International Journal of Information Management 33 (2013) 810–815

Contents lists available at SciVerse ScienceDirect

International Journal of Information Management

journal homepage: www.elsevier.com/locate/ijinfomgt

Viewpoint

Cloud computing: A democratizing force?

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ARTICLE INFO

Article history:

Keywords:
Cloud computing
Mobile
Developing country
Democratizing
Disruptive innovation

ABSTRACT

There has never been a more disruptive innovation in the IT landscape such as cloud computing since the emergence of the Web in the early 1990s. This IT delivery service has the potential to change many aspects of organizations' operations, thinking, culture, work and their ability to control global warming. With the increasing ubiquity and pervasiveness of mobile devices, cloud computing's impact could be even greater and much wider in its reach. But this emerging innovation has many hurdles to surmount to become the "telephone" or the "water" equivalent of the IT world. An examination of these issues will be made in this article and an exploration of the empowering and democratizing credentials of cloud computing will be attempted.

1. Introduction

Cloud computing is a model of delivering a range of IT services remotely through the Internet and/or a networked IT environment. When it emerged in 2007 it attracted a great deal of attention from many quarters (e.g., authors, consultants, technology analysts, companies). Many people (including industry analysts and leading figures in the IT world) dismissed it as a "fad" (Hasson, 2008; Johnson, 2008). With time, the model began to gain currency and many of the big players in the IT world threw their weight behind it. Concerned of being left behind (and the KODAK experience is still fresh in people's mind), many companies jumped on the cloud bandwagon. Many respected IT market research organizations predict great future growth for cloud computing services in the future. For example, Gartner (the global IT research and advisory company) anticipates a massive cloud computing explosion, fuelled largely by the economic turmoil of the last few years. In a report published in 2010, Gartner expected the global cloud services revenue to reach nearly US$150 billion by 2014. This level of spending, according to Gartner's Vice President, Ben Pring, is directly related to increased economic pressures which made organizations scrutinize every expenditure (Hickey, 2010).

The model of cloud computing relies on the delivery of mainly three types of services:

- business-related computer programmes (Software as a Service – SaaS);
- fast and almost unlimited processing capabilities, virtual machines (e.g., servers) and almost unlimited storage facilities (Infrastructure as a Service – IaaS);
- development tools and hosting options for clients preferring to create and manage their own Web applications (Platform as a Service – PaaS).

Cloud computing services can be provided by cloud vendors through their data centres. These forms of service are known as "public clouds". Subscribers to this service do not need to make any significant investments in hardware, software or staff and they can choose to pay for their services on a contract or pay-as-you go basis. Moreover, by using public clouds organizations can also make savings in terms of power consumption (e.g., less electricity to power and cool machines), producing less CO_2 emissions, less space to house IT machinery, etc. Organizations can also choose to have their data centres (located in their own premises) configured with cloud software to serve their own needs. This is an example of "private clouds". In this situation the organizations become their own "cloud service providers". Organizations that choose to "do it themselves" are likely to be those that are very security-conscious. Large organizations and/or organizations in sensitive businesses (e.g., defence, intelligence) might opt for having their own private clouds. This kind of arrangement forgoes many of the benefits that public clouds can afford organizations (e.g., metered software use, less skilled labour, less space and electricity expenses). According to one analyst, a private cloud is not a true cloud service because it lacks the freedom from capital investment and the virtually unlimited flexibility of cloud computing (Reese, 2009). Other organizations might choose to have some aspects of their business served by a combination of both public and private clouds. This kind of arrangement is becoming known as a "hybrid cloud".

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http://dx.doi.org/10.1016/j.ijinfomgt.2013.05.010

2. Break with the past

One of the main features of the cloud computing model is that it represents a significant break with the past in terms of IT delivery. By using cloud computing (provided by public cloud vendors) organization can now concentrate on their core businesses and leave the IT aspect of their operations to experts (who might not be located on their own premises). Public clouds can offer scalability (i.e., use according to requirement) and obviate the need to make large investments in expensive hardware and software licenses and offer organizations significant cost advantages (Leavitt, 2009; Lin, Fu, Zhu, & Dasmalchi, 2009). Continuous upgrades of software and hardware have become common (and expensive) practices in many organizations during the last three decades. Such expense is likely to be made worse in the current economic climate following the near collapse of the world's financial systems. Cloud computing can provide many of those organizations with the opportunity to continue to take advantage of new developments in IT technologies at, potentially, affordable costs.

3. Serious concerns

Despite the potential and attractive economic and flexible characteristics of cloud computing there are still many issues with this model that needs to be resolved. Issues relating to security, outages (i.e., temporary loss of service) and interoperability (i.e., portability or ability to change one's supplier) and are the most significant (Sultan, 2013). Security is no doubt one of the main concerns for organizations contemplating the adoption of this IT service model. A survey of more than 1650 IT and security decision-makers from a range of industries, conducted by IDG Enterprise in 2012, revealed that the number one barrier to implementing cloud strategies was security (70%), followed by concerns about accessing information (40%) and concerns about information governance (37%) (IDG Enterprise, 2012). Moreover, various governments, such as those in the European Union (EU), have privacy regulations that prohibit the transmission of some types of personal data outside the EU. This issue, however, is no longer a problem as many cloud vendors now (such as Amazon, Microsoft and others) were able to establish some of their cloud data centres in various locations across the EU region and elsewhere in the world and can offer their cloud clients the option of where they want their data to be stored.

Amongst other concerns were bankruptcy, outages and vendor-lock (resulting from lack of interoperability due to the non-adoption of open protocols or standards). Currently, many cloud providers offer their services through proprietary protocols or Application Programming Interfaces (APIs). This means that organizations that sign up for the services of cloud providers will find it difficult to change cloud providers in the same as way as, for example, changing an electricity supplier.

Furthermore, failure of a cloud provider that hosts client data in its data centres can have serious repercussions for those clients who trusted their data with that provider. This issue could force potential cloud users to go for well-established and large companies that are more likely to be around for many years to come (e.g., Microsoft, Amazon, Google, IBM, Salesforce.com).

Reliability can also be a serious problem for cloud users. Many of the big cloud providers such as Salesforce.com, Amazon, Google and Microsoft saw their systems afflicted with outages which affected large scores of their customers since 2008 (Clarke, 2011; Johnson, 2010; Leavitt, 2009; Naughton, 2009; Pepitone, 2011; Raphael, 2011). In keeping with previous years, the year 2012 also had its fair share of high profile cloud outages. For example, on 28 February, a so-called leap-year bug caused Azure (Microsoft's cloud platform) to suffer an extensive, worldwide outage that lasted for more than 24 h. Azure customers in Western Europe had also endured a loss of service (which lasted for 2.5 h) on 26 July due to a "misconfigured network device" that disrupted traffic to one cluster in Microsoft's West Europe sub-region. On 15 June, an Amazon Web Services (AWS) power outage cut services to customers for about 6 h, affecting its Elastic Compute Cloud (EC2) service, Amazon Relational Database Service and AWS Elastic Beanstalk, which are run from Amazon's data centres in Northern Virginia. Google App Engine, the company's platform for developing and hosting Web applications in Google-managed data centres, went down on 26 October for about 4 h due to slowness and errors causing 50% of requests to the App Engine to fail (McCarthy, 2012).

If there is anything that is likely to prevent cloud computing from becoming the IT equivalent of a public utility, it will no doubt be the issue of interoperability. Currently, it is not possible for cloud users to change their cloud providers with little difficulty in the same the same way as to when they change their telephone or electricity suppliers. This is because there are no open standards or protocols that cloud providers can use to underpin their platforms. Some of the big cloud providers (e.g., Amazon and Microsoft) have adopted SOAP (Simple Object Access Protocol) and REST (Representational State Transfer) protocols in their cloud platforms in order to address the interoperability problem. Organizations such as the Open Data Center Alliance, the Storage Networking Industry Association and the Distributed Management Task Force (DTMF) are also working with several other standards groups to address cloud services problem of interoperability. Thanks to the efforts of such bodies, a number of cloud standards (mainly based on REST) have emerged (Harsh, Dudouet, Cascella, Jégou, & Morin, 2012). Cloud vendors affiliated with these platforms and coalitions have the opportunity to position cloud solutions to meet market demand while keeping customer concerns around environment and interoperability issues top in their minds (Henlin, 2012). The need for inter-cloud interoperability was highlighted by Vint Cerf, a co-designer of the Internet's TCP/IP, who likened the current lack of cloud communication standards to that of computer networks in the early 1970s (Krill, 2010). However, some industry analysts see industry standards for cloud computing as something for the distant future and may not even be possible (Smith, 2010). Greed is often cited as one of the main barriers to interoperability because its non-existence benefits software vendors (Urquhart, 2012). A report by the European Commission (2012) states:

"Currently, individual vendors have an incentive to fight for dominance by locking in their customers, inhibiting standardized, industry-wide approaches. Despite numerous standardization efforts, mostly led by suppliers, clouds may develop in a way that lacks interoperability, data portability and reversibility, all crucial for the avoidance of lock-in. Standards in the cloud will also affect stakeholders beyond the ICT industry, in particular SMEs, public sector users and consumers. Such users are rarely able to evaluate suppliers' claims as to their implementation of standards, the interoperability of their clouds or the ease with which data can be moved from one provider to another".

Apart from "greed", the IT service is a more complex phenomenon. To think of the potential of cloud computing becoming another public utility (similar to water, gas and electricity) is probably a tall order. IT drives its complexity, to use James Moor's terminology, from its "logical malleability". This feature enables computers to be shaped and moulded to do any activity that can be characterized in terms of inputs, outputs and connecting logical operations (the precisely defined steps that take a computer from one state to the next). According to Moor, it is this feature which assures the enormous application of computer technology whose consequence will be transformations in our human activities and social institutions (Moor, 1985).

4. New market disruption

Cloud computing seems to have all the ingredients of a "new market" disruptive innovation if one is to employ the theory of disruptive innovation (developed by Christensen and his colleagues) as a point of reference (Christensen, Anthony, & Roth, 2004). According to this theory new market disruption occurs when an innovative product attracts customers who were prevented from acquiring similar products due to cost and/or complexity issues. Examples of such innovative products include Sony's first battery-powered transistor pocket radio, Canon's desk photocopier, the PC, etc. These innovations were able to create growth by making it easier for people to do something that historically required a great deal of expertise, expense or inconvenience.

Moreover, such innovations are often looked upon, initially, with cynicism or dismissed as useless inventions. The proposers of this theory provide many other examples; the most powerful is that of the telephone. William Orton, the President of Western Union (once a major US communications company specializing in telegraphy), described Alexander Graham Bell's telephone invention as "an electric toy" when his company declined to buy the inventor's patent for US$ 100,000. A few years later, the telephone eventually killed telegraphy and led to the demise of Western Union.

From this brief description, it is evident that cloud computing has many of the attributes of a disruptive innovation (Sultan & Sultan, 2012). For example, it has the potential to destabilize existing IT markets (e.g., those that rely on providing traditional on-premise IT solutions) and create other business opportunities that did not exist before (e.g., consuming IT, both as software and hardware) when needed, according to demand and with less requirements for infrastructural expenses (e.g., hardware, staff). The theory also suggests that disruptive innovations often tend to initially have performance problems. The aforementioned concerns of cloud computing and the infrequent loss of service experienced by cloud customers are clear examples of the initial performance issues that often characterize disruptive innovations.

5. The cost implications: ROI or value?

No doubt, the cost structure of cloud computing will be attractive to many organizations. In fact, research suggests that many of the businesses that contemplate the adoption of cloud computing are attracted by the potential savings that they are likely to make. A survey conducted by the European Commission in 2011 showed that the adoption of cloud computing has enabled 80% of surveyed organizations to reduce costs by 10–20% (European Commission, 2012). A survey of 500 IT and business professionals in the United States involved in IT decision making and 400 IT firms, conducted in 2012 by CompTIA (a major IT Research firm) found that 85% of the respondents felt more positive about the benefits of using cloud computing, up from 72% in 2011. The survey also found that more than eight in 10 companies use some form of cloud technology. When asked to identify the top driver for cloud implementation, 50% of the respondents mentioned cost cutting (CompTIA, 2012; Leftus, 2012). The CompTIA study also shows that IT channel companies (those providing services subcontracted from other businesses) are poised to step up their involvement with the cloud. Interestingly, the number one catalyst that channel firms cite as driving their entrance into cloud solutions is to provide their customers with access to new opportunities and capabilities not previously available to them. This, according to Carolyn April (CompTIA's Industry Analysis director) is "one of the truly disruptive aspects" of the cloud computing mode. She comments:

"Advanced software for analytics, unified communications, enterprise resource planning, customer relationship management and other sophisticated technology solutions were often out of the price range or skill set of many businesses. With cloud-based solutions and delivery and either set monthly pricing or a pay-as-you-go model, these technologies come within the financial reach of even the smallest of small businesses" (CompTIA, 2012).

Experience by some cloud users, however, suggests that the cloud rewards are often not immediate. One Chief Technical Officer (Doug Menafee) of a leading US emergency and hospital medicine management company (Schumacher Group) that successfully implemented a SaaS solution admitted that a cloud solution could be more expensive to run in the short term due to the heavy connectivity demands that require the installation of expensive high speed cables such as fibre optics. He explained that it takes a three year ROI (return on investment) period to break even and over five years to realize the economic benefits (Brooks, 2010a). The aforementioned 2012 survey by IDG Enterprise seems to support this view. The majority of the surveyed organizations (63%) agreed/strongly agreed that there will be long term cost savings despite short term costs associated with implementing cloud initiatives (IDG Enterprise, 2012). An online survey of 150 IT executives (located in the USA) conducted in 2012 by Forrester (the global research and advisory firm) and Juniper Networks (an American manufacturer of networking equipment) revealed that 58% of those surveyed admitted that using cloud services had put pressure on their networks which required their companies to upgrade their networking hardware (Hesseldahl, 2012).

Interestingly, there are many models in the market that purport to measure cloud computing's ROI (Brooks, 2010b). But is ROI suitable for cloud computing? Plummer (2012) argues that ROI is usually a measure of hard monetary return on the use of products or services and that the soft side of this model is almost always underplayed or ignored entirely. With cloud computing, according to Plummer, stipulating that a hard-money ROI will be achieved, in the form of savings, is likely to be disappointing. He argues that what matters in the case of cloud computing is "value". Measuring a service's ROI, according to him, is a great deal difficult when it comes to a piece of hardware or software because the only way you can tell if a service is successful is to examine how satisfied the consumers of that service. He further comments:

"Price is determined by what the market will bear. Performance is tracked based on any number of metrics that are related to what you want to get out of the service. Think about it. If you visit a high-priced steakhouse, do you think about an ROI on eating dinner? When you get your clothes dry cleaned, do you ask what the ROI is of dry cleaning versus doing it yourself? No. You focus on how good the meal is; or the price, reliability, and result given to you by the dry cleaner. That's because a world of services is a world focused on outcomes" (Plummer, 2012).

Although cost efficiency, according to Henlin (2012), fuelled early adoption of cloud computing, future long-term purchases of cloud computing solutions will depend on IT's ability to position cloud as driving business growth – moving beyond technology to link cloud with existing business processes. The CompTIA survey also suggests that three-quarters of the largest channel firms cite expanding customer opportunity as a major driver behind adopting cloud (CompTIA, 2012).

6. Democratizing IT

The aforementioned concerns are genuine and real. However, there are efforts to address some of those problems emanating from different bodies, as indicated above. Interoperability is likely to be increasingly important as the number of cloud providers increase. The issue of security is, nevertheless, a controversial one. Many analysts believe that security is likely to be more robust in a cloud

environment, given the massive resources of cloud providers, than one maintained in-house (Ashford, 2009; Financial Times, 2009; Linthicum, 2009). Nevertheless, many cloud providers are now offering hybrid solutions where clients are given some level of control over the security of their data (Taneja Group, 2011).

Given the compelling economic attractions of this computing service delivery model, many organizations are likely to embrace it despite its current problems. Small to medium enterprises (SMEs) are likely to be among the main beneficiaries of this computing service due to their limited resources which constrain their ability to make large IT investments (Sultan, 2010a,b,c,d, 2011).

If democracy means empowering the weak by providing equal access to resources, then, no doubt, cloud computing is a democratizing force. Waggener (2009) argues that cloud computing offers the promise of democratizing technology by enabling each one of us to become our own one-person IT team. This view is echoed by other authors. Dean (2011) sees in cloud computing an attempt to rewrite standard approaches to technology infrastructure while Kepes (2011) thinks that cloud computing has unleashed a democratization process similar to that brought about by the word processor. According to Kepes, the economics and speed of provisioning cloud computing resources is enabling an entire generation of businesses to be founded. Citing the story of Quora (a community question-and-answer website), he comments:

"...one needs only look at the meteoric growth of question and answer site Quora.com, which in December 2009 began to experience usage spikes of 5–10 times its normal load. By utilizing Cloud Computing for their infrastructure needs, Quora was able handle the load with relatively few issues" (Kepes, 2011).

Indeed, contrary to conventional wisdom, an increasing number of major companies are also embracing the cloud (Sultan, 2010a,b,c,d). For example, a report by Forrester, based upon a survey of small and large enterprises located in North America and Europe, revealed that large firms were more interested than small firms in leveraging IaaS (Infrastructure as a Service) external cloud capability (Golden, 2009). Among those organizations are those engaged in medical research and drug development for serious illnesses such as cancer. One of the greatest challenges for such organizations has been the need to obtain and maintain a computational infrastructure required for analysing a vast flow of proteomics data generated by mass spectrometry instruments used in determining the elemental composition as well as chemical structure of a molecule. Cloud computing provided that ability by removing the high cost barriers (e.g., infrastructural investments) and the complexities (e.g., learning, training) associated with such undertaking.

Cloud computing for High Performance Computing (HPC) has not been on the priority list of many cloud providers until recently. However, with the ability of more cloud vendors to provider faster speed and networking connections, cloud providers began to realize the business potential of providing reliable and cost-effective services for HPC-oriented organizations. Several application areas in this category appear particularly suitable for cloud computing. Among those are drug discovery, personalized medicine, translational medicine and genomics (Rubenstein, 2010). Amazon is emerging as the dominant player in this field. However, it is likely that more cloud providers will be moving into this computing area as more people from the scientific community begin to look at this computing service for solutions to their problems (Sultan & Sultan, 2012).

Indeed, the democratizing impact of cloud computing is being felt in less developed nations. For example, a number of African educational establishments have adopted cloud computing, largely due to the inadequate IT infrastructures that exist in their countries and their inability to cope with the endless cycle of hardware and software upgrades. Google, in particular, has been very successful in targeting the East African educational market. For example, the giant cloud provider has partnered with a number of East African educational establishments (e.g., the National University of Rwanda, the Kigali Institute for Education, the Kigali Institute for Science and Technology, the University of Nairobi, the United States International University, the Kenyan Methodist University and the University of Mauritius) in order to provide their students with some of the applications that exist in its collaborative and productivity cloud software (i.e., Google Apps). These universities were also helped by a World Bank grant that supports bandwidth subsidy in universities (Wanjiku, 2009).

In Ethiopia, Microsoft has rolled out 250,000 laptops to the country's teachers, all running on Microsoft's Azure cloud platform. The laptops were intended to enable teachers to download curriculum, keep track of academic records and securely transfer student data throughout the education system, without the extra cost of having to build a support system of hardware and software to connect them (Chan, 2009).

The ability of cloud computing to help African education, not only by reducing IT costs but also by making education more efficient than before, could revolutionize access and quality of education in this under-developed continent. Many of the large cloud providers see also lucrative opportunities in some of the developing countries. For example, IBM has established a number of computing centres in China, India, Vietnam and Brazil. Other cloud players such as Microsoft, VMware, Salesforce.com and Parallels are also active in the developing world (Kshetri, 2010).

There are increasing speculations from some industry observers that cloud computing could help developing countries overcome some of the limitations of their poor IT infrastructures. Given that cloud computing reduces reliance on physical infrastructure this, on the surface, seems to make sense. However, the reality is different in some developing countries that suffer from continuing power cuts and poor broadband infrastructures (essential necessities for a proper use of the Internet and consequently cloud computing). Such environments are unlikely to be conducive to any meaningful use of cloud computing. However, during the last few years the penetration of the Internet in many of these countries has been dramatic.

Egypt, for example, has been one of those countries that have experienced high Internet penetration rates during the last few years. A report by its Ministry of Communications and Information Technology (MCIT) indicated that there were 23.51 million Internet users in January 2011 growing at an annual rate of 39.61% while the proportion of households using the Internet was 32.76% and growing at an annual rate of 7.25% (MCIT, 2011). Tunisia also has one of the highest Internet penetration rates in the African continent with 3.6 million users, half of the population (Ryan, 2011). Such high rates of Internet usage (which enabled access to online social media) in these two countries have played an important role in toppling the dictatorial regimes in these two countries during what came to be known as the Arab Spring. This issue is echoed by Janardhan (2011) who argues that the growing use of new media (in reference to online social networking and Internet-enabled mobile devices) to advance political reforms is a natural consequence of the fast-rising number of Internet users in the Arab Word, estimated at 46 millions in 2008 which represents an impressive Internet-usage growth rate of about 13 folds between 2000 and 2008.

Broadband speeds in emerging markets may not be great (e.g., 1691 kbps) with average upload speed of 795 kbps. They are however adequate for basic cloud services. Some countries such as Egypt, South Africa, and the UAE have developed their networks sufficiently to support intermediate cloud applications such as CRM, ERP, and basic video conferencing. Large organizations in emerging markets are likely to find the model of cloud computing appealing as it addresses three of the most important challenges:

(1) limited availability of IT skills, (2) capital constraints, and (3) security risks (Ford & Belmans, 2012). A Cisco survey suggests that small businesses in developed countries will rely extensively on cloud applications to manage their communications and business processes over the next five years with nearly 50% of them will be spending more than one third of their IT budgets on cloud services in 2013 (Ford & Belmans, 2012). The cloud impact, according to these authors, will be much greater in emerging markets where small businesses do not have capital or the skills to use IT and will put such companies onto the first step of the technology ladder.

7. Mobile cloud computing

Indeed, if there is any real future for a massive uptake of cloud computing in the developing world it is likely to be through mobile devices. And there is rationale for this suggestion. In 2011 worldwide shipments of smart phones were estimated at 487.7 million, overtaking client PCs (e.g., pads, netbooks, notebooks, desktops). This was a 63% increase on the 299.7 million smart phones shipped throughout 2010. The increase of the demand for smart phones was driven partly by their availability at low prices and partly by a driving trend of increasing consumer appetite for Internet browsing, content consumption and engaging with apps and services on mobile devices (Canalys, 2012). According to Dikaiakos, Katsaros, Mehra, and Pallis (2009) one of the visions of the 21st century computing is that users will need to access Internet services over lightweight portable devices rather than through some descendant of the traditional desktop PC. And since users who have access to such devices are unlikely to have (or be interested in having) powerful machines, it is likely that cloud computing will be the source of that computing power.

The comfort level of mobile phone usage in these countries – combined with unreliable power supply and lack of broadband infrastructure – offers a unique opening that cloud computing could fill. Providing SaaS through mobile devices can give businesses in the developing world a free or low cost alternative to traditional desktop-based productivity applications. These businesses now have the option to use business software (e.g., CRM applications) that is prohibitively expensive in the traditional software world. By moving their data to the clouds, these businesses are not held hostage to frequent power failures and broadband disruptions that are common in many third world countries (Gounder, 2010).

With the advent of low cost smart phones and netbooks with mobile data capabilities, they can now have IT infrastructures that can parallel even those of developed countries (Greengard, 2010; Harris & Nunn, 2010; Subramaniam, 2008, cited in Gounder, 2010). The democratizing force of cloud computing provides an opportunity for individuals and businesses in developing countries to compete with those in advanced nations on an equal footing. Such an opportunity has the potential to create tremendous growth in these countries and help in their fight against global poverty (Subramaniam, 2008, cited in Gounder, 2010). Such scenario will no doubt have a disruptive impact on the world's ability to access IT resources and will potentially bridge the digital divide that currently exists between the developed and the developing countries or north and south, thus making cloud computing a force for good in a world marred by historic inequality and financial greed.

8. Conclusion

Despite early misgivings about its future and commercial viability by analysts and software vendors cloud computing has forged ahead and managed to establish itself as an IT service model that can deliver both savings and value to its users. Most importantly, the model has many of the features of a disruptive innovation. It has enabled affordable and easy access to IT resources (both software and hardware) that traditionally required a great deal of expense, expertise and inconvenience and has the potential to displace an IT market based on-premise delivery of IT resources.

Many organizations (large and small), as indicated in this article, have benefited from using this new model of IT service delivery and many have expressed interest in using it. If democracy is about empowering the weak by providing equal access to resources then cloud computing is emerging as a democratizing force. It has the potential to provide less-endowed SMEs with access to resources that would have been outside their affordable reach and, as indicated in this article, has also the potential to bridge the digital divide that exists between developed and developing countries.

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