
Chapter 5

The world online: demand for cloud services

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Although the underlying notion behind the term *cloud computing* was first developed decades ago, the possibility of actually using computing capacity in the same way as electricity or gas seemed to belong to some distant future. The early days of computing were dominated by the use of mainframes. These large computers did all the work and stored all the information, but they were remote and inaccessible to users, who could only access them via “dumb” terminals at their workstations, i.e. terminals that did not allow data to be processed or programs run locally. With the advent of the PC, computing moved to a distributed environment, where it was individual users’ computers that processed and stored data. This system provides users with greater control and flexibility but, as we shall see, it is inefficient. Internet and mobile communications are again changing the way users access information. In a world in which Internet access is now being transferred to mobile phones and terminals, and in people are socialising over social networks, users are increasingly demanding access to their information from anywhere and at any time. Cloud computing involves one further step in the development of computing, now so central to our new society. And users appear to be the great drivers of demand for these services, perhaps not in percentage terms, but certainly in terms of numbers. We may sometimes not be aware of it, but this demand is growing exponentially. A notion which until recently seemed destined for the distant future is now a normal demand from users.

Business and government, after some delay, are also throwing their hat into the clouds. This partly due to demand from employees and the public, but to a large degree it is because of the potential benefits it offers. The economic crisis has sped up adoption of the cloud as organisation seek to cut IT costs, but this is just one of many potential advantages. Businesses are gradually becoming aware of the range of opportunities the new concept has to offer. And at the same time, cloud computing is helping to leverage innovation. Small businesses and individual users can now access similar resources to large corporations, with minimum investment and pay-per-use charges. This makes it easier to roll out new ideas and boosts the expansions of successful ones thanks to increased demand. Nonetheless, in addition to the advantages, there are also some uncertainties and obstacles about the cloud that cannot be ignored. In order to minimise these, business and government need to establish a transition strategy that will set out the steps needed for progressive adoption of the cloud. This strategy must take into account all the social, economic and legal aspects that might be involved in data migration. Certain aspects are common to all possible strategies, but essentially they will depend on individual circumstances and each company or government will have to decide what it wants to move to the cloud and what type of cloud it wants to use at any given time.

However, cloud computing is not only a technological advance; it also has the potential to impact society in general. With the coming of the cloud, computing is now accessible to countries and individuals that lack the wherewithal to invest in the necessary infrastructure, but do have the talent and ideas to develop

innovative products. The spread of cloud computing can mark a quantum leap, levelling the playing field and spurring the development of emerging and third-world countries. The impact on education will be fundamental in this regard and the cloud's potential to encourage distance education and research are two of the central areas in which the new paradigm is proving its worth. Nonetheless, the cloud needs to show not only its commitment to development, but also its "greener" side. Society today is concerned about the sustainability of the planet and although—as we shall see—centralisation of computing helps reduce power consumption, large data centres are huge (and ever larger) energy consumers. Providers will therefore have to develop solutions to improve performance, an aspect on which some of them are already concentrating.

5.1. Working in the clouds: implications for business and the public sector

In 1965, Gordon E. Moore, co-founder of the microprocessor maker Intel, described a trend he had noted in integrated circuits whereby the number of transistors per chip doubled every two years⁶⁶. This trend, which came to be known as "Moore's Law", has held true for over forty years⁶⁷, leading to an approximately identical fall in the cost of computing and data storage. Despite this drop in the price of computing, however, the cost of recruiting staff with the necessary profile to implement and manage systems has not followed the same trend. Large business and governments have IT departments with specialists of this kind who are in charge of managing their technological infrastructures. Generally speaking, they account for a major part of their budgets. Smaller businesses, on the other hand, do not have the necessary capital to invest in a specialist department and have to content themselves with inferior technologies. Cloud computing partly arose to respond to this need among SMEs (small and medium-sized enterprises), but large companies and governments are taking an increasing interest in this new model as budgetary cuts become the norm in these recessionary times.

The feature of cloud computing that is attracting most attention in business and government is the possibility of turning the fixed costs of their data centres and IT departments into variable costs, paid for by use. At a time when credit is scarce and new investments are limited, the flexibility of having computing capacity on demand is particularly attractive, since it means businesses are no longer hindered by growing demand and costs falls proportionally with demand. The flexibility also encourages innovation in products and services, since small firms can put their ideas into practice, whereas previously they did not have the resources to do so. One should not make the mistake of viewing cloud computing as a simple technological change; it may represent a change in the operating model of business and government. In this new model, the business itself resides on the cloud, because it is there that the information is stored; this is one of the basic features of the new services economy.

Handing over control of the information to cloud providers is a step that needs to be studied carefully, especially when the information in question is confidential.

⁶⁶ http://download.intel.com/museum/Moores_Law/Articles-Press_Releases/Gordon_Moore_1965_Article.pdf.

⁶⁷ <http://www.intel.com/technology/mooreslaw/>.

This dilemma affects business, but particularly government. As we shall see, the particular characteristics of government make it a prime benefactor of the cloud, but constraints on the data being handled, particularly the personal information of its citizens, prevent total adoption, and other alternatives are therefore being sought. Nonetheless, as well as acting as a cloud user, the public sector should also play a role in establishing a regulatory framework for business, since the deployment of certain economic and technological trends is nearly always closely related to initiatives by a country's government.

For most organisations, the decision to be made will concern the type of cloud to be introduced and this will depend on the different intended uses; there is no reason why they should limit themselves to just one type of cloud. For small businesses the choice of clouds will be more limited, but for some large companies and government organisations, a private cloud may be a suitable alternative, since it will allow the organisation to optimise the cloud for its own purposes.

5.1.1. The democratisation of computing for SMEs and start-ups

How many innovative ideas have never actually been launched owing to a lack of resources? Inability to make the investment needed to implement a new idea, a new product or a new service is the reason why a whole host of innovative ideas have never advanced beyond the drawing board. This is all the more true in the case of small enterprises, given that they have greater financial constraints. Considerable investment tends to be required to launch new products and services and these firms often do not have the necessary capital, thus inhibiting their capacity for innovation.

In this arena, the technology has patently proved its ability to facilitate the launch of new business initiatives. The developments of the last decade have transformed society and the business world in general. The speed of change means that it is essential for businesses to be able to analyse information and know their customers, aspects in which SMEs are at a disadvantage compared to large corporations. Whereas the latter have committed major investments to IT and have technology departments that allow them to make use of the large quantities of information available, SMEs cannot afford such in-house systems and often have to make do with outdated computer systems. It is here that cloud computing can offer an alternative, by speeding up the benefits of technology for start-ups and small and medium-sized businesses. The applications, storage and infrastructure services that cloud servers can offer will enable many SMEs to compete on equal technological terms with large corporations. The major investments needed in IT are becoming a thing of the past and are being replaced by computing capacity on demand, turning a high fixed cost into a variable cost and thus reducing the risk incurred in launching new products and services and developing new business.

The cloud levels the playing field between SMEs and large corporations, opening up a more dynamic business world marked by innovation, in which the time-to-

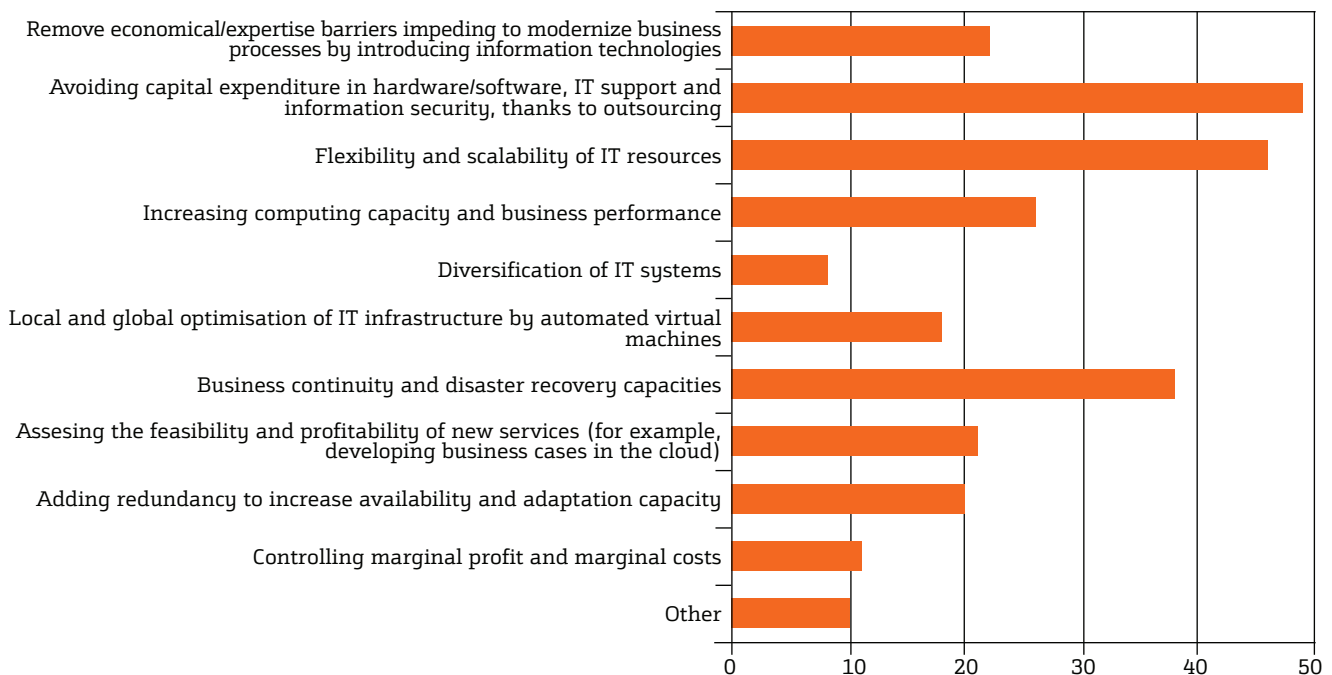


Illustration 8: Reasons for possible adoption of cloud computing.

Source: *An SME perspective on cloud computing, a survey by ENISA (The European Network and Information Security Agency)*⁷¹

A case in point is Phanfare, a company offering unlimited photo and video hosting, which decided to use Amazon's S3 service, which allows easy-access storage over the web⁷². According to Andrew Erlichson, CEO of Phanfare, the storage offered by Amazon has enabled it to cut the cost per gigabyte from 5 - 6 dollars to 2 - 3 dollars. In turn, it has allowed them to focus Phanfare's resources on developing software for processing videos and pictures, instead of on managing data storage. Erlichson says, "Our differentiator is software development; it's not storing data on generic disks".

Another appeal of cloud computing for SMEs is the reduction in implementation and updating times it offers. Cloud-based applications can be up and running in a few days and users can increase or reduce the resources they allocate to them almost instantaneously. In addition, they receive security and performance upgrades automatically at no additional cost. The reason is the reduction in development and testing times seen in latest-generation applications, thanks to the ease of re-using existing applications and the boost to open-code initiatives. This allows new businesses to start working in practically a matter of hours. As well as this significant reduction in time-to-market, it maximises the return on investment in IT, thus encouraging new business opportunities.

⁷¹ <http://www.enisa.europa.eu/act/rm/files/deliverables/cloud-computing-sme-survey/?searchterm=sme%20survey>.

⁷² http://www.businessweek.com/technology/content/aug2008/tc2008083_619516.htm.

Small and medium-sized enterprises are beginning progressively to adapt their businesses to the cloud. One of the simplest services to move to the cloud is undoubtedly e-mail. If you have used Gmail, Hotmail or Yahoo, you've already used cloud email. However, for a more professional and entirely functional service, it was necessary to create an in-house mail server, Microsoft Exchange Server, which is more complex, more expensive and comes with a costly support service. At present, services such as Microsoft Hosted Exchange and Google Apps Premium Edition offer professional e-mail services at a fraction of the cost of in-house solutions. Cloud email providers manage the entire service, taking care of all the initial configuration requirements, the migration from existing systems and user support. SMEs now have access to professional e-mail services with an assurance of availability, security and flexibility that were previously not available to them.

Moving e-mail to the cloud is a small step; however, the spectrum of applications offered on the cloud is vast. Providers offer on-line alternatives to standard applications such as word processors, spreadsheets and tools for preparing presentations, or even virtual operating systems that practically do away with the need to have a single PC for every employee. Another area of particular appeal for SMEs is the use of information on customers' tastes. In an increasingly sophisticated and complex world, it is essential to have information on customers' preferences in order to adapt products adapted accordingly. Cloud computing opens the door to data processing capacities that were heretofore only accessible to large companies. Indeed, cloud CRM and sales management applications appear to be the applications arousing most interest among SMEs (see Illustration 9).

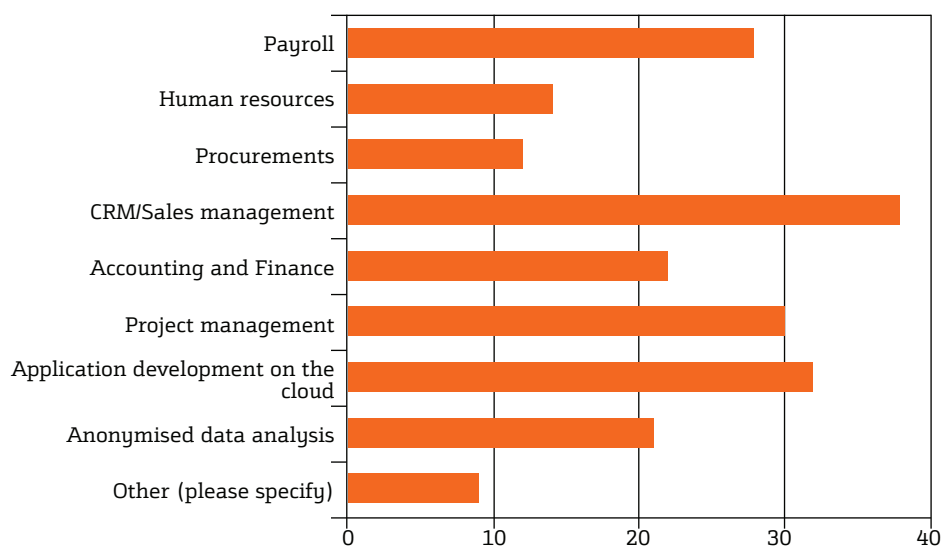


Illustration 9: Business Processes most likely to be managed from cloud applications.
Source: Survey by ENISA (European Network and Information Security Agency).

The varied range of cloud services available to small business is of particular interest from the perspective of the pay-per-use system. The perceived savings are greater in the case of SMEs than large corporations (See Illustration 10), since large cloud providers offer them access to economies of scale. This relieves the investment needs of newly-created or expanding companies, encouraging innovation and market competition and offering SMEs a chance to compete with the same computer capacities as large corporations.

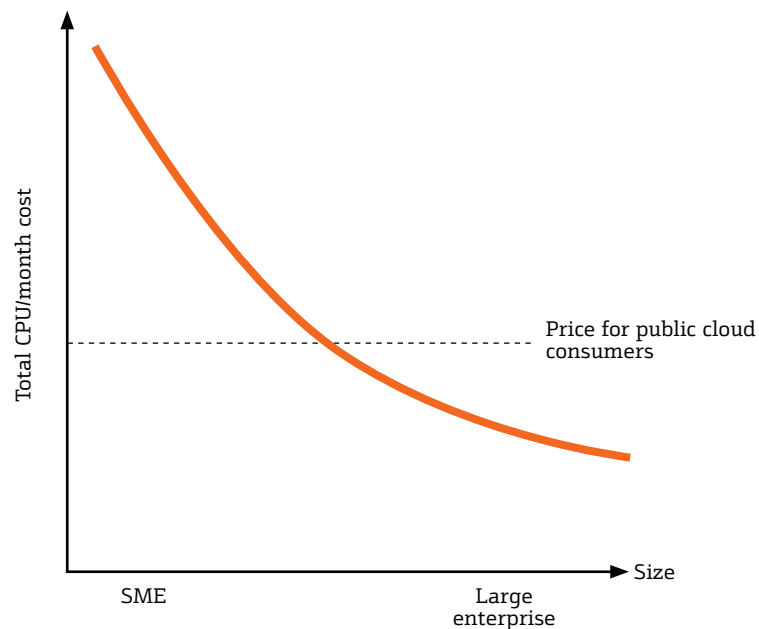


Illustration 10: Cost reduction resulting from use of cloud computing, depending on size.
Source: Amazon website.

Moreover, the services of the large cloud providers offer small business one important advantage over internally-run services: user support. This service, which the FTF experts rated as excellent, is a decisive factor for these firms, which do not have the resources required for such an expensive service. The economies of scale obtained by the large cloud computing providers allow the costs of these resources to be cut by maximising their use, since they are shared by a large number of firms, and the dead time so typical of this type of support is significantly cut. In addition, automatic service upgrades with no user intervention removes one of the primary causes of calls to support services.

The experts at Future Trends Forum feel that small business has been largely ignored by the technology providers. They say SMEs commonly operate on fragmented markets containing a host of small firms with the same computer

needs and the same businesses processes, but without a value-contributing technological offering. From this perspective, cloud computing covers these unsatisfied IT needs and creates synergies between them all.

What small business needs to think about before moving to the cloud

What happens if there's a power cut, a fire or a flood? One of the great concerns of any small firm is how the business will survive in the event of some unforeseen calamity. Systems for ensuring continuity are complex, expensive and unaffordable for most SMEs. Cloud-based services, accessible over the Net from anywhere, do not depend on equipment that is physically located on the company's premises and therefore incorporate a low-cost solution for remote access, disaster recovery and business continuity. Cloud providers make large investments in infrastructures to ensure the availability of their services. This includes replicating data in real time, alternative routing of data flow in the event of possible hardware errors, multiple energy sources and multiple Internet connections. Most small businesses cannot afford to reproduce the security systems developed by the providers and their service needs are therefore not as sophisticated as those of large companies. Thus one of the main headaches of large corporations, according to FTF experts, the "service level agreements", can be offered on a standardised basis and adjusted to the simpler needs of SMEs.

Another common query among SMEs relates to the risk of depending on an Internet connection to run their business. What happens if the connection fails? These days, Internet connections are relatively fast, stable and reliable, and among leading providers, connection problems are rare. However, businesses that cannot afford to lose the connection with cloud services can create solutions by using parallel connections with various providers or 3G connections. The additional cost of these solutions is amply offset by the savings offered by the cloud. Alternatively, some cloud providers are working to assuage users' concerns. Google, for example, offers users the possibility of accessing its Gmail service offline, by downloading messages and working on them when no network connection is available (e.g. during a flight) or when the Gmail service itself is not available⁷³. If cloud services are critically dependent on broad band connections, how can providers assure users that they will have access? Will the cloud providers themselves offer reliable network connections? Google's announcement that it plans to offer high-speed Internet connections appears to mark a step in this direction⁷⁴. Although the company has said it has no intention of entering the larger ISP market and that its offer is limited to a small number of users, its announcement has nonetheless not gone unnoticed among large Internet providers.

Information security is another of the factors that most concerns small business, but, as the Easynet Connect survey⁷⁵ shows, only 13% of firms consider that cloud computing is not sufficiently secure, given that it offers greater security than any of the alternatives available to these firms.

⁷³ <http://gmailblog.blogspot.com/2009/01/new-in-labs-offline-gmail.html>.

⁷⁴ <http://www.nytimes.com/2010/02/11/technology/companies/11google.html>.

⁷⁵ <http://www.easynetconnect.net/Portals/0/DownloadFiles/IndustryInsight/WhitePapers/Is%202010%20>

Finally, like any business decision, whether or not to move to the cloud will depend on the value contributed to the business. In the current economic climate, cloud computing is essentially being sold as a potential cost-cutter, with few servers focusing on the added value they can offer businesses. When the economic situation settles down and businesses cease to be so preoccupied with cost cutting, providers will have to face a greater challenge: how can cloud computing contribute value to business? The situation they face is similar to that of their target clients. They have to offer services that give companies value, just as the companies themselves have to develop products and services that offer added value to their customers. SMEs don't know exactly what services they want, but they are very sure what services they don't want. Cloud service providers will have to identify the companies' latent needs, develop personalised services to meet those needs and generate a demand for them.

What is needed to develop these services? Exactly the same as what the SMEs need: an analysis of information on customers and innovation. Cloud providers face a dilemma, since it is in precisely this area that the cloud is seen as being an accelerator for SMEs; they will therefore have to demonstrate its benefits by making use of their own services. Cloud providers can benefit from this situation, given that the difficulties they encounter using their own services will be similar to those faced by other companies and this means that innovation in new products will bring consolidation and improvement to existing ones. In this way, the cloud services market is moving towards offering a wide range of increasingly personalised services.

Present and future of cloud computing in SMEs

Although the media is full of news on the cloud computing phenomenon and its benefits for small business, [the technology is not being adopted as fast as expected by business in general, and SMEs in particular](#). Indeed, it is SMEs, as opposed to large companies, that are taking longest to move to the cloud. According to research for [ISP Easynet Connect by OpinionMatters](#) conducted in Britain at the end of 2009, shows only 13% of small businesses were using cloud computing. It also showed that among SMEs, the larger firms -i.e. those with between 100 and 250 employees- were more likely to use cloud technology⁷⁶.

One of the problems may be the shortage of staff in these companies with the capacity to appreciate the added value that Internet capacities have to offer for their business. However, those who have managed to see this value have in many cases obtained excellent results. A study by Microsoft⁷⁷ concluded that businesses that saw technology as a facilitator of business productivity and which use net-hosted services performed better than others. Sixty percent of SMEs who saw technology as a critical factor enjoyed increased revenue over the last twelve months, as opposed to 29% of those who did not view technology as being critical. The report also shows that over 40% of firms using cloud services saw income grow by 30% or more, whereas 90% of firms that do not use these services experienced a fall in income.

⁷⁶ <http://news.zdnet.co.uk/itmanagement/0,1000000308,39973688,00.htm>.

⁷⁷ <http://www.microsoft.com/presspass/press/2010/feb10/02-03techcriticalpr.mspx>.

Predicting the future is a complicated task, especially in the field of technology. Although there are some sceptics, the experts at the Future Trends Forum consider that cloud services have a promising future among SMEs, albeit they are not yet mature and may not suit all firms. Along the same lines, the CEO of Google España argued that cloud computing will represent a massive change, especially for small and medium-sized enterprises, although he thought that it might take three or four years for them to take this idea on board and apply it on a large scale, at least in Spain⁷⁸.

The fact is that the cloud offers small business an opportunity to play in a more senior league, by removing the barriers blocking entry into different markets and the capacity gap with large companies. The adoption of cloud computing among SMEs requires them to see the added value these new services can contribute to their business. Cloud computing is not a guarantee of success, since companies need differential products and services that depend only on themselves, but the figures shown that in the medium term, not adopting this new model could prove to be a handicap for SMEs.

5.1.2. The competitive pressure on large companies to move to the cloud

Small businesses seem to be moving inevitably towards adopting cloud computing; not to do so would mean missing out on an exciting new range of services at an affordable price. Most experts agree that cloud computing is particularly appealing for SMEs, but when it comes to larger companies, opinions vary. One study conducted by strategy consultants McKinsey & Co estimates that big companies could end up paying more than twice as much for those services as they would if they owned the same computing resources in-house⁷⁹. According to the author of the report, William Forrest: "Those who are banking on the whole-scale move to clouds from large enterprises are likely to be disappointed, unless someone comes out with a more attractive price than any provider currently on the market". The fact is that in the short term, big companies do not seem to be ready to adopt cloud computing and most cite security as the biggest stumbling-block⁸⁰.

The needs of large corporations also differ from those of small businesses, but does that really mean they can't benefit from cloud computing too? The answer is not a clear yes or no. Certainly, the advantages for large corporations are perhaps less evident than for small businesses, but that doesn't mean they can't benefit from the services the cloud offers. As the FTF experts put it, "the cloud is good for everyone, but not for everything". Although most current cloud services focus more on small businesses, the larger the company, the greater the interest it shows in this new model of service⁸¹.

Ignoring the potential of the cloud could be a strategic mistake in the long run. As a worldwide survey of cloud computing conducted in 2009 by technology consultants Avanade⁸² shows, the leaders of big corporations are aware of the possible benefits of this model, particularly in terms of reducing initial investments and augmenting capacity to react to market changes. However, only a

⁷⁸ <http://www.techweek.es/redes/informes/1005449004501/cloud-computing-supondra-revulsivo.1.html>.

⁷⁹ <http://www.forbes.com/2009/04/15/cloud-computing-enterprise-technology-cio-network-cloud-computing.html>.

⁸⁰ <http://www.idg.es/pcworldtech/mostrarnoticia.asp?id=82392&seccion=actualidad>.

⁸¹ <http://www.ca.com/gb/content/campaign.aspx?cid=228876>.

⁸² http://www.avanade.com/_uploaded/pdf/avanadethoughtleadershipcloudsurveyexecutivesummary833173.pdf.

disappointing 1% of IT heads in the 550 corporations surveyed by the systems management software development firm CA, said they had completely implemented cloud computing (see Illustration 11).

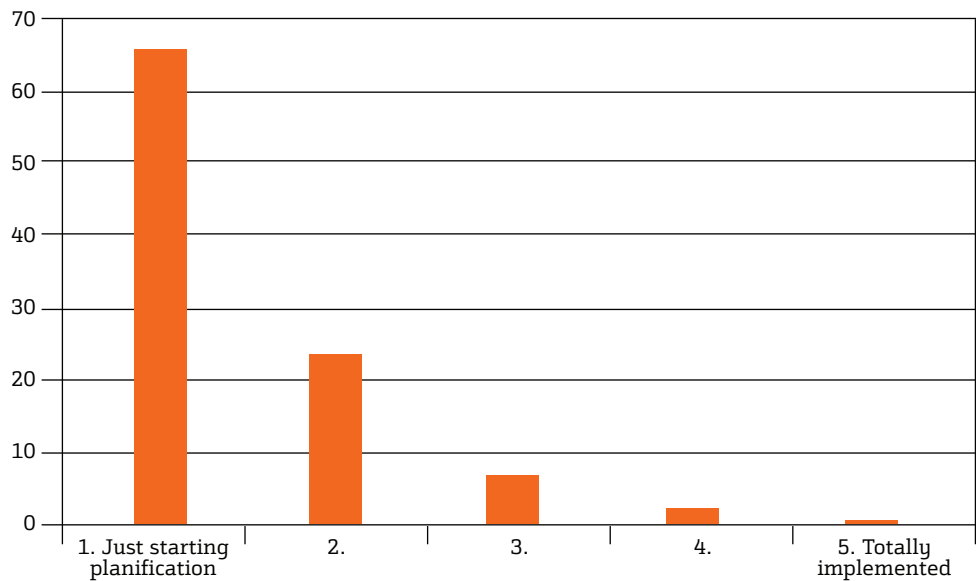


Illustration 11. How fully implemented is cloud computing in your organization?
 Base: organisations that have begun planning or implementing cloud computing
 Source: CA, study: "Unleashing the Power of Virtualization 2010".

What are the factors that hinder adoption of cloud computing? The CA study shows that 54% of all firms see drawbacks in aspects related to cloud management and 65% do not believe they have the in-house expertise to deliver this model. They also confirmed that the main stumbling block to implementation is the security issue (see Illustration 12). The issue of data security and confidentiality is more important for big companies and for the moment, the cloud does not meet the security standards of many firms. How, for example, can cloud security be adjusted to a company that actually destroys all the hard disks on which it has stored confidential information? One of the advantages of the big cloud providers is their capacity to re-use storage space and their processing capacity; this means that some of the security aspects certain firms require will not be simple to migrate to the cloud.

One of the factors large companies cite for not adopting cloud services is quite similar to the reason given by small businesses. A study by COLT, a firm providing cloud consultancy and computing services, shows that one of the main reasons why firms are not adopting cloud computing is the lack of experience with this technology among their IT managers⁸³, combined with confusion as to the precise

⁸³ http://www.colt.net/ES-es/MediaCentre/COLT_042460.

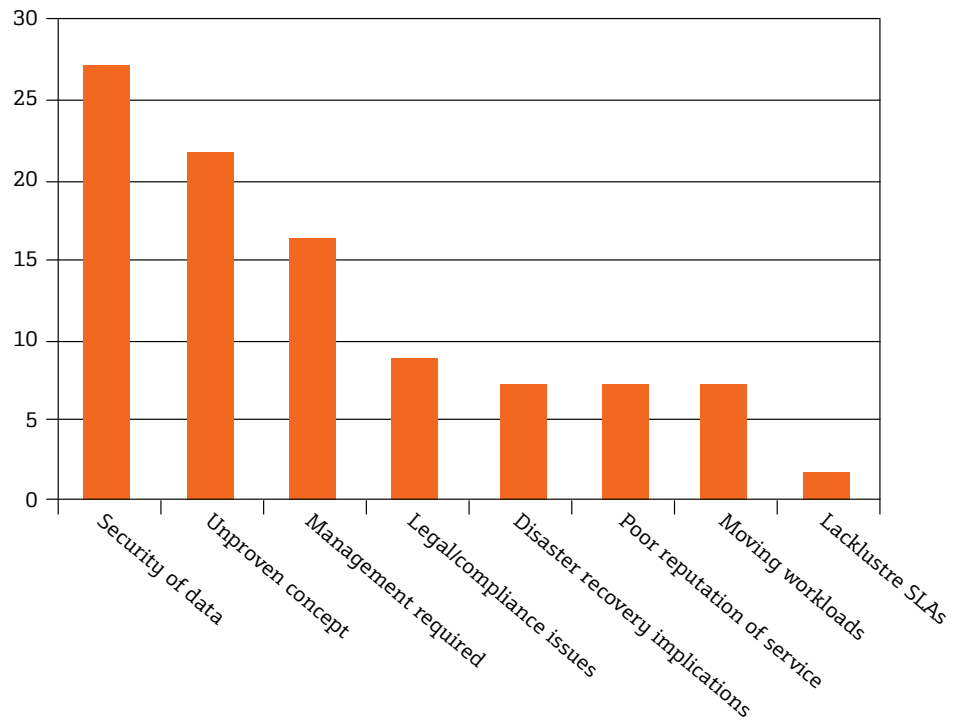


Illustration 12. Which of the following do you see as the main drawback of cloud computing?
 Source: *Unleashing the Power of Virtualization 2010*, study by CA.

meaning of the term cloud computing. The arguments used are not different from those that were employed when the Internet, e-mail and instant messaging first made an appearance in the workplace.

The main problems identified by the FTF experts are data security and privacy issues, difficulty integrating with existing systems and performance (see Illustration 13). They also pointed to other arguments used by firms to avoid adopting cloud computing: believing they can do it better/faster and cheaper in-house; thinking that the cloud is only for start-ups and SMEs; being unconvinced by the vagueness of the contract terms and conditions or being unwilling to move their entire IT infrastructure to the cloud. Given the reluctance to adopt the cloud, the FTF experts recommended that firms should distinguish between critical applications, which could be kept on internal systems or even private clouds for the moment, and non-critical applications, which could be moved to public clouds. When it comes to establishing security requirements for these applications, companies need to consider whether their own in-house systems really meet those requirements. Security is an important challenge for cloud providers and there is certainly plenty of work still to be done in this field; nonetheless, migration to the cloud should not be stopped because of excessive security requirements which not even existing in-house systems are capable of meeting.

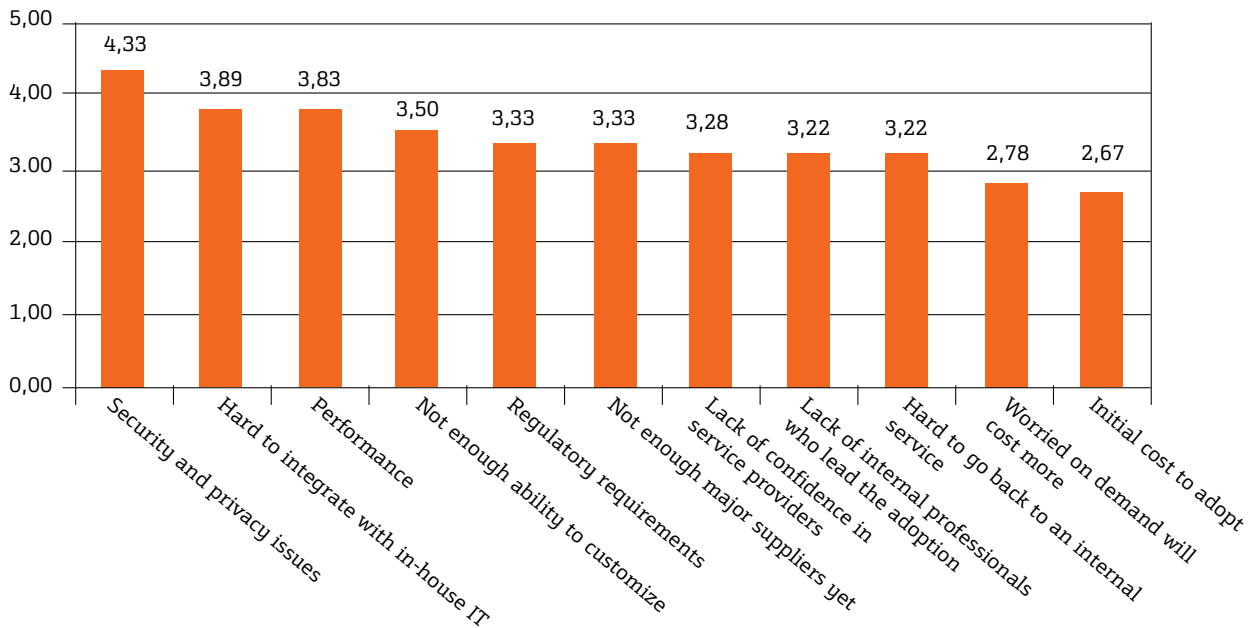


Illustration 13. Main concerns in the demand for cloud computing.
Source: authors.

Another obstacle to the adoption of cloud computing is that many big companies are unwilling to adopt new service options that would mean abandoning the internal systems in which they have invested so much money. They are driven by the idea that “if we’ve paid for it, we have to get our money’s worth out of it” and are reluctant to adopt new technologies or options to replace these systems. The common mistake of taking sunk costs into account in decision-making is due to the large investment in time and resources required in implementing systems such as Enterprise Resource Planning (ERP). As a result of this level of investment, companies tend to hang on to systems that rapidly become obsolete because of the speed at which technology is evolving. How often have you heard someone in your company say: “Now that this is working, we’d be better off leaving it alone”? If these costs were not taken into account when deciding on whether to move an application to the cloud or not, there would be a far higher rate of adoption of cloud services.

What the cloud can offer large companies

We’ve looked at the reasons typically given by large companies for not adopting cloud services, but what are the factors that are encouraging some of them to move their services to the cloud? The reason is that they offer value and solve some unresolved problems in their systems. Many organisations see the cloud as an economical alternative to their IT systems; however, this is a rather short-

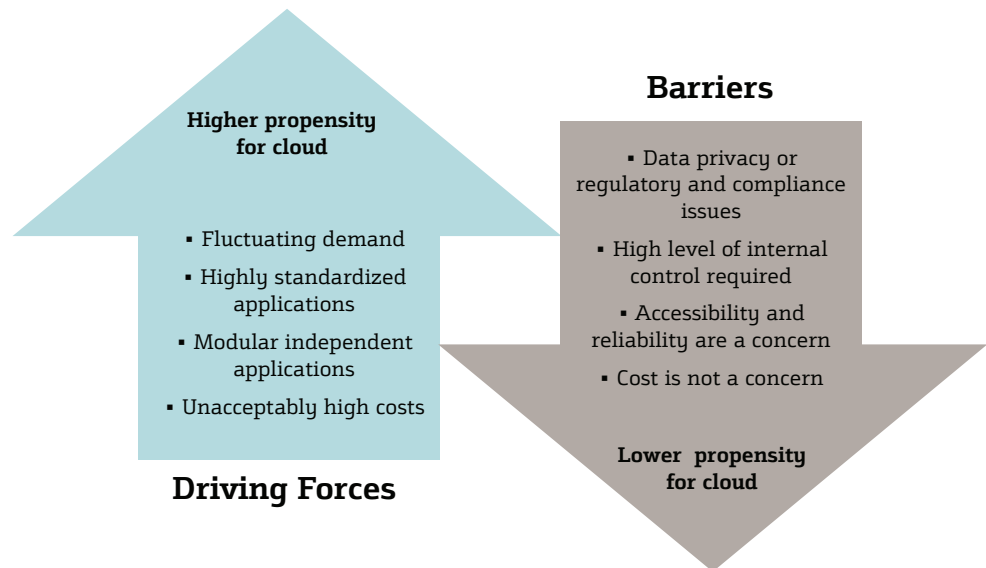


Illustration 14. Forces for and against the cloud
Source: Opinion of Future Trends Forum experts.

sighted vision of the possibilities offered by an entirely new concept that has evolved rapidly from some futuristic technology to a commercial model of services with large growth opportunities.

One of the great headaches of any systems department is the "demand prediction nightmare". Systems have to be capable of adapting to very variable and unpredictable customer demand and the result is usually overcapacity and –by extension– overspending. This overcapacity is a form of "insurance" to make sure demand does not outstrip system capacity, but it nonetheless represents a major cost for firms. One way out of this impasse is through the flexibility and scalability cloud computing can offer. In a cloud-based system, the capacity of applications and systems varies with demand. This means doing away with the "safety stock" and reducing the shadow price of having resources lying idle.

Another advantage of cloud computing is that it turns fixed costs into variable ones; that is to say, the large initial investments required to set up a system are converted into costs that vary with consumption. While large-scale investment in systems may prove more profitable in the long run if there is a high rate of usage, the real situation tends to be different, since installed capacity is based on a forecast of demand that often diverge from the real situation. Taken along with a very variable demand, it becomes practically impossible to get much use out of these systems. Virtualization eases these capacity surpluses, since different applications can share the same servers; if an application does not use all of the capacity on a server, it can be used in other applications. However, virtualization

also makes it more complicated to associate the costs of systems with the different services, since it is difficult to know the capacity actually used by each application. Determining the profitability of these services therefore requires complicated cost-allocation systems. Cloud computing releases companies from the problem of capacity and passes it on to the cloud providers. Turning initial investment into variable cost may not make a big difference to the final cost for a large corporation, but it minimises the risk involved in launching a new product or service. What happens, for example, when a service is not as successful as expected? In the current situation, the initial investment is lost; with cloud-computing, on the other hand, the cost will be minimal.

However, what do the IT systems departments of large companies think? As already mentioned (see "Computer clouds are coming"), IT departments have a conflict of interests when it comes to adopting cloud services. If communication is poor, they may think cloud computing means outsourcing their services. And because it is essential to have the IT department on board for a successful transition to the cloud, this misunderstanding can complicate migration or even prevent it from happening altogether. The cloud does not do away with the need for a systems department; it simply changes its functions. Systems maintenance and upgrading give way to innovation and development. The technology ceases to be a "necessary evil", supporting business areas, to become a fully-fledged "partner" in the business. These new functions transform the management model and the approach of the technology departments; their performance is no longer measured in terms of cost but instead in terms of innovation and profitability for the business. This is a complicated change and needs a transition process, but the potential benefits are reason enough for the company to give it a chance.

The experts at the Future Trends Forum see the cloud as a solution for what they call "the collapse of complexity", i.e. a proliferation of internal systems developed and customized independently for each corporate function. IT departments are devoting more and more resources to maintaining and upgrading these systems; however, the cloud offers an alternative way of standardising all these systems, releasing valuable personnel to focus on tasks that add value to the business.

What companies are moving to the cloud?

Slowly but surely, the cloud is making inroads among business and it is becoming ever more common to find large corporations taking advantage of cloud computing services. Many of them use these services as an economical alternative to their current applications. Others, however, use these systems to explore new opportunities which they could never previously have considered. The FTF experts identify the price of the services and the capacity to reduce internal IT costs as the main criteria in selecting a cloud provider (see Illustration 15).

⁸⁴ <http://open.blogs.nytimes.com/2007/11/01/self-service-prorated-super-computing-fun/>.

The New York Times is a good example of how the cloud can be used to offer new services⁸⁴. The newspaper decided to offer its readers all the articles published

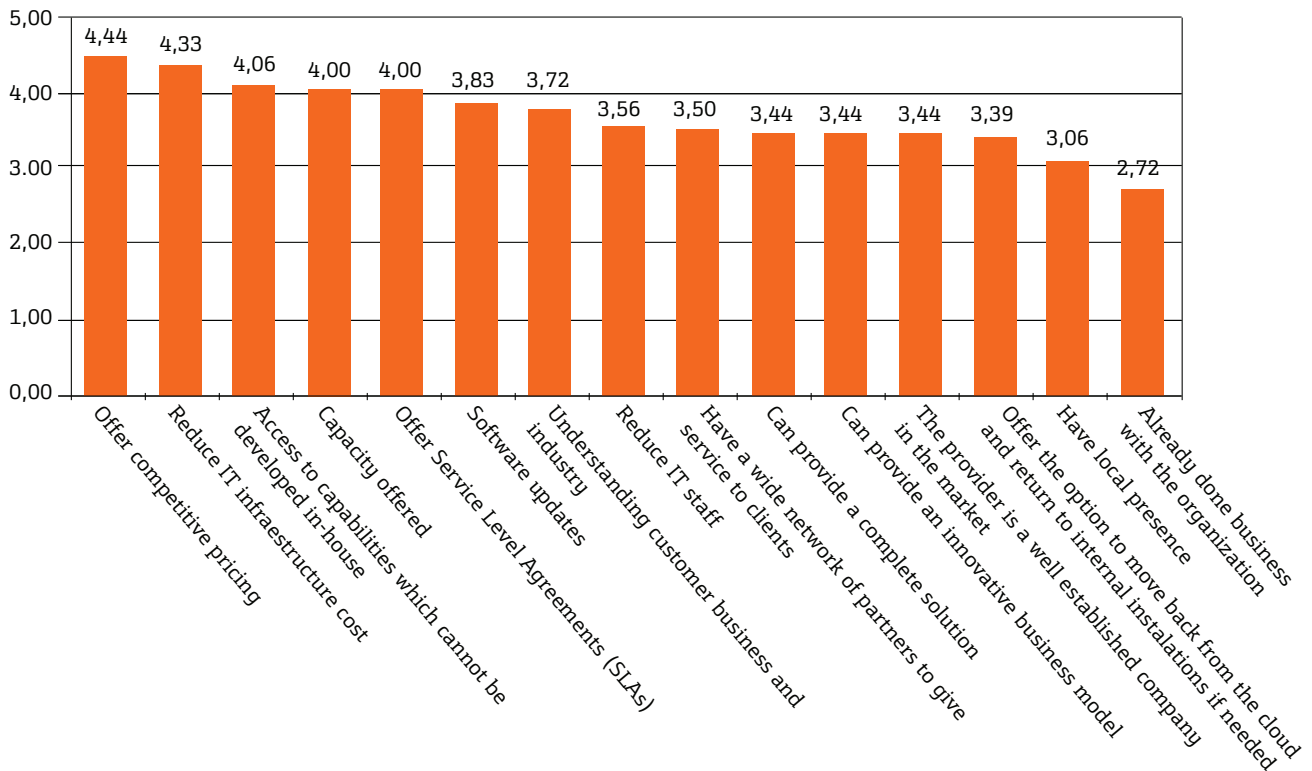


Illustration 15. Aspects rated highest when choosing a cloud computing provider.
Source: authors.

between 1851 and 1922, using scanned images of the original documents. Initially, the images were generated dynamically in PDF format as the user requested, but with increased traffic to their website, dynamic composition of PDFs ceased to be a suitable way of offering the information. As a result, the NYT decided to use cloud computing through the services of Amazon, storing 4 terabytes of images on Amazon S3 and processing these images using a program developed by the newspaper itself on the Amazon EC2 platform. Using one hundred instances of the Amazon EC2 service, the newspaper generated the PDF files with all the articles in twenty-four hours. These files were then stored on Amazon S3 and are now available to the public from its website.

In the current economic climate, pressure on companies to cut costs has also led to increased interest in the opportunities cloud computing has to offer. Companies such as Taylor Woodrow –the construction division of the VINCI group– have adopted SaaS to reduce the annual maintenance costs of their systems⁸⁵. Cloud computing is also particularly appealing for firms with seasonal businesses. An example is MLB Advanced Media which handles the official sites of the American baseball league, offering users information in multimedia formats, including audio and video⁸⁶. The inherent seasonality of the baseball league gets passed on to the

⁸⁵ <http://www.silicon.com/technology/networks/2008/07/10/taylor-woodrow-heads-for-the-cloud-39257523/print/>.

⁸⁶ <http://www.networkworld.com/news/2007/121007-your-take-mlb.html>.

company's servers, with demand peaks necessitating overcapacity during periods of low demand. Now, thanks to the service offered by Joyent, MLB Advanced Media has virtual servers on demand, allowing them to adjust system capacity to requirements at any time.

However, seeing the cloud as just an economical alternative to existing systems is a limited view and companies run the risk of losing interest when the financial situation stabilises. If they are not to waste the opportunities the cloud offers, companies need to study how the services it offers can help optimise their business models. This is the case of FICO, a leading provider of analytics and decision-making technology, which has introduced Salesforce's Ideas Community CRM service, which enables companies to collaborate directly with their customers⁸⁷. With the new service, FICO can determine the major problems its customers face and develop products to meet their needs, thus substantially improving its position in the highly fragmented industry of software development.

One encouraging statistic for the future of cloud computing is that 70% of companies using cloud-based services plan to move additional applications to the cloud in the near future, according to a survey by Mimecast, a company offering e-mail management solutions⁸⁸. This suggests that companies are beginning to see the value cloud computing can offer to their business.

New challenges for business

Companies need to be aware that cloud computing is not only going to imply changes in their systems procurement, but also adaptation in other business areas. Information technology offers major opportunities, but it also brings fresh challenges that threaten to alter established business models.

The very features that make cloud computing so attractive to business have fostered to a great extent the proliferation of social networks on the Internet, by reducing the development time of new portals and facilitating the scalability of resources to match increased user numbers. In contrast to the gradual growth of Facebook, based on buying or leasing data centres⁸⁹, new social networks can increase their capacity apace with new users, obviating the need for large-scale investment. The result is a boom in the number of social networks. And these new networks are helping remove the "knowledge asymmetry" that has traditionally given companies the edge over users. Users are sharing information on open forums; initially this took the form of customer reviews of products and services, but the trend has now spread to the mobilisation of whole user communities, which unite to support, discuss or take action on a product, service or project. This consumer-to-consumer activity (C2C) is transforming the way people choose; increasingly, they are basing their decision on information provided by other consumers and less on brand record, marketing or market reviews. The Trip Advisor website is a clear example. Users can rate and share their experiences on hotels and restaurants around the world, shifting the balance of power in the industry to the traveller. The potential of these networks is so immense that the

⁸⁷ <http://www.salesforce.com/customers/business-services/fico.jsp>.

⁸⁸ <http://www.mimecast.com/cloudsurvey/>.

⁸⁹ <http://blog.facebook.com/blog.php?post=262655797130>.

cloud providers themselves are developing their own social networks to cash in on the information they provide. A clear example can be seen in new developments at Google with the Google Buzz and Google Wave services.

According to Eric Schmidt, Google's chairman and CEO, cloud computing has major implications on the way corporations operate⁹⁰. "They can't be as controlling. They have to let information out". The old business models are history –just like that legendary quote from Henry Ford, "Any customer can have a car painted any colour that he wants so long as it is black"– and companies have to listen to the demands made by their customers, who are talking to them all the time over the net. Social networks have thus become excellent tools for firms wanting to tell users about their services and open channels of communication with them. As a result, some cloud providers are developing services that allow companies to capture the information on their interactions with users of social networks. This is the case of CRM Facebook Connector, an application developed by LINK development, a software development company, which makes it possible to connect Microsoft's on-line CRM service, Microsoft Dynamics CRM, with the social network Facebook⁹¹. While creating profiles in Facebook is one way of communicating with customers, this service allows firms to create news feeds for communicating with them, based on CRM cloud services.

A long way to go

Large companies are showing interest in the possibilities brought by the cloud, but providers need to be aware that the services currently offered are only a first step and there is still a long way to go.

There are several areas with potential for improvement that are currently limiting uptake of the cloud among large corporations. One is the speed of access to large quantities of information. The experts at the Future Trends Forum say that much of the problem lies on the fact that bandwidth is a scarce resource when it is required in large quantities. There is a very wide offering of consumer-grade bandwidth, but firms run into major problems when they want connections much more superior to the market standard.

Another area with room for improvement is the "service level agreements", which can become real nightmares for large companies, since their complexity increases in direct proportion to that of the service provided. Current in-house systems have been customized for the individual business needs and it is not simple to reproduce them on the cloud. Guaranteeing a level of service in these situations requires long and tedious negotiations between the company and the provider. As a result, moving existing systems, so carefully adapted to the company's inner workings, may sometimes make little sense.

The characteristics of large companies and the sophistication of their requirements are a handicap to them when it comes to adopting cloud computing. However, there is ever greater pressure for them to do so, since other smaller rivals can

⁹⁰ http://www.mckinseyquarterly.com/Googles_view_on_the_future_of_business_An_interview_with_CEO_Eric_Schmidt_2229#bio.

⁹¹ http://www.linkdev.com/Sol_Serv/Dynamics/addons.aspx.

outsource the standard business services to cloud providers with very little initial investment, substantially reducing entry barriers.

What conclusions can large companies draw from all of this? The cloud is not a wonderland in which they can obtain no-worries computing capacity. It is a complex resource that requires knowledge and hard work for proper management. Cloud computing continues to be greenfield territory, with a lot of room for improvement, and big companies have the capacity to model this business to meet their needs. If they don't get involved in cloud computing, they run the risk of becoming victims of a system which they could have helped design. It is therefore essential to define a migration strategy to the cloud that will make it possible to incorporate the services on a gradual basis, as the following sections will explain.

5.1.3. The value of cloud computing for the public sector

If you've ever wondered why you have to furnish the same information to get a driving license as you do to renew your passport, the reason is that we live in a world of *silos*. "Silos" are computer systems designed to perform a specific function that have evolved in isolation from other systems and examples include the Interior Ministry's National Identity Card database and the Treasury Department's database with tax information. These systems have their own information sources and there is little or no interaction between them.

Fortunately, cloud computing holds out great opportunities for improving the way individuals and government interact. Let's take an example: imagine someone suffering from a chronic disease, such as diabetes, who has a fainting attack. Regardless of what country she is in, when she is taken to hospital, the doctors will be able to access her medical records just by entering her national ID number into the system. They can then apply the most suitable treatment.

It should come as no surprise then that cloud computing is attracting the attention of governments around the world, including the new American administration with its open government directive. As part of this directive, the Obama administration has launched Apps.gov, an on-line showcase for federal agencies to find and hire cloud-based IT services⁹². The nature of central government, with its large-scale spending on hi-tech and data storage, makes the cloud particularly interesting. However, the benefits for state and local governments are not as evident if we take into account the global nature of the cloud infrastructure and the tricky issue of its impact on local economies. With governments now preoccupied with economic recovery, it is ever more important to demonstrate this relationship at this time. A survey by Mimecast, a cloud-based e-mail provider, shows that the government lags behind other leading industries in adopting cloud computing (see Illustration 16). However, a study by INPUT, a market research firm, estimates that spending on cloud computing by the US federal government will grow from \$277m in 2008 to \$792m in 2013, a composite annual growth rate (CAGR) of 23.4% over five years⁹³. Despite this growth, it is still estimated it will account for just 1% of total government spending.

⁹² <https://www.apps.gov/>.

⁹³ <http://www.networkworld.com/news/2009/043009-federal-cloud-adoption.html>.

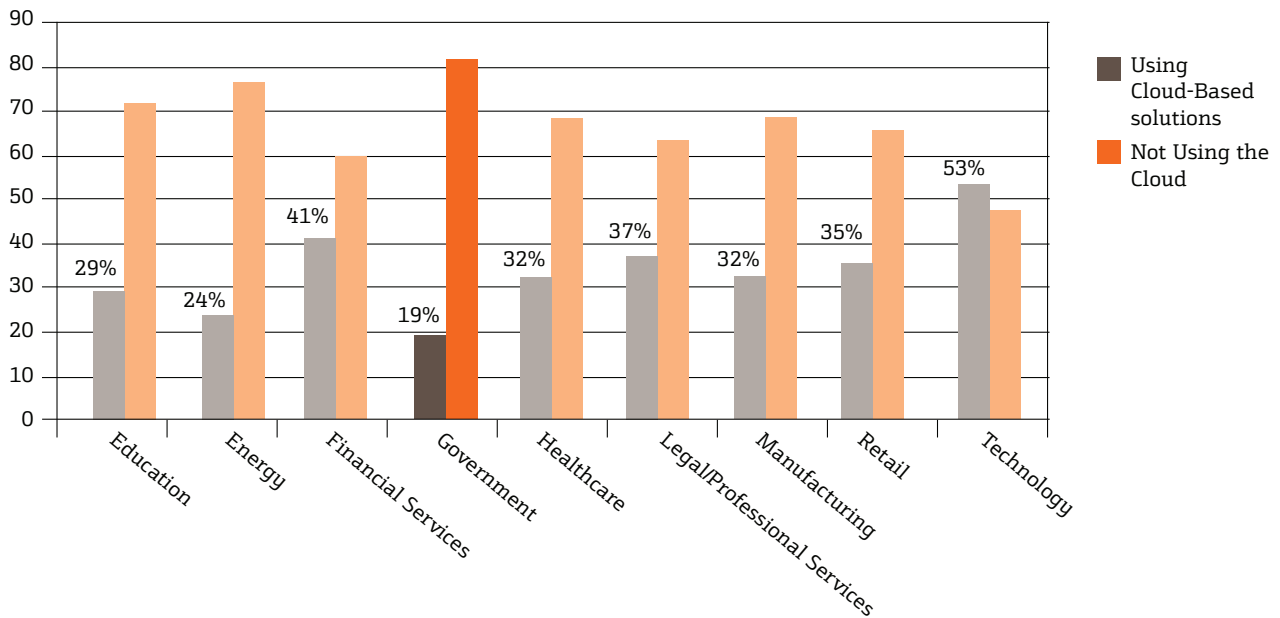


Illustration 16. Adoption of the cloud computing by industries
Source: Cloud Computing Survey, Mimecast.

What the cloud has to offer to the public sector

The opportunities of cloud computing for the public sector are not restricted to its relations with the public. Another major advantage is in the area of cost-cutting, all the more important at this time of tightening budgets. Concentration of processing and data storage allows cloud providers to offer a more economic service than in-house systems. In addition, the flexibility of the cloud means that the necessary capacity is available almost instantaneously, unlike in-house systems, which commonly have to have unused overcapacity built in to cope with peaks in demand. In addition to these advantages, there is less need for maintenance and any evolution in the software is centralised in the hands of the service provider.

These advantages are quite similar to those for private business. However, there are certain features that are peculiar to government that make cloud computing especially appealing. The large size, complexity and breadth of the government's hi-tech services require a simpler solution than traditional data centres. Governments commonly need to access geographical areas, people and sectors with the following features:

- They are very geographically dispersed, particularly in countries with a large land area.
- They have varying levels of Internet coverage and access.

- They require very different scales of computer resources, which have to be capable of serving the local government of large cities and small villages alike.
- The complexity of the applications they use varies substantially.
- They make frequent changes and do not have much experience with technology.
- They handle and require a lot of information.
- Each local government handles its own schedule.

Government departments have opted to retain individual computer systems, tailored to their needs, and, as a result, the government's capacity to reach more people and develop more applications is restricted by its capacity to build and maintain more datacentres. Cloud computing offers an alternative for unifying all these divergent systems, with centralised maintenance that will facilitate management and allow access from any location in the country; all that is needed is phone coverage. Thus cloud computing will not only allow governments to develop and replace new tools quicker; it will also encourage greater mobility among civil servants, who will no longer have to be sitting in front of a computer in the office to access the government's central systems, but will instead be able to access them from their own homes or over their mobile phones.

The providers are aware of the interest and appeal of cloud computing for government and are acting in consequence. Google is looking to obtain FISMA certification (Federal Information Security Management Act), required to all providers of the American government to be able to offer cloud computing services to what Sergey Brin, Google co-founder calls "probably the largest enterprise I know of"⁹⁴. Recovery.gov, the U.S. government's official website with access to data related to Recovery Act spending to stimulate the economy, uses Microsoft SharePoint as its user interaction platform. Microsoft is now trying to cash in on this to introduce another of its products in several departments of the administration⁹⁵. Other providers, such as Amazon⁹⁶ and Platform Computing⁹⁷ are also taking positions as suppliers of the government.

This government's function as an early adopter serves to promote the advantages of cloud computing among the public and act as an example to the market. However, it is important not to forget that governments also play a key role as cloud regulators and facilitators in their respective countries. Cloud providers are well aware of this circumstance and as a result, companies such as Microsoft are urging governments and the industry to work together for the good of cloud computing⁹⁸. Unlike Internet—which was first promoted by government and academia long before it was adopted by the market—private industry and consumers have been the leading champions of cloud computing. Nonetheless, regulators can play a very important role and contribute to create the optimum conditions for the market to evolve, such as promoting universal broadband and penalising computer crimes. Adopting the cloud in the public arena is one way for governments to gently begin exercising their role as regulators; given the large public spending involved in technology, they have the capacity to work alongside

⁹⁴ <http://www.infoworld.com/d/cloud-computing/government-cloud-coming-google-next-year-855>.

⁹⁵ <http://www.informationweek.com/news/government/info-management/showArticle.jhtml?articleID=222002100>.

⁹⁶ <http://seattle.bizjournals.com/seattle/stories/2009/05/25/story10.html>.

⁹⁷ <http://www.informationtechnologymarket.com/?p=69>.

⁹⁸ <http://www.microsoft.com/presspass/press/2010/jan10/1-20BrookingsPR.mspx>.

providers in defining technological, security and privacy standards. But public administrations must avoid over-regulation, since cloud computing presents great potential benefits and the public has already shown its support for extended use despite the hindrances.

Another incentive for adopting cloud computing is the increase in open government initiatives promoted by some administrations, among which US moves are particularly significant. President Barack Obama, has said "My Administration is committed to creating an unprecedented level of openness in Government. We will work together to ensure the public trust and establish a system of transparency, public participation, and collaboration. Openness will strengthen our democracy and promote efficiency and effectiveness in Government."⁹⁹. The purpose of this directive is to bring government closer to the public, encouraging participation and collaboration, and government agencies must accept the opening up of on-line data and post all the open government initiatives they are undertaking on the web. Cloud computing is the perfect candidate technology for sharing updated information with citizens, since no one can predict the demand this new initiative will generate. Chris Kemp, chief information officer at NASA's Ames Research Center says that almost all the agency's data is designed for a specific scientific use and they have little idea of how the public might use this information. Cloud computing allows the capacity of the system to be adapted to demand, so that a scalable platform can be created without the agencies having to worry about investing in infrastructures, scalability and accessibility. "The money gets to be spent on making the data useful to the public, and that's the key"¹⁰⁰.

What is hampering the adoption of cloud computing in the public sector?

Not all the advantages come free of charge; there important arguments against cloud computing in the public sector which cannot be ignored. The most important one is the issue surrounding the way information is handled, since much of it is confidential or sensitive and governments are reluctant to let it cross their borders. Indeed, on some occasions, data protection legislation does not allow them to do so. A case in point is the US Patriot Act, under which the American government can access cloud-based information if the servers are physically located within US territory. Consequently, governments from other countries are hesitant to use the cloud computing services of firms that have their datacentres in the US¹⁰¹.

Security is another key concern. Given that the personal information of the public is at stake, government rules tend to be very strict in this field. However, the two sectors that accounted for more than half of all cases of data loss in 2006 were precisely government and education¹⁰². This just goes to show that, as is so often the case in private business, the government's in-house systems often fail to meet the requirements it demands from external providers. In any case, the providers must demonstrate and certify their security capabilities, both in terms of data

⁹⁹ http://www.whitehouse.gov/the_press_office/TransparencyandOpenGovernment/.

¹⁰⁰ <http://fcw.com/Articles/2009/12/10/Open-government-cloud-computing.aspx?Page=1>.

¹⁰¹ <http://www.networkworld.com/newsletters/vpn/2009/092909cloudsec1.html>.

¹⁰² http://www.input.com/corp/events_seminar/presentations/PRES_20070118_Tzuo.pdf.

encryption and recovery in the event of possible disasters. At the same time, a lack of cloud standardisation is another deterrent for governments, since they can have no guarantees as to the portability of the information and services. As a result, the choice of provider is particularly important: once the information has been compromised, it is very difficult to migrate to another provider's systems. The lack of standardisation also poses a problem for business, thus, organisations are now being created to push for standards for cloud computing¹⁰³. Government support for these initiatives may be a fundamental step for its adoption by the large cloud computing providers.

Risks in the areas of data management, security and lack of standardisation will gradually diminish as the providers' offering matures and government gains experience in getting the right balance of public and private cloud services. However, there are other relevant aspects that are hampering the adoption of cloud computing in the public area. One of these aspects concerns public IT areas, since once government opts for cloud computing, the large infrastructures and maintenance associated with them will become unnecessary. IT departments will continue to play a very important role in the public structure, but they will have fewer resources and fewer staff. These changes are among the reasons why outsourcing has been relatively unpopular in certain countries and cloud computing is likely to run up against similar resistance.

Another important obstacle faced by government is the impact of cloud computing on the local economy and local employment. At a time when public spending is essential in sustaining local economies, there is a growing sensitivity to the way in which public money is being invested, and cloud computing has potential negative effects on those economies. The cloud turns infrastructure investments into operating expenses and that means fewer opportunities for local hi-tech businesses. Cloud-based services have little or no impact on the local economy since they are normally provided from other jurisdictions. The counter-argument is that the savings achieved by using the cloud can be invested in initiatives of greater value involving local players, but this alternative depends on the nature of the local ecosystem, since it can be complicated to find the right profile for managing the cloud. Needless to say, there will be some territories that will benefit when large providers set up their datacentres in them, but they will be the minority and they will be precisely the ones that can offer the best conditions in terms of tax incentives and concessions – an example is the change in Washington State tax legislation which led Windows Azure to relocate¹⁰⁴. These obstacles will be overcome as economic recovery gathers pace. Local economies will depend to a lesser extent on government spending and the focus of the debate will again start to centre on cutting public spending. However, at least in the short term, this is one of the most important barriers to the adoption of cloud computing.

¹⁰³ <http://opencloudconsortium.org/>.

¹⁰⁴ <http://blogs.msdn.com/windowsazure/archive/2009/08/04/migrating-from-usa-northwest.aspx>.

Government in the cloud, or on its own cloud.

Despite all the difficulties, the advantages of cloud computing in the public sector appear to be prevailing over the disadvantages and some governments are beginning to promote its use among public agencies. In the words of the US government IT chief: "When the employees go home, they have access to more technologies than they do at work. I said to myself, "Hold on a moment, people have this access at home; how can I bring it to the administration?". That was a major reason for moving in this direction". The federal government's commitment to cloud computing through the Apps.gov portal marks an important step in consolidating this technology. The site has been launched as part of the open government initiative and is designed to help public administrations and government agencies migrate their services and applications to the cloud. It is an on-line window to which agencies can go to ask for SaaS applications tailored to their specific needs and offered all the legal and technical guarantees backed by the government¹⁰⁵.

Other governments, on the contrary, have opted for the creation of a "government cloud", which may be a subset of the cloud offered by a provider or a cloud developed by the government itself. These clouds are subject to certain more restrictive security and location standards to overcome the legal constraints on confidential data or information of critical national interest. Among the most active in this area is the British government, which is planning to migrate all its digital services to a secure private cloud called G-cloud¹⁰⁶. This means that all investment in IT by public bodies must be in line with the cloud computing standards so that the data can be migrated once the G-cloud is available. The government of Japan has adopted a similar initiative to the British one. The aim is to develop a private cloud, the Kasumigaseki cloud, where all government computing will take place. This cloud will allow information and resources to be shared and will promote standardisation and consolidation of the government's IT resources. The Kasumigaseki cloud is part of the Digital Japan Creative Project, which seeks to create new ICT markets to promote the Japanese economy¹⁰⁷.

Among European countries working to move to the cloud are Sweden, France and Spain¹⁰⁸. Denmark has also released information on the savings achieved in a pilot scheme to migrate two of its systems, Digitaliser.dk and Nem-Handel to the cloud. At a European-wide level, however, the EU has nothing along the lines of America's open government directive. Nonetheless, we will undoubtedly see emerging cooperation among member states in an effort to promote cloud computing for the whole Union. In South Korea, the government plans to invest nearly €521 million to lay the foundations for an industry based on web computing, much of which will be devoted to cloud computing infrastructures¹⁰⁹. In China, the city of Dongying is launching a cloud computing initiative to encourage economic development through the creation of the Yellow River Delta Cloud Computing Center¹¹⁰, a cloud platform based on IBM technology. The aim is to turn the city into a centre of digital innovation. The city council of Wuxi has introduced a cloud services factory to improve available computing resources for local firms,

¹⁰⁵ https://www.apps.gov/cloud/advantage/main/start_page.do.

¹⁰⁶ http://www.culture.gov.uk/what_we_do/broadcasting/5631.aspx.

¹⁰⁷ <http://www.cloudbook.net/japancloud-gov>.

¹⁰⁸ <http://multilingual.texterity.com/multilingual/20100102?pg=46#pg46>.

¹⁰⁹ http://www.koreatimes.co.kr/www/news/biz/2009/12/123_58238.html.

¹¹⁰ <http://www.prnewswire.com/news-releases/ibm-cloud-computing-helps-chinese-city-of-dongying-develop-into-a-smarter-city-61339892.html>.

many of which do not have the financial capacity to afford the IT infrastructure they need to compete efficiently¹¹¹. The Thai government, too, plans to create a private cloud for the internal use of various government agencies as part of its efforts to develop and implement e-government applications¹¹².

Cloud computing and government solidarity

The potential of cloud computing in industrialised and emerging countries is vast, however there is another major reason why governments should encourage its development: solidarity with third-world countries. Here we can draw an analogy between government and business; like small business, third-world countries stand to benefit enormously from cloud computing, yet the pioneers in adopting the cloud are the governments of developed countries (like the large corporations, in our analogy).

The great majority of third-world countries lack the infrastructure to compete with developed countries and the gap between the two worlds is getting ever greater. However, just as a proliferation of mobile phones and wireless networks has enabled them to leap-frog the development of communications, avoiding the large investments made in developed countries, cloud computing may represent a major step forward in technological development. Compared to no other alternative, the cloud offers these countries storage and processing capacities and the greatest advances in the development of software without requiring investment they cannot afford. Any arguments against cloud computing are offset by the technological underdevelopment and the lack of strict laws on data protection, for which reason the governments of these countries should be the trailblazers in its use.

Another element that needs to be taken into account is that because of the very extensive dissemination of mobile communications in developing countries (See the statistics for Africa in Illustration 17), the lack of an efficient power grid, the unreliability of Internet access infrastructures and the high cost of software licences, cloud computing offers a very attractive alternative for meeting the IT needs of businesses in these countries. SaaS packages offer a free or low-cost alternative to traditional desktop applications, freeing firms from costly licences, and also giving access to on-line CRM applications at a cost that would be prohibitive with a traditional software model. Storing the data on the cloud frees businesses from frequent power outages and interruptions in the Internet access service. The data are always available over mobile terminals and, once the market for smartphones and netbooks matures and prices drop, businesses in these countries will be able to access an IT infrastructure comparable to that of large companies in developed countries.

¹¹¹ <http://www.forbes.com/2009/07/27/ibm-china-computing-intelligent-technology-ibm.html>.

¹¹² <http://www.futuregov.net/articles/2009/may/25/thailand-plans-private-cloud-e-gov/>.

However, the cost of these technologies continues to be relatively high by the economic standards of developing countries, and governments in developed countries should therefore be promoting standardisation and industrialisation of this technology. Once the cost of the services falls to affordable levels, cases of

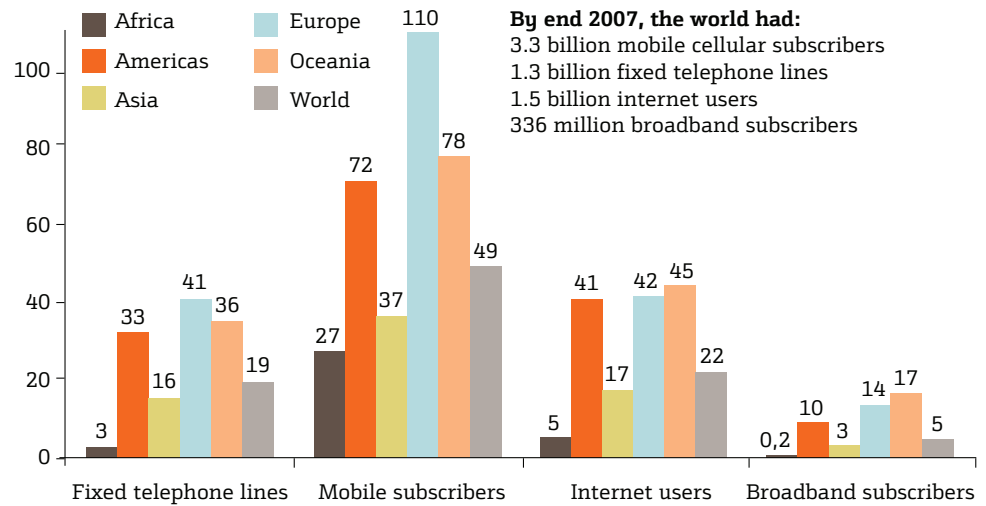


Illustration 17. Penetration of information and communications technology (ICT) by continent. Source: International Telecommunication Union – Statistics on global development of ICT¹¹³.

innovation in developing countries will become the norm rather than the exception. Although this will not put an end to inequality in the world, it will be one step further towards levelling the playing field, because cloud computing "democratises" information technology, from which the citizens of developing countries will be the greatest beneficiaries.

5.2. Landing on the cloud: strategies for transition to cloud computing

In 2009, a sixteen-country survey by Avanade, a global technical consultancy firm specialising in solutions based on the Microsoft platform, came up with a surprising figure for cloud computing in the business world. Over the previous nine months, it tracked a 320% increase in the number of people who said they were testing or planning to implement cloud computing¹¹⁴. In Spain, only 14.3% of the firms said it was not part of their plans¹¹⁵. Effectively, cloud services are being headlines as one of the major technological trends of 2010. A string of news stories have talked about the promising short-term future: "Public cloud services such as Amazon EC2 and Google are already dominating the consumer hi-tech landscape, as availability of the Chrome operating system –which incorporates desktop virtualization technology– will further consolidate these services as a viable mass computing platform"¹¹⁶.

However, beyond the good intentions and the interest shown in cloud computing, companies need to address a series of preliminary issues before they move to the cloud. FTF experts feel it is essential for firms to lay out their transition strategy in detail and prepare a solid and credible business plan before making a move. Illustration 18 shows an example of a framework for action going from

¹¹³ <http://www.itu.int/ITU-D/ict/statistics/ict/index.html>.

¹¹⁴ *Global Study: Recession has little impact in Cloud Computing Adoption*, Avanade News Release (2009).

¹¹⁵ <http://www.computing.es/Noticias/200912230028/El-60-por-ciento-de-las-empresas-espanolas-ve-el-cloud-como-una-inversion-estrategica.aspx>.

¹¹⁶ <http://www.redestelecom.es/Noticias/201001040014/Las-tendencias-tecnologicas-para-2010.aspx>.

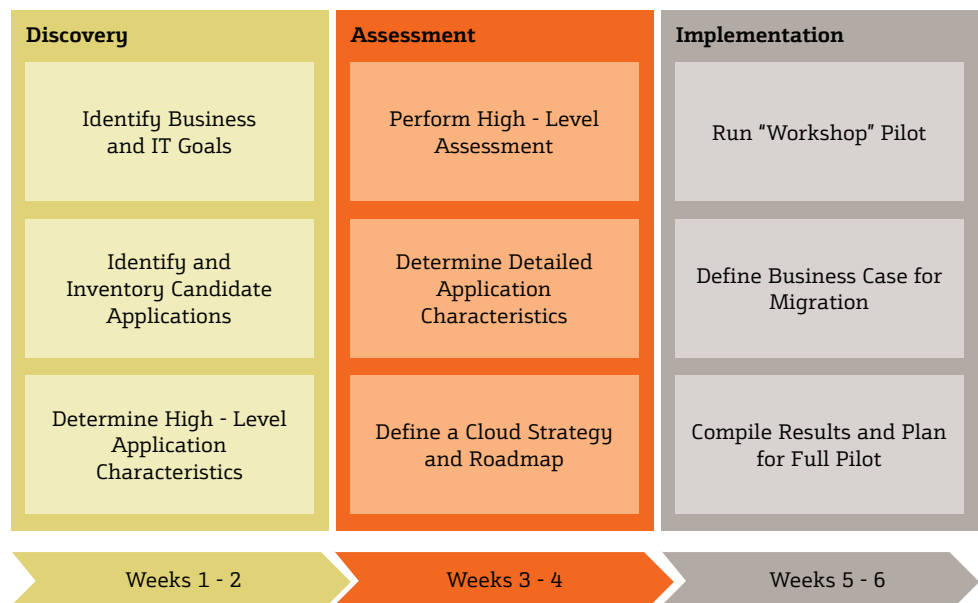


Illustration 18. Framework for adoption of cloud computing services
Source: Accenture.

identification of applications that could be migrated to the cloud right through to implementation of the cloud computing services themselves.

In reality, the decision is not so much *whether* to move to the cloud or not, but *what* to move to the cloud. First of all, the company needs to identify its business-critical activities and evaluate the role played in them by information systems. Moving these key applications to the cloud will certainly require a detailed analysis to justify moving to an environment that has yet to reach maturity. For the other applications, cloud computing is a more feasible option and at the beginning, they are likely to be the ones taking up most room in the clouds. The fact is that cloud computing can offer companies comprehensive solutions for basic business functions, such as sales (see Illustration 19).

What businesses have to decide: alternatives in the cloud world

In keeping with the main problem identified by the FTF experts, the first issues firms consider when it comes to moving to the cloud are security and privacy. Depending on how they deal with these matters, clouds can be classified as internal or external clouds and private or public clouds:

- An internal cloud is located at the company's own data centre and forms part of its capitalised assets. An external cloud, on the other hand, is hosted outside



Illustration 19. What does the cloud mean for sales?
Source: Salesforce, Peter Coffee.

the company's immediate context and forms part of the assets of the service provider – for the company, the provider's charges are booked as expenses.

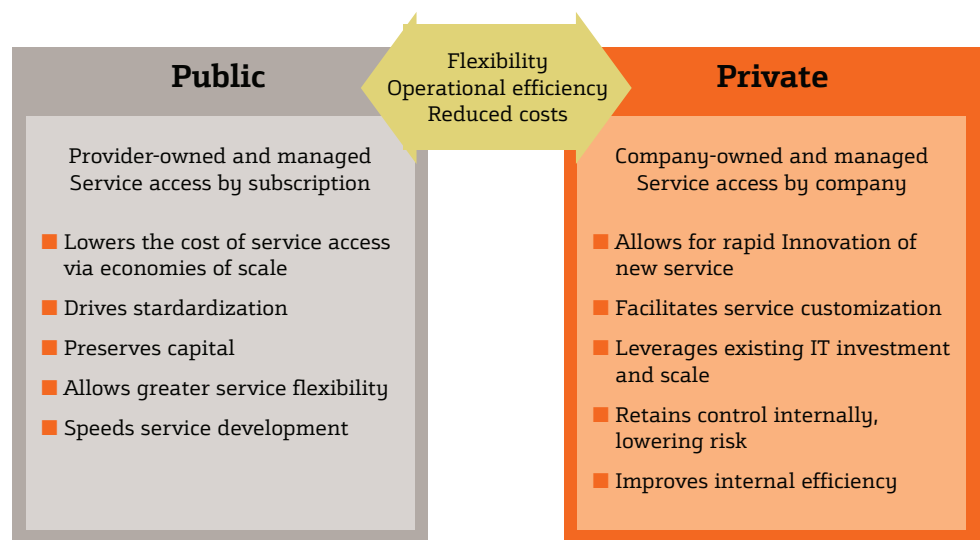
- A private cloud is for the exclusive use of a specific organisation, as opposed to the public cloud which is shared by many different firms, though each one is unaware of the existence of the others.

When the time comes to migrate, firms will make use of the two types of cloud. For example, a company may migrate its computing capacity to a private external cloud, i.e., one that belongs to a cloud provider, but which is not shared with any other organisation.

These two classifications are useful when it comes to identifying the advantages and disadvantages for companies of each type (see Illustration 20). The distinction between public and private clouds is based on the relative elasticity and isolation of each one. The private cloud allows clear limits to be set on the servers used, since it is not shared with any other company and can therefore ensure greater privacy of the stored data. The public cloud is more elastic, since it centralises the computing of many different firms, allowing providers to balance their different demand peaks. The result is that the providers get more use out of the servers

which brings prices down for their customers. The public cloud is more flexible, since it does not have the same constraints as private clouds. In a private cloud, once the contracted capacity has been exceeded, an additional server has to be hired out. Likewise, capacity can only be reduced when the resources of one or various servers are not needed. This means a staggered increase or decrease in computing resources. In a public cloud the resources amount to a pooling of computing capacity from which businesses use the resources they need, with no distinction between servers thanks to virtualization. In this way, the public cloud allows firms to adjust to maximum supply and demand for resources and, because there are fewer constraints, the adjustment can be instantaneous.

At the same time, there are essentially three characteristics differentiating an internal cloud from an external one: the nature of the costs, control over information and the location of the data. As we have seen, the providers' external clouds allow them to transform IT investments into variable expenses, whereas internal clouds require greater capital investment. However, the latter allows greater control over data, since the information is stored on the company's own in-house servers. On the contrary, when data is stored on an external cloud, control of the information is handed over to the service provider. Finally, external clouds often involve greater delocalisation of data, since a cloud provider normally has more servers than the business and these servers may be geographically scattered. Delocalisation of information can be restricted to some extent by means of service level agreements, but if the business requires the data to be located in specific sites or territories, as may be the case with bank's customer information or



Both private and public clouds drive flexibility, operational efficiency and cost reduction while enabling companies to meet different business requirements.

Illustration 20: Characteristics of public and private clouds.
 Source: *Staying aloft in tough times*, CIO White Paper, IBM.

citizen information held by a government, it may be more appropriate to go for an internal cloud.

There are other cloud classifications, but they are generally based on combinations of the two we have seen here. Other widely used concepts are the hybrid cloud—which is simply a combination of public clouds and private clouds or internal systems—and the government cloud, which can be the government's own private internal cloud (if only government departments have access to it) or an external public cloud (if it can be accessed by the public at large).

Moving to the cloud step by step

Based on its experience with a wide variety of customers, Accenture considers that there are three essential steps company information officers need to consider to make the most of the advantages today's cloud has to offer¹¹⁷. The first step is to identify business areas that are suitable for the migration. As we have seen, these tend to be areas that are not critical from the business's competitive position. For them there are cloud infrastructures such as Amazon EC2, which are mature enough, and which offer alternatives that compare favourably in terms of flexibility and economy to buying hardware. The second step is to identify the right users for the cloud applications; in other words, to decide which users' productivity can be improved after migration. Instead of buying or renewing software licences for each person working in the company, identify those that can adapt best to cloud-based solutions. To do this, you will need to select solutions that match the type of work performed by these users. For example, people working in support centres and remote centres are good candidates for using cloud desktops. The third and last step Accenture recommends really consists of taking small steps towards creating an internal cloud; in other words, to continue improving the use of existing IT resources through virtualization and consolidation of data centres, eventually leading to the creation of an internal cloud.

Ron Markezich, Corporate Vice President of Microsoft Online and former CIO of Microsoft, also has a list of actions CIOs should take when adopting cloud computing¹¹⁸ which may add to Accenture's suggestions:

- Study how cloud computing can integrate with the organisation's IT architecture by taking advantage of the benefits of both environments. To do this, he recommends using cloud services for applications that do not offer competitive advantage.
- Prepare the organization and surrounding ecosystem (suppliers, customers, etc.) for the changes and benefits cloud computing will bring.
- Plan carefully for identity management so that integration with any cloud service is seamless for users. This means that when the company adopts a new cloud-based service, employees will be able to access it with the same user name and password as for other applications.

¹¹⁷ http://www.accenture.com/NR/rdonlyres/F8D8819A-D047-4B1D-8739-2CBE28695652/0/Accenture_Technology_Labs_What_the_Enterprise_Needs_to_Know_About_Cloud_Computing.pdf.

¹¹⁸ <http://www.microsoft.com/Presspass/Features/2009/may09/05-20RonMarzekichQA.mspx>.

- Choose which applications to start the migration with. Try to keep risk and implementation workload low at first but at the same time drive excitement for the new services among all employees.
- Find a provider with credibility, capacity and a proven track-record. Get in touch with some of the provider's other customers who have already adopted cloud computing.

As we saw at the beginning of this piece, the most important step should be to identify the first applications for migration, but how do you go about it? According to a study by Accenture¹¹⁹, there are a series of tasks and applications which by their nature are best suited to head the list. Candidates include batch applications, i.e. those that do not have to be run on line or in real time and which normally use times of low demand from other applications, for example, at night. The best applications are those that have a self-contained dataset and make intensive use of computer resources during running time. Examples of such applications include those used in data conversion, cleansing and mining, data compression and encryption, simulation and risk modelling, and graphics rendering.

Other tasks can benefit substantially from migration to the cloud are software development and testing, mainly in large companies. A cloud infrastructure is a more suitable platform for global projects, since it facilitates collaboration among teams working in multiple locations. In turn, because the project teams can obtain development resources on the fly, the cloud can help minimise the potential risks of delay. Test environments like those offered by SOASTA¹²⁰, a provider of cloud test services, allow realistic load testing and performance simulations without requiring a high-cost infrastructure. However, not only software development but any of a large company's R&D projects is a potential candidate for the cloud, because they are highly iterative and demand fast ramp-up and quick scale-up and down.

Desktop tools are also typical candidates for moving to the cloud. Companies often consider this possibility to save money on licences and to meet the demands of younger employees, who are used to social networking and expect the company to have management systems and services that allow on-line collaboration; they are also less concerned with the cloud's security issues. However, Accenture recommends putting migration off until certain requirements are met, since desktop clouds are not yet mature enough for heavy use by users, mainly in common applications such as spreadsheets. As we have seen, employees at support centres and offshore centres are the best target for migrating business desktops.

The most suitable applications to be moved to the cloud will depend on the specific company, but an ever wider array of applications is becoming available. Illustration 21 shows examples of firms that have moved applications to the cloud for different business functions and activities.

¹¹⁹ http://www.accenture.com/Global/Services/Accenture_Technology_Labs/R_and_I/ToKnowAboutCloudComputing.htm.

¹²⁰ <http://www.soasta.com/>.





<p>IT governance / Project mgt.</p>	<p>Franchise Management</p>
<p> IT Governance and change control Built in 6 weeks</p>	<p> Franchise and Training Management Less than 8 months</p>
<p> Product Management Less than 10 weeks</p>	<p> Franchise Management Less than 3 months</p>
<p>Billing</p>	<p>Recruiting</p>
<p> Custom billing application Less than 6 months</p>	<p> Recruiting and training application Less than 6 months</p>
<p> Quoting, Licensing & Billing Less than 10 weeks</p>	<p> Performance and Time Off Less than 5 weeks</p>
<p>ERP/Accounting</p>	<p>Shipping and Distribution</p>
<p> Commercial/Accounting application Built in 6 months</p>	<p> Sample Management application Less than 6 months</p>
<p> Custom ERP system Built in 7 months</p>	<p> Distribution and Shipping Less than 3 months</p>

Illustration 21. Examples of applications moved to the cloud.
Source: Salesforce, Peter Coffee.

At the same time, the cloud is suitable for applications that have peak load demands, essentially when they are predictable. Examples of predictable peak load demands include the IT systems at retailers during the sales season or airlines during the holiday period. In such cases, the cloud can be seen as an additional resource for coping with excess demand; it means that the company's systems do not have to be designed to support peak capacity with resulting overcapacity the rest of the year round. However, when demand is unpredictable, as in the case of the securities market, peak load management becomes more complicated, and requires constant balancing of the resources obtained from in-house systems and external clouds. Software packages already exist to solve this problem, but they are not designed for widespread use. As these products mature, however, companies with this problem should be able to plan for their internal data centre capacities based on average demand instead of peak numbers.

As we have seen, companies should start by studying the viability of migrating these applications and projects, but there are a series of points that need to be

taken into consideration first. According to is4profit¹²¹, a portal that provides free information and advice to medium and small-sized firms, these are:

- The quality of the data to be transferred to the cloud.
- Parity between new data and old.
- The location of the cloud server.
- The bandwidth and reliability of the Internet connection, in terms of both upload and download speeds.
- Regulations that might affect the way customer data is handled.
- Whether existing PCs are suited to the new cloud system.
- How the company intends to adopt the cloud model: big bang (implementing all applications in one go) or as a phased approach.
- Scalability of the service.
- Training required by company staff.

The company should only start negotiating the availability and service of the Internet connection after it has decided what part of its business it plans to move to the cloud and the number of users that will be accessing these services. It is also important to take into account the potential impact for the company if the services it plans to migrate were to become unavailable. Telecom operators are particularly important in this regard and can act as intermediaries, helping firms to choose the best cloud provider and to manage the service level agreements between the two parties¹²².

The decision as to which IT services on in-house systems should be migrated to the cloud becomes easier as the range of cloud services matures. Until recently, it was limited to an overly standard list for the complex requirements of some businesses. Nor were companies particularly comfortable with the idea of data being handled outside their own secure borders. Price-wise, too, the limited use being made of these services meant that they were not cost-effective. With new offerings from cloud providers, companies now have a broad range of possibilities for moving to the cloud. They can choose between adopting IaaS services when the applications require high speed and large volumes (as in financial or engineering functions); PaaS services for rapid development and implementation of customised applications; or SaaS services for the business's common automated functions. Thanks to these new models, computer systems are no longer a factor of competitive advantage for companies and it makes sense to centralise them in specialist providers. Much of the IT has been "commoditized", becoming necessary, but not in itself sufficient, to keep up with other organisations. Promoting cloud computing allows firms to release talent from IT areas to develop key business elements, whereas keeping resources focused on "commoditized" technology takes time, money, staff and resources away from the real business. Illustration 22 shows the level of difficulty of migrating the different applications of a company as opposed to the value of migration.

In previous sections we have seen that only a small number of the firms that have adopted cloud computing use a "pure cloud" model; most prefer a hybrid model

¹²¹ <http://www.is4profit.com/business-advice/it-telecoms/cloud-computing-considerations-for-migration.html>.

¹²² http://www.bnamericas.com/news/telecomunicaciones/Firmas_del_sector_podrian_ser_intermediarias_en_evolucion_a_cloud_computing_segun_Yankee_Group.

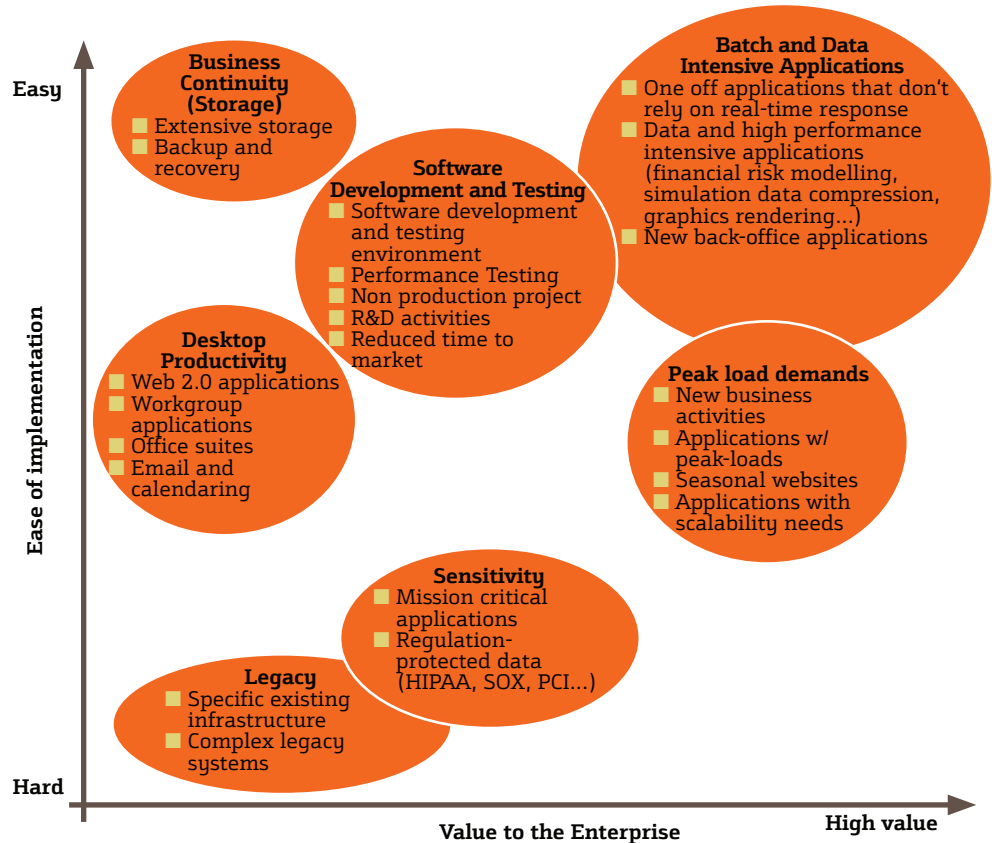


Illustration 22. Degree of difficulty of implementing cloud applications compared to the value of this implementation for the company.
Source: Accenture Technology Labs.

combining cloud and in-house systems. For the moment, this may be the most logical approach for large companies, who find it difficult to replace legacy systems (outdated systems which the company does not want to or cannot replace easily). Large corporations hold onto these systems in their in-house data centres until they are replaced by more modern ones. Critical applications can continue to be developed in the in-house data centres, but they should adhere to cloud computing standards. In this way, as the model matures, the in-house data centres will be transformed into internal clouds, which will maintain business-critical systems, while the other systems can be migrated to external clouds. At the same time, small and medium-sized enterprises, which lack large data centres, will use external clouds to handle nearly all their IT services.

Accenture believes that the systems departments of large organisations will continue to provide most of the IT services, especially those that enable the business's essential functions. Nonetheless, they must accept that the relative size

of their staff and resources in the organisation will be cut as cloud computing is adopted. According to the Future Trends Forum experts, this department may become even more relevant than ever; however, instead of having large numbers of staff working on systems maintenance, there will be a smaller number of positions focusing on management and negotiation with cloud providers.

How does government migrate to the cloud?

As we have already seen when discussing the value of cloud computing for the public sector, the sensitivity of the data handled by this sector makes migration to the cloud more complicated. However, like private companies, cloud computing also holds out interesting opportunities for government. Governments need to plan a roadmap for cloud adoption that will address the criticality, confidentiality and privacy of the data being handled. Under this roadmap, the first data to be transferred should be public information that is accessible to the general public over the government's websites. However, migration of non public information and personal data – subject to restrictive privacy laws – is not as intuitive and varies depending on the country in question. As we have seen in previous sections, some administrations, including the British and South Korean governments, are following different paths towards cloud adoption, but the very fact that they are taking the first steps in this direction is a very positive sign for the future of cloud computing.

In the case of government, the actual physical location of the data stored on a cloud provider's servers is of vital importance. Loss of control over citizens' information is a critical issue and may, on occasions, be restricted by national law. In order to relieve this problem, governments can follow a systematic process for studying ways of adopting the cloud for existing systems. As we have seen, the first step is to examine the possibility of moving public information that is already accessible to citizens over the web. Transferring this information to an external cloud provider may mean cutting costs in the short term, but the primary aim is for the government to become more familiar with the nature of the services on offer in the cloud. It will also need to examine all the data stored to detect any possible issues of privacy. However, this process need not be any different to those currently performed on in-house systems.

A second step consists of examining non-public data that does not contain personal information on citizens, to establish what data could be stored in the cloud. Not all data is equally critical. Once it has been sorted by criticality, it is necessary to weigh up the benefits and associated risks of migration. Examples of this type of data include national economic trends and accumulated population statistics. The third step is similar to the second one, but involves the personal data of citizens which is governed by more restrictive data protection legislation and therefore requires a more detailed study. Current legislation tends to require cloud providers to offer very high levels of reliability and security in ensuring data location. Maintaining that level of control over the cloud can impact the benefits it offers, since it does not allow providers to achieve the economies of scale on which

their value proposition is based. With existing cloud services, the only feasible option appears to be the private cloud, be it internal or external.

Yet to what type of cloud should governments migrate data? Because cloud services face similar challenges to other types of shared service, their success or failure will depend more on the model of the government than on technical aspects of the solution. Given the many security and location requirements imposed in developed countries, the hybrid cloud is a reasonable alternative for adopting cloud computing. The private part of this hybrid cloud allows the administration to keep a strong control over the data, even if they do not achieve the same level of potential cost savings as public clouds. The most security-sensitive data can be kept on internal clouds, while other data can be stored on private clouds managed by external providers. The public part will essentially consist of information that is freely available to the public, either over the Internet or through other media.

As we have seen, governments also have another option for their cloud migration strategy: they can create their own "government cloud". If the government plans to transfer a large mass of data to the cloud –either by migrating the information from various departments or from an entire jurisdiction– the best option may be to create a government cloud, which could be based in the government's own data centres or in external cloud providers, but both types must meet strict location and security requirements. In the case of the external providers, these requirements will be ensured by means of service level agreements, for which the government will have to negotiate issues such as the territory in which the data is located, maximum system down times, response times to problems and the minimum requirements for keeping auditing and security records. For introducing new information systems, the British government's new bill is an example to be followed¹²³. CIOs of public administrations will have to ensure that the new systems use a model that enables a similar level of scalability to cloud computing to facilitate subsequent migration to the cloud. To do this they will have to use virtualization models or directly use the services offered by providers.

The factors that need to be taken into account when defining a strategy for migration to the cloud in developing countries are different to those of developed countries. Developing countries should consider the public cloud as their first option, since they tend to lack suitable conditions for keeping a private cloud in their own country. Frequent power cuts and unreliable Internet connections in these regions tip the scales towards external clouds, which are generally located in countries with high levels of infrastructure reliability. Data protection legislation is not as strict and crime rates are higher, which means that the risks inherent to delocalisation in external clouds are offset by the security and privacy risks of a cloud installed inside the country itself.

¹²³ <http://news.zdnet.co.uk/itmanagement/0,1000000308,39664705,00.htm>.

5.3. What's written in the clouds: the educational, environmental and social impact

Even if we are not always aware of it, cloud computing is a constant presence in our society. Check your hotmail, run a search on Google... and you're actually using the cloud. Yet cloud computing is not just a question of improving the effectiveness of services that were already available on the Internet; its impact on society goes far deeper. Access to information anywhere and anytime is transforming our society and consumers have been quick to share that information and collaborate with each other at no apparent financial benefit to themselves. This feature of the information society was already apparent before the whole cloud computing concept emerged, with projects such as SETI@home, a program for searching for extraterrestrial intelligence developed by Berkeley University which, from 1999, has been using surplus computing capacity on volunteers' computers¹²⁴. However, cloud computing and social networks are facilitating collaboration and communication to limits that would have been inconceivable just a few years ago.

With the proliferation of the cloud, the information balance is moving towards the user, who now has more and more access to a greater amount of information formerly available only to business and government. As a result, governments are beginning to tap into citizen collaboration to perform certain tasks, leading to a phenomenon known as *crowdsourcing*. The other side of the coin is the cloud's potential to impact the very foundations of society – and especially education. Cloud computing is making headway in universities, with backing from cloud providers. The greatest academic potential of the cloud lies in its capacity to facilitate distance learning and research. Cloud computing is also relevant to another basis of today's society, the sustainability of the environment in which it operates. Concentration of demand in data centres has a major environmental impact and the cloud is proving to be a more energy-efficient model of IT.

Education in the cloud

Whereas Internet first arose in the government and academic arena, the roots of cloud computing can be traced back to the private sector and it has evolved outside the educational context. However, the lack of cloud computing industry standards gives the academic community an opportunity to offer advice, tools and techniques independently and impartially. The cloud is gradually finding its way into universities, with institutions of the standing of Harvard now offering specific courses on the subject¹²⁵. For some time now, cloud providers, aware of the potential of this group, have been directing their efforts towards the academic world. In 2007, Google and IBM came together to offer universities the resources and support they needed to develop an educational curriculum on software development in large-scale distributed computing systems¹²⁶. The project, which is still underway, includes specific contents designed by Google and the University of Washington¹²⁷. Many prestigious universities have joined the programme, including the University of

¹²⁴ http://www.planetary.org/programs/projects/innovative_technologies/setiathome/.

¹²⁵ <http://www.extension.harvard.edu/courses/csci.jsp#e-175>.

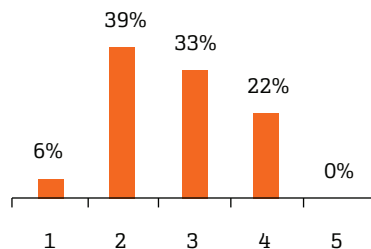
¹²⁶ http://www.pcworld.com/businesscenter/article/138195/google_ibm_promote_cloud_computing.html.

¹²⁷ <http://code.google.com/edu/parallel/index.html#content>.

Washington, the Carnegie Mellon University and the Massachusetts Institute of Technology (MIT)¹²⁸.

The cloud may have found a place in education, but the syllabuses are still mainly focusing on technical aspects of cloud computing. As we have seen in other sections of this report, however, a change is anticipated in the functions of company IT departments, creating a demand for profiles centring more on systems management, innovation and relations with providers. Is it not reasonable, then, to expect an equivalent change in university curricula? FTF experts are not convinced. Asked about the impact of cloud computing on university curricula, 50% thought it would have a large impact, resulting in a reorientation of the educational offering with a greater number of courses on cloud computing. On the other hand, only 22% of experts thought that it would usher in curricula that were more focused on systems management and less on technical aspects (see Illustration 23).

University IT curricula more focused on management aspects rather than technical skills



Reorientation of University IT courses (i.e. cloud computing courses)

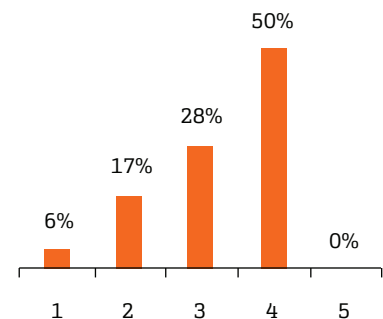


Illustration 23. Opinion of Future Trends Forum experts as to the impact of cloud computing on different areas (1=no impact, 5=very strong impact)
Source: authors.

Given what we have seen so far, we might ask the reason for this apparent contradiction between an increased demand from corporate IT departments for candidates with management skills and university curricula that continue to focus on technical aspects? When it comes to cloud computing, the education sector is following the path marked by private industry, with the result that it is business that is promoting cloud computing in universities. So far, it has been the cloud providers, as the leading potential beneficiaries, who have worked hardest to have cloud computing included on academic programs. However, their interest and their focus are largely restricted to technical aspects. The companies with most to gain from a systems management approach are the cloud users and for the moment, they are still studying the impact the cloud will have on the way they operate. In

¹²⁸ <http://www.cloudbook.net/ibm-google>.

the short term, such companies are unlikely to devote part of their resources to developing this subject at university level while they still have doubts as to the internal impact it will have and thus the sort of talent they are going to need.

However, the impact of cloud computing in the academic area is not limited to a change in the educational offer; benefits such as cost reduction and greater flexibility will mean that its effects will be similar to those anticipated in business. One of the core principles of any education system is learning through experimentation. It is natural, then, that schools should want to experiment with different types of applications and platforms. In a traditional software system, this is costly and difficult to achieve. Cloud computing offers much greater flexibility to experiment with new applications and platforms.

And if we look at differences between countries, the low cost of cloud computing, combined with its universal availability can help level the international playing field in the area of education. Now not only is it possible to develop a single national curriculum for all schools in a country; cloud computing now makes it possible to offer all students, from the United States to Africa, the same experience in education. Plans to deliver 250,000 laptop computers to schoolteachers in Ethiopia are an example of the opportunities the cloud holds out for developing countries¹²⁹. The aim of the project is to distribute laptop computers that run on Microsoft's cloud platform, Azure. The computers will enable teachers to download curriculum, keep track of academic records and securely transfer student data, without having to build a support system of hardware and software to connect them.

It is also true that in many countries, there are areas without coverage, which means that entire populations have no access to the Internet. In addition, the most underprivileged sectors of the population may be left out of the new forms of education if they do not get a chance to access a computer. Fortunately, advances in cloud computing and device connectivity, together with a reduction in the cost of *hardware* allow initiatives such as *One Laptop per Child*¹³⁰ and the *University of the People*¹³¹. The University of the People allows people around the world to receive an *on-line* university education practically free of charge and it is cloud computing that has made it possible.

Clearly, technological advances are changing the education system as we know it. The cloud can act as a facilitator for developing classroom telepresence and distance learning, as demonstrated by the imminent adoption of the cloud by the Open University¹³², Europe's leading distance university. The FTF experts all agreed that it will have an impact on distance learning at the expense of one-to-one education and 45% considered that the impact would be high or very high (see Illustration 24). The cloud offers students access to systems from any device anytime and anywhere, storing files and applications in a shared repository. This system lends itself to student participation and collaboration, essential attributes in a new society characterised by a proliferation in social networks and team work. It may still be difficult to imagine a student from a small African village attending classes at Harvard over a computer or a mobile phone, but cloud computing is

¹²⁹ http://seattletimes.nwsourc.com/html/microsoft/2009458942_microsoftazure13.html.

¹³⁰ <http://olpc.com/>.

¹³¹ <http://www.uopeople.org/>.

¹³² <http://news.zdnet.co.uk/internet/0,1000000097,39857569,00.htm>.

Boost in distance education at the expense of physical attendance

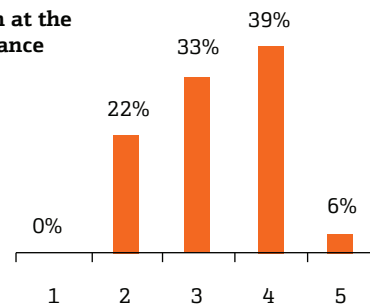


Illustration 24. Opinion of Future Trends Forum experts on the impact of cloud computing in distance education at the expense of one-to-one education (1=no impact, 5=very strong impact)
Source: authors.

enabling a proliferation of distance universities in developing countries, offering citizens access to an education which they could never previously have had, with resources that are comparable to those of the large universities, without the need to maintain large infrastructures.

University research departments may also benefit from this model. Scientific research requires a large volume of computer resources on an intermittent basis. The ability to scale up resources at certain times based on a pay-per-use system could offer cost savings and make it easier for researchers to develop their projects. *Cloud computing* improves systems efficiency, helping scientists to obtain results quickly. However, the cloud also levels out the research resources of different universities: all that is required is a reliable Internet connection to obtain major computing capacities anywhere in the world. The proliferation of mobile communications and cloud computing is enabling education centres in developing countries to replicate complex computing centres even if they do not have stable power infrastructures. A laptop computer with a battery, a generator and wireless Internet access over the mobile communications system are enough to reproduce a computing system with the capacity of the best university in the world.

Is the cloud really ecological?

Sustainability and climate change are the burning topics of the day. The spotlight is on all areas of industry and business to see how they perform in this area and cloud computing is no exception. Not only does it have to prove its benefits for business and the general public, it also has to justify its contribution to global sustainability.

The chief argument used in favour of cloud computing relates to the use of servers and the power consumption per server. In a traditional computing environment, each server is dedicated to a set of applications and operates in isolation from one another. Each one is sized to cope with peak load demands on

its applications, which means that there is a lot of unused capacity during periods of low demand. As a result, server usage tends to average between 5% and 20%¹³³, although they consume energy throughout operation, however little use is made of them. Thanks to virtualization, all applications share the server set, thus increasing utilisation. Total server capacity is calculated on the basis of anticipated demand from the total number of applications. Since the demand for each one is not distributed evenly over time, it can be assumed that load peaks of some applications will be offset by off-peak times in others. As a result, the total capacity required by all the servers is less than if they were planned in isolation, thus increasing usage, cutting the number of servers needed and reducing the power consumed.

Statistically, as the number of applications sharing the servers rises, the likelihood of peak load demand being compensated by off-peaks also rises, which means that greater use can be made of the equipment. Big companies can achieve high utilization rates, since they generally run large numbers of applications. Small businesses, on the other hand, cannot attain these levels and this is where cloud computing comes into its element. Demand aggregation allows providers such as Google and Amazon to operate at high utilization rates because they know that –statistically– not all users will be using the service at the same time, especially when the demand comes from different countries in very different time zones. This makes it possible to reduce the total number of servers required and, thus, the power consumption. This is the chief argument for the sustainability of cloud computing, but to test it out, figures on real utilization are needed and, for the moment, the large cloud providers are not prepared to disclose this information¹³⁴.

However, not all experts agree that cloud computing is so green. Its detractors claim that ultimately it does not reduce, but actually encourages, energy consumption. Their argument is based on the idea that access to computer resources without the need for large investments levels the playing field and encourages new actors onto the stage. These new actors, mainly small firms and individual users, use resources that were previously out of their reach. In this way, although utilization per server rises with demand concentration, ease of access to the resources pushes the demand far higher than it was before cloud computing made an appearance. Although this argument is well grounded, the benefits a cloud model can bring to a lower-income population appear to tip the scales of sustainability clearly in its favour.

Another important feature of the impact of cloud computing for the environment involves the centralisation of servers, a characteristic of this new technological management model. The servers are located in large data processing centres that consume immense quantities of energy. Altogether, these centres are estimated to consume between 1 and 2 percent of global electricity, or more than the total power consumption of a country like Sweden¹³⁵. Google estimates that each query on its search engine generates 0.2 grams of CO₂. As a result, it has created its own power subsidiary, Google

¹³³ <http://en.sap.info/virtualized-servers-save-real-money/2804>.

¹³⁴ <http://www.elasticvapor.com/2009/12/is-cloud-computing-actually.html>.

¹³⁵ http://www.nytimes.com/2009/06/14/magazine/14search-t.html?_r=3&ref=magazine&pagewanted=all.

Energy¹³⁶, to help it achieve carbon neutrality. Through this subsidiary, Google can buy and sell energy and thus manage better its energy resources and have greater access to renewable energy. What is the reason for this disproportionate energy consumption? It is partly due to the energy requirements of the servers themselves, but this amount accounts for less than half the power consumed; the rest is almost entirely used for cooling the data centres. The efficiency of the servers depends to a great extent on the temperature; accumulation of the equipment produces large amounts of heat, necessitating constant cooling to ensure that it performs correctly. The Finnish government wants to put this to work by creating a data centre under one of the most famous cathedrals in Helsinki and connecting the cooling system to its water mains to heat surrounding homes¹³⁷. Indeed, large data centres can be used as thermal power stations, harnessing the heat energy wasted in data centres and thus improving their energy efficiency.

Computing in traditional data centres is one of the least energy-efficient processes. Of the power supplied from the grid, approximately 55% is used to cool the equipment, with just 45% actually going to power the servers. And of this 45%, nearly two thirds is dissipated in the form of heat, which means that of all the electricity supplied to the data centre, only 13.5% is used to generate effective computing capacity (see Illustration 25). If we include distribution of the energy by the power grid, the effective percentage of energy actually used falls to around 3%. With the improvements in server utilization that cloud computing permits, 80% of that 3% of effective energy is used. The potential improvement in the efficiency of the rest of the process is much greater, given that it represents 97% of the power generated at source. As a result, large cloud providers are designing innovative systems to reduce energy consumption in this part of the process. Among the most active in this field is Google, which has designed a data centre in Belgium that has no chillers, but instead relies entirely upon free air cooling to keep its servers cool¹³⁸. Google says temperature conditions in the region will support free cooling almost all the year round, except, according to its engineers, for about seven days per year on average. When the outside temperature does get too hot, Google will switch off the servers and transfer the computing workload to other centres. For this purpose, it will incorporate weather forecasting into its data centre management model. Yahoo is building a data centre in Lockport, New York, based on a similar concept¹³⁹. Like Google's, this data centre - which Yahoo says is based on chicken coops - will have no chillers and will use the winds in the Buffalo area to cool the data centre.

These innovative data centres have led some experts to speculate about the concept of "following the moon", whereby large cloud providers would have a string of data centres dotted around the world and would constantly move the computing load to areas where it is night-time. Not only would they benefit from lower temperatures, they could also avail of lower electricity rates at off-peak times¹⁴⁰. There are doubts as to whether the "follow the moon" model is compatible with cloud computing¹⁴¹, but this has not prevented people from suggesting other models based on the same logic, such as "follow-the-sun",

¹³⁶ <http://cleanenergysector.com/2010/02/google-can-now-buy-sell-energy-what-next/>.

¹³⁷ <http://www.reuters.com/article/idU5TRE5AT01220091130>.

¹³⁸ http://www.computerworld.com.au/article/311616/google_banks_data_centre_no_chillers/?fp=4194304&fpid=1.

¹³⁹ <http://news.techworld.com/operating-systems/118682/yahoo-invents-chicken-coop-data-centre-design/>.

¹⁴⁰ <http://ecoinsite.com/2009/07/follow-the-moon-computing-strategy.html>.

¹⁴¹ <http://blog.componentoriented.com/2009/09/follow-the-moon-architecture/>.

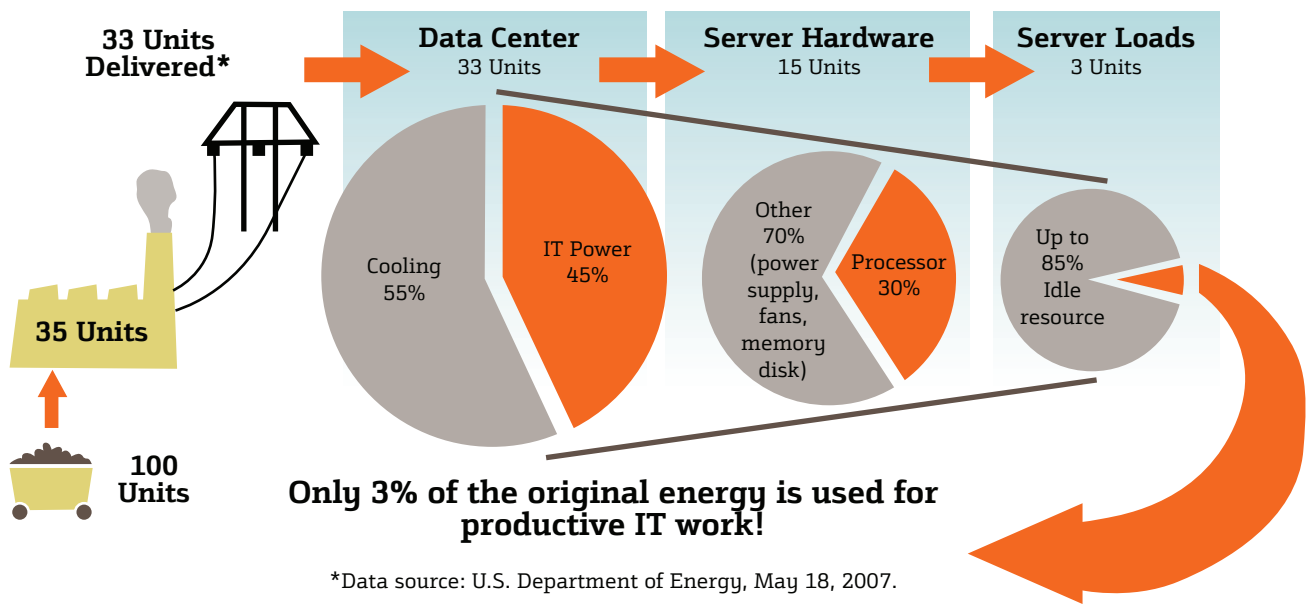


Illustration 25. The process of transforming power into computing capacity.

Source: "The Social Factor: Innovate, Ignite, and Win through Mass Collaboration and Social Networking", Maria Azua, IBM Press.

"follow-the-wind" and "follow-the-kilowatt"¹⁴². Cloud providers are working constantly to come up with ideas to reduce energy consumption. Google recently filed a patent for what it calls a "water-based data center"¹⁴³. This consists of a power generator that would obtain electricity from sea waves and coolers that would use sea water to cool the servers, bringing Google another step closer to its target of being carbon neutral.

Nobody can deny that computing has an environmental impact. The increase in the number of online queries on search engines and the proliferation of on-line services have obliged large cloud providers to increase the number of servers and open new data centres, with a resulting rise in power consumption. However, the growth in computing needs is not a result of cloud computing, but of the information society towards which the world has been evolving ever since the Internet first began to take off. In this context, the cloud is a more ecological alternative for the development of this society, since it uses energy more efficiently.

The Crowd in the Cloud

The proliferation of the cloud, together with the development of mobile devices, is spawning a significant change in the way society lives and works. People store their information on the cloud, from where they can access it anywhere and

¹⁴² <http://www.vertatique.com/cloud-computing-starting-follow-sunwindmoon>.

¹⁴³ <http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITO&FF&d=PG01&p=1&u=/metahtml/PTO/srchnum.html&r=1&f=G&l=50&s1=%220080209234%22.PGNR.&OS=DN/20080209234&RS=DN/20080209234>.

anytime via devices such as *netbooks* and iPhones. *Cloud computing* has transformed the concept of the Internet, previously just a means of connecting computers to obtain information posted on websites. In this new situation, the Internet is like a huge computer that stores and processes people's data, which they access through peripherals consisting not of a screen, keyboard and mouse, but of *smartphones*, *netbooks*, laptops, etc. This universal access to information is not only changing the way we live and work; it is also having a profound impact on the way we think, behave and interact. Every day, we use cloud-based applications and services, though on occasions we are not even aware we are doing so (see Illustration 26).



Illustration 26. User applications of user offered from the cloud.
Source: own preparation.

The cloud has freed us from being tied to a given place and a given device. The data floats in the cloud without the user having to worry about where it is physically located; the information is everywhere, where and when it is needed. Cloud computing and mobile devices are transforming our concept of space and time, and at the same time the way we interact with people, places and things. Restrictions of space and time are being cut even further than they were with the coming of e-mail and the Internet. The data travels with us and we are connected to people all the time. We are now much more aware of what is happening around us. You can know what the person sitting next to you and his friends are thinking, or you can find out what your childhood friend is planning to do tomorrow, even if she lives on the other side of the world. And by means of a simple query, you can even get a list of all the restaurants within a hundred metres of your current location.

Cloud computing and mobile devices have brought down the barriers to participation and collaboration, and this to a great extent has contributed to the proliferation of social networking. This is a new society characterised by user-to-user activity, in which participants share information on global forums. The result is a fundamental shift in the way people make decisions; increasingly they are relying on information posted *on-line* by Net users rather than the information provided by governments or businesses. The cloud breaks down the barriers to contents – art, expression, opinions and information of all types – which are growing exponentially and are becoming accessible to an ever wider audience. Whereas previously, contents mostly came from known channels, such as text books, encyclopaedias, newspapers and television, today most content comes from relatively unknown Internet sources. However, the Web is not an encyclopaedia with less reliable information; it is a place to post content and interact with it. People are no longer content just to reference or copy information; they want to interact with it. Individuals of any age can influence world opinion, making it simpler to contribute as individuals or groups to global art, information and opinion.

And this democratisation of computing is precisely one of the key features of the cloud. Users from anywhere in the world with Internet access can get hold of practically unlimited computing resources, develop products and make them accessible to audiences which, until recently, stood outside their reach. The music industry is a clear example. The large record companies are interested in musical styles with large audiences, in order to offset their vast marketing and advertising costs. However, new groups can access new market niches with little investment in resources; all they need to do is post their videos on YouTube or MySpace and hope that the users' opinions will reach the necessary audiences. The story of a young engineering student in Nairobi, Kenya, is another example of the possibilities of cloud computing in developing countries¹⁴⁴. Despite the fact that he did not have an iPhone, or even access to the iPhone service (the iPhone doesn't work in Nairobi), Wilfred Mworira developed an app for the device over the Net using an iPhone simulator. As he says himself, "Even if I don't have an iPhone, I can still have a world market for my work".

Google predicts that most of the great innovations in business applications over the next ten years will take place in the cloud¹⁴⁵. It bases this prediction on four key trends in society and business. The first is that innovations in usability, reliability and security are coming directly from consumers, and they are moving to the cloud. The second trend is that the contemporary world is based increasingly on collaboration and social relations, with priority being given to team productivity over individual productivity. Cloud computing is seen as a facilitator for this trend. The third trend is the change in the economics of IT, with users now having access to resources at very competitive prices, or even for free. In order to be competitive, businesses must be capable of ensuring those same levels of resources. And finally, the fourth trend is the fall in barriers to entry represented by connectivity, reliability and security, as a result of the development of cloud computing, which will encourage innovation among companies in that environment.

¹⁴⁴ http://www.nytimes.com/2008/07/20/business/worldbusiness/20ping.html?_r=1.

¹⁴⁵ http://www.informationweek.com/cloud-computing/blog/archives/2008/06/the_four_trends.html.

One particular feature of the new society is that the great majority of user-developed contents and applications are offered free of charge with no incentive for developers

apart from their desire to share. This willingness to generate and distribute products means that they reach the end user at no cost. Music, news, opinion, recipes, etc. In all these areas, user-shared contents are threatening established businesses. Examples include the growth of unknown bands in MySpace, the pressure suffered by newspapers and the closure of *Gourmet* magazine and other cooking publications. Communication amongst users is increasing consumers' expectations from firms, reducing their capacity to create or control the market, and it is also changing pricing models in a wide variety of industries. It's not all bad news for business, though: cloud computing offers many more opportunities to connect with users and consumers, leading to the emergence of new business models. Innocentive is one good example¹⁴⁶. The company acts as a problem solving portal, using *crowdsourcing*. Organisations in search of a solution – or *seekers* as they are known – post their problem on the Innocentive website, which is accessible to a community of users – or *solvers* –. The users offer solutions to the problem and the best one receives a "reward". In this way, Innocentive can offer companies innovative solutions, by tapping into a diverse community of solvers who are not conditioned by the policies and environments that surround the seekers.

At the same time, large cloud providers will have a chance to level the playing field for citizens in developing countries, by encouraging use of the cloud with competitive prices or free services. The way they do this may consist of reaching agreements with governments in these countries or through proposals such as WasteNothing.org., which offers the large cloud providers the possibility of donating surplus computing capacity to non governmental organisations¹⁴⁷. However, there is no doubt that the large providers have a chance to help development in the neediest countries, and in the long term, of even giving them a competitive edge.

The Haiti earthquake on 12 January 2010 is another example of the sort of service cloud computing can offer, in this case helping save lives in critical situations or natural catastrophes¹⁴⁸. Thanks to the widespread use of basic mobile telephony among Haitians and the relative speed with which a temporary telephone system could be got working, a service was set up to receive text messages asking for help. Through cloud computing, the messages received from the population were rerouted to a team outside the country, which had been brought together through *crowdsourcing*: and *cloud technologies*. This team took charge of translating the messages into English and sorting them. The messages, together with the coordinates and phone numbers taken from the cell locations, were sent back to people working on the ground in Haiti, enabling them to locate earthquake victims. At the same time, Google developed a cloud service to centralise the information available on people affected by the earthquake. This allowed information on people affected or missing to be supplied and obtained based on their first and last names¹⁴⁹. As well as other uses for help on the island, this information gave family and friends specific details of the people affected. As these examples demonstrate, even if certain aspects of the cloud, such as flexibility and *time-to-market*, tend to be highlighted because of their advantages for business, the cloud can also have a major impact on humanitarian aid and in society at large.

¹⁴⁶ <http://www.innocentive.com/>.

¹⁴⁷ <http://www.wastenothing.org/>.

¹⁴⁸ <http://www.readwriteweb.es/general/cloud-computing-terremoto-haiti/>.

¹⁴⁹ <http://www.readwriteweb.es/general/google-crisis-response-un-buscador-online-de-victimas-en-haiti/>.