Chattisgarh.

The Technology Advisory Group on Unique Projects' (TAGUP) recommends setting up National Information Utilities that operate as private Cloud infrastructure providers for government: government users would work with a team in the NIU to identify service and business requirements, while the back-end architecture, implementation and maintenance would take place within the NIU. Besides being less expensive and quicker to deploy for new solutions, a key feature of the Cloud is accessibility to advance IT for citizens and officials with low-end, low-processing power devices which is central to this design (Chapter 6). Thirty-one states have State Data Centres, a first step toward creating common IT services for various departments. (NASSCOM, 2012)[33]

Finally, the array of software, platforms, and infrastructure available to the general public has allowed individual policymakers and rural local governments with nearly non-existent discretionary budgets to work with communications and information management systems that would normally be out of their reach. A national member of parliament known for his responsiveness to events in his remote constituency coordinates a team of 15-18 people in Delhi,

[32] The press reports on the Cloud services for the Tamil Nadu government do not specify the service mode being employed.

[33] This is just a first step, however. Departments tend to cling to their data and powers to manage it and some of these data centres operate more like traditional hosting centres or even as backup facilities.

the state capital and his rural district using Blackberries and other smartphones, MS exchange server on the Cloud and Google Apps. The office runs like a business, without the start-up costs of buying and maintaining a server or developing collaboration software. Village leaders in Kutch, a remote and poor area of Gujarat, use Facebook and Skype to create collaborative documents, track meetings and consultations with their constituents and document village developments. A regional NGO has also developed courses on local government budgeting and financial management that are taught in part through Skype.[34]

De-concentrating Economic Opportunity

India's formal economy has historically been dominated by a small subset of very large firms with access to capital, government relations skills and other essential inputs. India has a "missing middle" in manufacturing employment meaning most jobs are in very small or very large enterprises with little evidence that the small businesses grow to be medium and/or large.[35] Economic activity, particularly non-agricultural activity, is also geographically concentrated. The 53 cities with populations of more than one million account for an estimated 32% of 2005-6 GDP; the 100 largest cities for 43%. (IIHS, 2011) Expansion of Cloud services could help de-concentrate economic opportunity in several important ways: by improving prospects for small-medium enterprises, supporting new business models, and expanding services tailored to rural areas.

The Cloud could contribute to leveling the playing field and improving the prospects for rural non-farm businesses in a number for ways. It is already difficult to find a small business or NGO that does not use some form of Cloud-enabled low cost or free software to lower IT costs. Sharma et al (2010)'s survey of thirty SMEs in India found that even companies that had already invested in onsite ERPs were considering migrating to the Cloud. They estimated that most companies could reduce their per-user costs by at least a third by moving to commercially available services. Cloud deployments were the third most common project type submitted by small enterprises (less than 1000 employees) for the 2012 PCQuest Best IT Implementation Projects, an increase from previous years.

Cloud architecture also removes one of the stumbling blocks for small businesses seeking to scale rapidly by reducing the need to reconfigure customer and transaction management as business grows. Viva Infomedia, for example, ran its direct marketing and market research business on a single server when it started, but switched to a Cloud solution as its business grew and its original architecture was unable to handle the weekend peaks in SMS volume. It has since scaled from processing 2 million SMS's per month in 2009 to 200 million SMS's per month today.[36]

The Cloud is a key part of emerging business models to improve health care, access to finance, education (see above), business and market information, and other services to support businesses and workforce in rural areas. The combination of a cheap front-end device connected to significant data and storage and analytic capacity in a centralized back-end has opened new business models in microfinance, veterinary care, weather monitoring and information

[34] The initiative is described at http://setupanchayat.wordpress.com.
[35] Mazumdar (2003); Hasan and Jandoc (2012)
[36] Srikanth RP (2011). "Viva Infomedia leverages the Cloud for managing rising volumes," *Informationweek,* November 24, 2011.

dissemination, retail, and population-level health monitoring and diagnostics, among other businesses. Tata Consultancy Services and State Bank of India have collaborated to offer TCS's core banking solution as a service to Regional Rural Banks, enabling the network to meet aggressive national financial inclusion goals. BPOs have also been able to move into lower-wage rural areas as the Cloud enables workload balancing between smaller centres. Early movers, such as Rural Shores and Desi Crew, have been considered "social enterprises" for providing employment in more remote areas, but land and labor economics are on their side.[37]

Cloud-based networking could also be part of a shift in market structure that has the potential to shift more control and profits to farmers rather than traders. Some of India's commodity markets are effectively controlled by a few key traders or intermediary companies. These individuals make the market, while the larger numbers of small farmers without access to storage, processing or information about supply and potential evolution of prices sell at whatever price they can obtain. Sangli District (Maharashtra) turmeric farmers' January 22, 2012 market boycott suggests that this equilibrium could change. Thousands of farmers coordinated the protest over Facebook forcing a doubling in the price they received for turmeric.[38]

As Cowhey and Kleeman argued, the Cloud's full potential to create new economic opportunities depends on the extent of broadband penetration, but the ever-expanding array of services available through the Cloud also increases the strength of the economic case for extending broadband access to rural areas. India's draft National Broadband Plan cites a World Bank estimate that a 10% increase in broadband penetration increases a developing country's GDP by 1.38%, with much of this effect coming from the impact of information and software services available through broadband. ICRIER's (2012) study of the growth dividends from Internet access and mobile phones argues that mobile phones have had higher growth impact in India than the internet -a 1.5 percentage point impact of 10% increase in penetration vs. 1.08 for the same increase in internet - in part because so many services have been made available over even lower-end phones.[39]

3. Broadband Access and Cloud Regulation: The Hurdles

India faces two primary hurdles in reaping the benefits of the Cloud: expanding broadband access and clarifying policies around data privacy, ownership, and liability for service failures. The first is complicated by the sheer scale of infrastructure expansion required and the institutional context of a large public sector incumbent plus divided authority between the regulator and the Ministry. India has also failed to establish a clear spectrum management policy, much less one that encourages investment in broadband-capable networks. The second hurdle seems closer to being overcome. There are no obvious political obstacles to establishing data protection policies, though enforcement may be a challenge. The Indian government's apparently increasing interest in

[37] Infrastructure is not yet on their side. Rural Shores had to subscribe to internet service from multiple providers in order to ensure a reasonably consistent connection. Mukherji (2012)

[38] http://articles.economictimes.indiatimes.com/2012-02-10/news/31046360_1_turmeric-farmers-social-media-sangli-district

[39] While the study estimate the overall growth using state level data on economic growth, internet and mobile phone access, it also looks at case studies on impacts of internet and mobile phone based applications in a number of sectors to "trace the pathways that translate into growth at the macro level."

controlling data flows, however, is more worrisome for global Cloud service providers (including those historically based in India) seeking to leverage facilities, applications, and data exchanges outside India to serve Indian customers.

Access to the Cloud: Broadband in India

Just as lack of access to broadband handicapped "utility computing" in the 1990s (Carr, 2009), India's infrastructure deficiencies could now hobble the growth and social impact of Cloud services. The vast majority of Indians do not have access to broadband or even mobile data services today and the prospects for expanding reliable broadband access remain murky. The government's ambitious broadband expansion targets have fueled substantial enthusiasm about India's "digital future," but it is not clear how these goals will be met.

The fixed line network would have to be upgraded dramatically to deliver 75 million household connections by 2014. TRAI (2010) estimates that there are 40 million copper loops in the country, but Marcus and Jain (2012) report "conservative industry estimates" that half of these are not sufficient to support broadband. The CATV network, which has 80 million subscribers according to TRAI (2010), could offer an alternative infrastructure for broadband connections, but only if the regulatory environment becomes more stable and the industry consolidates and upgrades technology. Most of the connections are still analogue. [40]

The NTP and the draft National Broadband Plan envision filling the gaps through public investment in an optical fiber network financed by the Universal Services Obligation Fund. It leaves implementation, however, to a public sector incumbent that not only has a mixed record of infrastructure expansion but would also potentially be in charge of deciding the funding, work plan and time-frame for the fibre network it would implement and then use as an internet service provider.[41]

Mobile broadband could be the key to rapid expansion of data service. Existing mobile technologies are able to exceed the 2 Mbps target in the 2012 Telecom Policy, but their deployment will depend on improving spectrum management and licensing as well as creating a business environment that allows operators to offer data services at the lowest possible cost. A major corruption scandal involving allocation of 2G spectrum has had a ripple effect on regulatory uncertainty. The Supreme Court revoked many of the licenses allocated around the time of the scandal, including some that appeared to conform to then-prevalent policy norms. Its orders on norms for allocation of spectrum and other resources also created strong incentives for caution bordering on paralysis in the allocation of 3G licenses. Government waffling on terms of use for

[40] There may be as many as 140 million subscribers according to industry sources (Marcus and Jain, 2012)

[41] While BSNL could potentially work quickly since it would not have to coordinate with any other players, would probably have an easier time than private or state entities in getting right of way, and already has a large core and access infrastructure, the arrangement creates significant incentive problems. BSNL would be an internet service provider, implementing agency for the creation of the fiber network, and, according to the draft NBP, a member of the High-Level Committee deciding the funding requirement, work plan, and time-frame for creating the network.TRAI publicly and vehemently disagreed with the DoT's suggestion to make BSNL the lead implementing agency for the NBP. See TRAI (2011), Annexure D and E. The TRAI suggestion would create a new authority with unclear ability to coordinate with BSNL, RailTel, and other stakeholders in the network.

existing 3G licenses did not help. Although domestic giants Airtel and Reliance Infocom are continuing with their plans to roll out 4G networks using spectrum they currently own[42], some international telecoms providers reportedly are scaling back their investment plans for combined voice and data services. Resolution of the uncertainty about spectrum policy and pricing will be an important factor in unleashing the powerful combination of mobile broadband access and Cloud services for the benefit of consumer, business, and government users in India.

There were just fewer than 14 million fixed broadband subscriptions as of March 2012, a penetration rate of 5.6% of households.[43] Most of these are concentrated in urban areas: as of 2010, 60% of the country's fixed line broadband subscriptions were in the ten largest cities and just 5% of the connections were in rural areas. (TRAI, 2010) The report notes that internet services with slower connections are more evenly distributed, but does not elaborate.

The growth rate of new fixed-line broadband subscriptions appears to have slowed over the past few years to just a 25% increase between 2010 and 2012. The ITU estimates that just 7.5% of India's population used the Internet as of 2010.[44] This is more than fourteen times the Internet-using proportion of the population in 2000 (then 0.53%), but the growth rate is relatively low in international comparison: 160th fastest out of the 220 countries that ITU has tracked over the decade. India ended the decade ranked 162 out of 220 countries in terms of Internet use.

Mobile phone access is more widely distributed. India had 919.7 million mobile subscriptions as of March 2012, of which 74% were active (TRAI, 2012). It is not clear how many individual subscribers this represents, since richer and more urbanized areas such as Delhi, Himachal Pradesh, Tamil Nadu, Punjab and Kerala had teledensity of more than 100%. It is also not clear how many of these mobile users have data plans or what their level of service is. Just 1% of the population had mobile broadband subscriptions in 2010 according to BSA (2011). Still, the growth prospects are significant, particularly if the broadband backbone develops and mobile becomes the predominant option for last-mile connectivity.

Privacy and Data Protection

India has the infrastructure to be a major global player in Cloud services. As of 2005 (the latest data available), it had 20,000 Mbps of international bandwidth, ranking 8 of 167 countries for which data were available.[45] Much of this capacity has been built over the last decade; the country had just 267 Mbps in 1999 and ranked 26th at that time. The industry is substantially internationally

[42] Airtel holds 4G spectrum in 8 markets invidually and through its partnership with Qualcomm and has already rolled out 4G services in Bangalore and Kolkata; Reliance holds 4G spectrum in all 22 of India's markets, though does not have the voice network and tower infrastructure to go with it.
[43] Broadband is defined as download speed of at least 256 kbps in these data. The new National Telecom Policy revises this definition to at least 512 kbps and 2 mbps by 2015. Data on fixed broadband subscriptions (13.79 million) from the Telecom Regulatory Authority of India (TRAI); Number of households (247 million) from the Census of India, 2012. If one assumes that most or all of these are urban connections, there would be 17.5 subscriptions per 100 urban households.
[44] Data reported by ITU rely on alternating reports from the Department of Telecoms and ITU estimates.
[45] World Development Indicators, as reported on nationmaster.com

oriented: IT accounted for more than one-fifth of the country's total exports during 2011-12, with IT services and BPO accounting for most of these revenues.[46]

India's weak data security policies are, however, a significant competitive disadvantage. Cloud services often provide greater security for data than traditional services or in-house databanks, but many users still balk at the perceived loss of control of their data. Nearly one quarter of respondents in a recent survey of firms considering shifting to Cloud services rated "data security" as the largest barrier to adoption, and over 10% listed "loss of control" as the largest barrier.[47] These potential customers are likely to look for strong legal regimes to reinforce providers' commercial incentives to provide secure services and provide some kind of framework for compensation in case of a data breach.

The Business Software Alliance (2012) India Country Report gives India a middle grade on data privacy. The Information Technology Act Amendment of 2008 makes it illegal for individuals to disclose sensitive personal information that they may be handling without the consent of the individual, even if the action is not in breach of contract. The Information Technology (*Reasonable Security Practices and Procedures and Sensitive Personal Data or Information-2011)* Rules require organizations collecting private data to give notice to people from whom they are collecting data, to disclose their privacy policy and to offer a dispute resolution process. However, it allows companies to define their own security standards, "commensurate with the information assets being protected with the nature of business" and considers reasonable protection to have been given if the company follows its documented processes. It suggests IS/ISO/IEC 27001 as one such reasonable standard but does not require it..[48]

Policymakers clearly recognize the problem: the National Telecom Policy 2012 raised concerns that its pro-Cloud position was undercut by the vague policy regime about data protection, privacy and liability for loss for existing users and providers. Also, the Gopalakrishnan Committee has a mandate to address privacy concerns. IT firms are also pressing for change. NASSCOM has called on its members to "work with government to develop policies for security, privacy, sensitive data management, audit requirements, legal guidelines, etc. to allay client fears. It should provide agency support for policy enforcement, certifications, international lobbying, etc." (12) Mumbai-based firms have formed a chapter of the international Cloud Security Alliance. Firms may also be able to triage India's poor data laws in the meantime by binding themselves through contracts with international partners to comply with provisions, such as the EC's "safe harbor" route. Many global Cloud service providers have robust systems for data protection in place because they handle data for their longstanding global services though compliance with the laws of Europe and the United States and other globally-recognized principles.

Policies concerning government access to Cloud data appear to be moving in the opposite direction. Most countries have some rules that provide the government privileged access to data on ISPs or Cloud providers, but India's powers are particularly sweeping. Government authorities have relatively unlimited access to data in the Cloud: Section 69 of the Information Technology Act

[46] NASSCOM estimates for IT Sector Exports, RBI data on overall exports.
[47] Alphawise, Morgan Stanley Research (2011), cited in NASSCOM (2012).
[48] Government of India, Ministry of Communications and IT (2011). *Notification G.S.R. 313.*

2000 allows the government access to any information transmitted through a computer resource "in the interest of the sovereignty or integrity of India, the security of the State, friendly relations with foreign States or public order or for preventing incitement to the commission of any cognizable offence." The reasons must be recorded in writing, but the government can require the technology provider to decode any data transmission.

The Indian government's increasing efforts to access and control data on the Cloud may not only be a deterrent to companies concerned about privacy of sensitive data, but also limit Indian users' access to the full range of Cloud services. In a move that could foreshadow a form of protectionism for India-located Cloud service providers, India forced RIM to provide access to its encrypted Blackberry Messenger service and set up a dedicated server in Mumbai in spring 2012, after a two-year discussion.

In any country, including India, there is a risk that barriers to the transborder nature of Cloud services may arise, sometimes even as unintended consequences of government actions driven by other public policy objectives. The Indian government has demonstrated its willingness and interest in blocking what it deems to be "objectionable" content with limited due process. For example, requests by the Indian government to Google to remove content from its website between July and December 2011 were 49% higher than in the previous reporting period. The DoT has reportedly issued a list of 150 sites that it would like ISPs to block, even as the Madras High Court ruled that an earlier government order to block an entire site instead of offensive URLs was illegal.[49] Policymakers are, again, debating curbs on social media after online rumors about violence against citizens from the northeast, allegedly posted by Pakistanis that provoked a mass exodus of northeasterners from southern states. While each case may have its merits, there is no institutional process to consider the costs and benefits of suspending services and flows of data.

Conclusion

Several scenarios could emerge from this context. If neither data privacy protection nor broadband access changes substantially, India may be able to maintain its existing strength as a global IT services provider, but not make major strides otherwise possible through the Cloud. In this first scenario, international Cloud services could reasonably develop as service providers linked by international data pipelines to the global economy. Contracts or treaties enabling firm-level "Safe Harbor" or similar certification could be a reasonable substitute for new laws on data for firms large enough to afford it.

The domestic IT industry would also have an advantage in this scenario by being better able to comply with directives to locate servers in India for unhampered government access to data. NASSCOM – Deloitte (2012) seems to accept country and regional variation in data privacy regulation as a given, noting that the existence of "legal zones" will allow regional players to remain competitive with the few global "scale" players who will emerge as the leaders in infrastructure as a service. Given the size of the market, international firms may also set up hosting centres in India in spite of the economic disadvantages of having to segregate Indian from other

[49] Mishra, Abhinandan, (2012). "Government wants 150 sites blocked," *Sunday Guardian*. June 24, 2012. http://www.sunday-guardian.com/news/government-wants-150-sites-blocked, accessed June 24, 2012.

consumers, but cost structure may be affected given the high prices of electricity and land near access to reliable bandwidth in India. Policy developments that restrict Cloud providers from serving Indian customers from globally distributed infrastructure would further limit the domestic development gains from the Cloud by restricting access to the global pool of information, applications, and service innovations.

Simply maintaining the IT Industry in some form would result in a disappointing outcome. The Cloud offers many potential benefits, particularly for a country in India's state of development. The Cloud could be a critical contributor to crucial solutions for scaling education, improving infrastructure (and governance) and re-invigorating the economy, but the domestic market and contributions will be limited in a bandwidth-constrained environment. Some limitations could be overcome with advances in data compression that allow more information to be accessed on mobile devices over 2G or 3G networks, but many applications will not be appealing in an environment with intermittent, slow access to the Cloud. The government's less ambitious plans to provide broadband at reasonably widely distributed hubs, such as universities or district-level governments if not panchayats could provide some access to Cloud social services and education as well as government use of Cloud as a service infrastructure, but may not provide sufficient everyday accessibility to support consumer or business use.

Looking ahead, India's main Cloud challenge will be to overcome the complicated political, circumstantial and institutional tangles affecting broadband deployment. A powerful public incumbent with a mixed track record in service and infrastructure development is currently the lead agency in deploying the fibre-optic network. This needs to be reconsidered. The cable industry is fragmented and unresponsive to regulatory direction, a state of affairs perpetuated by regulatory uncertainty about licensing and about the level of competition from wireless services once spectrum management is clarified. Regulatory clarity will enable the industry to consolidate, professionalize and respond to increasing demand for data services. The processes for spectrum allocation will need an overhaul if mobile networks are expected to provide last mile or even broader coverage to compensate for weak fixed infrastructure. The rules for 3G allocation were stalled for months. At the time of writing, the auction itself seemed likely to substantially miss the court-ordered deadline. The 4G networks could prove to be a kind of deus ex machina moving past the stalled options, but the business model for affordable 4G broadband remains too hazy to expect an easy resolution.

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Cloud Computing in Mexico: Prospects and Challenges for the Public and the Private Sectors[50]

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1. Introduction

Mexico sits next to the nation where the Internet and Cloud computing were developed yet less than 13% of its 112 million population have broadband access. Adoption of Cloud computing is growing and has the potential to diminish barriers to entry and to lower investment risks, including those associated with quick technological obsolescence. Diverse government agencies are providing Cloud computing enabled e-Government services and have become a driver for Internet usage in the population.[51] Cloud computing, a new technology model in the chain of innovations that have followed the evolution of the Internet, holds has the potential of generating a significant impact in the economy and increase welfare. As a driver of economic growth, the Cloud offers the opportunity to leapfrog traditional information and communication technologies (ICT) for the reasons laid out by Cowhey and Kleeman, particularly in the case of Mexico (Alford & Morton, 2009; IMCO, 2012).

However, to generate this impact, Cloud computing needs to be widely used by businesses, government entities and society as whole. Broadband network access, less expensive user devices, software and digital skills facilitate tapping the full potential of the Cloud. In addition, an adequate regulatory framework could not only promote its potential within countries, but also promote it across nations through the development or international standards and agreements. The aim of this chapter is to analyze the evolution of the ICT sector in Mexico with a focus on the enabling conditions that can facilitate the transition to Cloud computing.

In Mexico, adoption of Cloud computing is growing and it has the potential to diminish barriers to entry into the ICT market as well as to lower investment risks, including those associated with quick technological obsolescence. Diverse government agencies are providing Cloud computing-enabled e-Government services and have become drivers for Internet usage in the population.[52] However, we observe a significant divide between both the private sector and levels of government. Federal government agencies seem to be using Cloud computing more intensively than state and local governments, which often lack quality broadband access and the necessary human and financial resources. Although states and municipalities do not need to develop their own private Clouds, they still need to have high quality broadband access to obtain the benefits of Cloud computing applications. Therefore, Mexican governments face numerous challenges, such as a broadband infrastructure deficit with inequality of access to Internet by individuals, businesses and governments as well as security concerns derived from the nature of certain policy domains, such as public safety, public health or crisis management. Mexico has the unique opportunity to become the

[50] The authors acknowledge the valuable research assistance of Lucia Gamboa and Cesar Renteria.
[2]A salient example is the online tax payment system, which is now hosted in a private cloud and is used by most taxpayers in the country.
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next “digital paradise in Latin America given its relative advantage in the region in terms of broadband adoption and technical expertise and its proximity to the United States.

2. Mexico’s current situation

Since the first generation of telecommunication reforms in the 1990s, Mexico has significantly advanced its adoption of ICTs. Communication access penetration per 100 inhabitants has grown at an annual average of 20% from1990 to 2009, from 6.6 to 104.6, which was driven by wireless. Furthermore, growth of ICT in Mexico has advanced from representing 1.53% of GDP in 1990 to 3.05% in 2009 (Figure 1). As is the case for the developing world, the most impressive advance pertains to voice through mobile telephony. Even those at the lowest segment of the income level in Mexico use mobile services.

Figure 1

Telecommunication revenue as a percentage of GDP (1990-2009)

(Percentage of GDP)

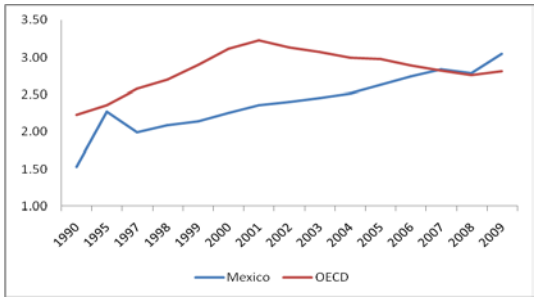
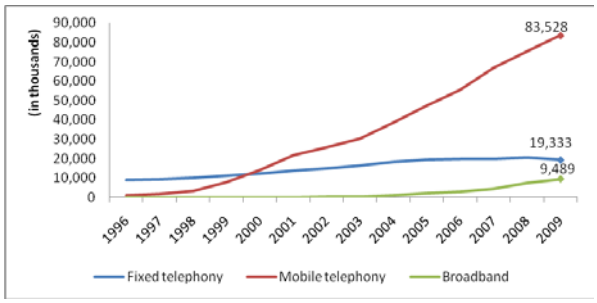


Figure 2

Number of subscriptions by type of ICT in Mexico (1996-2009)

(Number of subscriptions)



Source: OECD (2011).

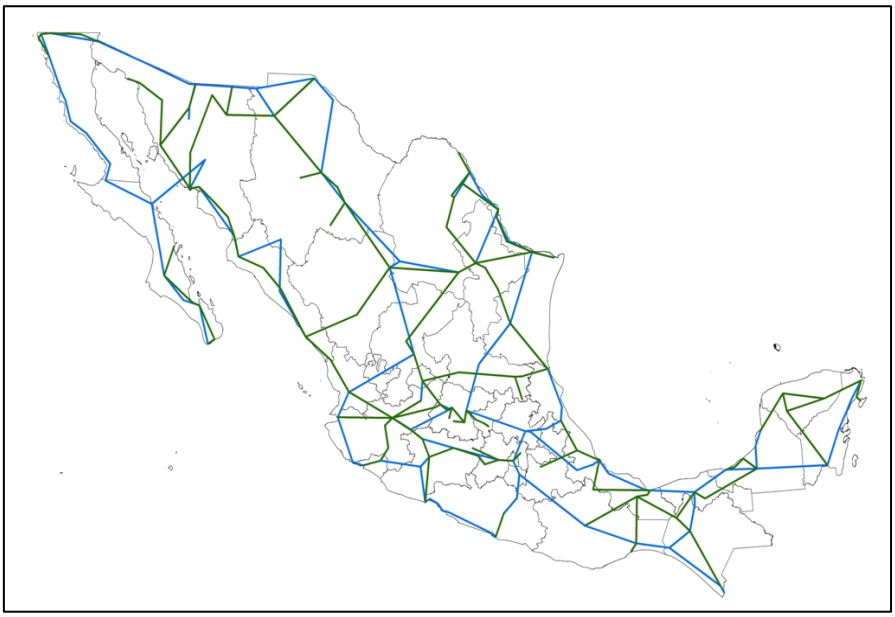
In terms of broadband development, Mexico has increased its penetration at an average rate of 47% compared to 11% in OECD countries during the last four years. Moreover, it has the third highest rate of broadband penetration in Latin America (behind only Uruguay and Chile). These indicators are encouraging; however, Mexico still falls behind other OECD countries and, more importantly, its current penetration levels cannot meet the growing needs of the Mexican economy.

Broadband adoption, in contrast to mobile services, is quite uneven; only 0.7% population of the poorest decile has broadband, while 22% of the same segment has access to mobile telephony (INEGI, 2011). Moreover, the national fixed network does not cover the majority of the Mexican territory despite competing network backbones. The publicly owned electric utility (*Comisión Federal de Electricidad*, CFE) has a national fiber backbone that only covers approximately 25% of the territory, i.e., 69% of the population.[53] A separate backbone of the dominant telecommunications carrier (Telmex) covers roughly the same routes (See Figure 3).

[53] Estimation based on INEGI data. Points of interconnections of the national backbone were estimated to have an influence zone with a radius of 40Km.

Figure 3

Coverage of Both National Public-Owned and Telmex-Owned Fiber Backbones

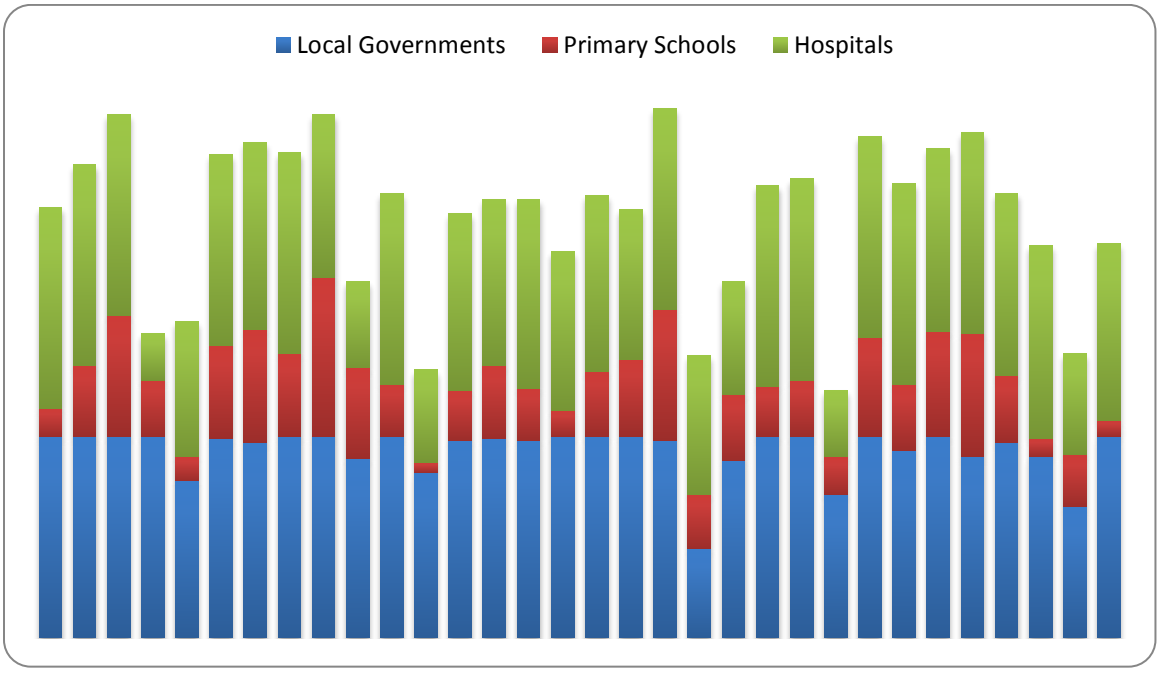


Source: Made by the authors, based on CFE information.
Note: blue lines are for Telmex and green lines are for (CFE).

The unequal broadband coverage exacerbates institutional connectivity disparities. While 80% of local government offices have internet access, states such as Oaxaca and Yucatan have the lowest access proportion: 44% and 65%, respectively (INEGI, 2009). In the case of education and health care Cloud-based services, like distance education and telemedicine, the average national internet access for primary and secondary schools is approximately 35%. Additionally, only 14% of public hospitals have access to telemedicine, while eight states do not have any access (Brambila & Mariscal, 2012). Figure 4 shows the coverage differences among states. Note that connection quality is not considered and access does not guarantee speed requirements for cloud-based services.

Figure 4

Proportion of institutions with Internet by type and state

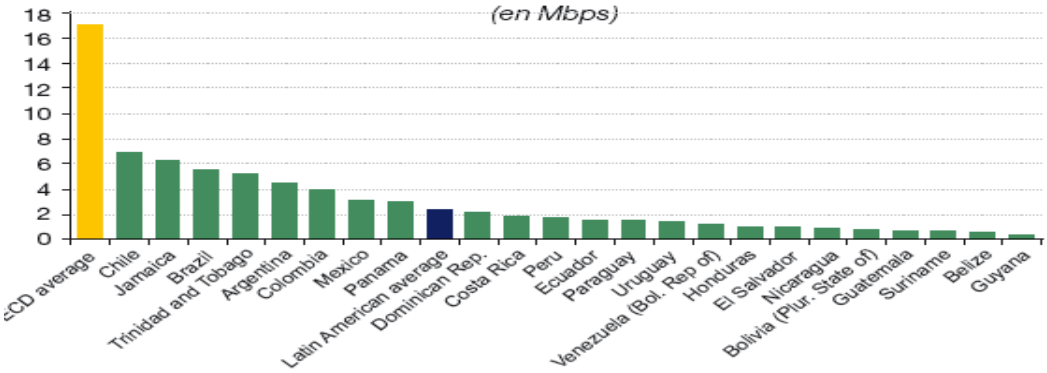


Source: Brambila & Mariscal, 2012.

Mexico compares favorably on both speed and price when compared to the average of the countries in the region. In terms of speed, the region's average is 2.3 Mbps and Mexico's 3.0 Mbps speed is above that (see Figure 5).[54] However, when compared to OECD countries, Mexico ranked last in 2010 with an average connection speed of 1.5 Mbps, while the average for members of the group was 4.3Mbps (OECD, 2011). Moreover, the reliability of broadband service is highly variable.

Figure 5

Average download speed offered in Latin America



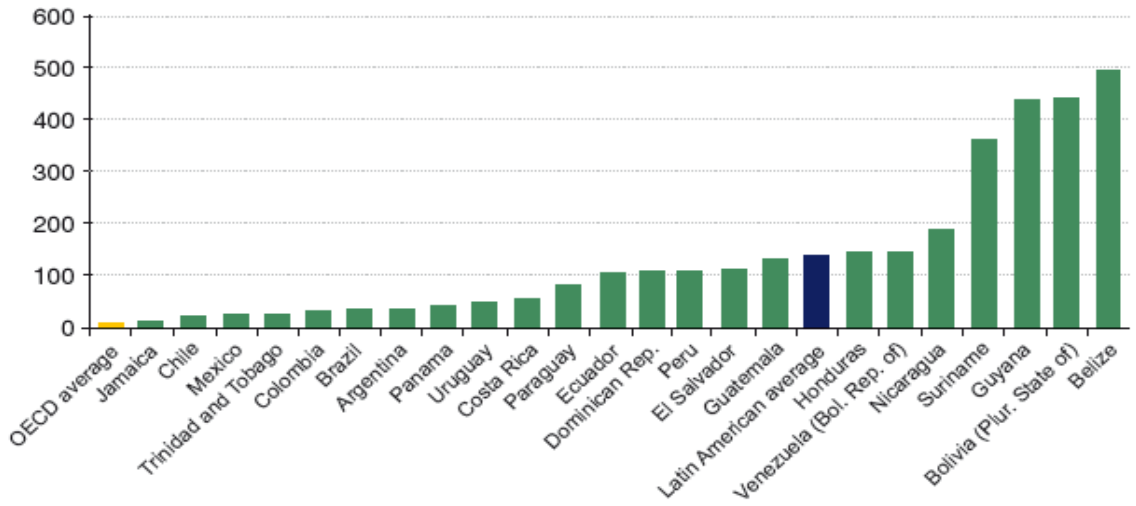
Source: Galperin and Ruzzier (2011).

[54] The data from Galperin and Ruzzier used different methodologies than used in the OECD Outlook, so results may be slightly different, but are consistent with rankings and average ratios.

In terms of accessibility, broadband prices are good indicators for evaluating market maturity in terms of competition. Consistent with the data formerly shown, Mexico is ranked among the countries in Latin America with the lowest prices in US dollars per Mbps, just behind Chile and Jamaica (see Figure 6).

Figure 6

Broadband tariffs per Mbps
(US dollars at PPP)



Source: Galperin and Ruzzier (2011).

However, when compared with OECD countries, Mexico has the highest tariffs per Mbps. Moreover, Mexico's monthly price for 1Mbps, above 20 USD, is ten times that of Japan, twice that of Portugal and far above the United States (where the average charge is 3.33 USD per Mbps) (OECD, 2011). Thus, despite recent advances, Mexico faces limited access to high quality broadband, which may be the single most important inhibitor of the continued Cloud computing growth.

In terms of infrastructure for Cloud computing, Mexico mainly uses the services offered by the big names in the market, Google and Amazon. Also, Triada, a subsidiary of Telmex, provides virtual information storage, application hosting platforms and online services for national and international firms as well as the Mexican government. This provider owns the largest data centers in Latin America and has received the highest certification level by the International Computer Room Expert Association (ICREA). Its customers include Hewlett Packard, IBM and the Mexican government's Revenue Administration System (SAT in Spanish).

3. Policy objectives

Mexico has ambitious goals for broadband network deployment, but it has not clearly articulated a Cloud computing strategy. An interoperability and open data scheme exists that defines Cloud computing and establishes that government agencies must determine the terms and contracting conditions for Cloud services,[55] but a comprehensive government strategy does not exist.

In regard to broadband, the e-Mexico Digital Agenda strategy (2010-2015) has the goal of delivering 38% of fixed and mobile penetration by 2015; however, the current levels of penetration indicate that this aspirational metric will be hard to reach. The recently-announced Digital Agenda also aims toward reaching 70% broadband penetration in Mexico's Small & Medium Enterprises (SMEs) with 20 or more employees (Agenda Digital, 2012). Additionally, this year the Ministry of Communications and Transport (SCT, by its acronym in Spanish) issued a plan ("*Acciones para el Fortalecimiento de las TIC y la Banda Ancha*") oriented toward improving the supply of telecommunication services through public and private investment in infrastructure. [56] One option is using passive infrastructure owned by the State to lever more than 6,000 governmental properties and the rights of way over 49,000 kilometers. This program also includes the creation of an Internet Exchange Point (IXP) to facilitate access without traffic having to travel to the United States before coming back to the user in Mexico.

Spectrum availability is a crucial input for the development of wireless broadband services. The growth of end user devices combined with consumers' and business' need to stay connected is creating new network requirements. Like the United States, Mexico has announced ambitious plans to free up spectrum for mobile broadband.[57] There are 425 MHz of available spectrum in the bands of 700MHzwith 2.3 and 2.5 GHz expected to be available to carriers during the coming years.[58]Just as importantly, the transition from analog to digital television will occur in 2015. This will liberate the 700 MHz spectrum and generate a 'digital dividend' in a frequency band critical for rapid broadband services coverage.

The Digital Agenda announced goals for developing demand for services through the promotion of ICT adoption, as well as the creation of content and application markets. This is intended to help Mexican users acquire the skills and tools necessary to take advantage of broadband applications. It will also increase the number of Community Digital Centers, advancing from the current 6,788 to 24,000 in late 2012. This will be mainly achieved by increasing the existing satellite-based capacity. Besides, implementation of an intensive campaign on digital literacy through these centers is contemplated with the collaboration of various public institutions, such as the National Institute

[55]Esquema de interoperabilidad y de Datos Abiertos de la Administración Pública Federal, see: http://www.dof.gob.mx/nota_detalle.php?codigo=5208001&fecha=06/09/2011

[56] One of the plan's strategies is to deploy a network of fiber-to-the-node through a public-private partnership to reach unprofitable areas; the goal is to cover 400 un-served municipalities. SCT determined that these zones are unprofitable based on the European Union Regulatory Commission's criteria.

[57] However, if critics of Mexican policy are correct, the Mexican mobile broadband network is less competitive than that of the United States, thereby raising questions about the incentive of operators to invest for competitive advantage.

[58] Other bands, such as 71-76 and 81-86 GHz will be declared for free use with the objective of enhancing operators transport capacity.

for Adult Literacy, the Mexican Institute of Youth and the Health, Social Development and Education Ministries.

Thus, the Ministry of Communications, (Secretaría de Comunicaciones y Transportes – SCT) has been the most important governmental actor in articulating polices that aim to improve network access. Indeed, these objectives are crucial requirements for Cloud services provision; however, there is no coordinating effort between SCT and other agencies, such as the Ministry of Economy (SE) or the Ministry of Public Function, to design a comprehensive Cloud computing strategy. The SE's Information Technology Sector Development Program 2.0[59] (PROSOFT, by its acronym in Spanish) is the most articulated strategy to promote IT competitiveness within the private sector. It aims to "position Mexico as a service hub of logistics and IT by taking advantage of its geographic position, its preferential access to markets and its large human capital endowment" (SE, 2008). Despite the fact that this strategy promotes IT outsourcing and insourcing, software development, and greater access for private companies, it makes no reference to Cloud computing services in particular. Thus, compared to countries like India, Mexico has no clear plan or policy bundle for the Cloud.

4. Private Sector and the Cloud: Opportunities for Cost Reductions

In Mexico, the adoption of technological tools by companies has been uneven. Data from 2008 indicates that only 50% of companies with ten or more employees use broadband (OECD, 2010). Only 40% of SME's have access to a computer, of which only 25% uses the Internet mainly for information search (Visa & Nielsen, 2008).

The shared nature of Cloud services can contribute to a decrease in IT operating expenditures and provide access to applications that would otherwise be unaffordable[60] (Nelson, 2009). Some estimates suggest the economic payoffs for Mexico could be very significant. The *Instituto Mexicano para la Competitividad* (IMCO) estimated the aggregate potential private sector savings based on a study by Etro (2009). They calculate that a structural change in the business' cost function diminishes fixed costs by 1% to 5%. This reduction diminishes market barriers, thus boosting competition, production and consumption. For Mexico, a decrease of 1% in fixed costs of SME's translates into 1,800 new SME's or 63,400 new jobs.[61]

Specifically, a 45-employee business transitioning from an on premise IT operation to an Office 365 service would save 67% of its total IT expenses, equivalent to 2.7% of the total costs of a Mexican medium business. These savings are derived from cutting large initial spending on

[59] The first PROSOFT program was launched in 2002. This new version builds on the previous program incorporating IT services and BPO objectives.

[60] Once the transition takes place, there are additional factors that must be considered in the cost reduction calculus. They include the newly created demand for file servers, the firm's capacity to cut personnel and the file server utilization rates.

61 In adopting the model developed for Europe to analyze Mexico, IMCO estimated that Mexico had 180,665 ME's which have 35 employees on average. *The Economic Impact of Cloud Computing on Business Creation, Employment and Output in Europe* (2009) estimate uses a stochastic and dynamic general equilibrium model. While the Cloud can lower IT costs, complex migrations to cloud can involve higher transition costs because of labor costs, time and expenses. (West, 2010; Berry & Reisman, 2012).

infrastructure, access to economies of scale only available to large companies, outsourcing maintenance and tech support to the service provider, access to better security schemes and time-to-market services improvement. But high broadband costs coupled with low quality inhibit Cloud growth potential may deepen the inequalities in the adoption of technological tools by companies. The Cloud has the potential to open up access to new entrants who currently encounter market barriers due to high costs; however, without infrastructure growth and lower tariffs, the Cloud may only end up benefiting those who already have access.

5. Government Uses of Cloud Computing

The benefits that governments can achieve from their use of cloud computing are significant (Paquette, Jaeger & Wilson, 2010; Zissis & Lekkas, 2011). Cloud computing could potentially reduce costs, improve the quality of services, and promote participation and collaboration among governments, government agencies, and between governments, citizens, private firms, and NGO's. However, in the context of Mexico, it is important to consider some challenges such as the divide between federal agencies and state and local governments, the lack of broadband access in the country, and the inadequacy of the legal and regulatory framework.

Some of the benefits for the public sector of advanced Cloud computing use are identified in previous studies (IMCO, 2011; Zissis & Lekkas, 2011): (1) Increasing the collaboration among agencies and departments through wikis and application in the Cloud in order to improve Web content; (2) Promoting government efficiency through the use of Cloud-based applications and services on-demand; (3) Allowing database access from different levels of government agencies that are attempting to solve particular public or policy problems; (4) Providing online services to local governments, which otherwise would not have the infrastructure and technical capabilities to develop or contract these services in traditional models; (5) Reaching citizens by providing a platform for them to propose actions and comment about government programs and services; and (6) Improving the services to citizens through the use of Cloud portals that provide effective information and services.

In addition, a new interoperability and open data directive identifies Cloud computing as an essential factor for improving the provision of services to citizens by the federal government (IMCO, 2011). For example, the new citizen-oriented portal of the federal government (www.gob.mx) is hosted in the Cloud (IMCO, 2011). In June 2011, this portal started operating through cloud services (Google's Site Search technology) in order to reduce costs. (In its first year the Cloud service cost rose to $1.6 million but hardware costs dropped even as the volume of searches doubled from 50 to 100 million) (Garza-Cantú, 2012). From the citizens' point of view, the Cloud has one of the main advantage: People are able to access information and services from multiple government agencies using a single authentication process. There are three main components of this project (Miranda, 2012): (1) specialized search engine, (2) webpage with personalized information and services, and (3) a website with government information linked to specific location through maps.

In 2012, the Revenue Administration Service (*Servicio de Administración Tributaria*, SAT), another federal example of the program's use, moved its tax payment platform to the Cloud. The

SAT's website hosts 100 thousand daily searches, which is ten times more than any other federal portal (Garza-Cantú, 2012). The SAT started outsourcing some of its IT services in 2003 and by 2009 a virtualization process was initiated as a first step to go into a private Cloud. The SAT Cloud computing solution is comprehensive and includes standard services, such as collaboration, email, and instant messaging and other services such as security cameras and intelligent monitoring (Moreno-Gutierrez, 2010).

At the state level, the government of Guanajuato implemented a Cloud computing application to improve its internal services (Navarro Espínola, 2010). The Cloud helped them improve interoperability and flexibility in order to grow their capacity to develop and manage a state-run platform. The functions included were email, calendar, document management, websites, video, and contacts (*Política Digital*, 2009). The Guanajuato government identified the following items as critical factors for their decision (IMCO, 2011): (1) profound budgetary limitations, (2) reducing the cost of IT management and support, (3) increasing interoperability, and (4) flexibility for new needs and future growth. In 2009, 70% of state government employees were using the Cloud-based collaboration tool and reporting improvements in collaboration, security and information management.

Another interesting example is Mexico City government and its use of Cloud computing's software as a communications tool (Guillot, 2010). The purpose of the initiative is to integrate all city social services and have the information available to the agencies responsible for those services. The Angel Network, as the project is called, will become the largest social services system in Latin America. Given the size and uncertainty of demand for the project, building the necessary infrastructure would have been expensive and time consuming;) therefore, , government officials decided to outsource some of the services and use a Cloud-based Customer Relationships Management (CRM), which was compatible with the existing call centers (Guillot, 2012) (Garza-Cantu, 2010). In addition to Angel Network, Mexico City is also using a Cloud computing solutions for its email service, collaborative calendars, document sharing, websites, and video.

The Mexican Institute for Competitiveness (IMCO, 2011) estimates some of the savings derived from this new technological model: the public sector could save up to 1.7% of the Gross Domestic Product (GDP) if all agencies moved to the Cloud. On average, federal agencies could save 35% of their total IT budget; state government could save about 27% of their annual IT budget.[62].

6. Challenges to Cloud Computing in Mexico

As stated above, the disparity between federal government agencies and state and local governments is a real challenge to Cloud computing; the disparity includes unequal access to adequate broadband infrastructure, limited capital and inadequate technical and administrative expertise to develop and manage Cloud computing solutions. Though some may view broadband access as a challenge specific to local governments, the problem also includes federal and state

[62] IMCO also identified which agencies would obtain the greater benefits: (1) Revenue Administration Service, (2) Mexican Petrol, (3) Mexican Institute for Health and Social Security, and (4) the Ministry of Education. On average, federal agencies could save 35% of their total IT budget.

agencies as well. Agencies throughout the government constantly interact with businesses and citizens that often lack reliable high-speed Internet accesses.

Another important challenge for Cloud computing use within the Mexican government is security (Paquette, Jaeger & Wilson, 2010; Zissis & Lekkas, 2011) due to the risk of exposing information to vendors or even third parties. Providers need to implement sufficient security measures and policies to avoid cyberattacks (Miranda, 2012). In addition, government agencies need to mitigate risks associated with certain services in the Cloud. The actions taken to avert risks need to be tailored to each organization and need to consider the risks for certain types of data (Moreno-Gutierrez, 2010). Agencies with highly secured data, such as national security or intelligence agencies, will probably not use the Cloud. Security risks are not the same for every project in every policy domain. Governments should assess the risks and necessary measures for specific applications and services using the Cloud. A low risk situation is Mexican citizens accessing open curriculums from U.S. universities, s which would only benefit them and the nation.

The creation of the IXP in Mexico would facilitate lower-cost and improved access to the Cloud providing additional incentives for Cloud computing vendors to enter the market. More competition would lead to greater efficiencies and lower costs for government and private users.

The absence of international standards and variations in domestic privacy laws raises other challenges for both governments and the private sector in Mexico and other countries. In countries such as Mexico, there are continued debates about the different models for privacy protection. For example, are more sector-specific regulations (which Mexican officials associate with the United States) or more blanket general rules (which Mexican officials associate with the European Union) superior? Or, given common goals, are they roughly equivalent? Ultimately, the government must determine which approach would best balance security and privacy when using Cloud data storage. [63] It is clear that a broader embrace of Cloud computing would benefit from a common international approach to these issues.

Past international efforts have come short of developing a common framework for Cloud-related policy. The OECD has shown an effort in this direction by issuing guidelines to address privacy issues related to cross-data flows; however, they were adopted in 1980 and have not been revised. Another attempt was made by the United States who submitted a proposal in 2007, endorsed by Mexico, to expand the United Nations' Provisional Central Product Classification (CPC) to include "computer and related services, regardless of whether they are delivered via a network, including the Internet", but this proposal has not been adopted.[64]

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[63] The debates in the United States over merits of its Electronic Communications Privacy Act (ECPA), signed in 1986, and the Patriot Act tend to be the dominant examples discussed in Mexico due to the proximity of the United States. Both laws have numerous critics and defenders. There is evidence that consumers believe that such U.S. regulations, and their counterparts in other countries, may present a risk that governments of foreign companies could access their private data for intelligence purposes (Berry & Reisman, 2012). Sorting out the facts goes beyond this paper. For example, US officials and cloud firms stress that exaggerated concerns over the Patriot Act have been used as a way to discourage foreign countries from housing data with US providers (Rauf, 2011).

[64] CPC 84 – Computer and related services. WTO. 26 January 2007. Available at: http://trade.ec.europa.eu/doclib/docs/2008/september/tradoc_140348.pdf

7. Policy Recommendations

Broadband development is a necessary condition for Cloud computing's growth. The Mexican telecommunications sector has increased its market efficiency, especially in recent years with advances in achieving lower interconnection rates and spectrum allocation.[65]However, there are still barriers to entry, and thus investment has not been sufficient to counter the current lack of access to broadband by a significant part of the Mexican population. The elimination of barriers to entry in the sector includes strengthening institutional processes that provide certainty to investment, the release of additional spectrum bands, licensing more fiber optic capacity and granting rights of way to telecom companies.

More importantly, there has been a lack of a long-term vision for the role of the state in promoting both broadband development and Cloud computing adoption. The recent policies of the Calderon government point in the right direction; they need to be continued by the next administration. Moreover, a nationally coordinated program to promote a transition to Cloud computing must be designed; it should include close collaboration between the SCT, which promotes broadband adoption, and the Ministry of Economics, which would promote a transition to Cloud computing. Even though there are isolated initiatives in government that use Cloud computing, there is a lack of coordination and a comprehensive program to promote its use both in local governments and in small and medium enterprises. An integrated policy program must come from the President's office in order to provide the leverage and coordination necessary for wide adoption of Cloud computing.

Mexico is becoming an increasingly important hub for business process outsourcing (BPO) and other outsourcing services (Business Monitor International, 2012). A similar hub could be established for Cloud computing services, with Mexico serving not just Latin America but also the United States and Canada. Mexico's lead in broadband penetration, hosting the largest data centers in Latin America, its proximity to the United States and being the largest Spanish speaking country in the world provide ideal conditions for this leading role. However, Mexico must first address its infrastructure deficit and provide the necessary regulatory framework to take further advantage of these conditions. Even though Mexico has a privacy baseline regulation for data protection,[66] it could strengthen its jurisdiction in a manner similar to countries that provide secrecy stipulations and therefore a higher level of data privacy. In terms of infrastructure, the current deficit could deter foreign organizations wanting to contract Cloud computing services outside from Mexico, since they would not have reliable and fast access to their data and applications. The government has the potential to lead the transition to Cloud computing, bringing with it Mexican citizens as well as the private sector.

In organizational terms, it is very important that Cloud-computing solutions are closely aligned to the mission of the government and its overall IT strategy (Miranda, 2012). It is also important to perform a detailed cost-benefit analysis before deciding how to pursue a Cloud computing solution.

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[65] The SCT and COFETEL have adopted a policy of gradual reduction of interconnection tariffs, for example for fixed telephone lines the reduction has been from 1.25 USD in 2000 to .32 USD in 2011. In terms of spectrum allocation, before 2010 Mexico had about 150MHz, which increased about 60% to 240MHz (SCT, 2010).

[66]Reglamento de la Ley Federal de Protección de DatosPersonales en Posesión de los Particulares. See: http://dof.gob.mx/nota_detalle.php?codigo=5226005&fecha=21/12/2011

In many cases, going to the Cloud will be cost-effective, but depending on the specific problem and the characteristics of the policy domain and the national context, using Cloud computing solutions may not be the best alternative. Governments need to carefully analyze all their options and make a final decision based on solid data. Some of the new capabilities may require fundamental changes in the structure and functions of IT organizations within government. It is not only about staffing adequately, but also about redesigning processes and structures to better fit a new environment in which cloud computing applications are at the core of the activities of government IT organizations.

Integrating Cloud computing into existing government processes is not always easy and requires technology, policy, management and staff development (Miranda, 2012). The set of workforce capacities would need to change too. Government organizations, which now need programming and network skills would need staff members who know how to establish contractual relationships that are enforceable and easy to manage. Cloud computing applications need well defined contracts and a clear definition of roles between the agency requiring the service and the IT vendor offering the solution.

In summary, Mexico has a strong potential to become the digital paradise for Latin America r in terms of Cloud computing and other IT services. However, the next administration must provide a clear long-term vision to lead its citizens and the private sector in this transition. The Mexican government must transform isolated policies into a coherently aligned program in close collaboration with the private sector, demonstrating its commitment by tackling the broadband infrastructure deficit that currently exists.

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Cloud computing in South Africa: Prospects and Challenges

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1. INTRODUCTION

South Africa has characteristics of both an advanced and developing economy. It has access to technology, sophisticated institutions including research and universities, a strong private sector and fiscal resources. At the same time, one-half of the 50 million people in South Africa live below the poverty line, with a large proportion with weak educational attainment and less than 12% have the broadband access needed for effective Cloud services. South Africa is an early-adopter of leading-edge technologies by high-end users (both individuals and corporations) in ways that parallel developed economies, while the majority of the population, the public sector, and most small and micro enterprises reflect the slower adoption pattern in developing countries. Thus, it is a nation where Cloud computing offers substantial potential to bolster economic growth and to contribute to solutions that help resolve inequities in access to services.

Some of the most important benefits from the Cloud would be gained through diffusion amongst SMEs and in public services. Enabling immediate access to the IT infrastructure and services previously only available to large enterprises, Cloud computing can significantly enhance innovation and entrepreneurship. It also has the potential to open up international and offshore markets not previously accessible to most South African companies and to contribute both to economic growth and competitiveness.

However, a range of factors inhibit the widespread adoption of Cloud services within the country. While there are high expectations, Cloud implementation in South Africa lags behind more mature and competitive markets. The success of the Cloud is premised on the availability, accessibility and affordability of the underlying infrastructure. This is a critical determinant of cloud diffusion[67] and one of the primary factors inhibiting the adoption of Cloud computing in South Africa. The country's ranking on global ICT indices has declined dramatically over the last decade (WEF, 2004, 2012 and ITU, 1998, 2008). Other factors inhibiting the take-up of Cloud services relate to concerns around security, privacy and surveillance, particularly amongst highly-regulated and risk-averse sectors such as financial services.

The potential value of this disruptive new technology is evident in the entry of all the major technology firms in South Africa. From consumer online service firms like Amazon Web Services (AWS) and Google, to new Cloud-based start-ups like Salesforce.com, these companies have presence in the SA market. While the larger, more traditional global companies, such as Microsoft, are finding ways to differentiate their product line offerings at the national level, telcos, such as incumbent fixed line operator Telkom, and mobile operators are also trying to leverage their existing infrastructure and offer Cloud services as they seek ways to broaden their revenue streams in response to increased competition and a decrease in legacy market growth.

[67] Microsoft estimates that total cost of ownership on 100 000 servers data centre is 80% lower than one with 1000 servers. See "The Economics of the Cloud", November 2010, available at *http://wwwmicrosoft.com/presspass/presskits/cloud/docs/The-Economics-of-the-Cloud.pdf*, visited 26 June 2012.

It is difficult to quantify the exact extent of Cloud computing in South Africa. Besides the problems associated with the very limited public and official data that exists on the ICT sector as a whole, the term has been over-used or misused and it is often used to refer to all data outsourcing or all online services. There is a clear increase in the uptake of virtualisation technologies as enterprises have become increasingly aware of the potential benefits of the services, yet many claim to be using the Cloud when they are simply making use of outsourcing and storage facilities on remote servers. On the other hand, personal Cloud-based solutions, such as Dropbox and Google Apps or Flicker, are widely used by individuals.

The global financial crisis has intensified interest in the Cloud as a means of reducing capital expenditure and optimizing IT resource utilization in South Africa. However, there is a preference for private over public Cloud implementations. The private Cloud is seen to provide firms with increased security or ensure they control where their data is stored, which governance rules and shortly legislation may demand. However, industry commentators believe that current cost-cutting pressures will compel IT intensive enterprises onto the public Cloud services in an attempt to consolidate and achieve economies of scale making the agreement on global rules that will enable this *essential* (Interviews with MTN, Internet Solutions and Pamoja, June 2012).

Besides the challenges of constrained broadband availability for the expansion of Cloud computing services, several regulatory challenges face Cloud providers wishing to provide services into and out of South Africa. These include differences in domestic data privacy, security and freedom of expression regimes in different jurisdictions across the globe. South Africa has not been engaged in international efforts by multilateral organizations to standardize cloud-related policy. This negatively impacts South Africa's ability to attract Cloud computing services exported from large computer and data processing services companies, mainly from the United States, which offer services in South Africa, and within South Africa itself, [68]

This chapter is organized as into sections 2 through 5. Section 2 considers the high level objectives of ICT policy, as against the current reality. Section 3 reviews available knowledge on cloud computing in SA. Little empirical research data is available, thus there is more reliance here on interviews and media reports. Section 4 considers the adoption of Cloud-based services for private and public services. Section 5 presents challenges to the diffusion of Cloud computing. Section 6 concludes the chapter.

2. ICT LANDSCAPE

South Africa has fallen in ICT competitiveness rankings during the past decade (WEF, 2012 and ITU, 2008). Telecommunications has not ranked high on the list of priorities for the new regime in South Africa, with infrastructure related to housing, water, electricity and road infrastructure receiving greater attention. A comprehensive ICT policy review and evaluation have not been done for 15 years. In 2011, the former Minister of Communications, Roy Padayachee, brought the largest communications companies together aiming to find solutions to achieving 100% broadband and the creation of one million jobs through ICT for a "Vision 2020". A new Minister, Dina Pule, was installed in 2012 and broadened this process to a wider group of stakeholders. The Minister

[68] See for example efforts by International Telecommunications Union (ITU) to raise awareness in African http://www.itu.int/ITU-D/afr/events/FTRA/2012/documents/Session9_Study_on_CC_Fall.pdf

instituted a national policy review with the intention of developing an integrated e-strategy for the country by the end of 2013.

This was in response to and in alignment with the National Development Plan for South Africa, which proposes that by 2030, ICT is expected to underpin the development of an inclusive dynamic information society and knowledge economy. In the short term from 2012 to 2015, this will entail the development of a "comprehensive and integrated e-strategy that reflects the cross-cutting nature of ICTs" (National Development Plan, 2011). ICT use strategies such as e-literacy, skills development and institutional development and other strategies to promote ICT diffusion strategies that provide for intergovernmental as well as private and public co-ordination are a principal part of the process. Another key focal point will be affordable access to a number of services through the effective regulation of competitive markets (National Development Plan, 2011).

In the medium term of 2015 through2020, a target earlier proposed by the Department of Communications is to achieve 100% broadband penetration by 2020. This will include expanding the definition of broadband from 256 kilobits per second to at least 2 megabits per second (National Development Plan, 2011).

In the long term of 2020 through2030, the South African government plans to make extensive use of ICTs in delivery of services to citizens. Services will include government, information and educational services. The Plan suggested greater collaboration between the state, industry and academia as part of the e-strategy (National Development Plan, 2011). Although not explicitly cited, Cloud technologies are seen as key to this process, and creating the needed broadband infrastructure to enable Cloud is explicitly seen as essential.

Currently, the average access speed for individuals is approximately 384 kbps in 2010 (ITU 2011)[69]. While the stated goal is to achieve 100% broadband by 2020, there is currently only connectivity for 9% to 13% of the population. South Africa will need to achieve an appropriate balance between quality, speed, access and diffusion. Over the past decade, SA has fallen in the ITU ranks from 72 in 2002 to 97 by 2010. In Africa, SA ranks fifth after Mauritius (69), Seychelles (71), Tunisia (84), Morocco (90), and Egypt (91).

Affordability and access will be critical factors in ensuring a faster diffusion of Internet usage. In the first instance, modeling for the Vision 2020 process reveals that it would cost approximately an additional USD$40 billion to expand the current networks to achieve 100% broadband, with a combination of mobile and fixed line access. However, this would require a substantial shift in culture, and credible commitments to effective access to backbone infrastructure.

3. TRENDS IN CLOUD COMPUTING IN THE SA CONTEXT

There is growing awareness of the benefits Cloud computing can offer to businesses of all sizes, according to some of the global network operators that have a South African presence. Very few firms are able to offer truly global Cloud infrastructure – primarily AWS, Google and Microsoft. All three of the major Cloud computing offerings are operational in South Africa – AWS's massive shared computing capacity EC2, Google and software vendor Microsoft are aggressively pushing

[69] The speeds will differ depending on service providers, time of day, or location. For example, MyBroadband reviewed 41 Internet service providers and respective services. The download speeds ranged from 0.22 – 4.7 mbps in November 2011. (MyBroadband 2012).

the Cloud. These companies compete locally with established carriers and large managed data network service providers, such as Internet Solutions (a division of SA based Dimension Data, now owned by NTT).

Cloud computing is a growing area of business in South Africa, but some service providers possibly overstate their involvement. Some claim to have offered Cloud-based services for more than 15 years and other major players claim to have pioneered such services in South Africa during the last three years. What is clear is that the potential benefits of being on the Cloud are becoming better-known and more and more enterprises are using Cloud services or plan to use a form of Cloud service within the next 24 months in South Africa (McKinsey presentation ICT Indaba, Cape Town June 2012.)

While large corporate enterprises are the early adopters of Cloud computing in South Africa, as elsewhere in the world, the greatest beneficiaries of adopting Cloud in developing countries, such as South Africa, arguably exist for SME and the public sector. These sectors have historically not invested as intensively in IT infrastructure and services and by moving onto the Cloud they can enjoy the cost-benefits associated with the economies of scale offered by the Cloud at a fraction of the cost of having invested in the physical network and services (Microsoft South Africa. Interviewed 29 June 2012).

The South African Cloud computing arena is in transition as many enterprises begin substituting their established in-house IT departments for private Cloud services (Internet Solutions, Microsoft, interviews). New economic realities including downward pressure on revenues due to the global economic recession and rising capital overheads are likely to force some companies with private Cloud systems to move applications into the public Cloud. In most cases, the main issue that comes with moving companies onto the public Cloud relates to trust and security and country or company governance rules. Service provider trust remains a major issue constraining the outsourcing of services.

Legal constraints on extension of trans-border cloud services

Finding the right balance between protection of information and commercial advancement will be a challenge going forward. The legal constraints arising from the imminent Protection of Personal Information Bill (POPI) aimed at protecting the privacy of individuals and the security of stored data are significant. However, they may be essential in ensuring that cross border trade is facilitated in providing assurance to foreign and SA operator trading. International norms will be needed in the future to ensure privacy provisions that are essential in protecting data do not also hinder the potential commercial development possible through electronic trade. Until that is done, the POPI will be an essential piece of legislation to enable trade and its slow passage will in itself be the barrier to transactions.

Tammy Bortz, from legal firm Werksmans, (Bortz 2012) says the POPI Bill will impact cross border data flows, especially where South African companies use offshore Cloud providers. The POPI Bill prohibits the transfer of personal information to a foreign entity unless the recipient of the information is subject to a law or agreement which upholds similar information protection principles or the data subject consents to the transfer. As a result, Bortz advises companies to establish what laws apply to protect personal information in the jurisdiction in which the Cloud

provider is situated and to consider any restrictions of the transfer of such data back into South Africa.

The legal implication of the proposed bill is that companies are more likely to find it risky to move data outside South Africa due to the more stringent privacy laws. Additionally, if the bill becomes an act it is likely to limit the places in which a company can cost-effectively do business, as companies will be reluctant to be liable for any breaches on a customer's privacy. It is argued that local companies are not able to offer the same economies of scale offered by companies that provide Cloud services on a global scale (Pamoja, interviewed17 July 2012).

Analysts argue that South African entrepreneurs should be able to focus on creating Value Added Services. Legislation, such as the POPI Bill, could force entrepreneurs to choose a far more expensive Cloud service provider in order to simplify the contract and reduce risk. "This is an unnecessary throttle on our development", argues Fripp (2011).

"Local Cloud service providers face an uphill battle in their attempts to compete with foreign providers. To make matters worse, the POPI Bill is a step closer to protectionism that will shackle us to uneconomic, unreliable, expensive options when there is, literally, a world of possibilities out there for us to choose from".

"The global information economy, including Cloud computing, works best when information flows freely across borders in a responsible way with appropriate privacy and security protections. Efforts to lock data within a particular country or region will not only undermine the benefits of the global information economy, but also disadvantage local enterprises that want to take advantage of the tremendous cost, productivity and innovation advantages that cloud computing enables," says Benioff (Fripp 2011).

A South African entrepreneur who offers SaaS using cheaper, more reliable offshore hosting will be able to offer products at a lower cost. New businesses will be able to sell more products to more people and, in turn, will be able to grow his business more effectively. "While I don't advocate for irresponsible use of personal data, I do feel that we need a legislative environment that is sensitive to the globalisation of IT that is taking place, and takes steps to make it easier for South Africans to benefit" (Fripp 2011).

INFRASTRUCTURE AS SERVICE

AWS's virtual servers are the global leaders in the IaaS field. In South Africa AWS competes against local providers such as Telkom, Internet Solutions and MTN Solutions. In South Africa hosting and data centre providers believe that the key concepts underpinning Cloud computing have been derived from hosting and co-location services, which they refer to as part of infrastructure as service offerings. Infrastructure providers believe that Cloud services is the logical next step and are moving up the value chain to include offerings such as software as a service (Internet Solutions, interviewed 28 June 2012).

PLATFORM AS A SERVICE

Microsoft believes its Windows Azure platform has the largest share of the South African PaaS market, with no material competitors (Microsoft South Africa, Interviewed 29 June 2012), but Google's App Engine has a South African presence. Microsoft believes that competitiveness in

PaaS depends on the richness of the ecosystem of applications that leverage a common frameworks and interfaces. Most PaaS providers monetize the services by charging developers to use the underlying processing power, storage and network capacity, and other higher level service such as billing, optimized content delivery and service level guarantees (Kushida et al, 2012: 71). But providers differentiate themselves on their unique platform attributes, efficiency of application development and the user and development population size. This is why Microsoft is supporting SME to use their platform for development purposes, with the associated benefit for Microsoft of building market share among clients who have invested in learning its architecture.

SOFTWARE AS A SERVICE

Cloud services eliminate the operational complexity and cost of installing, maintaining and upgrading complex IT systems in the users' own environment (Kushinda et al, 2012: 72). Software as service providers, such as Salesforce.com, create third party application markets to enhance their server offering. The company provides CRM and related Cloud computing application solutions and development tools for the business web. Applications and content services, which include Google Apps and Microsoft Office, offer productivity services, e-mail, customer relationship management CRM and Enterprise Resource Planning via the Cloud.

Salesforce's Benioff, says Cloud-based Software-as-a-Service (SaaS) represents a great opportunity for South African entrepreneurs. The much lower barriers to entry and simplicity of launching Cloud-based services open up international markets to local businesses (Fripp 2011). This allows local businesses to generate revenue flows into the country. According to Fripp (2011), analyst firm IDC expects the worldwide SaaS market to reach more than US$40 billion by 2014, while ABI Research expects the global market for hosted services to reach US$34 billion in 2012. This trend is reflected in the South African market where interest in SaaS is growing rapidly.

There are some leading examples that mark the direction of Cloud adoption. For example, T-Systems now offer SAP infrastructure in the cloud, and signed on Consol Glass in September 2011 (Fripp 2011).

INTEGRATION AS A SERVICE

This is a delivery model in which functionality of system integration is put it into the Cloud, providing data transport between enterprise-wide systems and third parties (suppliers and other trading partners) on-demand. South African-based Cloud aggregator Pamoja seeks to provide integration services between different Cloud providers based on open application programme interfaces (APIs). This model is expected to allow greater flexibility than closed proprietor Cloud computing services as companies have the liberty to select different Cloud service from multiple Cloud providers and that best meet their specifications and at the best price.

SEACOM (providing dedicated bandwidth between Africa and Europe) has announced its intention to provide Cloud computing services for the African continent, through its subsidiary Pamoja. This will deliver internationally based Cloud services to African end-users as locally connected services and avoid international bandwidth costs (Pamoja, interviewed 17 July 2012). This will be an essential ingredient in generating sufficient volumes onto SEACOM infrastructure. SEACOM contends that "submarine connectivity accounts for about 90%-95% of the distance a byte of information travels, yet is only a fraction of the total cost of a service to the user. Backhaul and last-

mile connectivity is scarce and priced at premium." (Business Day, Thibiso Mochiko, 17 August 2012)

IBM announced its expanding Cloud services for South Africa in September 2011. This builds on its existing Business Continuity and Recovery Service Centre, and adds IBM Cloud Data Centre and Cloud Lab in Johannesburg. IBM Smart Cloud solutions allows for either private Cloud services or provision in the IBM Cloud. According to Manners (2011), South Africa is the fourth country globally to have both Cloud Data Centre and Cloud Lab. The data centre is the first opportunity to South African enterprise clients to receive hybrid cloud services that offer "offer predetermined service level agreements on software as a service (SaaS) or utility-based computing model while also conforming to governance issues within data storage".

4. ADOPTION OF PUBLIC AND PRIVATE CLOUD SERVICES SECTORS

The public service stands to gain from economies of scale and cost savings offered by public Cloud services, but has been slow to adopt such services (Microsoft South Africa, Interviewed 29 June 2012). It is further contended that SMEs, on the other hand, stand to gain the most from public Cloud services (Microsoft South Africa, Interviewed 29 June 2012).

Table 1: Current predominant uses of cloud computing by different sectors and subsectors

	None		Some		Extensive

Sector & subsectors	IaaS	PaaS	SaaS
Public service			
Education (Higher)			
Enterprise			
SME			
Personal			

Source: Compiled by authors on basis of interviews

HIGHER EDUCATION AND RESEARCH

Much has been written about the potential of Cloud computing in the developing world to be a powerful tool for socioeconomic benefits, particularly for the rapidly expanding education sector in Africa. It is argued that since Africans are relatively unconstrained by existing IT infrastructure, educational and research institutions could be "essentially leapfrogging to the Cloud" with pay-as-you-go mobile phone, which would be capable of liberating users from the memory and processor constraints of location-based computing (see Fritelli 2012 for example).

Despite the potential to stimulate innovation by lowering the bar for new entrants, entrepreneurs and researchers for experimentation, other than pockets of activity sponsored by Google (Umbono) and World Bank (m-labs) most research institutions are not experiencing the flexibility and computing capacity made available by the Cloud. Further, if trans-border data are constraining remote education and access to world class curriculum and possibly testing, this would further limit the benefits of Cloud services to this critical segment in Africa.

AWS's Cloud infrastructure, along with Google and Microsoft's developer tools, provide access to components previously not available for creating Cloud-based systems. But these require broadband connections. The South African Research and Education Network (SANRen), which is operated by The Tertiary Education and Research Network (TENET) on behalf of the Department of Science and Technology, has been able to source its own international bandwidth through a 10 GPs circuit to London on the SEACOM cable for a fraction of the cost of nationally commercial available bandwidth and dimensioned its network to conform with contemporary research expectations and meet some of the technical conditions for cloud computing.

TENET is working to extend the benefits of the SANRen Network to different campuses across South Africa. The SANRen Network includes a 10 GPs backbone and fibre rings in Johannesburg, Pretoria, Cape Town and Durban. The University of KwaZulu-Nata in Durban provides a PaaS support for remote developers working on an open source global m-Health application suite, also leveraging this and related networks but again data regulations may limit its utility for international Cloud-based service provisioning.

Some of its university clients are considering moving dedicated e-mail services onto the web, but there does not seem to be sufficient confidence in moving entire administrative systems or resource bases onto the Cloud. (TENET, Interviewed 26 June 2012) Seven universities are willing to move onto the Cloud but reliable/redundant international connectivity remains a challenge. The main driver for wishing to do so relates to agility of Cloud services, but with a risk of disruption the value is diminished (TENET, Interviewed 26 June 2012).

A number of research computing projects are also expected to move to AWS as the provider makes its computing platform available to the universities for free. Data privacy and security of Cloud services was of some concern amongst universities, but potential cost saving could be a more influential driver of universities onto the Cloud, according to Greaves.

PRIMARY AND SECONDARY EDUCATION

The quality of education remains a central challenge for South Africa. At the school level, only 7% of all those born in 1994 completed high school with the equivalent of a 50% pass mark. About half of this cohort dropped out in the last two-to-three years of school, also with insufficient capability to access post-school opportunities. There are about three million youth aged 15 to 24 who are out of school and out of work. The intention is to dramatically expand vocational training and education, but in a context where this system is small relative to demand. In higher education, there is the intention of expanding distance learning as reflected in a policy paper prepared by the Department of Higher Education in 2012. Half of the university students are enrolled at a distance learning institution, the University of South Africa (UNISA). Unisa has the intention of strengthening online learning, including the development of mentors for students.

The use of cloud services is currently minimal in solving these challenges. However, it is clear that they are unlikely to be resolved without widespread access to low cost bandwidth, devices and Cloud-based education and appropriate relaxing of data protection regulations to enable remote Cloud-based services.

ENTERPRISES

Larger firms are more likely to invest in private cloud services (Mahlong, 2012). At present, large enterprises are leveraging dedicated IT departments and are beginning to outsource some applications to third parties. While some companies have migrated onto the cloud, this is mostly onto the private cloud as companies still have security concerns about moving on the public cloud. "Out of 100 large JSE-listed corporations that we interviewed, 46% are already using cloud computing," said World Wide Worx MD Arthur Goldstuck. "Another 6% plan to introduce it next year and another 4% the year after, so it will be close to 60% by 2013."(IT News Africa 2011). Cloud providers believe that the significant benefits, and security and privacy improvements from the public cloud will help migrate customers there in time. However, even with these obvious advantages some large enterprises are constrained by governance rules that prevent them from moving some of their applications into the public Cloud as the location of the server is unknown as required by law or company policy (Microsoft South Africa, Interviewed 29 June 2012).

One of the major deals to emerge was the purchase of Johannesburg and London listed data network management company Dimension Data by NTT in 2010 for $3.12 billion. The stated purpose of the acquisition was to leverage the complementary strengths of both companies in order to provide end-to-end, global-one-stop and high quality ICT services. This entailed combining NTT's network carrier capabilities and assets with Dimension Data's pan-African system integrator expertise as both companies were geared towards strengthening their global position in preparation for the provision of managed infrastructure services and cloud computing (NTT and Dimension Data, 2010).

For South African companies to attract substantial Cloud business, it will have to reach greater scale and lower cost. According to Frip (2011), the base fees for cloud hosting are comparable between SA and overseas, but the cost of service providers' offerings diverge considerably. "Data traffic for South African hosting options costs between R15 and R85 per GB, depending on the level of service required. Foreign Cloud service providers charge as little as R1 per GB for data transfer". Fripp (2011a) tributes the difference in charges for service providers like Rackspace, Microsoft Azure or Amazon EC2, to scale, which enables lower per customer charges. South African companies rely on a smaller customer base and high cost bandwidth. This will pose challenges for the expansion of South African IT-enabled offshoring services to foreign clients.

SMEs

There is a general perception that small-medium enterprises have the most to gain from the associated economies of scale at a fraction of the price of investing in such infrastructure and services and are expected to adopt public Cloud services more quickly. However, the high cost of bandwidth and absence of long-standing trust relationships have inhibited SME take up (Microsoft South Africa, Interviewed 29 June 2012). It is estimated that by 2011, only 9% of SMEs made use of the Cloud, according to Arthur Goldstuck (Engineering News 2012).

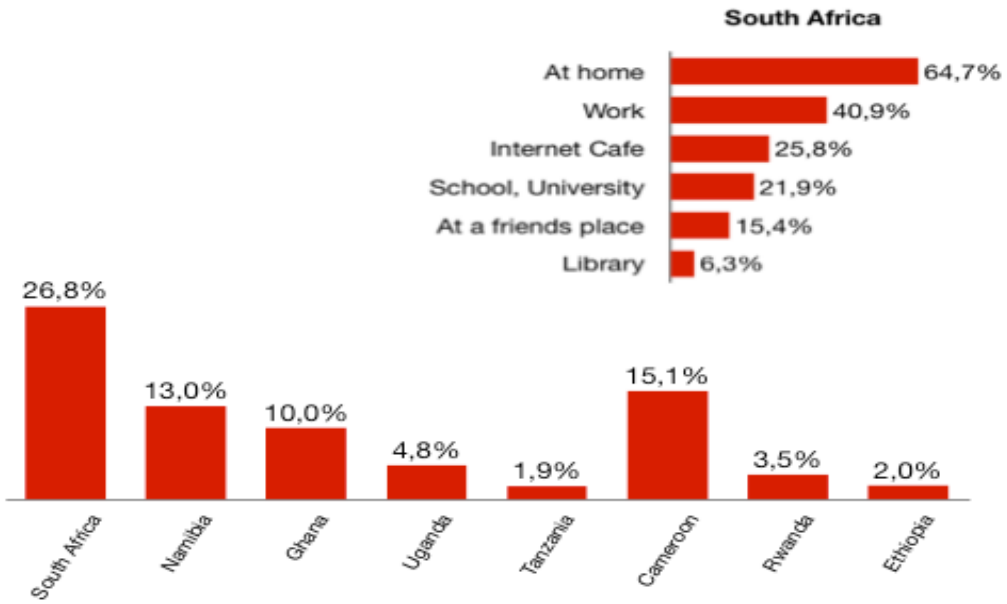
The benefits of the Cloud are, as a result, being marketed aggressively to small-medium businesses (Microsoft, IBM, McKinsey presentations ICT Indaba 2012). Microsoft, as part of a programme that supports innovation and entrepreneurship, is offering start-ups free Cloud services on their platform. A few local, small software businesses will be offered USD 60,000 of free Cloud computing over a two-year period. This, of course, is also likely to lock them into their services in the longer term.

5. CHALLENGES TO WIDESPREAD CLOUD COMPUTING

5.1.1. Broadband Connectivity

The South African landscape is characterised by high access and usage costs, low PC ownership and a weak IT literacy (Research ICT Africa 2012 database). The South African market is the largest in Sub-Saharan Africa and, unlike more mature markets, fixed and mobile voice services drive telecom revenues. There are two fixed-line operators (Telkom, Neotel) and one state-owned national broadband company (Infraco, which was launched in 2007). The local fixed market is dominated by Telkom with the late entrant Neotel making very small inroads in the market since launching commercially in 2007 following several years of licensing delays. Neotel has less than 10% of the fixed market. Telkom, the incumbent fixed-line network, is smaller now than before privatisation following the large scale disconnection of nearly 2 million subscribers. These subscribers were unable to afford services toward the end of the official monopoly period in 2001 and, since then, have declined year on year to 4,297,400 in 2009. Total number of minutes of local traffic has also declined but international traffic has not (Telkom Annual Report 2010).

Figure 1 – Computer ownership and usage in South Africa 2011



Source: Research ICT Africa.2011/2012 Household and Individual User database

Fewer than 2% of South Africans had wireline broadband access as of 2010. With the low penetration of fixed broadband resulting from this legacy unlike that of mature economies, the advent of mobile broadband has rapidly overtaken fixed broadband. Unlike Europe in and North America, where there was universal fixed line services, mobile broadband is increasingly being used as primary service rather than as complementary service to fixed broadband in the home (Gillwald and Simon, 2012).

This sub-optimal performance is reflected in South Africa's steady descent down global rankings, such as the World Economic Forum where South Africa was ranked 34 in 2004 to 72 in 2012, while on the ITU Development Index it fell from 77 in 2002 to 92 in 2008.

Delays to the licensing of the network operators, particularly by Broadband Infraco – (which promised mobile operators, previously prevented from building their own backhaul networks, in particular very low cost access to a public network and initially appeared to have squeezed out private sector investment) – forced other operators to build out their own competing intercity links, undermining its potential business case. Furthermore, local governments and municipalities are also beginning to invest in the last mile.

Some provincial governments, such as Gauteng and the Western Cape, have instituted broadband plans and government e-services, as have their major cities, Johannesburg and Cape Town. Ethekwini municipality in KwaZulu Natal has also proceeded with metropolitan networks and services.

The result has been significant duplication in metropolitan areas where multiple cables, including non-licensed cable company Dark Fibre Africa, have been laid along with some duplication on the main intercity routes and very little extension of the network off the main routes to smaller towns and villages.

The poor penetration of the fixed line network together with high costs has historically resulted in relatively slow uptake of ADSL. Against this, fixed wireless broadband offering of the second network operator have not really been able to compete. It was, in fact, 3G mobile broadband service offerings by the mobile operators that quickly overtook ADSL and these offerings, unlike those in Europe and North America, are many people's primary broadband connection, not a supplementary mobile connection.

High quality, low cost always-on bandwidth is therefore not pervasive. Although the number of undersea cable projects underway have improved international bandwidth and despite many network operators investing in backhaul and metro fibre projects, national terrestrial network and last-mile connectivity remains a challenge especially outside of major economic centres.

5.1.2. International bandwidth

Until 2009, South Africa had among the highest international bandwidth prices in the world, four new submarine cable systems have caused prices to drop significantly. The privately held, open access SEACOM cable was the first competing cable to land in 2009 and is significant in that it is the only cable servicing eastern seaboard of the continent and links South Africa, Mozambique, Madagascar, Tanzania and Kenya with India and Europe.

The EASSy and MainOne cable landed in 2010 and the West African Cable system (WACS) become operational in late 2011 with an initial capacity of 500 gigabytes upgradable to a mammoth 5.12 terabytes (Africa, 21012), while the ACE cable is expected to be online in 2012.

The landing of these cables has led to an improvement in international bandwidth capacity, both with regard to the quality and price of bandwidth, as well as competitive sales to all carriers, which has led to greater affordability of international bandwidth. This cost saving, however, has not always been passed on to the customer, with either additional bandwidth for the same price or for moderately reduced prices seen in the market.

The high price and erratic quality of bandwidth have been the two main limiting factors for the uptake of externally sourced or export Cloud computing services by corporations in South Africa and remains a concern for current and potential Cloud users. Among SME's, the issues relate more fundamentally to access and pricing.

Despite the high cost of bandwidth, providers present a strong business case for the adoption of public Cloud services. It is argued that there are some applications that require a lot of bandwidth. The cost incurred by businesses is related to the volume of information transmitted and the complexity of the data. If the company is connected 24 hours a day the costs can be significant. In this case, the public Cloud computing services become attractive as they provide the opportunity to streamline costs. This is a major driver for the increased uptake of Cloud-based services in South Africa (Microsoft South Africa, interviewed 29 June 2012). With the problems of international bandwidth effectively addressed, the challenge now lies in the national terrestrial backbone highlighted above.

5.1.3. Regulatory issues

REGULATORY UNCERTAINTY AND COMPETITION

The policy and regulatory environment is currently framed by the Electronic Communications Act of 2006, with some amendments made since then, plus the introduction of convergence legislation.

The emergence of the private and public corporate landscape has been an uneven birthing process, with movement toward a more competitive environment taking place in fits and starts. The partial privatisation of the fixed-line incumbent (Telkom) was completed in 2002 and, after much delay and legal contestation, a third mobile operator, CellC, was licensed.

In 2000, the Independent Communications Authority of South Africa (ICASA) Act merged two existing regulatory authorities: the Independent Broadcasting Authority and the South African Telecommunications Regulatory Authority. This was achieved with no prior policy or law on convergence and, therefore, resulted in a single institution informed by two different statutes on broadcasting and telecommunications. The Act was amended in 2006 to accommodate the changes to the appointment process in the Council in line with the Electronic Communications Act, passed in 2005 and operational in 2006, which sought to create an enabling environment for convergence.

Policy uncertainty in the ICT sector in South Africa has a negative impact on objectives of affordable access to services including universal broadband. Mixed and often contradictory strategies and sequencing problems with privatization, liberalisation and independent regulation have been compounded by weak state coordination (See Gilllwald 2005). Out-maneuvered by

foreign equity partners involved in the partial privatisation of the incumbent network, the primary objective of doubling the number of subscribers on the network did not materialise, while the incumbent used its extended monopoly to entrench its dominance in the market and undermine new entrants in the liberalized Value Added Networks (VANS) sector.[70]

Constrained by institutional arrangements that limited their autonomy, however, the regulator has not often had the statutory powers, and seldom the enforcement capacity, to circumscribe the behaviour of the incumbent so it does not negatively impact other service providers. Without effective regulation, the assumed benefits of liberalisation, including more affordable access and more efficient allocation of resources in the market through competition, did not materialise[71].

In response to the negative outcomes in the sector and as a result of a decade of failed reform led by the Department of Communication and the apparent inability of the State to use its 37% remaining share of Telkom, (including the failure to fashion Telkom as the national broadband champion on international bids such as the World Cup and the Wide Area Array Satellite,) without reference to existing sector policy the Department of Public Enterprises established a new state owned broadband company Broadband Infraco (see Gillwald 2009 for more detailed account).

This cut across the already delayed licensing framework of the Department, undermining its credibility in terms of state commitments to investors. The policy paralysis within the Department of Communication was finally broken by a ground breaking court[72] ruling that liberated service providers from Telkom and other PSTN operators and compelled the Ministry and ICASA to licence new service providers and allow them to provide their own facilities.[73]

This immediately allowed hundreds of previous VANS operators to offer full services, creating conditions conducive to entry into the market by foreign investors. One example is NTT's purchase of Dimension Data discussed above.

CONSUMER PROTECTION

One of the major regulatory issues relates to property of the data stored on the Cloud, particularly when consumers want to change suppliers. Currently, companies are locked in to a particular Cloud provider as most of the solutions are proprietary. This raises questions about who will monitor timely compliance of contractual obligations. At present, this is not being regulated by either the sector regulator, ICASA or the Consumer Commission.

[70] The Competition Commission has proposed to the Competition Tribunal that Telkom be fined ZAR3.5billion fine for anti-competitive behavior during this period.

71 While the sector regulator received several anticompetitive complaints these were all either taken on review by Telkom and lost on procedural grounds or took so long in the courts they were overtaken by events.

72 Altech vs Minister of Communications, ICASA and others (2008)

[73] In 2006 Altech brought a court action challenging the decision to limit the number of converted ECNS licences against ICASA and the Minister of Communications on whose directive ICASA had acted. It also sought relief from a contested prohibition on VANS being able to provide their own network facilities without having to obtain these from incumbent licensed telecom network operators such as Telkom or Neotel. The ruling overturned ICASA restrictions on ECNS licences and ruled in favour of self-provision of telecommunications facilities (See Gillwald 2009 for analysis of its implications for sector development)

PRIVACY

At present, there are no clear guidelines for South African providers with regard to the protection of information in the Cloud. This is a major constraint in attracting investors to South Africa (Microsoft South Africa, Interviewed 29 June 2012).

Currently, the Electronic Communications and Transactions Act (2002) has limited privacy protections for information collected electronically (BSA 2012). South Africa is far from being aligned with international standards. Copyright laws in South Africa are not aligned to those in the US or Europe. (BSA 2012).

SECURITY AND PIRACY

A study by the Business Software Alliance South Africa (2012) raises issues relating to software licence abuse and piracy through the Cloud. About 42% of businesses that use paid Cloud services around the world were reported to be sharing their log-in credentials within their organisations. While 45% in emerging economies and only 30% in mature markets were reported to be sharing their credentials internally. Even though some licences allow sharing of accounts, Cloud service providers do not charge by the seat but by the amount of computing resources consumed. About 56% businesses that use Cloud services believe that it is wrong to share log-in credentials, which is regarded as software piracy. Other than software piracy, other issues raised included piracy of entertainment, such as music, and infringement of intellectual property rights.

TAXATION

Providing data services across borders and between different jurisdictions also has potentially negative tax implications. Cloud providers face different tax regimes and, at present, there is no locally coordinated position. Furthermore, there is disagreement about whether a Cloud service should be taxed where it's delivered or where it's consumed. The current lack of agreement over the tax regimes is likely to further limit the ability of operators to optimise the economies of scale associated with international aggregation of data storage and other services (Pamoja, interviewed 17 July 2012). This jurisdictional issue is commonly raised in new forms of international transaction and it can be expected to be resolved in the Cloud domain and not remain a significant issue over time.

CONTROL OF DEVICE

A key feature of infrastructure operated by public Clouds is the evolution toward Clouds of Clouds in the same way as the Internet evolved into a network of networks (Renda, 2012). This will only be possible if open interfaces govern the exchange and portability of data from one Cloud to another at no switching costs.

Interoperability into the Cloud will be critical, whether for proprietorial systems such as Apple or those opting for operating systems such as Google that connect to the ecosystem. For example, Telcos are far more likely to bundle service through their gateways. However, we can expect that Cloud-based interoperability will be easier to manage today than in the past due to the increased adoption of web-based interface protocols (common in Web 2.0 environments and largely independent of the Cloud).

PROMOTION OF FREE TRADE

The stated policy intention of government is to promote open-source software. For example, a formal policy for use of open source software in government was adopted in 2007. However, the broader strategy has not yet been implemented. Moreover, any public procurement is subject to stringent Preferential Procurement rules. SA is not a member of the WTO plurilateral agreement on Government procurement (BSA 2011).

6. CONCLUSION

Cloud computing in South Africa is in its early growth stages. Global companies are aggressively marketing the benefits of Cloud services. Many large companies that have adopted virtualisation technologies are beginning to realise that Cloud computing has significant efficiency gains and have the potential to enhance innovation and entrepreneurship. As a result, companies have started to transition their IT departments to private Clouds. While concerns surrounding security and privacy of data continue to hamper the adoption of public Cloud services, it is believed that cost pressures are expected to force companies to increasingly move some applications onto public Clouds in order to streamline costs. The state could play an important role in utilising Cloud services and innovation in widespread activities such as education.

The availability and affordability of broadband is a critical determining factor for the growth of Cloud computing services in South Africa. In addition, addressing the policy gaps concerning protection of private information, data and cyber security will go a long way in creating trust and adoption of Cloud-based services. This will, in turn, facilitate access to international markets and offshore niche markets and contribute both to economic growth and competitiveness.

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ANNEXURE 1 – LEGAL FRAMEWORK

1. National ICT policy and legal framework.

The Electronic Communications Act was passed in 2005. The Act was developed with the aim of preparing the telecommunications sector for a converged and competitive environment. The Act was signed into effect in 2006, although many of the aspects of the law have yet to be implemented. The Act sought to ensure a non-discriminatory access regime, an effective competition framework and efficient and equitable spectrum assignment and use in a technologically neutral licensing framework (Esselaar, Gillwald, Moyo and Naidoo, 2010). In September 2009, the Department of Communication gazetted a broadband policy for with the purpose of increasing accessibility and affordability throughout South Africa (Government Gazette 32578, 18 September 2009). The role of the state in the broadband policy is to invest where there are cases of market failure (Esselaar et al, 2010).

Hampered by a market structure unsupportive of competition and ineffectual regulation, policy outcomes, however, have not fulfilled any of these objectives. During the last decade, South Africa has slipped steadily down global indices as indicated above. The Department of Public Enterprises (DPE) in recognition of the national broadband deficit embarked on a separate process to establish Broadband Infraco (Infraco), a state-owned company that has invested in national and international backbone electronic communications networks. In October 2009, ICASA issued an electronic network services licence to Infraco to provide wholesale services to other electronic network service providers.

2. Protection of Private Information (POPI) Bill

At present, there is no clarity with regard to the protection of information. This is a major constraint in attracting investors to South Africa (Microsoft South Africa, Interviewed 29 June 2012). In 2009, the South African government proposed the Protection of Personal Information (POPI) Bill in order to bring South Africa's data protection frameworks in line with international standards. The bill is expected to affect the way companies collect, process and transmit personal information. The bill stipulates that information cannot be collected from individuals (natural or juristic) without their consent and agreement on reasons for collection. Organisations such as banks, retailers or any other organisation that determines the need to collect particular information, are responsible for ensuring compliance. The bill further includes restrictions on transmitting, storing or processing personal information outside South Africa, unless the destination country has the same levels of regulatory protection in place. In addition, the bill requires companies to proactively inform affected parties in the case of security or privacy breaches that could potentially impact their reputations. The POPI bill has implications for consumer-focused sectors including telecoms, healthcare, retail and financial sectors. The bill also impacts Cloud services. Companies will need to ensure that internal IT staff is knowledgeable of the legislation in order to ensure compliance.

There are significant implications for cost of business associated with the requirements of the proposed legislation, but there is widespread agreement that the development of services offered on the Cloud is dependent on a sense of trust that people's private data is protected and cannot be divulged to third parties or be exploited for commercial purposes.

In terms of data protection, the POPI bill will only have a real impact when it becomes law. If the bill becomes an act, it is likely to facilitate greater information flows between different continents where this was previously restricted due to the lack of adequate data protection (Microsoft South Africa, interviewed 29 June 2012).

The current policy will have to increasingly take into account the dynamism of the market. For example, at present, the younger generation places less importance on privacy and more importance on honesty. The increased use of online services and social networks has made it necessary give more constitutional rights to privacy. From an Internet service provider perspective, which acts as a gateway to the Cloud, is the importance to find a balance between the rights of subscribers and the rights of the state (ISPA, Interviewed 26 June 2012). In addition, information is not only moving into the Cloud but is increasingly becoming IP-based and there is a need to address this perspective within the policy and law.

3. Electronic Communications Transactions Act 2002

Despite South Africa being among the leading countries in terms of introducing e-commerce and transactions legislation nearly a decade ago, about 60% of the Act is still not implemented, so issues of cyber-security and trust required for diffusion of Cloud-type services remains problematic. Even though the Electronic Communications and Transactions Act (ECT Act), which covers activities like ecommerce and personal information collected through electronic means, was passed as long ago as 2002, large sections of the Act have not been implemented. The Act provides legal recognition for electronic contracts and signatures. It contains guidelines on record keeping, electronic evidence and automated transactions. It mandates cryptography service providers to be registered and electronic signatures to be accredited by authentication service providers. In addition, the protection of critical databases is mandatory (ECT Act, 2002). Chapter 11 of the ECT Act makes provisions for protection of personal information and cyber-security. The Act outlines a number of cyber offences and allows cyber inspectors to administer the act. However, this has not been operationalized in nearly a decade (ISPA, Interviewed 26 June 2012).

One of the key challenges related to the ECT Act is that the privacy provisions are voluntary. According to Dominic Cull (interview 26 June 2012), the e-commerce provisions are adequate, however there are challenges that remain regarding international co-operation and enforcement. In 2011, South Africa drafted an amended national cyber security framework, but it has not been gazetted (ISPA, Interviewed 26 June 2012).

Unlocking the Benefits of the Cloud: Policy Principles

Peter Cowhey and Michael Kleeman

Our introductory essay proposed five long-term benefits from the Cloud for emerging economies. We argued that these fit the larger story of economic transformation of lower-and middle-income countries and the interdependencies of the world economy.

Five Implications of the Cloud for Emerging Economies

1. The Cloud is central to being competitive in higher value-added products because products in the world economy are becoming more ICT intensive.
2. Cloud ICT is vital to being competitive in South-South commerce, already the fastest growing share of world trade and investment and the future home to most of the world's middle class.
3. Cloud computing can strengthen SMEs and employment in all economies.
4. The Cloud creates significant benefits for both individual users and governments.
5. The emergence of the Cloud and the build out of broadband infrastructures has strong synergies in developing economies.

The country studies have illustrated these benefits in some detail. For example, India, Mexico and South Africa are all promoting powerful ICT and Broadband networks in order to advance the technological underpinning of more value-added benefits in world commerce. Leaving aside the importance of the Cloud for their manufacturing processes, such as Mexico's sophisticated automobile production plants, all three countries are looking to become suppliers of Cloud-based services for both domestic and South-South commerce. Business processing as a Service is an example. India is providing Cloud services to Africa. South African companies hope to be Cloud providers to their region. Mexico hopes to be a "digital paradise" for Latin America. These offerings are provided by both giant global ICT firms and companies based in these emerging economies.

All three country studies described powerful benefits for SMEs and job creation that the Cloud would create. The Cloud reduces the cost, the upfront investment and the operational complexities of using ICT to help build smaller businesses into larger ones. At the same time, both SMEs and individual users are relying on many "free" Cloud services that are, in turn, paid for by Cloud enabled advertising often delivered trans-border. Restricting the Cloud, and on-line ads enabled by the Cloud, would greatly reduce the ICT service options for many users.

It was also striking to observe how many projects and experiments are under way in these three countries to use the Cloud to improve government services. These range from health to taxation and social services. The countries differ significantly in how systematically and self-consciously they link these initiatives into a strategy for government use of Cloud computing.

A broader implication of an understanding of global technology and economic developments, and the particular stories of individual countries, is the *enormous benefit of experimentation and learning by doing in an environment driven by market competition and a national policy to invest in digital capabilities*. The Cloud is the next major addition, along with the growth of a mobile broadband and a seemingly infinite variety of powerful end user devices (ranging from wireless sensors through smart grids and smart phones), in redefining how networked information can transform the world economy and many essential services for society.

It will take experience, trial and error, plus lots of smart, determined entrepreneurs in the private and public sectors, to figure out true potential of this new technology.[74] Innovation, the turning of a new technology into a powerful contribution to the economy and society, takes more than invention and massive investment. It requires interpersonal networking to spread the diffusion of the innovation and maximize learning about its possible applications. It takes an infrastructure of shared assets, such as research universities providing skilled people, and it takes innovative business models that will overturn established market practices and enable opportunities for new entrepreneurs. And, it requires specialized investment arrangements geared to the market, as exemplified by the emergence of venture capitalists that were willing to take far larger risks than conventional banks and were far more attuned to market nuances than public research funding, to fund much of the Internet's transition from a technology to massive commercial innovations.[75]

This broad range approach will require the embedding of national experimentation and innovation in the context of global experimentation and innovation. Governments can play a positive role in reducing uncertainty about the rules of the road concerning inevitable and legitimate questions about privacy, security, and equity. But, just as the emergence of the Internet infrastructure and the sophisticated export sectors of developing economies benefited from more open markets, the Cloud will be most powerful where government rules restrain from detailed micro-management and encourage multi-stakeholder groups with sophisticated expertise to continuously refine detailed solutions.

These experiments and innovations have been evolving over the years. We have, for years, permitted personal financial information in the form of credit card systems (think Visa), link banks, merchants, support services (fraud detection services, for instance) and consumers in shared data systems running across national boundaries. The transnational character holds true for email, plus mobile telephone billing and text based content, that transit numerous national jurisdictions and do so without major harm to national interests. These examples, and others, suggest that, with proper care and under minimal regulatory structure, transnational data need not be a sovereign risk. Medical consultation systems (such as "outsourcing" radiology readings) involve sensitive cross-border personal data flows that benefit patients, because a combination of medical ethics and privacy rules create a system that focuses on the required forms of protection but does not attempt to limit the movement of data. The Cloud's capabilities will accelerate these and many other developments. Therefore, it brings these innovations into more dramatic focus. But the global forerunners show that there are huge benefits from encouraging global experimentation within light-handed guidelines.

[74] David and Wright, 1999
[75] Breznitz and Cowhey, 2012.

Policy Measures to Promote the Benefits of the Cloud

A global Cloud infrastructure raises significant issues that need to be addressed on a national and even corporate or individual level. In the introduction to this report we stated the prerequisites for a Cloud infrastructure as follows:

These benefits of the Cloud require the effective and efficient movement of Internet-based information flow between the customer and the Cloud services provider. This cannot occur without three key technological capabilities. First, while some Cloud-supported applications can be delivered on narrow band networks (such as mobile health data bases), the biggest payoffs from the Cloud will arise when high speed communications service (often called "Broadband") is available. Second, Cloud Computing requires the unrestricted flow of information between customer and service provider. Third, Cloud data centers can only be effective if they achieve significant economies of scale and scope, and can respond dynamically to their customers' needs wherever they arise and with whatever data they need. This implies freedom to locate and operate data centers on the basis of efficiency considerations, and to scale data centers by handling cross-border data needs. And, as a surprising corollary, the deployment of an effective Cloud infrastructure improves the economic case for creating broadband networks in lower or lower-middle income countries.

For these conditions to emerge it will require prudent public policy that is supported by appropriate, complementary action in civil society. There is nothing requiring a single top down policy design for the global ICT infrastructure that will take advantage of the Cloud and broadband. Indeed, any such unified design could blunt the innovation of ICT infrastructure and associated services.

Nonetheless, a review of the country studies of Mexico, India and South Africa suggest that there are three critical issues for this nexus of government and civil society policy and action. We suggest how a common, global approach to some principles for policy could facilitate effective national action within a dynamic global ICT infrastructure.

1. It takes an explicit vision to achieve the potential of ICT for economic and societal goals. In all three countries there is a clearly articulated vision, with varying degrees of success in execution, for the growth of national broadband systems. This includes complementary investments in human capital investment to enable populations to take full advantage of broadband at work and at home. But all three countries have only haltingly envisioned what it would require to take full advantage of the benefits of Cloud computing. Yet, if this essay is correct, Cloud computing is an essential complementary capability to broadband; indeed, there are significant synergies in the economics of their deployment.

As the country studies showed, the emergence of Cloud service revenues provide incentives for broadband build out. Nonetheless, national policies to promote broadband and the skills to use ICT are essential complements to increasing the benefits of the Cloud.[76] Indeed, we conclude that:

[76] The principles suggested here often draw on the OECD (2011), the Aspen Institute (2012), and APEC (2005).

The Cloud's centrality to National ICT strategy: promoting a sound Cloud eco-system should be considered an intrinsic part of a national ICT strategy that, at minimum, advances universal broadband build out. Including all communities, urban and rural, makes human capital investments in digital skills and identifies how to use ICT to improve government services.

Building on the lessons from the advances made in promoting higher investment, lower prices and faster innovation since the introduction of competition in telecommunications and information service markets, sound decision-making processes are essential to making the markets work for the public interest.

Transparent rules and decision processes with multi-stakeholder participation: Governments should focus on creating transparent rules and due process in rule-making encouraging multi-stakeholder notice and comment. When possible, they should rely on multi-stakeholder groups to craft many of the detailed policies necessary to maximize the benefits from the Cloud.

While no set of processes can in themselves assure sound policies, these approaches raise the odds that governments will gather the most appropriate information and create market confidence in the competitive investment that must complement public investment in such assets as human capital and, in some cases, network infrastructure to areas that are particularly hard to serve, such as those with small scattered populations.[77]

2. It takes a global ICT network to achieve full national benefits. A national approach to creating and using this ICT infrastructure foregoes most of its potential. For example, South Africa's domestic broadband build out will go faster if integrated into cross-border broadband investments. Also, preventing the ability of global ICT infrastructures to provide local national services misses much of the Cloud's performance benefits. Even in a country with a major Cloud infrastructure, the diversity of data, applications and peak capacity needs will require reliance on unrestricted and unencumbered services from Cloud infrastructure in other countries. Moreover, redundancy in storage and processing is important to achieving reliability.

Free Flow of Information: To achieve the full benefits of global interconnection, governments should allow information to move freely and be stored globally.

Flexible placement of facilities: Governments should not require that facilities or information

be located in a specific country or region.

Encourage infrastructure development and services in open competitive markets: Encouragement of cross-border market access for investment in ICT (including broadband and Cloud facilities) and commerce (including trade in services) under transparent rules will be critical to achieving the potential of the Cloud and broadband.

The corollary to taking advantage of the ICT network and computing structure is to avoid entangling public policy choices influencing the Cloud (and the Internet) in micro-management of commercial innovation tied to an Internet driven ICT system. An example is the concern expressed over interoperability of various Cloud systems. When solutions are not perfectly interoperable it is not a reason for a policy intervention. Imagine if governments intervened in a mature technology market, such as automobiles, because many of the mechanical components of a Mercedes or Ford

[77] Noam, 2001

automobile are not fully interoperable. The variety of automobile "solutions" is, in fact, what drives continual upgrades in a mature technology.

The logic of an Internet-organized structure for ICT, including Cloud systems, is built around the increasingly standardized interfaces of Internet and related protocols that permit rapid experimentation with solutions through trial and error. Variety is part of the innovation system anchored by the common Internet protocols (that are set by an open system of global standard setting). As one technology executive described how this works in one key underpinning for ICT applications, HTML5: "What has driven HTML5 and what has driven the ecosystem of the Internet is that fast, iterative design process that happens when you have more control over the expression of your ideas at a scale that is massive." [78] Trying many different solutions quickly across millions of users, now a standard tool for software developed in Cloud environments, is a key to innovation. This suggests the following principle:

> *Cloud policy should rely on the open, voluntary global system for Internet/Web standard setting to sort out questions of interoperability.* For example, standard setting organizations, like the Internet Engineering Task Force and the World Wide Web Consortium, have strong track records and are open to participation by all interested parties. They successfully marry voluntary, commercially driven standard-setting with participation by all interested parties with the appropriate expertise.

3. A national strategy for addressing legitimate policy concerns about the privacy of user information and security of information, which Cloud computing brings into sharp focus, works best within a framework of global principles and policy approaches consistent with competitive markets and flexible implementation strategies that can cope with rapidly changing technology. Our experience with ICT is that allowing both specialization and diversity in problem solving is an important part of creating a dynamic technical ecosystem that can grow and adapt to market needs and social goals quickly. Detailed prescriptions from the top down, especially those imposing uniform technical practices to a dynamic and evolving ecosystem, are counter-productive.

There is an emerging international consensus that countries and civil society should adopt high level, compatible principles for strengthening both privacy and security (OECD, 2011; Aspen Institute, 2012). Indeed, as APEC (2005) recognized in its work on privacy, effective national measures to advance privacy protection and information security in a world with a global ICT infrastructure requires compatible national policy approaches.[79] The details of national policies may be fine-tuned to individual national sensibilities, but the approach of each nation should conform to the general principles. However, care should be taken to create policies that reflect a true underlying need, and minimally satisfy that need, along with appropriate transparency and, if needed, penalties when these policies are not adequately adhered to.

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[78] The quotation is from Rob Chandhok. http://www.fiercedeveloper.com/story/qualcomms-rob-chandhok-predicts-future-cross-platform-development-and-progr/2012-07-01#ixzz24bwl1LHn. On the modular standardization of the Internet interfaces, and their implication for competition, see Cowhey and Aronson, 2009.

[79] On implementation of the APEC framework see: http://ibmprivacy.com/2011/11/17/the-promise-of-the-apec-cross-border-privacy-rules/

We have, for years, permitted personal financial information in the form of credit card and other financial transactions to transit numerous national jurisdictions and have done so without major harm to national interests. This example, and many others, suggest with proper care, and under minimal regulatory structure, transnational data need not be a sovereign risk.

It is important to note that the benefits of a sound policy framework go beyond the benefits of protection for individual users (whether individuals or businesses). They also grow confidence in the use of the Cloud ICT environment. Our country case studies indicate even businesses continue to worry about the privacy of their data on public Cloud facilities and providers of these services should take care to both undertake the necessary steps to protect data and inform users of the protections they undertake.

While finding ways to secure data and respect broad principles about privacy of data stored in the Cloud are important, we note that two issues keep emerging across countries. We briefly explicate these issues and suggest ways of beginning to handle them in a practical, responsible manner.

We believe that the first of these issues is a dead end. This is the notion of data sovereignty—that a government can only protect citizen rights and national security if the data of its citizens remains exclusively within its borders. While issues of cross-border jurisdiction (what to do with Mexican data stored in Brazil) are perennial in international commerce and require resolution over time, the solution does not require locking data up within national borders[80]. For example, the protection of citizen privacy rights does not require the physical location of the data in the country[81]. Data tagging, encryption and management systems allow data to be complex and expensive to decrypt and have national identity tags that trigger the appropriate rules for its management, wherever the data reside. Two broad principles capturing this idea are:

Flexible location of data: Data should be allowed to be stored geographically depending on market and engineering considerations and governments should instead focus policy on functional goals for different types of data (e.g., personal medical data may have higher standards than merchant data) if necessary, and a transparent system for remedies in the case of violations of privacy protections.

Global compatibility of privacy and data security rules: National rules should be anchored in globally recognized principles (e.g., the APEC or OECD privacy guidelines) and should be crafted to assure commercial non-discrimination among providers of infrastructure and services. When possible, governments should offer mutual recognition of other countries' laws that achieve the same objective.

Second, our case studies made clear that the security of data issue of government access to personal data is a sensitive issue everywhere. Every government exercises the power to access personal data for security reasons, although national practices vary. Even among wealthy democracies, many countries exercise this power frequently and with considerable secrecy. (Indeed, parliamentary systems tend to delegate more discretion to the executive branch of government than is typical in a system of divided powers found in countries like the United States. Thus, many parliamentary

[80] National Foreign Trade Council et al, 2011

[81] In fact today virtually all international e-commerce would violate a sovereign jurisdictional requirement, independent from any Cloud implementation

governments exercise these surveillance powers with fewer requirements for transparency than in the United States.)

On matters so close to the fundamental responsibility of governments for security, there will continually be a debate about the right degree of government access. But recognizing the need for a common set of principles and drawing on the best lessons from the extensive experience in handling this balancing act in the past would be good starting points. This suggests the following general principle:

Governments should embrace internationally recognized principles for Internet data privacy and security that draw on policy precedents: As the Aspen IDEA Principles (2012) proposed, "Governments should work to create a level playing field and achieve global interoperability on privacy and data protection principles by basing privacy rules on globally recognized principles (such as the OECD privacy guidelines)… Internet providers should disclose requested third-party information only to the extent required by law and, to the extent permitted by law, should provide affected customers [regardless of nationality] with reasonable advance notice of any such compelled disclosure.)." [82]

As governments wrestle with this sensitive issue, they should also consider the fact that there is a long history of balancing goals of privacy and national security. The Economist has suggested that, as a starting point for working out balance, governments consider: "A good general principle would be to afford data stored in a private e-mail account as much protection as letters stored in a locked desk drawer..." [83] While this pithy formula won't be the right final answer, it reminds us that there is a rich prior history of reconciling security and privacy that assists governments in working out a common set of policy principles.

[82] Aspen Institute, 2012. The clause, "regardless of nationality", was added by the authors.
[83] The Economist, 2012.

Conclusion

The Cloud, and its underlying broadband networks, is the next logical phase in the move toward global connectivity, which started with the telegraph and most recently was embodied by the Internet. The benefits of the Cloud, with its economic efficiencies and technological drivers, are growing inevitably in scale and scope. The move toward the Cloud is not the pinnacle of our technological achievement in ICT, but it is a significant plateau, building on numerous technology trends that have converged to enable its emergence. Like the globalization of products and physical commerce and the Internet before it, the Cloud disrupts legacy practices but will bring value across all segments of society and increase intellectual, economic and social inclusion worldwide. Along with any change comes the legitimate concern about potential negative impacts. However, if globalization and the Internet have taught us anything, it is that the public values the benefits these changes can bring and that by moving with a bit of patience, and a light hand, governments can achieve the dual goals of protecting their citizens and improving their lives in the face of such changes.

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