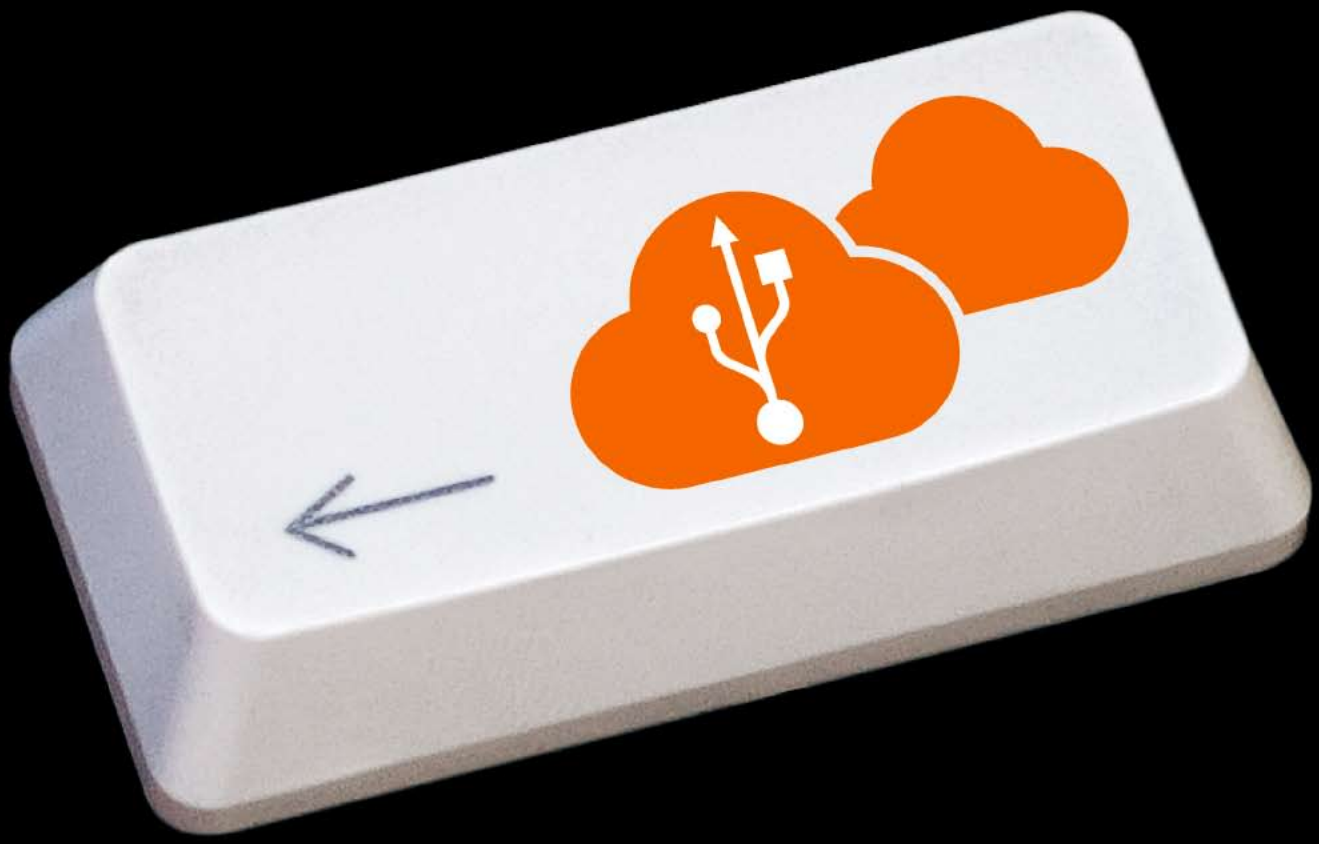
Fundación
de la Innovación
Bankinter

13 Cloud Computing

The Third Wave of Information Technologies



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Many thanks.
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Contents

Executive Summary

We are currently witnessing the dawn of the new paradigm of "cloud computing", grounded on the idea that anything that can be done on a computer can be transferred to the cloud — in other words, to the Internet. In this model, computer resources are used in just the same way as any other service utility, such as electricity or the telephone. These resources are offered by cloud providers, which manage them in large remote data centres, providing a service to large numbers of customers who can access them over any Internet-connected device. By 2012 it is estimated that the cloud computing market will have a turnover of 42 billion dollars, and will extend to large and established providers such as Google, Microsoft, Salesforce, IBM and Amazon.

Cloud supply

Services offered from the cloud can be classified as follows: infrastructures (Infrastructure as a Service), development platforms (Platform as a Service), applications (Software as a Service) and even business processes (Process as a Service). Virtualization has been the key advance in the development of the clouds. It consists of sharing the use of servers among different applications.

The profitability of the large providers is based on economies of scale; they make large investments but have insignificant distribution costs. This means that they can make profits by aggregating small consumers. The customers, on the other hand, save the large investment they would otherwise have to make in infrastructures and receive a variable-cost service, with pay-per-use tariffing.

Not all providers offer this type of charge system. Indeed, the majority are still based on more predictable pre-paid models. However, companies such as Amazon have already set an unstoppable trend towards turning computing into an undifferentiated product.

Companies tend to be reluctant to hand over the management of their most important asset, information; as a result, privacy is the most critical aspect in the cloud. Providers and others seeking solutions to this problem have come up with initiatives such as Cloud Security Alliance and the Enterprise Cloud Buyers Council. Business is also wary of the lack of standards, a factor that restricts the appeal and ease of "moving to the clouds". The National Institute of Standards and Technology and the Open Cloud Manifesto use different alternatives to respond to this issue.

The cloud allows firms to focus more on their business and speed up improvements in their products and services, thus encouraging innovation. However, they are also encouraging user participation and with it what is known as crowdsourcing, a system of open innovation in which anyone can contribute.

Cloud demand

Among business and government, the recession has led to interest in the cloud as a means of cutting costs. However, this is not its sole appeal: it also offers a broad range of possibilities, as users are gradually coming to realise.

The cloud is particularly attractive for SMEs and start-ups. Firstly, because these firms do not currently have easy access to capital, the reduction in initial investment the cloud offers is one way of remaining competitive. Secondly, the cloud cuts time-to-market; new services can be ready in a question of hours, at limited risk. Thirdly, it gives them access to economies of scale through the providers. Fourthly, they can access much more sophisticated security systems. And finally, they benefit from highly specialist user support.

Although few firms were using cloud services in 2009, a very large percentage had plans to move to the cloud. The main reason they gave was the reduction in costs involved, but it is predicted that the reasons will change once the financial crisis has blown over. What the cloud really offers SMEs is the possibility of playing in a bigger league.

Cloud services are more widely used in big companies. For them, the main advantage is they can turn fixed costs into variable ones. This gives them a better idea of the real costs of each application while at the same time minimising the risks involved in launching new products and services. The cloud holds out great future opportunities, one of the most important of which will be the use of social networks. Nonetheless, only 1% said they have fully implemented cloud computing. The main barriers appear to be security and privacy, although confusion over the term and difficulty in managing service level agreements also pose major obstacles.

Cloud computing is not limited to business, however. The great size, complexity and large physical area government technology services need to cover make them ideal candidates in this race to the clouds. The main obstacle in this process will be the sensitivity of government-handled information. Governments throughout the world are starting initiatives to promote the technology. Among the most

important examples are Britain and Japan, which have decided to create private "government" clouds.

Government will play a fundamental role in developing cloud computing, in its twin roles as a regulator, setting the market game rules and an early adopter with a higher level of hi-tech expenditure than any private company. However, when it comes to exercising their position, governments should not only consider the impact the new model will have on their markets, but also the effect it will have on more needy countries, which could be the great beneficiaries of the new technology.

Businesses and governments need to lay down a suitable strategy for moving to the cloud. For business, the first step will be to identify the most suitable applications and users. They will then have to evolve their internal systems towards the cloud. In the case of governments, the order of the move will depend on the sensitivity of the information. The first data to be migrated will be public information, while non-public data, particularly information on citizens, will be handled with much greater caution.

The new "cloud" model of accessing information is transforming society. People are beginning to share information and collaborate for no apparent economic gain. There is a tendency to highlight the benefits for business, but cloud computing also has humanitarian and social potential.

The origins of the cloud lie in the private sector, but the academic community needs to position itself as an independent advisor and shape its technical curricula to the new needs of the cloud, which are more concerned with management than development. At the same time, the cloud will promote telepresence, distance research and distance learning, key factors for fostering equal education for different parts of the world.

Nonetheless, the cloud still has to demonstrate its "green" credentials; cloud computing makes more efficient use of energy by increasing the utilisation of systems, but much of the energy is lost in transmission and cooling, and big companies are already developing innovative systems to improve efficiency rates.

And what is happening in Spain?

Innovative companies are springing up in Spain to offer cloud services, but the real appeal lies on the consumer side. Spain is a market founded on services,

particularly tourism, and a business world in which 99% of all businesses are SMEs. It also has a high rate of Internet and mobile phone penetration and this means that the majority of these firms are potential cloud users. At the same time, strong pressure to cut government spending has aroused interest in the potential of cloud computing. In short, the country's future looks "cloudy", in the very best sense of the word.

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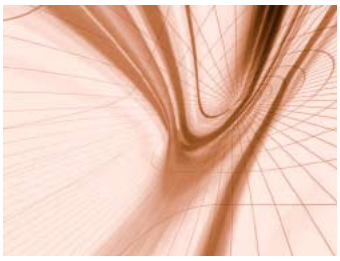
Chapter 1

Foreword

1 Foreword



The buzz and excitement around cloud computing has been steadily building over the last few years. There is general agreement that something big and profound is going on out there, although we may not be totally sure what it is yet. "There is a clear consensus that there is no real consensus on what cloud computing is," was one of the key conclusions at a recent conference on the subject.

So, what in the world is cloud computing? Is it the evolution of the Internet? Is it a new model of computing? Is it a way of delivering just about anything "as a service"? Does cloud computing represent the *industrialization* of IT, much as happened with electricity one hundred years ago as it became widely used across the economy and society?

Cloud computing, in my opinion, is all the above and then some. It is like the fable of the blind men and the elephant. Each one touches a different part of the elephant. They then compare notes on what they felt, and learn that they are in complete disagreement.

To begin with, cloud is the natural evolution of the Internet. As we all know, the original Internet was primarily developed as a TCP/IP network. It later added a number of communication oriented applications like e-mail and file transfer. The advent of the World Wide Web in the early 1990s transformed the Internet into a huge source of information and content, and coupled with the browser, ushered the Internet into the wider commercial world a few years later. Later in the decade, companies started to leverage the Internet for all kinds of *e-business* applications. Irrational exuberance and the dot-com bubble followed.

The bursting of the bubble barely slowed down the continuing advances of the Internet. A number of new initiatives were aimed at making it easier to access IT resources and applications over the Internet, including virtualization, grid computing, service oriented architectures and utility computing. Other initiatives focused on making the Internet much more pervasive and accessible over a wide variety of devices beyond personal computers, including smartphones, mobile devices and sensors.

Cloud computing is essentially turning the Internet into a major part computing platform, significantly extending and improving the technologies and capabilities first introduced in these earlier initiatives. The Cloud is becoming *the platform* for applications, information and services for the billions of smart devices and trillions of smart sensors connected to the Internet.

Cloud thus represents the emergence of a new model of computing in the IT industry. This is a big deal, because in the fifty to sixty years since there has been an IT industry, this would be only the third such model, with centralized and client-server computing being the two previous ones.

In its early decades, the '50s, '60s and '70s, just about all computing was centralized, typically consisting of mainframes and supercomputers located behind the glass walls of the data center. Generally, these computers were quite expensive, shared by many users, and managed by a central IT organization. Minicomputers were smaller and less expensive versions of these central computers designed to be used by departmental functions in large enterprises as well as smaller companies.

The 1980s saw the emergence of increasingly powerful and inexpensive microprocessors, personal computers and Unix-based workstations. These technologies paved the way for the new distributed client-server model of computing. The architecture of these client-server systems was quite different from the architecture of the mainframes of the central computing model. The designs were optimized for low costs and simplicity, rather than efficiency and reliability.

The underlying assumption in the client-server model was that because the individual systems were fairly inexpensive, you could add as many systems as you needed to support the various applications and users in the installation. Over time, companies ended up with very large numbers of relatively small servers, distributed over various departments in the organization, each dedicated to a single application. Because the server were not shared among multiple application or a large enough group of users, they often ran at low utilizations, between 10% and 20%. These factors eventually led to significantly increased management complexities and costs.

The web-based applications that began to appear in the mid 1990s generally followed a client-server model. The much larger number of users now able to access these web applications required servers that were significantly more scalable and reliable, as well as offering significantly better systems management. We saw the rise of very large web sites from Google, Amazon, Yahoo and others, that provided all kinds of consumer services to huge numbers of users, including search, maps, shopping and news. Later on, we saw the rise of Web 2.0 concepts like blogs and wikis, and social networking sites like MySpace and Facebook, which rapidly grew to support large numbers of users communicating and sharing information with each other.

Through the years, we kept adding features to the client-server IT infrastructures to make them more scalable and easier to manage. I believe that what finally gave us unmistakable signals that client-server was running out of gas was the explosive rise of mobile devices in the last few years, as well as the prospect of even larger number of sensors and other digital technologies, each with their own IP address, that were started to be embedded into myriads of things in the physical world, like cars, appliances, medical equipment, cameras, roadways, pipelines, and pharmaceuticals.

Client-server computing was not up to the massive scalability and low costs required to support these billions of new mobile devices and trillions of sensors. A

new model of computing, no longer optimized around individual PCs but around the Internet as a whole was needed. As is often the case, it has taken a number of years for the marketplace to reach consensus and finally give this new computing model a name around which everyone can rally. Cloud computing has emerged as the name most people have settled on for this new, Internet-based computing model.

The scale and reach of cloud computing is driving a major revolution in the way services, applications and information are delivered and consumed. Cloud is driving a much needed industrialization of IT data centers and of the IT infrastructure in general. Thirty years ago, we saw something similar happen in manufacturing. Before that time, most manufacturing plants were fairly inefficient by almost any measure, and were turning out products of varying quality. Then, driven by the huge success of Toyota and other companies around the world, the industrial sector and academia discovered the merits of applying engineering discipline as well as a holistic, systems-wide approach to manufacturing processes.

Data centers are the manufacturing plants for the 21st century services and information economy. But, with the exception of a few, relatively young, *born-to-the-cloud* companies, the data centers of most enterprises are in the same pre-industrialization phase that manufacturing was thirty years ago. They have not exercised the needed engineering discipline in their IT operations. They have allowed different departments in their organization to architect their own systems and application, which often do not interoperate with each other. Unless these data centers significantly improve the quality and efficiency of their operations, they will just not be competitive. Many will not be able to do so, and will instead rely on professional service providers for many of their IT operations, much as has happened in manufacturing.

But, perhaps the major revolution that cloud computing will usher is in the design of the services and applications themselves, to make them much easier for people to consume and interact with, often on the go with a mobile device and a relatively small screen. While many talk about Cloud as IT-as-a-service, platforms-as-a-service, or software-as-a-service, the reality is that most people would rather not have to know anything about IT, platforms and software to deal with information, applications and IT-based services in general. What they really want is well-designed-services-as-a-service to help them in their everyday work and life - be it dealing with money, health matters, communications, entertainment and so on. I fully expect that the years ahead will usher in a plethora of innovative new services, which will be highly useful and a pleasure to use, as well as ubiquitously available at very reasonable costs.

I like the way *The Economist* described cloud computing in its introduction to a recent special report on the subject:

"In the beginning computers were human. Then they took the shape of metal boxes, filling entire rooms before becoming ever smaller and more widespread.

Now they are evaporating altogether and becoming accessible from anywhere [...] Computing is taking on yet another new shape. It is becoming more centralized again as some of the activity moves into data centers. But more importantly, it is turning into what has come to be called a 'cloud', or collections of clouds."

"Computing power will become more and more disembodied and will be consumed where and when it is needed [...] it will also profoundly change the way people work and companies operate. It will allow digital technology to penetrate every nook and cranny of the economy and of society, creating some tricky political problems along the way."

Irving Wladawsky-Berger
Chairman Emeritus, IBM Academy of Technology.

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Chapter 2

Introduction

2 Introduction

One of the keys to success in a world in continuous development is to know how to anticipate change and the impact it may have in the medium and long-term future. If we can master this knowledge, we can identify and capitalise on future business opportunities. Certain tools are essential in achieving this aim and they include an analysis of future trends. Bankinter set up its Fundación de la Innovación with a clear objective: to influence the present by looking to the future and to stimulate the creation of business opportunities at the cutting edge of technology and management in order to promote innovation in the Spanish business world. It is an ambitious and innovative project, through which Bankinter hopes to stimulate the creation of business opportunities arising out of changes in the social context. With over 300 international expert opinion leaders from different disciplines, hailing from around the world, and a superb board of trustees, the project also seeks to reinforce Bankinter's commitment to society.

The Future Trends Forum (FTF) is the Fundación de la Innovación Bankinter's most important and most fully consolidated project. It is the showcase of Bankinter's culture: innovation and commitment to new developments. The FTF is Spain's leading forum on long-term forecasting and innovation and embraces top scientists, academics, businesspeople, entrepreneurs and other leading international intellectuals. It is the only multidisciplinary, multi-industry and international think-tank in Europe. It seeks to convey all the objectivity of a forum enriched by a range of viewpoints, which remains unbiased and unswayed by interests of any kind.

The forum strives to predict the immediate future by detecting the social, economic, scientific and technological trends that are most likely to change the way we live and work, analysing possible scenarios and impacts on current business models in sectors that will be most affected. Based on its discussions it seeks to draw conclusions on to the best way of creating wealth out of the situation. These recommendations are intended to be circulated among different strategic spheres of society

FTF members themselves can propose issues for discussion and a vote is taken on the ones that will eventually be addressed. The final result comes when the conclusions of this survey of employers, professionals, top management, companies and institutions are publicised. In this phase, a report is published and lectures are given in major cities in Spain.

This latest publication, prepared with Accenture as the main collaborator, presents the Future Trends Forum's conclusions on the impact the new paradigm of cloud computing may have on society and on the market.

It begins by defining the new model of cloud computing and its associated market. The report describes the factors that have influenced the emergence of this new

model of technological management and analyses the conditions paving the way for this new technology to take hold in society.

It goes on to analyse cloud computing from the perspective of supply, identifying the main cloud providers, and the business models on which their success is based; describing different categories of cloud services, pricing methods and barriers to future development and assessing the impact these new services will have on innovation.

The report goes on to look at the demand side of cloud-based services. First we analyse the implications of cloud computing for business (distinguishing between SMEs, start-ups and big corporations) and for government. For each of these groups, we study the main advantages and disadvantages of the cloud, as well as the current state of the industry. We then describe the strategies that both government and business need to follow in moving to the cloud. Finally, we look at the impact the new model will have on society, education and the environment.

The last section of the report focuses on the Spanish market. It starts with an analysis of Spain's position as a breeding ground for cloud providers and goes on to look at the Spanish market from the point of view of use of cloud services in business and government.

Once again, the Fundación de la Innovación Bankinter hopes that this new publication will act as a source of knowledge, but, above all, will offer stimulation and guidance to professionals and employers from different sectors to harness the advantages and opportunities that may arise in an uncertain economic landscape. More than ever before, companies that know how to understand changes and act in consequence will not only manage to stay in the market, but will emerge strengthened from the crisis, ready to benefit from the new wave of growth when it comes.

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Chapter 3

Computer clouds are coming

3 Computer clouds are coming

Got your head in a cloud? Don't worry: we're not accusing you of being distracted as you read this book. We're asking just how involved you are in a trend that is sweeping the IT sector. We're talking about the paradigm of cloud computing.

Whether you're the CEO of a company spending a sizeable portion of its budget on computer infrastructure or just a common-or-garden computer user uploading photos to Internet sites to share with your friends or even the head of a government IT department facing cutbacks as a consequence of the current financial scenario, it's a trend you'll need to keep an eye open for. But what exactly *is* cloud computing? Although there is no agreed definition, the basic idea behind the model is that anything that can be done in the way of computing, either over an individual PC, a corporate server or a smartphone, from storing and processing data to running programs, can be moved to the "cloud", i.e. to the Net. In the cloud model, computer processing and storage resources are used just like any other type of public utility, such as electricity or phone services. Services such as applications, networks, programming tools and storage capacity can all offered on a large scale over the Internet instead of just operating locally. They are administered in big remote data centres serving large numbers of clients who access them remotely, thus multiplying the users' storage capacity. Cloud computing, therefore, far from clouding up the IT scene, helps clear it up, opening up a new horizon of possibilities for communication, collaboration and work, no matter where users are, just provided they have Internet access.

The protagonists of the cloud computing market

Who are the players in this new supply-and-demand scenario for cloud services? Supply comes from a number of companies that have looked far enough ahead to see the opportunities presented by the market, which is forecast to attain turnover of 42 billion dollars in 2012[1]. Cloud computing providers can offer firms an IT model that gives them almost immediate access to computer resources without needing to pay out in advance, thus maximising the yield on their investment and considerably cutting time to market for products and services. The reason is the reduction in the development and testing time of new-generation applications, which in turn shortens the time it takes to realise business opportunities. For their part, suppliers can benefit from economies of scale by providing standardised cloud-computing services to large numbers of clients. This entire ecosystem is driven by a proliferation of new applications, created by developers who are drawn by the appeal of this new potential market, and by the ease of re-use of existing applications, all of which will give new impetus to open-code software initiatives.

As we have already seen, the demand comes from companies, public institutions and users interested in "being in the cloud". On the one hand, businesses will benefit from a service for which they pay on a per-use basis, which will save them investment in setting-up, improving and maintaining an in-house IT department.

[1] http://blogs.idc.com/ie/?p=224.

This will lead to a shift from traditional fixed costs to variable costs in terms of technical infrastructure and acquiring hardware, software licences and upgrades, as well as paying for in-house or contract experts. Clients pay for what they use (hence "pay-per-use") and there is no longer any need for over-provisioning to allow for demand peaks, with slack periods in between when the resources lie idle. In some way, this means transferring the risk of planning and quantifying the need for IT resources from the company to the cloud providers. Companies can focus on their business rather than worrying about technological aspects. Ultimately, cloud computing will facilitate the introduction of new ideas by promoting innovation. More importantly, it will enable the company to make services instantly available to anyone with Internet access, thus helping make firms more competitive.

At the same time, although it is true that cloud-computing offers the average Internet user a chance to access multiple highly-complex IT systems in real time and at an affordable cost (or for free in some cases) by way of cloud computing, many are not even aware that much of their everyday online activity—in services such as Gmail and social networks such as Facebook—already uses cloud technology. Many such consumer applications are free services, paid for through advertising.

Finally, the potential value of cloud computing to governments is particularly appealing. Pluses include its contribution to achieving cost-cutting targets, its use as a platform for encouraging citizen participation and involvement and the possibility of offering government services and sharing knowledge over the net. One of the most important contributions governments can make to the expansion of cloud computing will undoubtedly be to promote its advantages by becoming *early adopters*[2]. In addition to this scenario in which governments act as mere cloud users, there is also the key role they play as regulators and facilitators of this technological model in their respective countries.

Why is 'cloud computing' in fashion?

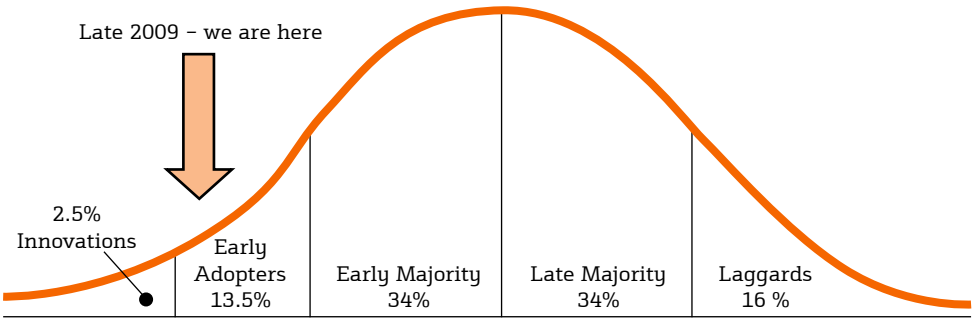
So why now? Why is everyone suddenly talking about the cloud as an increasingly tangible reality? People often refer to cloud computing as "the fifth generation" following the mainframe, the PC, the client-server system and the World Wide Web. With this long (in terms less of years than of progress achieved) history behind it, cloud computing is now being seen as a "democratisation" of information technology. It gives the great majority of people and small enterprises access to new applications, platforms and infrastructure anytime, from anywhere. Defenders of cloud computing argue that it can break down the barriers that hinder innovation and increase interoperability between currently incompatible technologies. Moreover, they see in cloud computing a way for emerging countries to adapt rapidly to new technologies, by using its infrastructure and applications via the single service fee, without having to commit to a large initial outlay, thus placing them at the same level as their international competitors. For such countries, the "mobile cloud"—i.e. access to these applications from mobile devices—

[2] http://www.marketspaceadvisory.com/cloud/envisioning-the-cloud.pdf.

holds out the promise of reducing the "digital divide" between them and developed economies.

In addition to these advantages of cloud computing, there is also the "green" aspect, now so highly valued, with strong pressure being brought to bear on companies to introduce more sustainable policies. Cloud computing encourages a "greener" IT model, largely because shared processing and storage centres offer more efficient energy consumption than individual companies. In early 2010, newspapers and blogs were all talking about Google's request to the US federal authorities to be allowed to operate on the energy market. Because it runs so many servers, the Mountain View firm is a major power consumer. It now has plans to obtain energy from alternative sources such as the solar plants it has already fitted.

In reality, cloud computing is not a new idea. "Salesforce.com, for example, has been operating for almost ten years and the phrase "the network is the computer" has been in current coinage for quite some time, summarising as it does the concept of placing processing capacity outside the user company and onto the network. However, until now provision of this type of service was limited and its development was slow"[3]. Following a period of experimentation by development pioneers, cloud computing and cloud services are now gradually being adopted by some companies. In other words, at this moment in time the technology does not yet have sufficient acceptance to be described as a majority implementation (see Illustration 1.). Nonetheless, experts agree that this situation is about to change because the technology has matured sufficiently and a strong industry has been built up, with players including Google, Microsoft, Salesforce, IBM and Amazon. If, as expected, demand follows the usual curve of any product or service on the market, it should begin to increase in the near future when the industry starts to overcome certain obstacles that (as we shall see) are hindering large-scale proliferation of cloud computing.



Early days – cloud technology adoption in companies.

Illustration 1: Avanade 2009 Global Cloud Computing Survey.
Source: Avanade.

[3] "Cloud Computing: a bright future!", Nota Enter IE (12/03/09). http://www.enter.ie.edu/enter/mybox/cms/10550.pdf

The doubts that are dispersing the cloud

In effect, in order for cloud computing to become a true technological phenomenon among business, it will have to overcome a series of obstacles that are preventing companies from engaging with such a large project. First and foremost, there is one difficulty that cannot be ignored: in-house IT experts, who should be responsible for dealing with the project, have a conflict of interests when it comes to the proliferation of cloud services. As happened with outsourcing, in-house IT departments are afraid of being displaced by external providers and that makes it difficult for them to sing the praises of cloud computing. However, Nicholas Carr, author of books such as *IT Doesn't Matter* and *The Big Switch* says the move to the cloud is inevitable and necessary: "What I think is more powerful than the resistance that may come from IT departments looking to protect their turf is the competitive necessity companies face to reduce the cost of IT while simultaneously expanding their IT capacity—and the cloud offers one good way to do that"[4]. Carr argues that cloud computing will become more mainstream precisely when companies feel the pressure of seeing their competitors moving to the cloud and cutting costs in the process. This competitive pressure, he says, will be enough to overcome resistance from IT departments.

A lack of motivation among corporate IT departments to recommend the adoption of cloud computing is not the only stumbling block. There is a latent risk of the privacy of the uploaded data being badly handled. Furthermore, security mechanisms do not appear to have advanced as quickly as they would need to in order to allay the public's fears. Many companies question just how reliable a long term contract with a provider can be and what guarantees they would have with regard to data recovery if the company-provider relationship came to an end. The law as it stands does not appear to protect the user in all possible new situations that might arise. In addition to these problems there is the fact that the full potential of the moves made in open-code software has yet to be harnessed for improving cloud applications. To date, users have not been given enough room to participate actively in the cloud environment. Likewise, there is still a long way to go to achieve the standards that will help increase the size of the cloud.

Under these circumstances, it is hardly surprising that many of the experts in the Future Trends Forum pointed both to the need to prioritise data privacy and security and to the creation of more personalised cloud services for companies and users. For this reason, some companies such as Google and Amazon have begun to offer more "flexible" services to meet customers' needs and even "private" clouds to address their qualms about security issues. This report will examine these customised services and the drivers and brakes to cloud computing.

More than just a passing fad?

What is the future of cloud computing? There is little agreement among those involved. Most consider that it marks a new stage in the development of the Internet. Some of the cloud's detractors, however, see it as little more than a

[4] http://www.infoworld.com/d/cloud-computing/nick-carr-many-ways-cloud-computing-will-disrupt-it-798?page=0,1.

passing fad. Whoever proves to be right, consumers have already begun to benefit unknowingly from the advantages of the cloud and companies are beginning to see the business opportunities of offering their services in the cloud. *A priori*, the potential benefits for companies are too attractive to be ignored, especially in the case of small and medium-sized enterprises, for whom cloud computing offers a democratisation of technological power. Ultimately, getting into the cloud means accepting certain rules, with the attendant advantages and disadvantages. Like any technological development, it is the responsibility of each company to weigh up the benefits and risks of cloud computing before deciding whether or not they want to get involved.

3.1. Flying above the clouds: keys for understanding 'cloud computing'

It may all have started with the clip-art cloud diagram that used to be employed to depict the Internet, a network to which users are connected without really knowing what is behind it (infrastructures, technologies and applications). Many experts say they first heard mention of cloud computing in the early 1990s. So why has the cloud's time come now, nearly two decades later? To answer that question, let's start with an explanation of the concept.

The fact is that there no agreed definition of cloud computing. This is causing a certain amount of confusion among possible candidates to "get on" the cloud and has become one of the factors that is slowing down its adoption[5]. A survey by Proofpoint, the leader in corporate message protection solutions, shows that 40% of IT professionals surveyed said they were confused about the term cloud computing given the many definitions in existence[6]. The US National Institute of Standards and Technology (NIST) covers all its bases before offering it own definition, including a note saying: "Cloud computing is still an evolving paradigm. Its definitions, use cases, underlying technologies, issues, risks, and benefits will be refined in a spirited debate by the public and private sectors. These definitions, attributes, and characteristics will evolve and change over time." Having clarified this point, it goes on to define cloud computing as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction[7].

In the area of cloud service providers, Accenture offers the following definition: "cloud computing is a collection of network-based services, accessible from anywhere"[8]. The best way of understanding this, especially for those who are not familiar with the idea, is to divide the explanation into more manageable parts. The term *services* refers to computer resources that are needed by both companies and users: networks, servers, storage capacity and applications. This new concept involves transforming the IT market as we currently know it, in which a wide variety of products (computers, hard disks, servers, etc.) are marketed and in which, moreover, a large number of services are starting to be offered. What is

[5] http://www.blogtelecom.com/el-desconocimiento-y-la-confusion-ralentizan-la-adopcion-de-cloud-computing/.

[6] http://www.proofpoint.com/news-and-events/press-releases/pressdetail.php?PressReleaseID=252.

[7] http://convergence.blogs.ie.edu/archives/convergence/2009/04/la-confusion-de-cloud-computing.php.

[8] *Cloud: Good for Every One...Not Every Thing* (2009), presentation by Joseph Tobolski, Accenture's Cloud Computing Director.

meant by being "accessible from anywhere" is that the services can be used from any device (computer, telephone, etc.) provided only that it has Internet access. To complete these definitions, however we need to add a series of qualifications without which any talk of cloud computing would be meaningless. Some providers[9] consider that it involves the convergence of three major trends: Software as a Service (SaaS), whereby applications are available on demand by consumers on a subscription basis; virtualization, where applications are separated from infrastructure; and utility computing, where the access to servers a business requires is offered as just another variable-priced service across a grid.

SaaS could be explained as a software distribution model that offers clients access over a network (generally the Internet). It dates back to the first mainstreaming of the Internet, which caused a drop in the price of bandwidth and led some companies to realise that it was no longer necessary to build in-house data processing centres for each company. In this model, the application is owned by a provider, which charges a fee for its use. In this way, instead of having to establish, maintain and constantly upgrade an in-house IT department, companies have the option of turning their fixed costs into variable ones. When you think about it, you soon see that everything in computing can be changed in this way, from the technical infrastructure, the hardware, the software licences and upgrades, all the way through to the in-house or contract experts. By transferring the risk of planning and quantifying the need for computer resources, companies can focus on their business and leave the technological aspects to the providers.

Virtualization consists precisely of having applications that are no longer subject to physical constraints, i.e. they don't have to be in the same place as the computer infrastructure. This allows the servers to be shared by many applications, and applications to be run virtually anywhere. And "anywhere", ultimately, means the cloud. Indeed, virtualization has been one of the major factors to win over in-house IT departments, given the flexibility and speed the activity offers as compared to the traditional formula of using one server per application.

The last component needed for cloud computing is utility computing, the possibility of paying for computer resources by use, in the same way as other supplies such as electricity and water. For the client, this means that they can have alternating periods of high and low demand without burdening the company with additional cost. This model is often referred to as "elastic services" because the level of services can be expanded or contracted according to demand. This represents a significant incentive in the business world, especially for small and medium-sized enterprises, who can afford greater capacities than they could in-house. An article published in *The Economist* gives a very clear example: "During the dotcom boom, the first thing a start-up had to do was raise the money to buy a room full of servers. If a website experienced a sudden surge in popularity, more servers were needed to meet demand. Today a capacity can be rented as needed, allowing cloud services to scale up smoothly. This lowers barriers to entry and promotes innovation and competition"[10].

[9] http://www.rpath.com/corp/cloudinenglish.

[10] "Battle of the Clouds", *The Economist* (15/10/2009).

Paralleling the increase in the popularity of cloud computing, some confusion had grown up as to the exact boundary between the concepts of cloud computing and SaaS. Essentially, both involve access to applications over the Internet and generally the hosting of those applications on third-party servers. So, what's the difference between the two models? This question has been discussed on many forums. The presentation *Cloud computing in Plain English*, by rPath[11], uses a very representative metaphor to distinguish between the two. rPath is an innovator in automating system provisioning and maintenance of physical, virtual and cloud environments. Traditional licensed software, they say, was like buying a premium sedan: for a fixed price (paid in cash, of course), you got all the bells and whistles, support and extended warrantee, whether you used it or not. SaaS is like leasing a car; you can't make any changes to it (like having it repainted in another colour) because it doesn't really belong it you. You pay the same amount monthly and you're guaranteed a certain level of service on the car. Now cloud computing has ushered in a whole revolution: it's like having a metered taxi cab at your disposal: you only pay for the distance travelled and not for any additional associated cost such as maintenance or repair of the vehicle. And you can vary the length of your trips because it's so economical. At the same time, software as a service appears to be more directly associated with the business world, whereas cloud computing includes offerings for both companies and private individuals.

To put it another way, cloud computing refers both to the applications and services offered over the Internet and to the hardware and software of the data centres offering these services. Cloud computing is therefore a very broad concept of which SaaS is only one part. The transformation in services involved in cloud computing can extend to other computer areas such as infrastructure (IaaS o Infrastructure as a Service) and platforms (PaaS).

Another common mistake is to assume that in the future there will be a large number of clouds, and that they will all be public[12]. On public clouds, resources are obtained *a la self-service* over the Internet and invoiced by use; end users don't know who else might be working on the same server, the same network or the same disks. However, this scenario is unlikely to take off in a big way, given the complex IT needs of large companies. Clouds of this type will certainly exist, but alongside them there will be another two types of cloud. Many companies are preferring to build and operate their own "private clouds", which are like public clouds but for the exclusive use of the company that hires them. Fortunately for business, the decision to go for cloud computing doesn't have to be an "all or nothing" one. In principle, the "hybrid cloud" is a very appealing option, since it creates an IT environment for companies consisting of various in-house and/or external providers. This gives them the possibility of reducing costs based on the use of public cloud services and at the same time, have the level of control and standard-conformity that private clouds offer. Later on, we will analyse in greater detail the factors and implications that companies need to take into account when deciding on their strategy within the framework of cloud computing (see Point 5.2.). To sum up, this a model in which IT providers participate over networks, managing their services in a separate physical location to the place where they

[11] http://www.rpath.com/corp/cloudinenglish.

[12] http://www.accenture.com/Global/Services/Accenture_Technology_Labs/R_and_I/ToKnowAbout*Cloud*Computing.htm.

are used by consumers, be they businesses or individual users. One feature of this model is that it requires less initial outlay on computer resources, since the services are made available as and when they are needed and payment is by use. Moreover, there is a high degree of scalability meaning that the services are offered fluidly, handling varying levels of operations without compromising quality.

This model is seen as a whole new paradigm shift because it means that companies and users no longer have to know or specialise in the IT technology they use, either to carry out their day-to-day business or to perform such diverse tasks as storing large amounts of e-mails or communicating over a social network with people from around the world. To a certain extent, we are seeing a democratisation of information technology and shifting IT barriers of cost, time, quality, scale and geographical location[13].

3.2. The perfect storm

Going back to the question we asked at the beginning of this chapter, why should businesses pay for taxi cabs when they are already accustomed to using their own cars and consider them to be sufficiently reliable? Cloud computing has emerged at the high point of globalisation, when the move is towards the industrialisation of information technology. There has been a significant growth in the variety of products and services on offer, as well as an increase in business volume and a profound change in the way in which consumers use the technology.

Some experts are already talking about the cloud computing market. Indeed, Daryl Plummer, managing VP and chief Gartner fellow and an international IT guru, argues that the true power of cloud computing lies in the way it creates a marketplace with service providers and consumers. He says the way these services will be charged won't necessarily be based on the infrastructure costs or the software products on offer, but on the value of the service to the customer[14].

And he's quite right. There are a number of reasons why cloud computing is shaping up to be the top market in the technological area for 2010. Firstly, and most importantly, because the technologies and standards needed to operate it (virtualization, web and non-web programming languages and interfaces, search-engine technology, etc.) have matured to such an extent and the industry has acquired enough experience for the range of services on offer to multiply and be more reliable. Such influential firms as Google, Microsoft, Salesforce, Amazon and IBM have begun to offer cloud computing services and are prioritising ways of positioning themselves in this field.

Secondly, cloud computing is increasingly being seen as a way for firms to reduce and eliminate capital spending. Immersed in a deep economic downturn in which cost cutting is the prevailing management principle, the possibility of having computer resources available but only paying for what you use is an appealing value proposition. Moreover, it offers an alternative to buying ever more expensive

[13] http://www.aberdeen.com/summary/report/benchmark/6220-RA-*cloud*-computing-sustainability.asp.

[14] http://www.daniweb.com/news/story220253.html.

software licences and considerably reduces personnel costs. For this reason, cloud computing is being seen as a model that can continue to sustain a firm's operations with less funding, given the budgetary cuts faced by general IT managers. At the same time, it is also being seen as a way for small and medium-sized enterprises and start-ups to handle more manageable capital requirements for setting up, developing and maintaining their operations. And if they experience strong growth, the model can help them achieve a greater scale of operations without major additional spending.

In turn, within a globalised context, firms are working less and less in isolation and becoming increasingly more integrated with their customers and providers. For this reason, they need to be more prepared to respond quickly to the changes this high degree of interaction involves. Internet-based applications offer an alternative to internal applications because they provide the necessary collaboration and can be accessed from anywhere. A younger employee-profile in an organisation works in favour of this trend; such people have grown up in the Internet era and have learned technical skills in everyday use at home. For this generation, new technologies represent no special challenge; quite the opposite, they form an inherent part of their lives. In addition, because the cloud allows employees to interact with the workplace from any location, it opens the door to more teleworking. Think for a moment what cloud computing would have meant for all the companies that had to close their offices in mid-2009 as a result of the swine flu epidemic.

Thirdly, the mainstreaming of economic and technological trends is nearly always closely related to government initiatives. In this case, the so-called *g-cloud* is seen as a strategic priority for countries such as the UK and Japan. The role of the public sector is not just limited to establishing a regulatory framework for the business; government is also a consumer of cloud computing, given its need for ICT products and services in areas such as education, health and defence. And government will have new ways of interacting with citizens, offering public services and sharing information. Many active projects have been identified in countries such as Sweden, France and Spain which, although not as ambitious as Britain's, represent a first insight into what will start to happen in coming years. Will the next few years see an EU-wide target of a common infrastructure, based on collaboration and innovation?

One way of telling whether a trend has gone mainstream is to look at academic syllabuses. In this case, Facebook has announced the creation of a scholarship programme to support postgraduate students in academic year 2010-2011 in areas of study such as cloud computing, scalable systems and efficient data centres and data recovery[15]. Universities as important as Harvard are now including specific courses on cloud computing as part of their educational offering[16].

Finally, cloud computing's time has come in environmental terms as well. Climate change is one of the hottest and most widely discussed topics in the media. Any reduction in energy costs and environmental impact would get a very positive

[15] http://maestriaicni.blogspot.com/2010/01/facebook-ofrece-becas-estudiantes-de.html.

[16] http://www.extension.harvard.edu/courses/csci.jsp#e-175.

press, given the pressure on corporate and government management to implement green policies. One likely trend over coming years will be a predisposition among organisations to reduce energy-related costs, as well as joint efforts by different countries to reduce the greenhouse gas emissions caused by power consumption. Cloud computing is an environmentally more sustainable IT model, since power consumption is more efficient in shared data centres than individual corporate ones.

Speaking of sustainability leads us to consider the role that emerging economies can play on the new cloud computing stage. Just as these economies are showing surprising economic growth rates by current global standards, it is not unreasonable to think they may gain a position on the IT market by taking advantage of the ubiquity and lower technology costs in the cloud. There is already a move towards opening cloud computing centres in these countries and this may become further consolidated in the near future.

In short, like a perfect storm, the boom in cloud computing is the product of a convergence of different factors that together shape the current climate. Some commentators suggest that this "perfect storm" will not only lead to a major shift in the IT industry but that it will also change the way people work and companies operate[17]. Irving Wladawsky-Berger, Chairman Emeritus of the IBM Academy of Technology and one of the experts on the Future Trends Forum, considers that the emergence of cloud computing is a vitally important milestone in the application of IT to improving the services sector, the main foundation of modern economies. To explain the relevance this might have for the world economy, he draws a parallel with the impact the introduction of automated technologies had on manual labour in the Industrial Revolution. Wladawsky-Berger argues that cloud computing will be of key importance in managing the vast quantity of information and services we now have to handle and will contribute to reducing the complexity of today's computer models, a complexity that is frequently passed on to the end user. He says: "I believe that this industrialization of services will turn out to be one of the key ingredients in whatever future historians end up calling the 21st century equivalent of the Industrial Revolution"[18].

[17] http://www.economist.com/specialreports/displaystory.cfm?story_id=E1_TNQTTRRN.

[18] http://blog.irvingwb.com/blog/2009/02/the-industrialization-of-services.html.

4

Chapter 4

Commitment to the Cloud among tech companies

4 Commitment to the Cloud among tech companies

Commitment to the Cloud among tech companies
"You don't generate your own electricity; why generate your own computing?"
Jeff Bezos, CEO of Amazon

Cloud computing has all the potential to be one of the powerhouses of innovation in the business field. On the one hand, it facilitates the establishment of new business in nearly all industries, although experts suggest that the areas with most potential for use are health, telecommunications and education (see Illustration 2). At the same time, for technology providers the cloud computing market opens a door to new consumers such as small and medium-sized enterprises and emerging markets which could not previously afford the cost of their products. As was the case during the dot.com boom, when some of the giants we know today first came to the fore, companies competing on tech market cannot limit themselves to following a trend. They have to be able to think ahead and capitalise on an innovative strategy that will allow them to get on the "wave" (in this case the cloud), because there are always more failure stories than success stories.

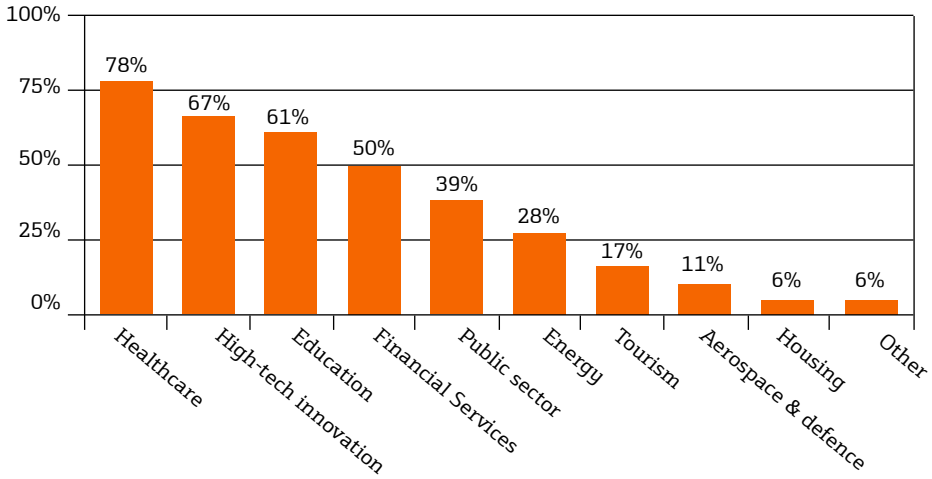


Illustration 2: Sectors in which cloud computing will have greatest impact.
Source: Authors.

Irving Wladawsky-Berger, Chairman Emeritus of the IBM Academy of Technology and one of the experts on the Future Trends Forum, explains his idea of cloud computing and the opportunity it holds out as "a new consumer and development model inspired by Internet services, which solves a problem that has been evident for some time with the extension of computing service"[19]. Think for a moment of all the applications that have become an essential part of your

[19] http://blog.irvingwb.com/blog/cloud_computing/.

everyday life: Facebook, Google Maps... even your local neighbourhood citizens' forum. Now think of all the devices that let you keep hooked up 24 hours a day, whether it be your laptop via a WiFi connection or your Blackberry with its real-time upgrades. A level of interaction is being generated which is not sustainable for the current IT model. There has been a need for a model that will allow a high level of scaleability to ensure that people can use all these services and that existing data centres can offer them. And cloud computing, says Wladawsky-Berger, is precisely that model, enabling users to use services and providers to provide them.

Some FTF experts wondered which comes first: do users adapt to the development and launch of a new technology or is it consumer behaviour that drives technological advances? Which came first, the chicken or the egg?

Generation "as a service"

Outside the debate on the origin of the cloud computing market, in this chapter we will be analysing the area of service provision, i.e., all matters related to providers and services in the cloud. New ways of working and interacting personally at a global level require a "however-and-from-wherever" model. The great goal is to provide reliable, flexible and profitable access over the Internet without the need for any physical infrastructure. Providers are very much aware that if they are to compete at a global level, they need to be able to increase the capacity of their resources infinitely without compromising quality and without having to redesign solutions. Ideally, what they should be able to offer users is summed up as "0, 1, ∞", i.e. "zero" own infrastructure and acquisition, adoption and maintenance costs; "one" consistent and flexible environment; and an "infinite" scaleability to respond to changes in business, ensuring interoperability between different products and services and at the same time, a certain degree of personalisation[20].

In this regard, a shift is currently occurring from a model of individual supply to a shared platform. Until now, providers provided each company with an IT solution that required its own configuration, monitoring, upgrades and data recovery. With the coming of cloud computing, what is now on offer is a platform in which all the data and the applications from the different companies exist alongside one another in a single logical environment. This means that the provider can manage them faster and more efficiently, since any change can be implemented simultaneously for all clients.

In parallel, the traditional PC is being replaced or complemented by a number of smaller wireless devices, such as smartphones, netbooks and tablets. The rise in these products constitutes the tangible evidence that mobile technology is the order of the day, facilitating access to the information from anywhere at any time. Cloud computing will simply promote the demand for this type of device even further, precisely because it offers ubiquitous access to a wide supply of services. Other areas, however, are seeing a return to the origins of computing. In some ways, cloud computing means revisiting the original client-server model so typical

[20] "Allow none of foo, exactly one of foo, or any number of foo", The Jargon File, http://www.catb.org/jargon/.

of mainframe architecture. In this model, users accessed the system from a simple terminal and worked remotely on the mainframe server, with all the computing and data storage taking place on the server, not the client. With the coming of the PC, computing and data storage moved to the user's terminal and the client-server model was abandoned.

Cloud computing marks a return to this classic model: the cloud can be compared to a large mainframe which users access remotely from their own terminals.

These developments may change the way the market share is divided up among computer providers. The giant Microsoft looks set to gradually lose some of its supremacy to Google and Apple. The battle in the clouds has begun. "Although Windows still runs 90% of PCs, the fading importance of the PC means that Microsoft is no longer an all-powerful monopolist."[21]. Google and Apple have their own global network of data centres and seek to offer a complete range of cloud services, from tools for collaboration and business applications, to storage services and software for smartphones and other devices[22]. In addition to these two, there are of course many other firms offering cloud services, all competing for greater market share. We shall discuss these later, but first we need to clarify the concepts related to the way in which providers sell cloud computing.

Just like clouds in the atmosphere, the supply of cloud computing also comes in very different shapes and sizes. Some experts on the Future Trends Forum feel it should not be seen as a new technology, but as an "operational model that is determined by the way in which a business or individual obtains access to information functions". Depending, among other factors, on the speed, use and capital invested, these functions can be broken down into three types: Infrastructure as a Service (IaaS); Platform as a Service (PaaS); and Software as a Service (SaaS).

One of these, SaaS, has already been described. SaaS allows users to have best practices in software available to them without making huge capital investments, paying only for what they use. The classic example is Salesforce.com, a customer relationship management (CRM) Internet service with a pay-per-use system. More recent upgrades of the applications are included in the subscription, which means that clients never have to worry about unforeseen costs. It comes as no surprise, therefore, that their slogan boasts "Success. Not Software". In other words, the company's services focus on contributing to their clients' "success" rather than being limited to the sale of software. While the first wave of SaaS developed in business areas such as CRM (as in the case of Salesforce.com), human capital and financial management, the second wave focused on desktop productivity tools, including text processing, spreadsheets, e-mail and net-conferencing. Some have already dubbed it *Desktop as a Service* (DaaS). The applications work on infrastructure owned by others and are available from anywhere via the usual Internet browsers.

[21] "Clash of the Clouds", *The Economist* (15/10/2009).

[22] "Clash of the Clouds", *The Economist* (15/10/2009).

Secondly, *Infrastructure as a Service* (IaaS) consists of outsourcing the data processing machines. As we mentioned at the beginning of this chapter, there is no longer any need for firms to maintain in-house data centres. Instead, thanks to virtualization, (i.e. the physical separation between the infrastructure and the place where the operations run) companies can pay for the resources as and when they use them. An important example in this field is Amazon Elastic Compute Cloud (EC2), a vast sophisticated data storage centre which customers can access to use servers, storage and networks for a fee, with the possibility of tailoring the service to demand. This is the "elastic" part, since the service "expands" and "contracts" depending on specific processing, bandwidth and storage power needs.

Finally, the *Platform as a Service* (PaaS) function encompasses all activities related to development and implementation of applications from the Internet. To work successfully, it has to facilitate developers' work by providing them with access to any users needing their applications, while maintaining system security and scaleability and using standards that will enable their applications to operate in other clouds. Windows Azure Platform offers a flexible environment for developers to create their cloud applications and services –thus reducing time to market– and to adapt the need for resources to meet the changing demands of their business. One of the most significant contributions of PaaS has been to improve the productivity of development teams, since it creates collaborative support from developers in different locations.

Developers have been quick to show their preferences among the offerings of the different cloud providers. Illustration 3 shows the relative position of the main providers in 3D, based on the developers' perception. The first dimension (horizontal axis) shows how developers rate the providers' ability to execute their cloud services strategy. The second dimension (vertical axis) shows how "complete" they felt the solutions offered to be. The third dimension shows how much they had adopted the services: the external circumference in black represents adoption in a period of twelve months, whereas the red sphere shows only current adoption. It is immediately clear that developers see Amazon and Google as having the most complete solutions with the best capacity to implement their initiatives. The extent to which they have adopted the two solutions is very similar at present; however, they expect to use Google more than Amazon over the next year. This perception is not surprising given that the two companies began offering public cloud services before others and have more experience in providing services. In addition, developers are more familiar with their offering because they've been on the market longer.

The next three companies in terms of current pace of adoption were IBM, VMware and Microsoft. The latter, despite being perceived as quite a complete solution with its Azure platform, is outstripped by most of the companies in the survey because it is considered less capable of implementing its cloud services.

To return to the classification of cloud services, Accenture talks about a fourth level, derived out of a combination of Business Process Outsourcing (BPO) and

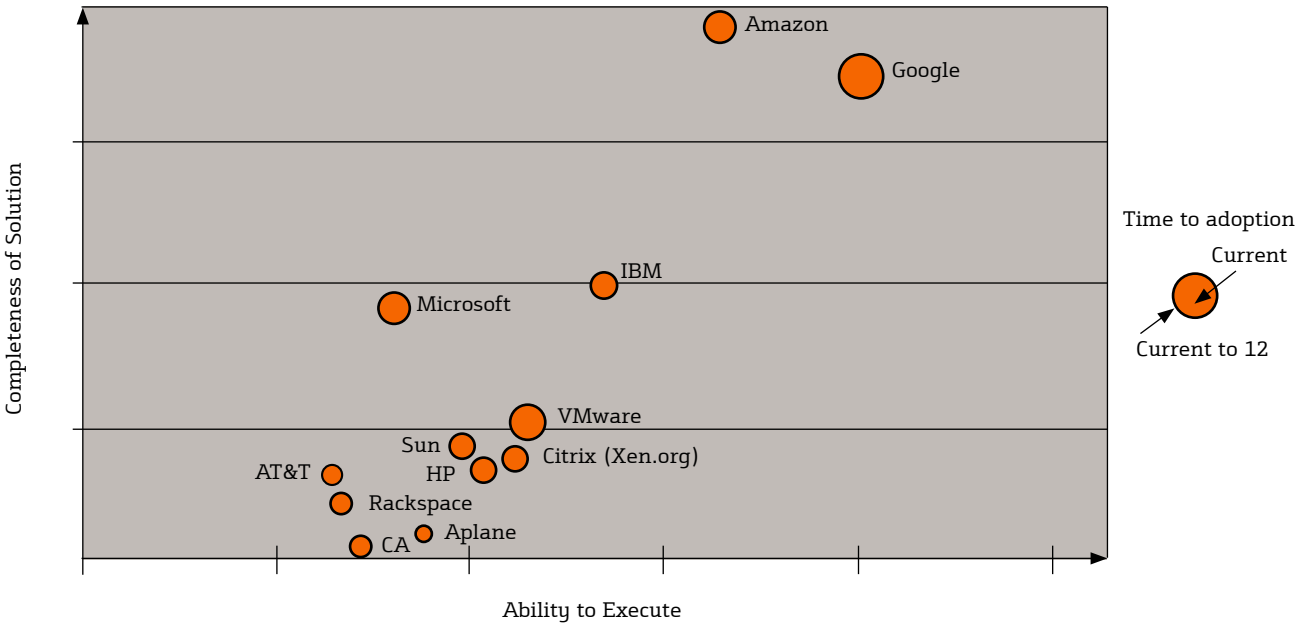


Illustration 3: Developers' perception of cloud computing providers
Source: http://www.evansdata.com/reports/viewSample.php.

Process Oriented Software. *Process as a Service* (PraaS) is based on start-to-finish external, Internet-operated management of a business process, such as complaints, expenses or the supply chain. It therefore involves not only the organisation, but also other stakeholders, such as customers and providers. And the most important feature is that it can be used directly by any employee, without requiring intervention from IT staff. A good example of PraaS supply is ADP Employease, which offers over 1,500 providers with a combination of process web and outsourcing applications for comprehensive payroll management. New start-ups in this area are not limited to offering software over the Internet but instead take a further step in customer service. ServiceChannel[23], for example, offers facility managers a single platform for procuring, managing and paying for facility maintenance services in real time on their web platform and thus promises to contribute to the business's return on investment. This is another example of a shift in focus between PraaS and SaaS. For company management, PraaS is a way of contributing to the business; the technological advantages that might interest IT managers fade in significance.

As Illustration 4 shows, cloud solutions are available at all IT levels in the company. Until now, each tier was developed independently, with particular importance placed on the "application". However, Accenture notes that "we may see an increasing dependency between upper layers and lower layers of the cloud stack. For example, new application players could turn to infrastructure cloud

[23] http://www.servicechannel.com/sc/login/index.html.

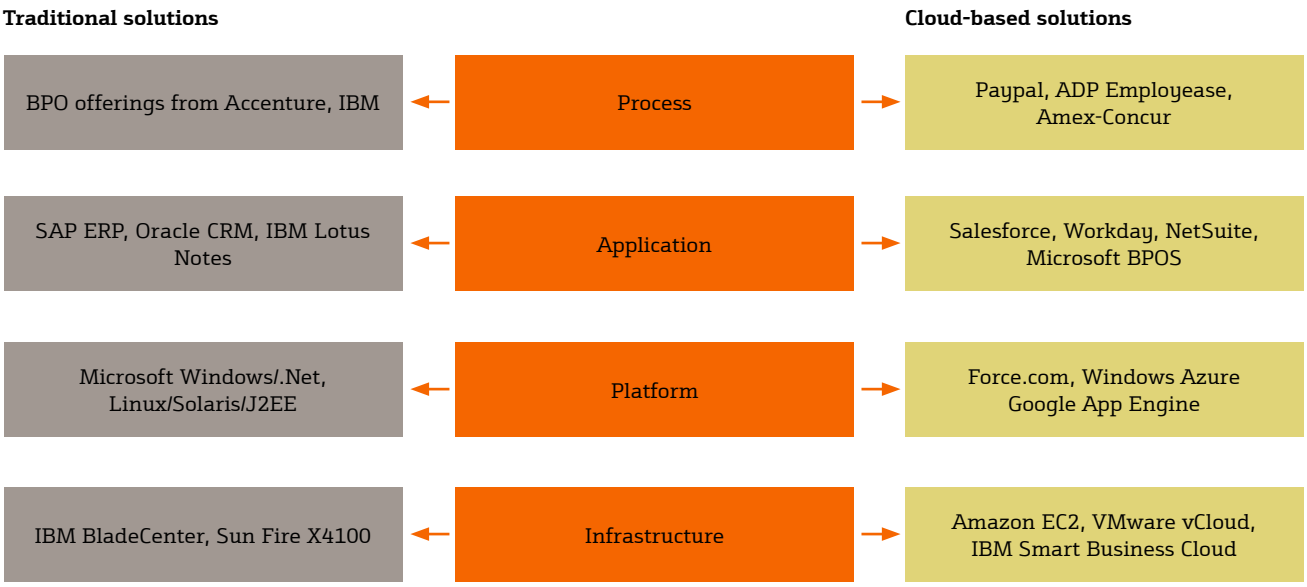


Illustration 4: Traditional solutions versus *cloud-based solutions*
Source: *What the Enterprise Needs to Know About Cloud computing*, Accenture (October 2009).

providers to achieve a better cost structure, elasticity and faster time to market. Potential process cloud providers may follow a similar path to offer virtual BPO without owning their own hardware and software platforms."[24].

Business models

According to a study by IDC, a high-tech market research firm, the amount of data generated during 2008 was 3% higher than the company's forecasts and it is estimated that the information generated will continue to grow dramatically. IDC forecasts that in 2012 the amount of data generated worldwide will be approximately five times as much as in 2008[25]. Efficient data storage, management and access will be key aspects of the new society and the idea of centralising most of the information in the cloud will be an increasingly attractive one. The cloud computing market is led by the large providers who successfully gazed into the crystal ball and found positions on an unfamiliar market, where they have managed to gain a substantial market share. However, there is still room to conquer some of the largest and most traditional companies, now taking the first steps towards the cloud, and there is also a market for smaller providers who know how to meet companies' more exclusive needs, encouraging the creation of successful niches.

The primary business model of the large cloud providers is based on the concept of the long tail, a term coined by Chris Anderson, journalist, writer and lecturer, in

[24] *What the Enterprise Needs to Know About Cloud computing*, Accenture (October 2009).

[25] *As the Economy Contracts, the Digital Universe Expands*, IDC White Paper (May, 2009).

an article published in October 2004[26]. In this model (see Illustration 5), by centralising inventories and reducing distribution costs companies can gain a significant benefit by selling small quantities of products that are difficult to find in normal distribution channels (orange area in the illustration) rather than selling large quantities of popular products (red area in the illustration).

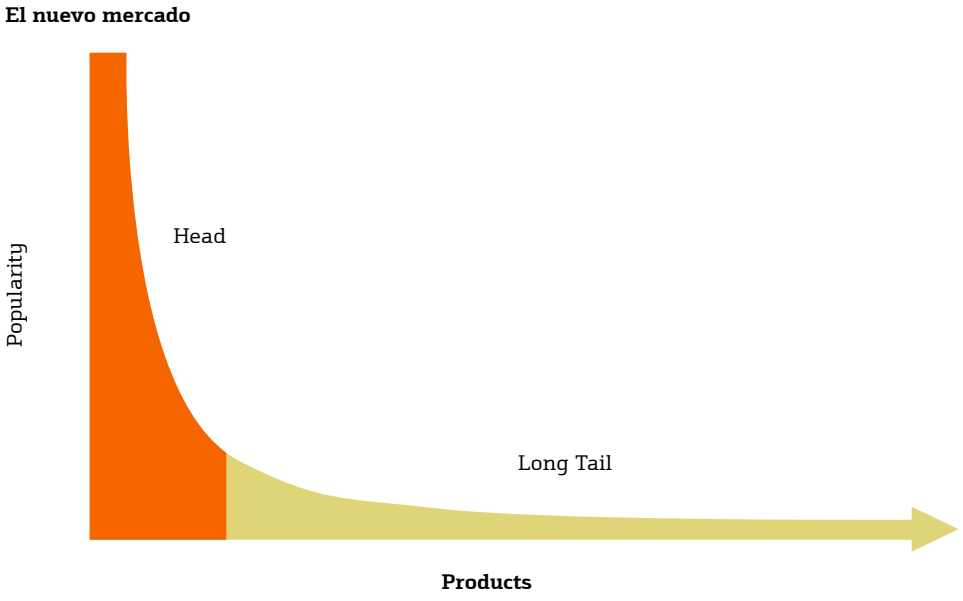


Illustration 5. Long Tail Concept.
Source: http://www.longtail.com/

To see how this model works in the case of a cloud provider, let's look at one example: Salesforce's CRM services. The company has large data centres containing all the computing capacity it offers its customers. In the long-tail model, this is equivalent to the centralisation of inventories. Once a data centre has been built, it costs practically nothing to distribute that capacity to clients until demand outstrips the total capacity of the centre and a new one has to be built. Similarly, the maintenance cost of the CRM services is unrelated to the number of clients, since they all use the same service and upgrades are distributed automatically. Thus for Salesforce the benefit of providing service to a client requiring a large capacity is the same as that of offering the same service to thousands of small clients using the same capacity in aggregate. In a certain sense, the providers' business model is almost a mirror-image of their value proposal for their clients, given that they have large fixed costs and practically no variable costs. This obliges providers to acquire a sufficiently large customer base to cover these fixed costs and obtain a profit.

[26] http://www.wired.com/wired/archive/12.10/tail.html.

Facebook and, to a great extent, Google have a different business model to Salesforce's, though one that is also based on the long-tail concept. These providers offer their services to private users free of charge, and make their income from advertising. However, this advertising does not consist of the classical big-audience TV commercial, but personalised links that vary depending on the user's queries or activities on their social network. By using the large amount of information available in their databases, these providers can target advertising at very specific segments of the population. Given that the advertisements consist of simple links or small images shown on the sidebars of the webpages, it costs practically nothing for the cloud computing providers to add them, which means that they can offer small companies space at affordable prices. These companies benefit not only from the low costs, but also from the fact that their advertisements are targeted much more directly at the market segments in which their potential customers may be found. This model also uses the long-tail concept, but to operate it needs to have a very large base of users of free services, in order to have enough population segments and enough information to attract advertisers.

The long-tail model is valid for large providers of the three main classes of cloud service: IaaS, PaaS and SaaS. In all three cases, the providers make major investments in infrastructures and have very low variable costs. As a result, they are always interested in acquiring new clients, regardless of the capacity this may require. Thus their target extends to both small customers and large companies, though particularly the latter, since their high levels of demand for computing capacity ensure a very significant and more stable source of income than small clients. New emerging providers, attracted by the opportunities of the cloud, are at a disadvantage to large ones. Whereas the latter have an established client base to cover the costs of their infrastructures, the former run the risk of not being able to achieve enough clients. However, the products offered by large providers tend to be standardised, since each service needs to have a minimum client base to be profitable and this offers new companies an opportunity to fill a gap on the market by offering specialist services. In other words, given their inability to compete in cost terms with the large companies, small providers have to distinguish themselves through their service. PraaS is an opportunity to stand out in this respect, by managing an entire business process from the cloud. With specialist services, the client base will be reduced even further, but the revenue per client will be greater the more value offered. In turn, by not concentrating on competing in cost terms, these small cloud providers can minimise their investments by making use of the services offered by the large providers.

The development of the cloud will attract new previously unknown business models. In *Business Strategy for Cloud Providers*[27], IBM highlights four models arising out of the splitting-up of traditional cloud computing providers:

- Providers of hardware, software or professional cloud-based services to other cloud providers. They invest in or purchase new technologies and implement the research and mergers needed to develop new capacities. This group is

[27] *Business Strategy for Cloud Providers*, IBM Global Business Services Strategy and Change White Paper (2009).

made up of large corporations and the product they offer will be equivalent to a commodity.

- Cloud-based IT outsourcing providers. These are partnerships between outsourcing firms and SaaS providers who offer the infrastructure, applications services and assistance in migrating to the cloud.

- SaaS Aggregators, especially attractive for new and small providers, who meet all the specific or complementary SaaS solutions for a single industry. Their target market segment are companies that are looking for a comprehensive cloud-based solution.

- Managed IaaS providers, providing value-added services to address latency, data security and unique company needs. They invest in costly initial infrastructure, but augment their revenue through these additional services, as well as others such as help desk and asset management, for which they charge a premium fee.

Cloud computing can be seen as a market consisting of a relatively small set of providers of large standardised services with a wide client base, together with a large range of small companies offering differential services. The make-up of these groups will be influenced by large established providers, but also by the strategies adopted by large corporations in adopting cloud services. These companies can act as a springboard for incipient cloud providers; the demand from just one of them might be enough to cover the fixed costs of one or various data centres. Thus a small provider can offer a specialist service and meet the demand of a large corporation and once the service has been optimised, offer it to other potential customers. There is nothing to stop this provider from being a subsidiary or spin-off that starts out meeting the demand of the parent company and gradually extends its customer base to become one of the large cloud providers.

Clash of Titans

Over the last decade, IT technology has consolidated its position as a cornerstone of the economy and markets, over and above any other business sector. Large high-tech companies have become the new giants on the stock market, rivalling once all-powerful index leaders such as banks and pharmaceutical firms. Indeed, the big five in the field –Microsoft, Google, Apple, IBM and Oracle– now boast business figures that come close to those of oil companies such as Exxon, Chevron, PetroChina, RD Shell and Total[28]. "In 2009 they had their moment of glory on the stock market, with spectacular rises, ranging from Oracle's 40% to Apple's 150%, 102% for Google and nearly 60% for Microsoft and IBM"[29].

These giants, which had previously concentrated on different areas to each other, are now converging and positioning themselves on the cloud market, which they are approaching with a multi-product and multi-provider focus. Pioneering firms have been building the bases of cloud computing, bringing innovative services to

[28] "La era de los gigantes tecnológicos", www.cotizalia.com (31/12/2009).

[29] "La era de los gigantes tecnológicos", www.cotizalia.com (31/12/2009).

companies and users. However, it will soon no longer be enough just to offer basic cloud services: differentiation will be an imperative. Only those who are fastest in bringing the advances to the market can gain a larger share and higher margins.

Forrester Research see the opportunities as coming mainly for two types of agents: the enablers and the service providers[30]. The former contribute the infrastructures underlying the model, focusing on technological areas such as virtualization and data centre automation. This is the case of names such as IBM, VMware/EMC, Red Hat, Intel, Sun, Citrix and BladeLogic. The latter are companies that base their businesses in the Internet, and which place their large technological environments at the disposal of clients following the SaaS model. They offer file management and personnel information services, as well as Office and network applications. They are represented by giants such as Microsoft and Google which, in keeping with their business strategy, anticipate technological trends and even plot the route for others. However, other big names have also come on strong, including Amazon, Salesforce.com and Rackspace.

In many cases, it would be difficult to class these providers within a single type of service. The same company may often straddle the boundaries between one tier and another. For example, AWS encompasses a series of services offered by Amazon between IaaS and PaaS, embracing computing capacity to meet specific needs (EC2, Elastic Compute Cloud), mass data storage (S3, Simple Storage Service) and a queue service for storing data travelling between different computers (SQS, Simple Queue Service). Salesforce, the ultimate SaaS company, with its CRM products over the Internet, launched Force.com as an integrated set of application tools and services which software providers and corporate IT departments could use to create and run any type of commercial application. Today, over 80,000 applications run on this PaaS[31].

The two arch-enemies, Microsoft and Google, have also launched their own PaaS solutions, Azure and Google Apps Engine respectively. These are basically targeted at developers and firms that want to set up their own services on a third-party platform. The benefits are the same in the two cases: cost-savings, less need for know-how and re-use of the components offered by the platform.

Firms such as Amazon are aware that there are benefits to be gained from entering partnerships with other companies. Amazon offers the cloud, the partners provide the applications. The other companies gain from placing their solutions in the cloud without investment in either infrastructure or maintenance. This is the case of IBM which in early 2009 announced that it was offering its products on Amazon's EC2 machines using a pay-per-use system. Amazon, meanwhile, are delighted with the deal because in the eyes of the consumer, it is offering solutions from brands with consolidated leading-edge products on the in-house and cloud market[32].

For its part, Google has been a cloud company since it first appeared in 1998, with a global network of data centres using an unknown number of servers (the

[30] "*Cloud computing*, ¿qué es, para qué sirve y cuál es el negocio?", Carlos García, www.materiabiz.com (December, 2009).

[31] https://www.salesforce.com/es/platform/what-is-it.jsp.

[32] "IBM, otra grande que se ennovia con Amazon", www.saasmania.com (12/02/2009).

company's best-kept secret). Following a period during which Google was best-known for its famous search engine and for being financed by advertising, it now offers a series of products such as web applications, operating systems for PC and mobiles (Android) and its star product, Chrome. It is also making a name for itself in the sale of business services, with a view to diversifying its revenue sources.

"If Google was born in the sky, Microsoft started on the ground."[33]. Yet despite what one might assume, given its aversion to open source software, Microsoft is no stranger to cloud computing. Its Xbox games console has powerful online features; it has built a network of data centres; it is developing a web version of Office and it offers companies software and services on-line.

Another issue that will affect the distribution of power on the hi-tech market is the impact that IT service providers from emerging countries will have. They have already left their mark on the market to a considerable degree in recent years, especially in the US and are likely to continue to do so in cloud computing services[34].

All the major firms in the industry are currently doing their level best to stake out territory in the cloud. And of course there's no shortage of nay-sayers. Nokia and Oracle consider the cloud to be a marketing invention with little real impact. They say that cloud computing is just a new name for the server farms, taking us back to the days of the IBM 3270[35].

The Right Price

Way back in 1961, John McCarthy, a prominent computer scientist known for his contributions in the field of artificial intelligence said that computer science would become just another public utility, like the telephone service, giving rise to a major new industry[36]. Unquestionably, one of the most important innovations of cloud computing is the provision of services for which clients are charged by consumption rather than number of users. This means that companies can easily alternate between demand peaks and periods in which the resources are not in use. This alone might appear to be enough to attract clients, yet providers are having to go to great lengths to draw them in; they are currently implementing aggressive pricing strategies, not unlike the sales season for any consumer product. Amazon EC2 cut its prices by 15% in November 2009; a standard Linux instance[37] fell from 10 to 8.5 cents per hour, and a yearly premium subscription to Picasa, Google's photo storage application, has dropped from twenty dollars to five.[38]. The tariffs charged to clients are becoming more complex, too. Amazon, for example, has an on-line calculator that estimates a total cost based on the use of different resources[39]. Some experts even predict that 2010 will see the advent of a smorgasbord arrangement in the cloud, with clients signing up to a variety of services for a fixed number of hours[40]. Comparisons between the prices of different providers are already frequent in Internet.

Clients aren't the only ones who need persuading; some providers are not prepared to change their predictable income models for a pay-per-use system. As a

[33] "Clash of the Clouds", *The Economist* (15/10/2009).

[34] http://www.enter.ie.edu/enter/mybox/cms/10550.pdf.

[35] http://newmediaera.blogspot.com/2009/04/vueltas-con-el-cloud-computing.html.

[36] http://en.wikipedia.org/wiki/Utility_computing.

[37] An instance, in this context. is the virtual use of an operating system (Linux), i.e., it is not installed on the PC.

[38] "10 big cloud trends for 2010", Patrick Thibodeau, www.computerworld.com (28/12/2009).

[39] http://calculator.s3.amazonaws.com/calc5.html.

[40] "10 big cloud trends for 2010", Patrick Thibodeau, www.computerworld.com (28/12/2009).

result, they are offering better prices to clients who sign up to their pre-paid services. However, the flip-side of this tactic is the requirement for permanence which may not prove profitable.

For the moment, providers appear to be at liberty to set the type of tariff structure: a survey revealed that 34% majority of users weren't sure how they preferred to pay for cloud services (see Illustration 6.). They need to study the uses and benefits of the cloud because they do not have a clear idea what they can or should demand from the provider. The remainder of those surveyed preferred to pay on a monthly basis without signing up to a yearly contract based on resource requirements.

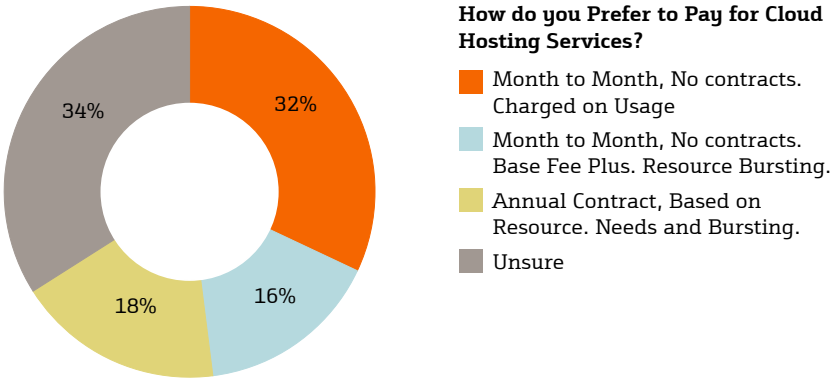


Illustration 6: How Customers Prefer To Pay For Cloud Hosting Services.
Source: http://www.b10wh.com/2009/02/the-size-of-the-company-does-not-reflect-on-utilization-of-cloud-computing/.

Spot Instances, the new system for auctioning excess storage capacity set up by Amazon in December 2009, may be the forerunner of a computing pricing system similar to that for energy[41]. Under this system, clients make bids for excess capacity and get the requested capacity as long as the supply is above a minimum price set by the on-line giant. Even if the supply exceeds this amount, the customer only pays the minimum established price, which is determined on the basis of the balance between supply and demand, so that it varies throughout the day just like oil or coal. This system is suitable for applications that do not need to be run at any particular time; however, it is not viable for applications that have to be available at all times, since Amazon will cut the capacity when the minimum price exceeds the tendered price and that could happen at any time. This pricing model has the potential to reduce IT costs for many firms, but the most important thing is that it has opened the way for IT to evolve in the same way as commodities.

Another way in which providers could differentiate their offer is by providing better service level agreements (SLAs), consisting of contracts between the

[41] http://www.economist.com/business-finance/displaystory.cfm?story_id=15663898.

provider of the service and its client agreeing on the quality of the service. They include specifications on service definition, performance measurement, problem management, client's duties, guarantees and conditions for termination of the agreement. To verify compliance with the contract, variables are often used such as supply cuts (see Illustration 7.) and Return to Operation (RTO) time. Serious questions are now being asked about the providers' capacity to ensure certain levels of SLA, given that the performance of the systems depends on the Internet and it is practically impossible to commit to offering specific figures. Many experts suggest that efficiency in attending to business requirements by means of an SLA, together with the degree to which services can be customised, is what is really going to determine whether cloud computing takes off or not.

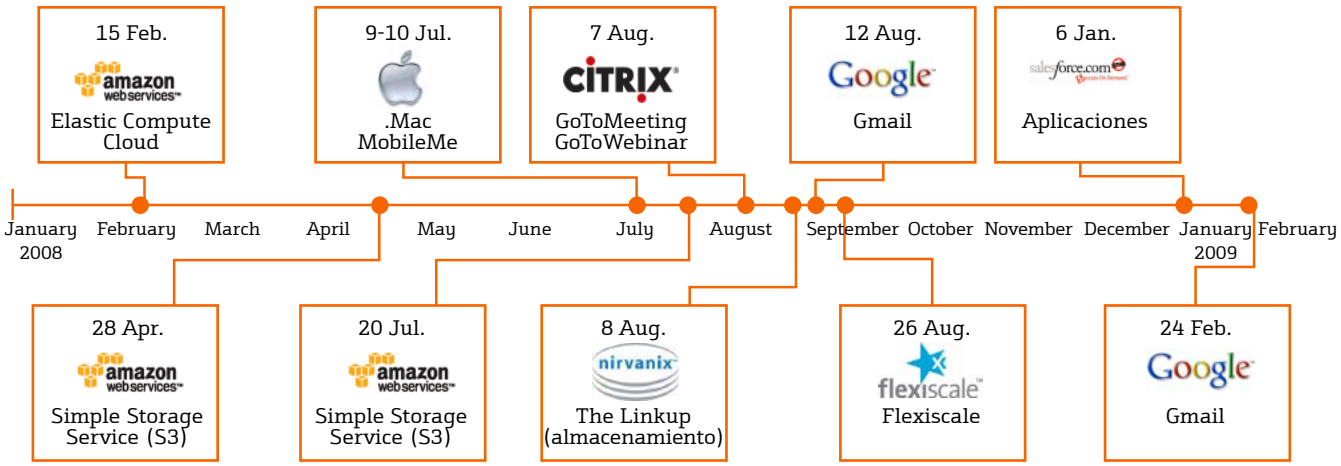


Illustration 7: Major recent supply cuts.
Source: *Envisioning the Cloud: The Next Computing Paradigm,* Marketspace (20/03/2009).

The latest price-related challenge faced by the cloud computing community is that of licences. "The traditional licensing model of today's corporate software does not adapt well to the world of the cloud, where the logic is that an application is run on a large number of servers"[42]. It is tremendously costly for the providers of these licences to monitor their use in en environment characterised by virtualization, elasticity and scaleability of the services. A new model of licences is therefore an indispensable requirement for cloud computing to take off. Among other issues, it will be necessary to address the portability of the licences to the cloud and the implementation of indicators that set a price for the use made of the software, including the costs of upgrades and technical support.

Some experts argue that free software is practically the only type of software that can be used in the cloud because "licence charges do not go up as the number of

[42] "*Cloud computing*, ¿qué es, para qué sirve y cuál es el negocio?", Carlos García, www.materiabiz.com (December, 2009).

users increases"[43]. Otherwise, offering cloud computing services would not be economically viable. The term *free software* is often used interchangeably with *open source software* but it is important to note that the two are not exactly the same. *Open source* is a development methodology, whereas *free software* is a social movement[44]. In other words, one consists of making the source code of a program visible for everyone as a more collaborative method for developing applications, whereas the other works to defend the user's freedom. It is also important to get the definition straight: free software is not "zero-charge" software (i.e. *freeware*) but free in the sense of "unrestricted" because it may be used, copied, modified and redistributed without the limitations of a licence.

In conclusion, cloud computing offers providers a market full of possibilities although there is still room for greater price competition, an improvement in the SLAs on offer and a tailor-made licence model. Moreover, all the signs are that cloud computing will simply blur the boundaries between proprietary software and free and open software.

Can you trust cloud computing?

Inevitably, one of the most common themes in any discussion of cloud computing is the challenge of security and the loss of control over data and systems. Say you are the IT manager of a company that is considering migrating to the cloud. What concerns would you have? One of the primary worries tends be that one of the firm's most prized assets, information, will no longer depend on the company. All the company's information is sent from in-house servers and stored on external ones. This loss of control considerably augments the feeling of insecurity among in-house IT departments.

Avanade believes that there are three important things to remember about cloud security[45]. First, cloud security is almost exactly like your internal security. The security tools you use every day are the same tools that will be used to protect your data in the cloud. The one difference is that you share the service with other clients Second, security issues involving the cloud can all be addressed using your current security tools. Security needs should be carefully considered. But they shouldn't be viewed as a hindrance if you are considering a move to the cloud. The important thing is that if firms have not been strict enough with their security up to now, they shouldn't begin to be strict because of the cloud but because it's important for their business. Third, if you select a quality cloud services provider, your security in the cloud will be as good as, or better, than with in-house security. At the end of the day, an IT firm is more likely to offer greater security than one from a different area. To know whether a provider is good in this aspect, one good indicator tends to be its success on the market and the way in which it resolves its own safety challenges.

What should a provider take into account to meet cloud security expectations? First of all, it is essential that security is guaranteed by means of processes and checks throughout the entire chain of supply, from the cloud computing providers through to the service users, by way of the organisation itself. The security management

[43] http://www.jtech.ua.es/jornadas/charlas/modelos_negocio.pdf.

[44] http://www.gnu.org/philosophy/free-software-for-freedom.html.

[45] *A Practical Guide to Cloud Computing Security*, Avanade (27/08/2009).

processes must, on the one hand, identify and evaluate the existing assets and, on the other, identify and classify possible risks by impact, frequency and probability. All of this should lead to a plan that includes certain contingency steps, for which it is essential for the provider's commitment to be in line with the organisation's needs, ensuring aspects such as making sure that the data is in the right physical location; that the data from the different organisations using the cloud does not get mixed up; that thorough audits are performed; that the permanence of the data is assured; and that plans are provided for running effective security backup copies.

Providers must also have recovery plans in the event of catastrophes such as natural disasters or terrorist attacks. Before September 2001, it was almost impossible to convince an organisation of the need to invest in a plan of this type. September 11 marked a turning point in this aspect, and these days most firms don't think twice about making sure their business can survive an incident of this kind. It was estimated that replacing the technology at affected securities firms, including hardware (workstations, PCs, servers, printers, storage devices, wiring, communication hubs to routers and switches, etc.) and software (networks, operating systems, applications infrastructures, etc.) would cost around $3.2 billion[46]. It would be no bad idea for organisations to ask their cloud providers whether their data centres are geographically scattered and whether their facilities have suitable security measures in place to diversify the risks of data loss.

There are groups of providers such as Cloud Security Alliance[47] –made up of members such as Dell, Cisco and AT&T– and the Enterprise Cloud Buyers Council –whose members include Microsoft, Cisco and IBM[48]– which are trying to break down some of the barriers to the adoption of cloud computing by ensuring security, reliability and transparent access to information in the cloud. Clearly, security is a problem that affects all providers, simply by dint of the fact that the way in which the cloud is organised means that the risk is shared by all. For example, if an SaaS provider needs an infrastructure, it won't build one, but will request one from an IaaS provider. It therefore becomes a shared objective that all agents have to deal with together[49].

Data privacy is closely related to the issue of cloud security. There has recently been a spate of cases of people de-activating their Facebook or Twitter accounts because they felt they had lost part of their privacy. Remember that with cloud computing any information stored locally can be in the cloud, including e-mails, files, photos, financial information, calendar notes, address books and many others. Information stored in the cloud is everywhere and nowhere at the same time. For this reason it is often legally presumed to be located in the country of a provider's physical servers. This location can have a significant impact on the way in which the information can or cannot be protected. For example, personal information that ends up being held by a cloud provider in a European Union member state could be permanently subject to EU privacy laws[50]. As for the issue of anticipating points of conflict, the information could be transferred from one jurisdiction to another without the user's knowledge, making it difficult to know what regulation protects it at any time. Criminals will be able to make themselves

[46] "Sept. 11 teaches real lessons in disaster recovery and business continuity planning", articles.techrepublic.com (17/05/2002).

[47] http://www.cloudsecurityalliance.org/.

[48] http://www.computerworld.com/s/article/9141998/Microsoft_Cisco_IBM_and_others_form_cloud_computing_group.

[49] *A Practical Guide to Cloud Computing Security*, Avanade (27/08/2009).

[50] *Privacy in the Clouds: Risks to Privacy and Confidentiality from Cloud computing*, World Privacy Forum (23/02/2009).

at home on line, hopping from one jurisdiction to another, while public authorities from different countries will have to learn to co-operate more[51].

A future of walled gardens

The increasing complexity and quantity of systems and data has engendered chaos in information technology. The uncontrolled extension of processes and applications means that it is ever less easy and efficient to access the services used. Think of all the different user names and passwords you have: one for your business e-mail account, another for you personal mail, another for a social network, one for your firm's Intranet, not to mention the access codes for on-line banking, etc. You might think it's safer to do things that way – and you might be right. Nonetheless, some experts argue that the underlying intentionality is very similar to that seen in the face of technological advances in the past. It is what is known as a technological lock-in [52], because it attacks the interoperability of systems and applications. In some cases, the result is simply to oblige you to fill in a form with private data every time you want to join, for example, a social network. Each network is a walled garden where the benefits are artificially restricted, thus making it impossible, for example, to associate a Facebook friend with one on MySpace[53].

The impact is even greater when it comes to the risk of rival companies' marketing their own formats that are incompatible with all the rest. With the increasing complexity of systems and processes, it will not be possible to connect and interrelate them unless a certain degree of standardisation is encouraged. If not, it will hamper the creation of efficient services, safe and easy to access and use. Companies must take into account the criterion of interoperability in order to undertake cloud-based projects if they want to avoid technological lock-ins and ensure that switching between one service and another on the cloud is less problematic. Providers, for their part, have to agree on certain standards that will facilitate the movement of data in the cloud. Only in this way can we avoid the mistakes of the past (which violated the rules of free competition) and increase the appeal and ease of "moving to the clouds".

The "father" of the Internet calls for a standard

For the services we are talking about to be interoperable, there naturally has to be some agreement on how things should operate. It is the same old story in IT: when a technological development reaches the phase of mass adoption, the need arises to create certain shared standards accepted by all parties involved.

In early 2010, Vint Cerf, considered to be one of the "fathers" of the Internet, pointed to the need to create standards on data portability in cloud computing[54]. He explained that there are now several clouds created by firms such as Microsoft, Amazon, IBM and Google, but that they lack mutual interoperability. In other words, there are no standards that would allow the different clouds to communicate with each other. Without common specifications for interfaces and protocols, the risk of a "technological lock-in" in a given cloud increases. From an

[51] *Privacy in the Clouds: Risks to Privacy and Confidentiality from Cloud computing*, World Privacy Forum (23/02/2009).

[52] "Clash of the Clouds", *The Economist* (15/10/2009).

[53] "Pull down the walled gardens", news.bbc.co.uk (15/08/2007).

[54] "Cerf urges standards for cloud computing", www.infoworld.com (8/01/2010).

architectural standpoint, a single logical cloud that masks the complexity of different cloud-based offerings is highly desirable in order to minimize application design complexity. This requires developing and adopting foundation cloud computing standards for identity, authentication, federation, and encryption."[55].

According to the National Institute of Standards and Technology[56], it is necessary to "provide guidance to industry and government for the creation and management of relevant cloud computing standards allowing all parties to gain the maximum value from cloud computing"[57]. Under this premise, cloud computing is a fungible, i.e., a cloud may easily be replaced by another and the information transferred from one place to another. For this purpose it is proposed to make data and applications portable, to establish a federated security service and to foster common models of interfaces, semantics and programming. The Open Cloud Manifesto, of which Accenture is a member, is further proof that providers are trying to achieve certain common standards and greater transparency. The manifesto is a declaration of principles defending the opening up of the cloud. In the next chapter, where we shall look at the demand for cloud computing, we will analyse in greater detail the different forms a cloud can take: public, private or hybrid. For now, we shall set out the principles on which this manifesto is based[58]:

1. Cloud providers must work together to ensure that the challenges to cloud adoption are addressed through open collaboration and the appropriate use of standards.

2. They must not use their market position to lock customers into their particular platforms and limit their choice of providers.

3. They must adopt existing standards and avoid reinventing or duplicating them.

4. When it becomes necessary to adjust existing standards, they must be pragmatic to avoid creating more standards than necessary and ensure that they promote innovation and do not inhibit it.

5. They must carry out initiatives on the basis of customer needs, not merely the technical needs of cloud providers.

6. All those involved must work together to ensure that their initiatives do not conflict or overlap.

If these groups do not achieve their aims in time, governments may intervene to regulate the cloud by force. Given the short history of cloud computing to date, there is a risk that more restrictive standards might compromise innovation.

A cloud of specialisation and innovation

The Future Trends Forum experts agree that the true future of cloud computing depends on specialisation in the supply of services and on allowing users to

[55] "Developing an Enterprise Cloud Computing Strategy", White Paper Intel Information Technology (January 2009).

[56] US agency whose mission to promote industrial innovation and competitiveness in the country through progress in standards and technologies that improve economic security and quality of life.

[57] Effectively and Securely Using the Cloud Computing Paradigm, Peter Mell, Tim Grance (NIST, Information Technology Laboratory, 2009).

[58] Adapted from www.opencloudmanifesto.org.

personalise them. While the great majority of providers offer a broad range of integrated cloud services, it still remains to be seen what others specialising more in specific areas will do, as is the case of Salesforce and NetSuite. Software developers have a chance to create applications with a high degree of specialisation faster and more efficiently by using cloud platforms which have to a great extent simplified programming tasks: rather than "writing" code, it is now more a case of "clicking and dragging" software modules. In this regard, cloud computing allows users to develop and manage applications that can easily increase their capacity (scaleability), function at speed (performance) and seldom fail (reliability), without worrying about the underlying infrastructure [59]. A good example is Facebook, which provides an excellent platform for users to create their own social networking applications[60]. With the time and energy not consumed by administering programming environments, the cloud enables companies to make better use of developer talent and expands the pool of potential workers who could master the tools to come up with innovative ideas.

In *The Future of Internet and How to Stop It*, Jonathan Zittrain[61] offers a very different view. He says that moving to the cloud may even act as a disincentive to innovation. The reason is the user response to the viruses, spam and cyber-attacks that have contaminated the PC and led to the adoption of devices such as the iPhone and the Xbox, which only allow innovation initiatives to be developed with the manufacturer's approval. This creates a sterile environment, which is not open to new ideas. As a counter-argument, firms such as Apple have always been very open to collaboration in a common environment where developers can share knowledge and gather talent, thus increasing the chance of new specialities appearing in applications. And the cloud offers precisely such an environment.

In effect, cloud computing reduces innovation costs and breaks down the barriers to user participation. It frees companies from worrying about IT-related issues and allows them to centre more on their business, since they have computer resources that match their needs without having to make a large economic and human investment in implementation. In this way, the companies' products and services get better faster and fall in price. In turn, new businesses are created with more flexible structures. The most immediate consequence is an intensification of competition, in turn stimulating innovation, setting in motion a virtuous circle. Obviously, this marks a turning point for emerging markets, since they can make use of cloud infrastructure and applications to start out on even footing with their international competitors.

Innovation will also be promoted under the umbrella of the Open Source movement, which enables application source code to be freely altered so that it can be improved by developers. The possibility of re-using existing code will enable new applications to be created faster and more easily, acting as a leg-up for innovative software initiatives. Richard Stallman is recognised as the creator of the free software concept. The story goes that in the laboratory where he worked, he decided to fix a printer that was not generating any network message to warn of paper jams, with the result that there was an immense backlog in the system.

[59] *Envisioning the Cloud: The Next Computing Paradigm*, Marketspace (20/03/2009).

[60] *Envisioning the Cloud: The Next Computing Paradigm*, Marketspace (20/03/2009).

[61] *The Future of Internet and How to Stop It*, Jonathan Zittrain, Yale University Press (April 2008).

Without asking for anything in return, Stallman requested access to the source code of the printer drivers, so that he could implement a network message warning about jams. When the company refused, Stallman realised how restrictive it was to use privative operating systems that prevented a user or programmer from solving an error found in the application. As a result, in 1985, he founded the Free Software Foundation (FSF) and introduced the definition of free software and the concept of copyleft, which he developed to give users more freedom and limit the possibilities of the software being appropriated by individuals or firms.

Today numerous firms offer product hosting and provide developers with the necessary tools to create open code initiatives: Amongst the most important are Red Hat, WordPress, OpenBravo, JasperSoft, SugarCRM and MySQL.

It is hardly surprising, then, that cloud computing has been referred to in many forums as the new driver of innovation. As we have seen throughout this study, on the supply side it has materialised into a new business model in the form of services of business processes, software, platforms and infrastructure. Remember that its calling card is access from anywhere (virtualization), the possibility of increasing capacity predictably (scaleability), availability of resources that can be extended or reduced to meet requirements at any time (elasticity), pay-per-use charging for resources and the offering of products and services to more than one company or user at the same time. We are constantly being bombarded with innovations and improvements in the world of cloud computing. Time will tell whether those who see it as a whole new field of opportunities were right... or whether it all turns out to be a passing fad.

The crowd in the cloud

The cloud computing supply model means that organisations using services are going to share the resources in a common environment. Obviously, this will encourage people to be more predisposed to collaborating. "The PC and its applications were conceived to increase individual productivity, while cloud-based applications and services –by dint of their residing on a shared platform– favour teamwork and collaboration. In that sense, as content and communication converge in the cloud, every application becomes a social application"[62].

Within a globalised framework, businesses are becoming increasingly widely dispersed. Cloud computing is seen as a way of bringing them closer to one another and facilitating collaboration, especially in the case of SMEs, which tend to form ad hoc and virtual work teams. Company CEOs have seen the value of these collaboration agreements. Sometimes it is simply a matter or reorganising or motivating the staff in the company; on other occasions it is necessary to look beyond organisational borders. If the search is limited to in-house, ideas are often passed over that might offer an alternative perspective. This is why top management are focusing on promoting an environment that is increasingly open to innovation among employees, users and members, instead of maintaining the traditional model of innovation.

[62] *Envisioning the Cloud: The Next Computing Paradigm,* Marketspace (20/03/2009).

In the area of collaborative innovation, open innovation –also known as *crowdsourcing*– consists of seeing innovation as an open system in which agents inside and outside the organisation all participate. The reasons why this phenomenon has arisen are as follows: the process of globalisation; democratisation and the accelerated rate of development in technologies; ever-more demanding clients; and the thin line separating professionals from amateurs[63]. The ultimate example is Wikipedia, a free encyclopaedia created by internauts from around the world with varying degrees of expertise on the subjects dealt with. The most creative functions in Google are often contributed by the users themselves. There are even social networks –such as NineSigma, YourEncore and yet2.com– which bring together participants and experts from different specialities, with no restrictions on time or space, to offer solutions to the problems posed by organisations.

One aspect we have touched on in this publication, and which very closely relates cloud computing to collaboration is the open code movement. Many providers have considered the idea of their software being distributed and developed freely by third parties. By placing the code of its two most recent creations, Android and Chrome OS at the users' disposal, Google has managed to increase demand for its products and the scope of its advertising.

It also makes life even more difficult for its rivals, who are still charging for their products. Surprising though it might seem, even Microsoft, famous for keeping its source code like a state secret, is participating in initiatives that defend freedom of action in this area[64].

Apple, on the other hand, is prepared to swim against the tide. On the one hand, the company is very interested in cloud computing and has built a data centre worth billions of dollars. However, its interests have always centred more on users than on organisations. According to a study, in 2009 iTunes sold 25% of all music in physical format in the US. The figure for the digital market in the same country is much more surprising: 69% of total sales during the first half of 2009 were downloaded from iTunes[65]. Despite this preference among average users, open source is not precisely part of Apple's strategy. On the contrary, they do their utmost to block dissemination of their operating system to any other device that is not part of their brand and to limit iPhone-compatible applications. Nor do they openly share their innovation plans and they keep the recipe of their success jealously guarded.

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In short, cloud computing consists of a wide variety of computer solutions that contribute operational efficiency to firms, without a physical link to the resources and without maintenance costs for the infrastructure. This is a decisive step in the industrialisation of information technology and the possibilities for cloud providers to create emerging and innovative business models are infinite. The sky is most certainly the limit.

[63] http://www.slideshare.net/abediaga/innovacin-abierta-ms-allde-la-innovacin-tradicional.

[64] http://www.microsoft.com/opensource/.

[65] http://www.npd.com/press/releases/press_090818.html.

5

Chapter 5

The world online: demand for cloud services

5 The world online: demand for cloud services

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 years[66]. This trend, which came to be known as "Moore's Law", has held true for over forty years[67], 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-

market of any new idea is considerably shortened. Ultimately, the range of products and services on offer is expected to grow; some will be successful and spread further, others will fail and disappear from the market. The rapid development of the market and the flexibility cloud computing provides will enable firms with successful products or services to grow quickly, whereas those with less successful ones will be able to withdraw them just as quickly and seek new solutions, since the relatively low cost of launching new products will allow small business to try and try again until at last they succeed. For a country like Spain, where 97.3% of companies in 2008 had fewer than twenty employees, this is very good news in principle[68].

The benefits of cloud computing are substantial, but is small business really aware of the possibilities that providers offer? According to a study drawn up by the cloud hosting company Rackspace in 2008[69], only 27% of small businesses in the US and 33% in Britain were familiar with the term *cloud hosting,* whereas among mid-sized companies the figure was 57% and 53% respectively. However, a study published in January 2010 by Easy Connect[70] showed 73% of British SMEs predicting that they would use cloud computing in the next five years, reflecting a substantial change in the degree of knowledge on the nature and workings of cloud computing and the possible benefits for this type of company.

The appeal of the cloud for SMEs

While cost-cutting costs has always been an objective for SME management, in the current economic climate, with the liquidity of the financial system reduced and the capital available to firms substantially reduced, it has now become critically important. SMEs are facing a slow-down in consumption, which increases the competitive pressures on the market, with fewer resources at their disposal. In this context, cloud computing is a very attractive alternative for cutting costs and increasing competitiveness. Some firms are seizing the moment to replace their traditional systems and internal servers with cloud-based computing models. Traditional systems require regular investment and force the company to create an IT department or hire personnel specialising in IT management. In comparison, cloud-based systems are simple, because they can be accessed via a web browser or even worked remotely over mobile terminals. The provider also takes control of the work of maintenance even more importantly, system improvement. These characteristics allow SMEs to reduce their initial investments and cut maintenance costs. Cloud service providers take control of updating systems centrally and the valuable resources once devoted to this task can be released, allowing companies to focus on developing innovative applications and new projects, offering new benefits for the business.

It is precisely this potential cost cutting that makes cloud computing so attractive for small business. A survey conducted by ENISA (the European Network and Information Security Agency) found that 68% of SMEs surveyed said that their primary reasons for engaging cloud services was to cut costs (See Illustration 8:).

[68] http://www.ine.es/daco/daco42/dirce/dirce09.pdf.

[69] http://www.rackspace.com/downloads/surveys/CloudAwarenessSurvey.pdf.

[70] http://www.easynetconnect.net/Portals/0/DownloadFiles/IndustryInsight/WhitePapers/Is%202010%.

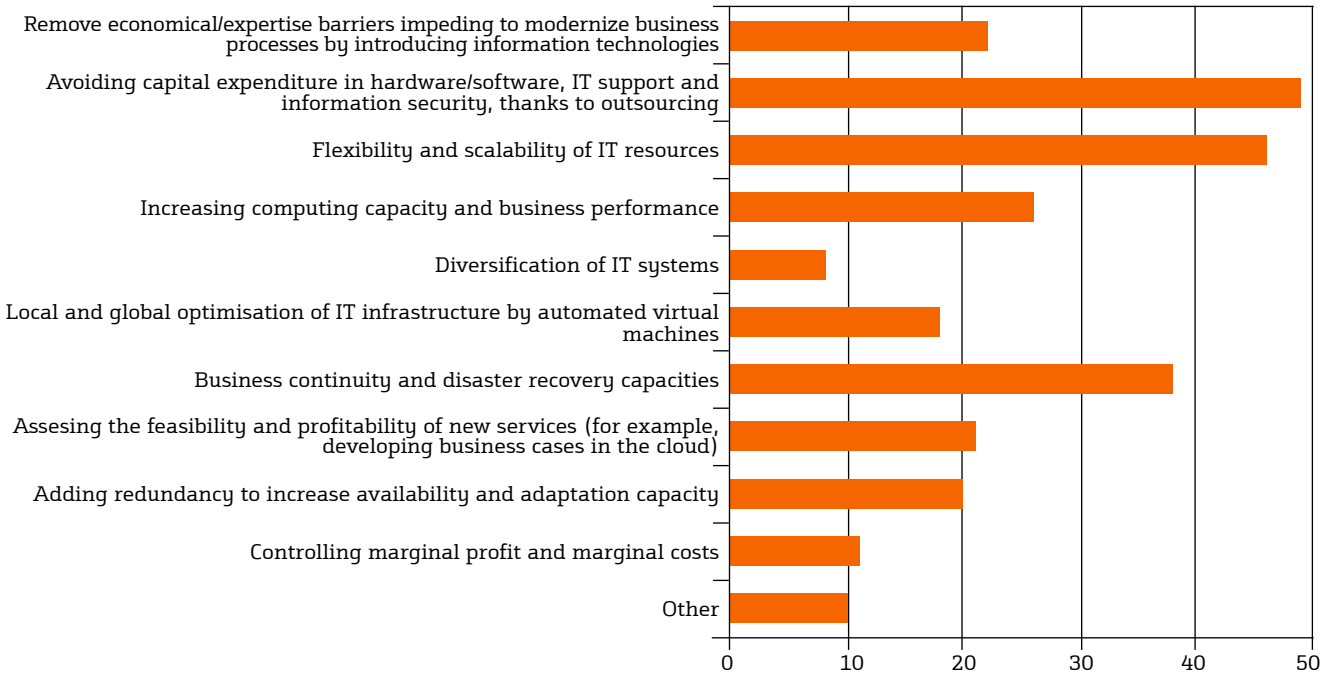


Illustration 8: Reasons for possible adoption of cloud computing.
Source: *An SME perspective on cloud computing, a survey by ENISA* (The European Network and Information Security Agency)[71]

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 web[72]. 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).

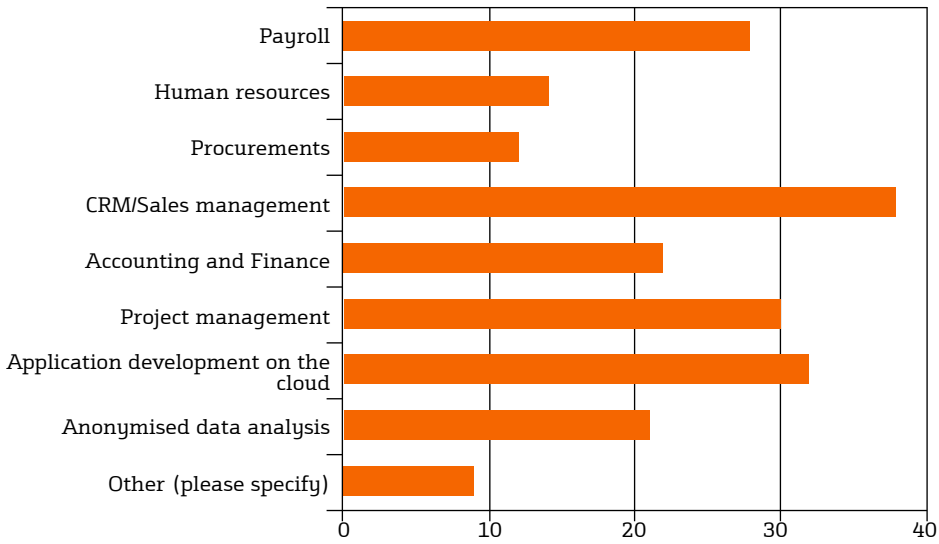


Illustration 9: Business Processes most likely to be managed from cloud applications.
Source: Survey by ENISA (European Network and Information Security Agency).

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.

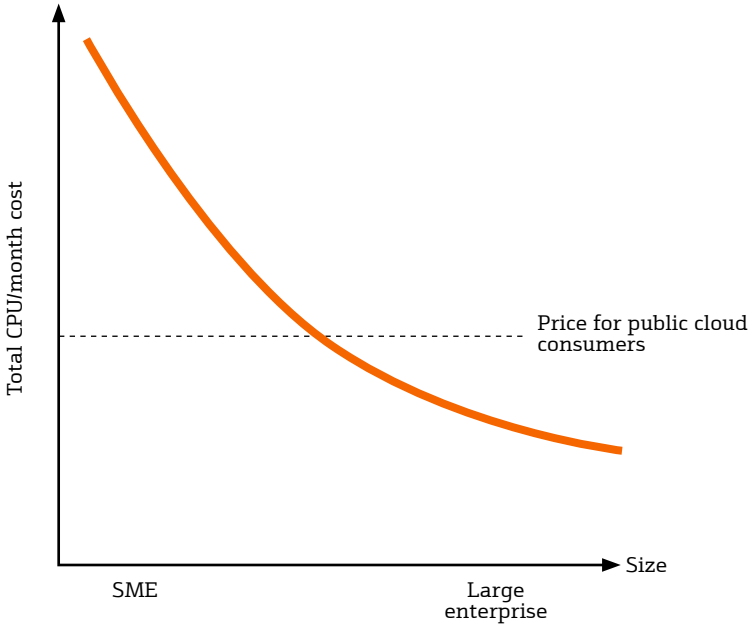


Illustration 10: Cost reduction resulting from use of cloud computing, depending on size.
Source: Amazon website.

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 available[73]. 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 direction[74]. 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 survey[75] 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%.

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 technology[76].

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 Microsoft[77] 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 Spain[78].

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-house[79]. 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-block[80].

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 service[81].

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 Avanade[82] 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 Illlustration 11).

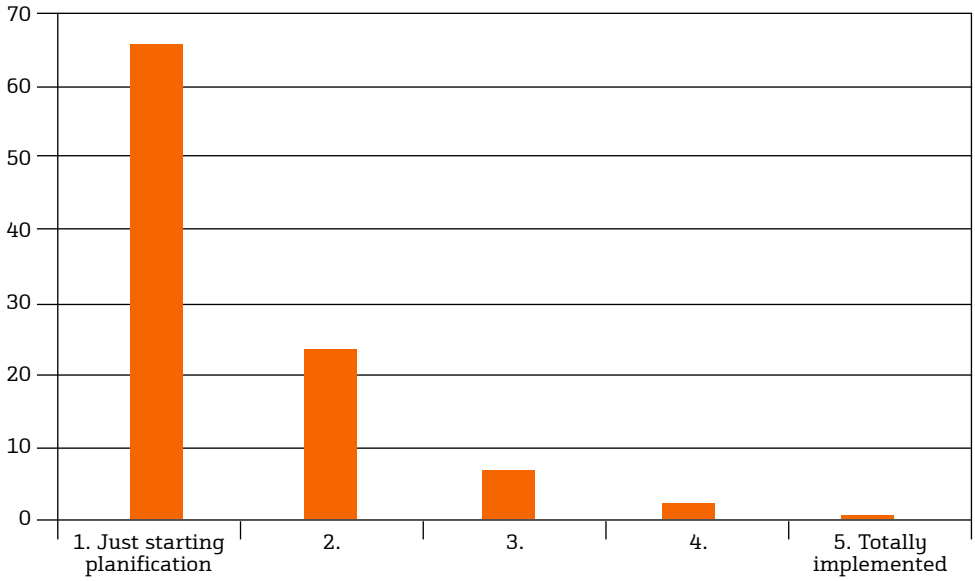


Illustration 11. How fully implemented is cloud computing in your organization?
Base: organisations that have begun planning or implementing cloud computing
Source: CA, study: "Unleashing the Power of Virtualization 2010".

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 managers[83], combined with confusion as to the precise

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

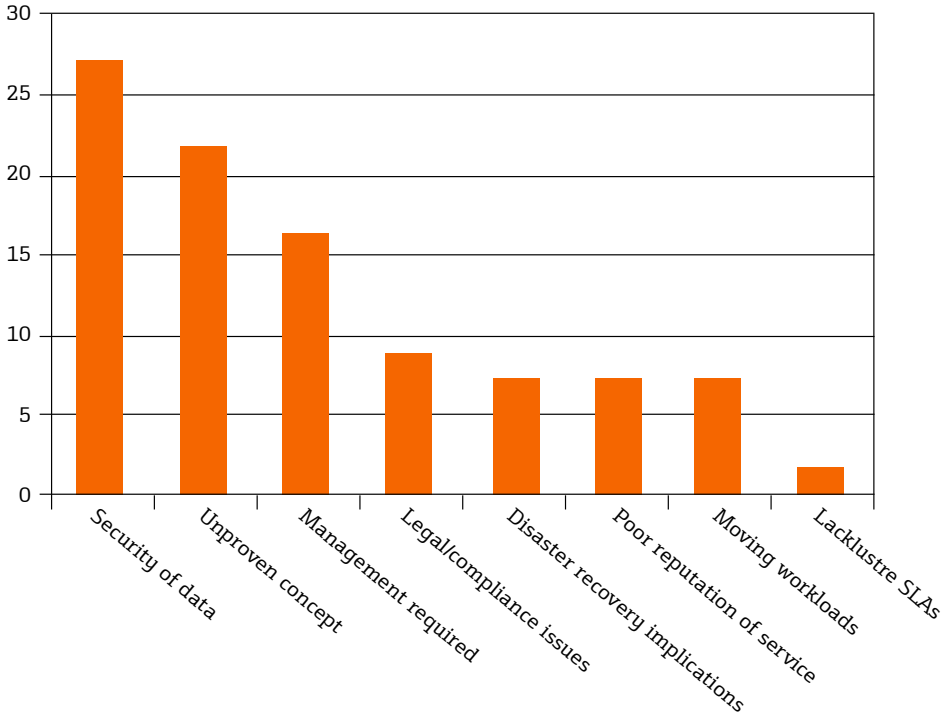


Illustration 12. Which of the following do you see as the main drawback of cloud computing?
Source: *Unleashing the Power of Virtualization 2010*, study by CA.

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.

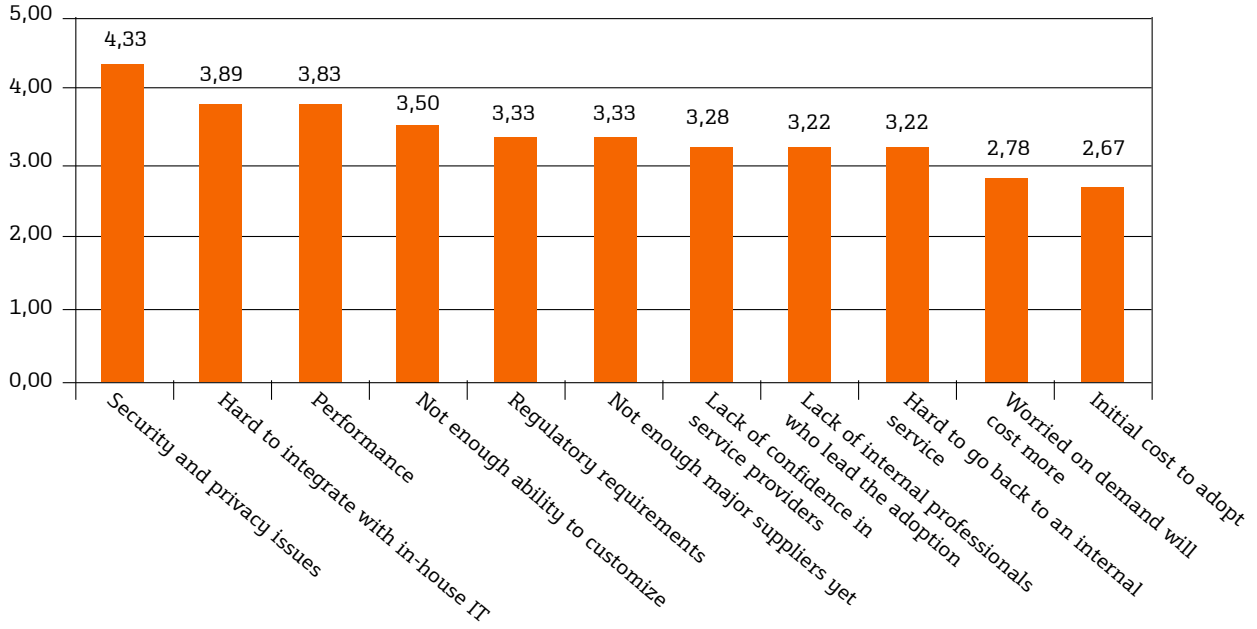


Illustration 13. Main concerns in the demand for cloud computing.
Source: authors.

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-

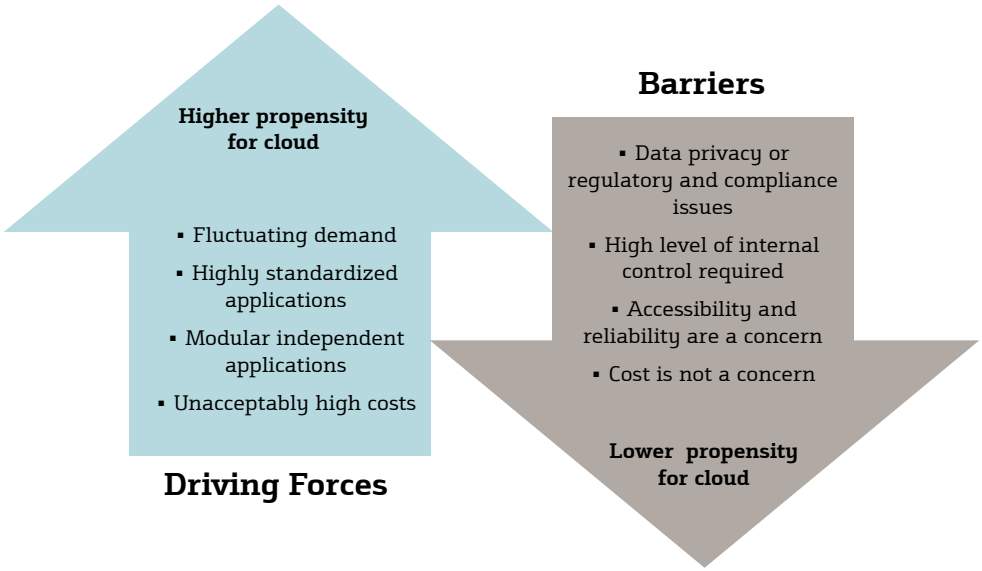


Illustration 14. Forces for and against the cloud
Source: Opinion of Future Trends Forum experts.

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).

The New York Times is a good example of how the cloud can be used to offer new services[84]. The newspaper decided to offer its readers all the articles published

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

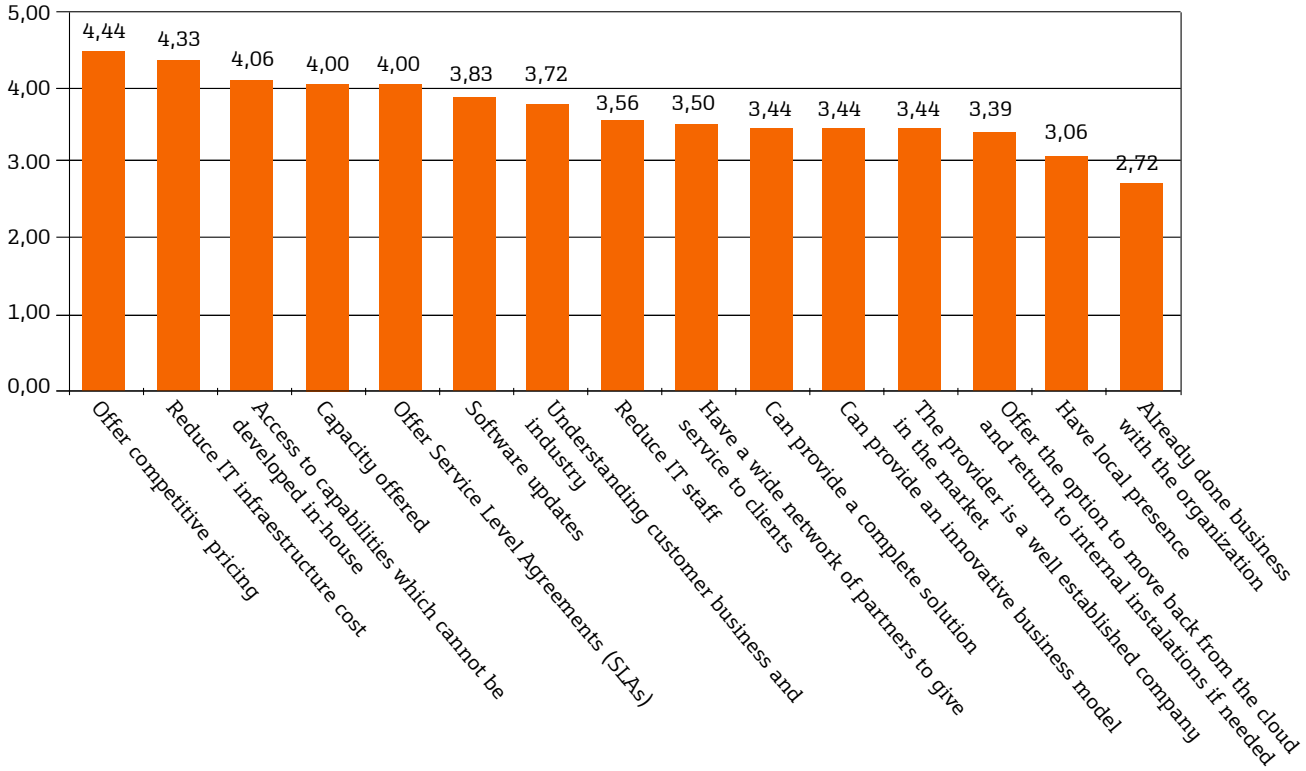


Illustration 15. Aspects rated highest when choosing a cloud computing provider.
Source: authors.

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 systems[85]. 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 video[86]. 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 customers[87]. 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 solutions[88]. 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 centres[89], 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 operate[90]. "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 Facebook[91]. 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 services[92]. 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 years[93]. 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.

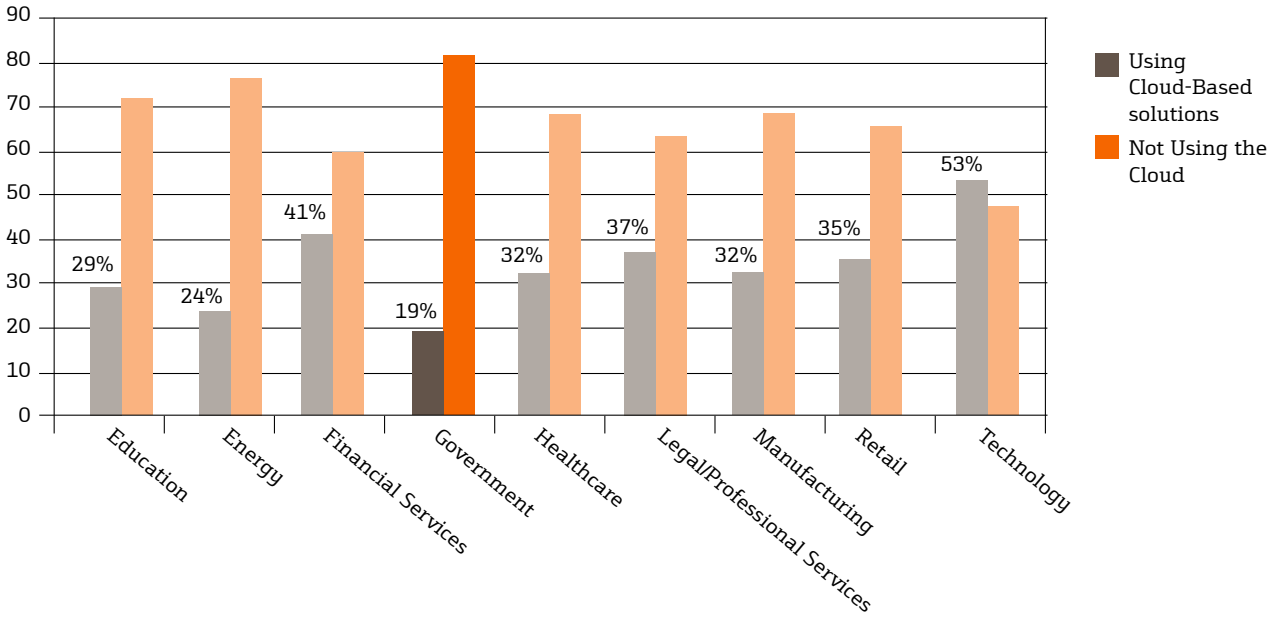


Illustration 16. Adoption of the cloud computing by industries
Source: Cloud Computing Survey, Mimecast.

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 administration[95]. Other providers, such as Amazon[96] and Platform Computing[97] 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 computing[98]. 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 US[101].

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 education[102]. 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 computing[103]. 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 relocate[104]. 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 government[105].

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-cloud[106]. 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 economy[107].

Among European countries working to move to the cloud are Sweden, France and Spain[108]. 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 infrastructures[109]. 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 Center[110], 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 efficiently[111]. 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 applications[112].

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.

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

[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/.

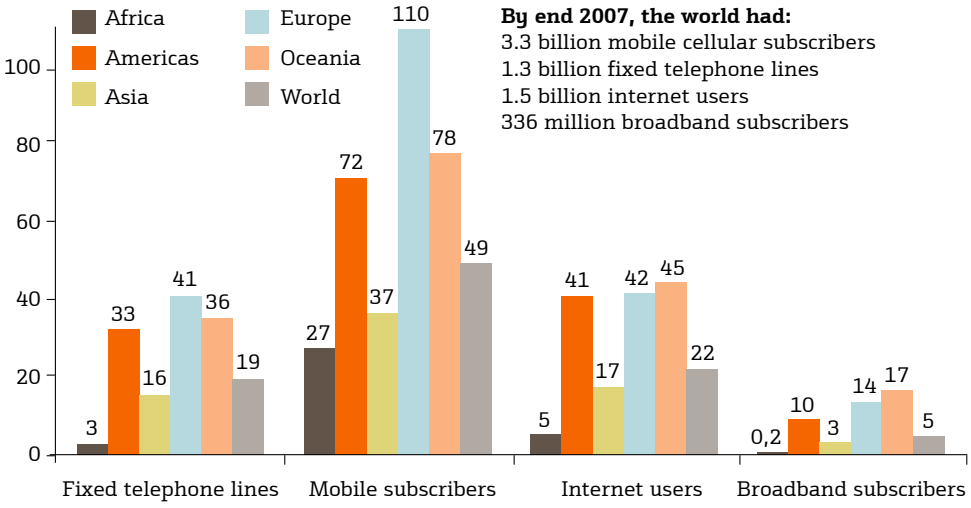


Illustration 17. Penetration of information and communications technology (ICT) by continent.
Source: International Telecommunication Union – Statistics on global development of ICT[113].

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 computing[114]. In Spain, only 14.3% of the firms said it was not part of their plans[115]. 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.

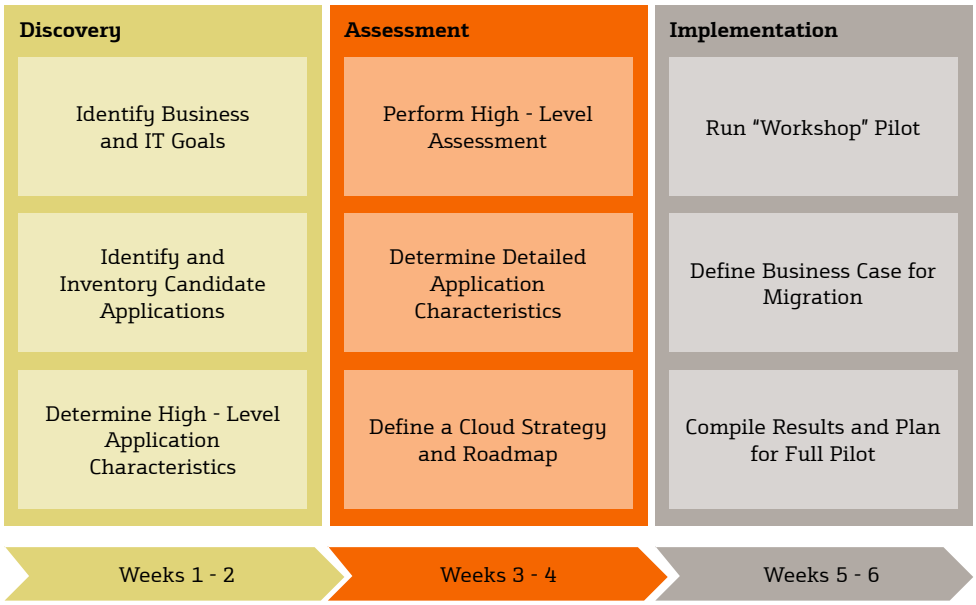


Illustration 18. Framework for adoption of cloud computing services
Source: Accenture.

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.

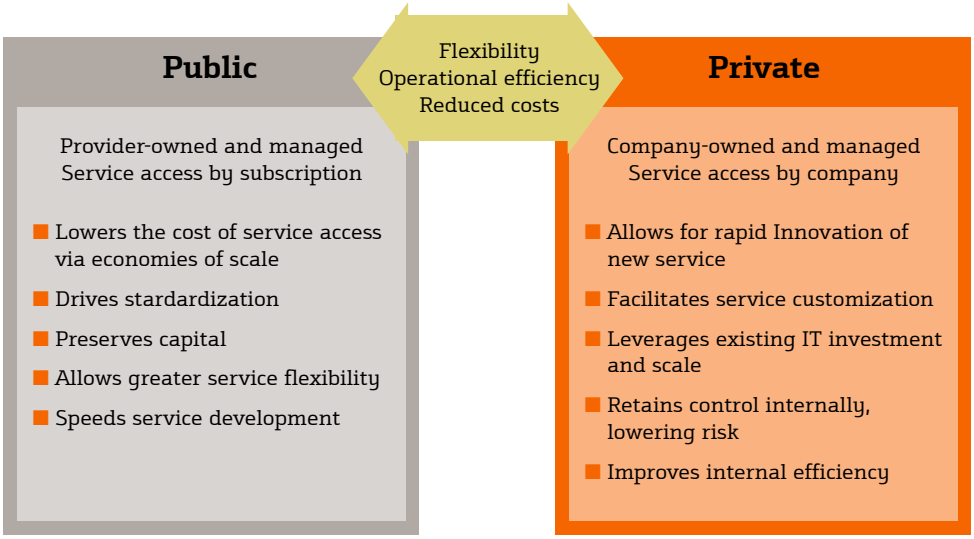
- A private cloud is for the exclusive use of a specific organisation, as opposed to the public cloud which is shared by many different firms, though each one is unaware of the existence of the others.

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 another 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 offer[117]. 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 computing[118] 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 Accenture[119], 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 SOASTA[120], 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/.

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 is4profit[121], 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 parties[122].

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.

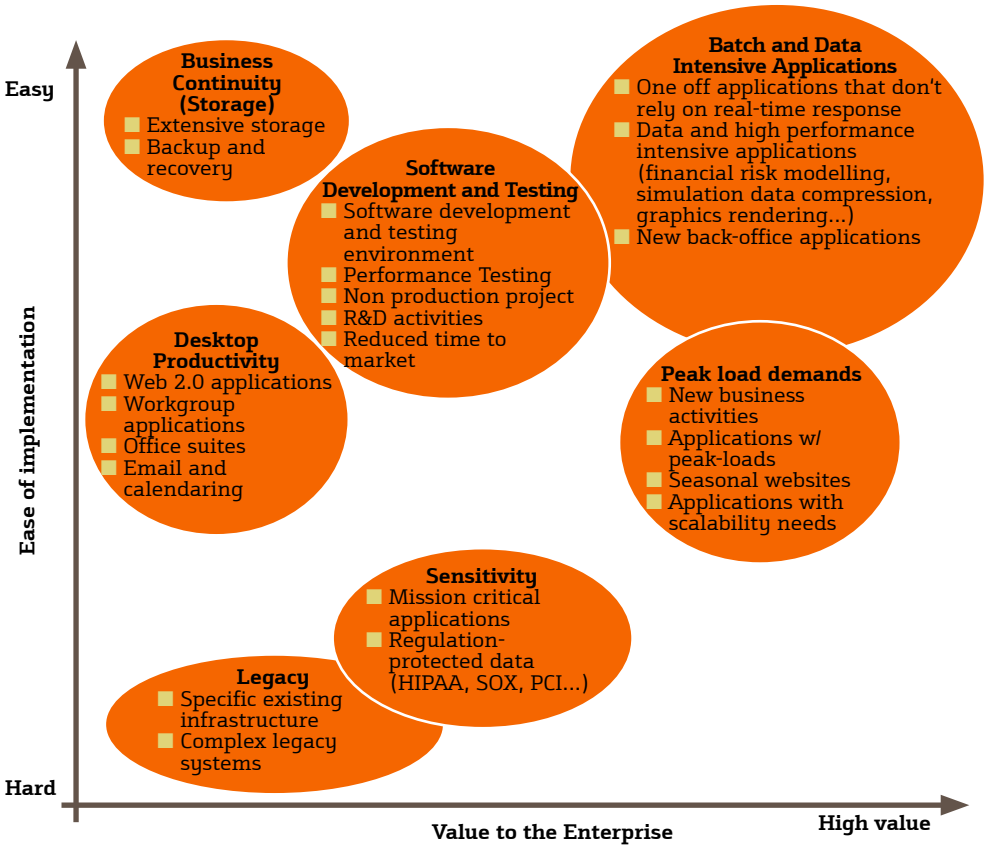


Illustration 22. Degree of difficulty of implementing cloud applications compared to the value of this implementation for the company.
Source: Accenture Technology Labs.

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 followed[123]. 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' computers[124]. 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 subject[125]. 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 systems[126]. The project, which is still underway, includes specific contents designed by Google and the University of Washington[127]. 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).

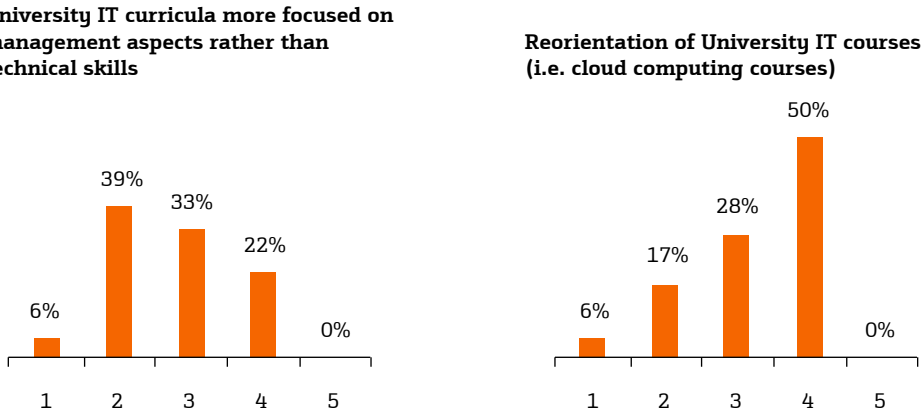


Illustration 23. Opinion of Future Trends Forum experts as to the impact of cloud computing on different areas (1=no impact, 5=very strong impact)
Source: authors.

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 University[132], 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.nwsource.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.

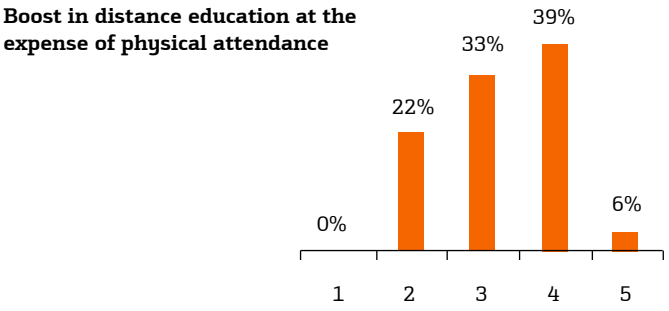


Illustration 24. Opinion of Future Trends Forum experts on the impact of cloud computing in distance education at the expense of one-to-one education (1=no impact, 5=very strong impact)
Source: authors.

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 information[134].

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 Sweden[135]. Google estimates that each query on its search engine generates 0.2 grams of CO_2. 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.

Energy[136], 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 homes[137]. 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 cool[138]. 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 concept[139]. 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 times[140]. There are doubts as to whether the "follow the moon" model is compatible with cloud computing[141], 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/idUSTRE5AT01220091130.

[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/.

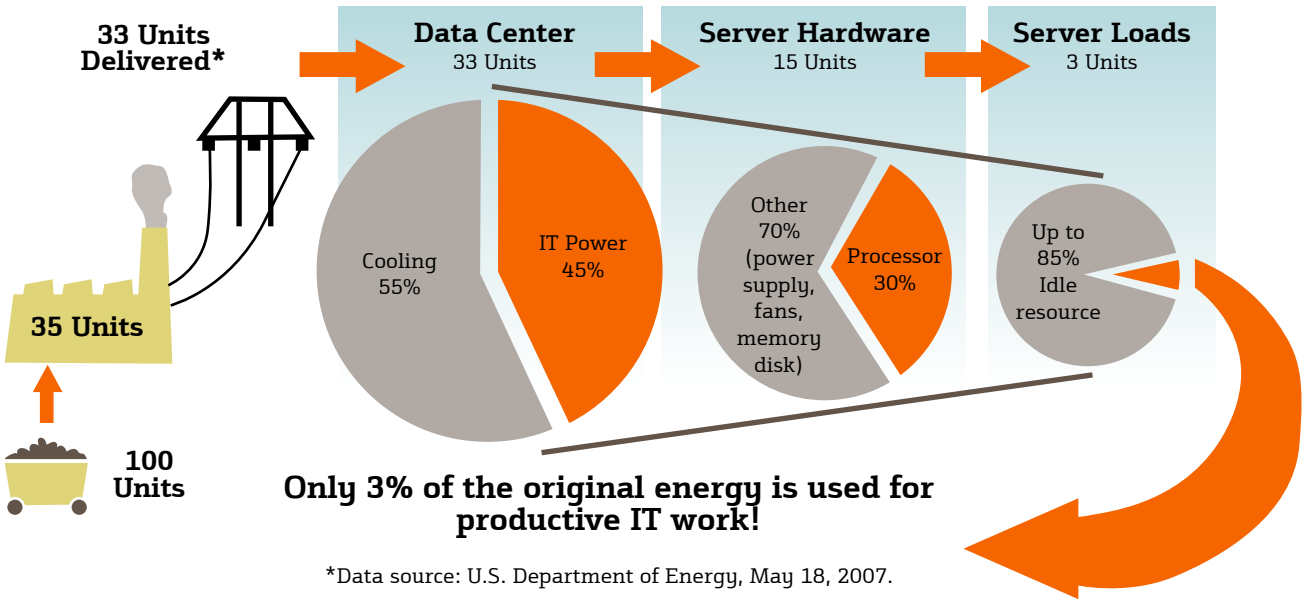


Illustration 25. The process of transforming power into computing capacity.
Source: "The Social Factor: Innovate, Ignite, and Win through Mass Collaboration and Social Networking", Maria Azua, IBM Press.

"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=HITOFF&d=PG01&p=1&u=/netahtml/PTO/srchnum.html&r=1&f=G&l=50&s1=%2220080209234%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 countries[144]. 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 Mworia 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 cloud[145]. 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.

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

[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.

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 example[146]. 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 organisations [147]. 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 catastrophes[148]. 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 we 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 names[149]. 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/.

6

Chapter 6

The outlook for cloud computing in Spain

6 The outlook for cloud computing in Spain

Cloud computing is an ever more tangible reality. As society evolves towards greater mobility, demanding to be able to access information from anywhere in the world, it will be increasingly attracted by services offered on the cloud. It is precisely in the services sector—where information management and dealings with clients are essential—that the greatest benefits can be gained from new advances in cloud computing. The cloud may therefore have a very important impact on the Spanish economy, which is so firmly grounded on the services sector, accounting as it does for 50% of GDP and 43% of all jobs, according to the latest figure from the Spanish Statistics Institute (Instituto Nacional de Estadística, INE)[150]. There is, however, another feature of the Spanish business world that makes it ideally placed for adopting the cloud. As we have seen in previous sections, cloud computing is of particular interest for SMEs. Small companies do not have the necessary resources to invest in large data infrastructures; the cloud, on the other hand, gives them a chance to catch up with larger companies in terms of technological capacity. DIRCE, the INE's Central Companies Directory, listed 3,355,830 active companies in Spain at 1 January 2009[151]. Of these, only 5,375 had 200 or more salaried employees, meaning that over 99.84% of the firms were SMEs. This makes Spain as a whole a major potential user of cloud services. Yet SMEs are not the only companies that might be interested. The economic crisis is also having an impact on larger corporations, which are currently seeing restrictions being placed on their investments in technology, and this might just tip the scales towards the use of cloud services.

Spain could also be an attractive location for hosting the elements needed to offer cloud services to other geographical areas. A study published by Gartner, a leading IT research and consultancy service, places Spain among the top thirty locations for hosting offshore services[152]. Among the country's main attractions as a delivery centre, Gartner lists its cost advantages over countries in northern and western Europe, a good command of foreign languages, good IT and transport infrastructures and strong ties with Latin America[153]. Some firms, such as Accenture, have already selected Spain as a delivery centre[154]; however, when it comes to locating data centres, large cloud providers also factor in other criteria in which Spain does not rank as well, such as a climate with moderate or cold temperatures and easy access to clean, inexpensive energy. According to Michael Manos, Microsoft's senior director of data centre services, his company uses more than 35 different factors to select the location of their data processing centres; based on these criteria, they draw up a coloured map of the globe, which allows them to identify suitable locations for siting their large centres[155].

For the moment, Spain would not seem to be an attractive location for large cloud providers, judging by the fact that two of the world's most global firms, Google[156] and Amazon[157], have no data centres on Spanish soil. Nonetheless, the country is proving to be a breeding ground for innovative companies providing

[150] http://www.ine.es/prensa/iass_prensa.htm.

[151] The 3,355,830 firms extend across all industries except agriculture and fishing, public administration, defence and compulsory social insurance, homes employing domestic personnel and extraterritorial organisations. Source: http://www.ine.es/jaxi/menu.do?type=pcaxis&path=/t37/p201&file=inebase&L=0.

[152] "Gartner's 30 Leading Locations for Offshore Services", Ian Marriott, Gartner, November, 2009.

[153] "Analysis of Spain as an Offshore Services Location", Ian Marriott and Gianluca Tramacere, Gartner, October, 2009.

[154] http://www.accenture.com/Global/Services/Global_Delivery_and_Sourcing/AccentureSpain.htm.

[155] http://www.areadevelopment.com/viewpoint/jun08/michael-manos-microsoft.shtml.

[156] http://www.datacenterknowledge.com/archives/2008/03/27/google-data-center-faq/.

[157] http://www.datacenterknowledge.com/archives/2008/11/18/where-amazons-data-centers-are-located/.

services to users over the net, either using cloud technologies or directly offering cloud services. EyeOS is an example of these new firms. The free, open code eyeOS system, allows users to create a strong cloud desktop, which can be accessed from any device via a browser. It also has a simple platform for developing customised applications on this desktop. Tuenti is another clear example. Set up in 2006, the company developed a social network targeted at Spanish youth which has grown into the largest competitor to Facebook in the country.

However, the cloud environment in Spain will not only be marked by these small firms; the way the large companies position themselves will have a major impact on the way it develops too. Telefónica, Spain's leading telecommunications operator, recently went into partnership with NEC to offer cloud services in Latin America, in a move that clearly reflects its desire to become a serious competitor on the cloud market[158]. Its dominant position in Spanish access infrastructures makes Telefónica a serious threat to large cloud providers. The fact that is has presented a new interface to improve cloud interoperability and its integration with the communications networks shows that it is keen to capitalise on this position[159]. Another area that needs to be considered is the future of computing in large financial institutions. Banks such as Banco Santander, BBVA and Banco Sabadell have large processing centres for managing all their systems and applications. The trend towards virtualization of their servers[160] is turning these large centres into private clouds and as they gain experience in managing them, they might venture to set up as cloud providers, creating spin-offs to manage their data centres.

IDC España, a technological market research firm, predicted that the crisis and fall in GDP in 2009 would speed up the consolidation, virtualization and automation of data centres, arguing that this would lead to greater outsourcing of these services[161]. In 2010 cloud computing is already one of its ten main market trends in ICTs[162]. However, to judge from the result of a survey by CA[163], cloud computing has not won over many Spanish companies. Eighty-six percent of firms surveyed said they were undecided as to the future of the cloud. This contrasts with certain features of the Spanish market—some of which we have already touched on—which make cloud computing a particularly attractive model for the country.

The effect of the cloud on the services sector

The first most important feature of the Spanish market is the predominance of the services sector. Of all sectors, this is the one best positioned to lead the migration to the cloud; it is made up of businesses whose chief asset are people, with no complex supply chains and physical assets requiring on-site management systems (like factories and department stores). This should make them more flexible when it comes to capturing new business opportunities, since they care more capable of redefining their processes and even the limits of the company as market conditions change. To do this, the companies focus on the activities that set them

[158] http://www.nec.co.jp/press/en/1002/1803.html.

[159] http://es.finance.yahoo.com/noticias/telefonica-presenta-el-apitcloud-para-la-interoperabilidad-de-cloud-computing-iberonewea5c327b7952.html?x=0.

[160] http://www.itcio.es/virtualizacion-centro-datos/soluciones-negocio/1005206011402/banco-sabadell-apoya-virtualizacion.1.html.

[161] http://www.eweekeurope.es/noticias/las-10-tendencias-en-tic-para-el-mercado-espanol-435.

[162] http://www.computing.es/Noticias/201001150000/Los-primeros-signos-positivos-de-recuperacion-en-el-mercado-iberico-TIC-no-se-veran-hasta-el-cuarto-trimestre.aspx.

[163] http://www.baquia.com/actualidad/noticias/15871/el-cloud-computing-no-convence-a-las-empresas-espanolas.

apart, with a view to serving clients, turning to external experts for their other activities. As a result, services companies are now beginning to consider using experts to manage infrastructures, applications and software—all tasks that can be delegated to cloud service providers.

Within the services sector, one of the areas most affected by the economic recession is the financial sector, particularly savings banks. There is increasing debate on the inefficient management of these institutions and the need for mergers to reduce the number of organisations. Mergers are complex processes not only because of the human aspect of integrating two different management models different, but also because of the typical differences in computer models. Nonetheless, these processes hold out opportunities for adopting cloud-based services. The banks will have to review their different computer systems in detail before merging; this represents a unique opportunity to define a strategy of adopting cloud computing that could transform the current processing centres into private clouds and identify the information and computing resources that might be moved to public clouds. However, in order for this to be possible, the IT managers of the savings banks must know what opportunities cloud computing offers; it will be up to the large cloud providers to enlighten them. In this regard, Microsoft seems to be taking the lead, presenting the benefits of its cloud services at the Ninth Microsoft Savings Banks Forum[164]. At the same time, the large Spanish banks are looking for opportunities to expand their international business by acquiring assets in other organisations (an example is the rival bids for the UK offices of Royal Bank of Scotland by Banco Santander and BBVA [165]). Virtualization is an established technology in these organisations, but these acquisitions represent an opportunity to make the most of the cloud's advantages.

A similar process of consolidation to that of the savings banks is also taking place in the media, particularly in television. With the coming of TDT (terrestrial digital television) and a consequent mushrooming in the number of channels available, existing channels are suffering a drop in advertising revenue and are currently involved in a restructuring process. New business models tend to reduce staff costs by replacing permanent in-house staff with external collaborators. As a result, many journalists are now working free-lance, with no access to the major information sources and technological tools available to them at the communication groups. These free-lancers are calling for greater access to the large groups' information[166], and adopting the cloud is seen as a way of solving this problem. Using cloud services, the information could be made be available from any terminal; free-lance journalists could therefore access it from their own computers or mobile phones. In this model, the communication groups would administer each collaborator's access permits and would be able to control the information each journalist accessed, depending on the type of collaboration.

[164] http://www.consultoras.org/frontend/aec/Cloud-En-Las-Cajas-De-Ahorro-vn11850-vst778.

[165] http://www.expansion.com/2010/03/29/opinion/llave-online/1269890745.html.

[166] http://www.consultoras.org/frontend/aec/Los-Periodistas-Reclaman-Mayor-Acceso-A-La-Informacion-Y-A-Soluciones-Tecnologicas-Especificas-Para-vn11454-vst778.

Cloud computing will have an uneven effect on telecommunications, but the trend set by Telefónica gives an idea of the road the main operators may take. As Internet access providers, they have a direct contact with the client and are in a privileged position to offer specialist cloud services. From a simple phone line to television, the range of offerings has evolved as competition has increased and revenue from established services has fallen. Cloud services represent the next stage in the difficult race between operators, who will need to evolve apace with the technology. Competing against the large cloud providers will be no easy task, but operators will be able to integrate their offerings with phone, broad band and television services. This will help them overcome users' reluctance to join the cloud by using a known image, recognised and trusted by the customer.

As for the services sector, tourism is undoubtedly a basic lever for the Spanish economy. This is a much more fragmented industry, containing as it does large chains, such as the NH and AC hotel groups, and a host of individual businesses, such as small hotels, restaurants and camp sites. Cloud computing is attractive at both ends of the scale, but particularly for small businesses. They will be able to access computing capacities that will enable them to manage information better and offer customers the same quality on-line services as large hotel chains. However, the cloud may have an even greater impact on the industry, by simplifying the possibility of sharing information between travel agencies and end destinations. This will encourage greater specialisation in the industry, with a model in which the agencies are responsible for engaging clients, while catering establishments and accommodations focus their efforts on the client's experience and satisfaction.

The cloud and Spanish companies

The second noteworthy feature of the Spanish market is the predominance of SMEs in the industrial sphere. As we saw in the section on "The democratisation of IT for SMEs and start ups", it is these companies that stand to benefit most from cloud services and a review of INE statistics shows the potential market for cloud providers. As Illustration 27 shows, Spain has a very high rate of access to the Internet (96.2%) and mobile phones (90.9%) among SMEs, making them good potential consumers of cloud services[167]. Although e-mail is used in the vast majority of firms and nearly two thirds have their own website, the use of other electronic services is not very widespread: three quarters of all firms lack a customer relationship management (CRM) application and only 14.2% share electronic information with other members of the value chain. These statistics are encouraging for cloud providers; with the right strategy of communicating the benefits of the cloud, they could easily gain access to this emerging market.

[167] The percentages shown in the illustration include large companies. However, the results can be extrapolated to SMEs, since they represent 99.84% of all businesses. The percentages marked as services do not include food and beverage companies, financial institutions, public administration, defence and social security.

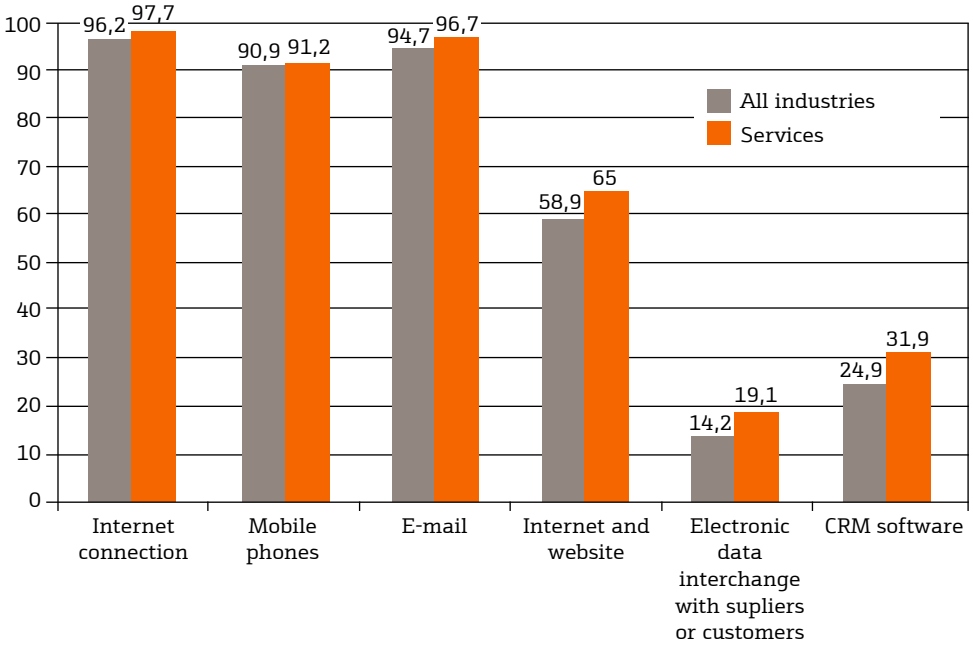


Illustration 27. Percentage of ICT penetration in Spanish companies
Source: Data from the INE as of 1 January 2009.

A survey by Sage, a company specialising in developing management software for small and medium-sized enterprises, reflects the current situation among Spanish SMEs. This study, entitled *Radiografía de la pyme 2010*[168], shows the results of a survey of nearly 8,000 SMEs and free-lance workers on the use of management software. The results show that only 32% of the firms surveyed acquired computer applications during 2009 and, of these, the great majority (68%) invested in management software (see Illustration 28).

The same study shows that nearly two thirds of those surveyed considered the lack of funding to be the main barrier for setting up a company. Despite the fact that 56% said they were interested in accessing their data over the net, these problems of funding tended to limit their investments in IT. Here again, there is an opportunity for cloud providers, who can provide these services on a "pay-per-use" basis, freeing the firms from initial investments in software licences and development. Illustration 29 shows the low use of computer applications in the different areas of the company, with the largest rate of adoption in accounting management (though only in 30% of the firms). When asked about the future, only 24% planned to invest in software, mostly in management applications, and among the most important technological trends was the development of on-line applications.

[168] http://www.sage.es/radiografiadelapyme2010/Radiografia_de_la_pyme_2010.pdf.

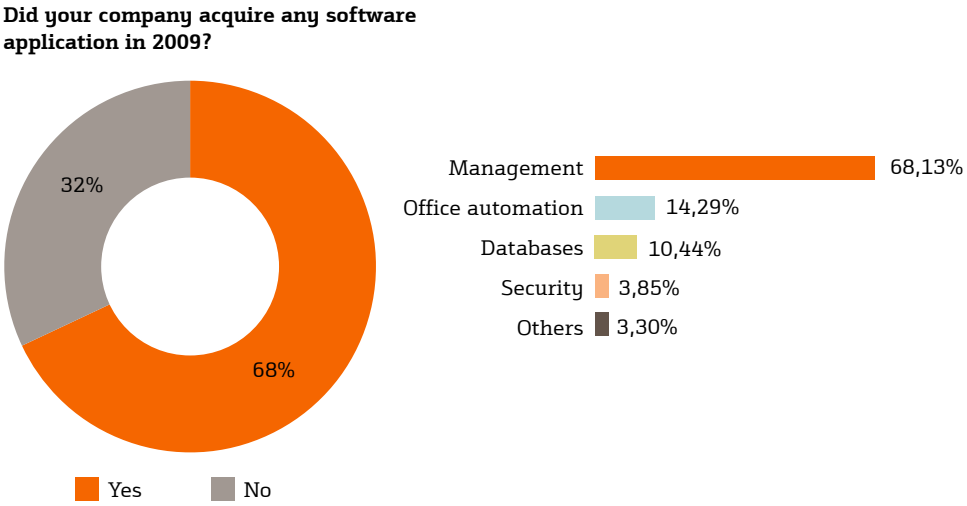


Illustration 28. Acquisition of computer applications by SMEs
Source: *Radiografía de la pyme 2010*, Sage.

These results confirm that there is a need for computer applications among Spanish SMEs, but also a barrier to their being adopted, characterised by a lack of resources and financing. The cloud is an opportunity to break down this barrier. Nonetheless, the cloud providers' task is not merely to offer the right services, but also to ensure that the SMEs know that they exist. The Spanish market holds out major opportunities, as long as providers are capable of targeting their offerings appropriately.

The future of Spanish government and citizens is in the clouds

A Spanish government report entitled *La Sociedad de la Información en España [The Information Society in Spain]*[169] points out that 50% of Spanish territory is classed mountainous, with INE figures showing that 84% of all municipalities have a population of less than 5,000. These features make developing communication infrastructures a complicated task; however, as part of its Broadband Rollout Plan (PEBA), the Spanish government aims to extend access to 99% of Spanish territory[170]. With a rural and mountainous geography, and the great majority of inhabitants having access to broadband, the Spanish population may be among the greatest beneficiaries of the development of the cloud.

However, another important feature of the Spanish economy, accentuated by the economic crisis, is the size of its civil service. The government has upped public spending in recent years in an attempt to encourage economic growth and in 2009, the public deficit stood at 11.4% of GDP, according to estimates from the BBVA's Studies Service[171]. With a commitment to reduce this percentage to the 3% imposed by the European Union by 2013, the government will have to wield the

[169] http://www.planavanza.es/InformacionGeneral/ResumenEjecutivo2/Documents/2009-12-16%20Contexto%20Avanza%20SI.pdf.

[170] http://www.planavanza.es/InformacionGeneral/ResumenEjecutivo2/Documents/2009-12-16%20Contexto%20Avanza%20SI.pdf.

[171] http://serviciodeestudios.bbva.com/KETD/fbin/mult/100216_perspectivasparalaeconomiaglobal2010_tcm346-215122.pdf?ts=842010.

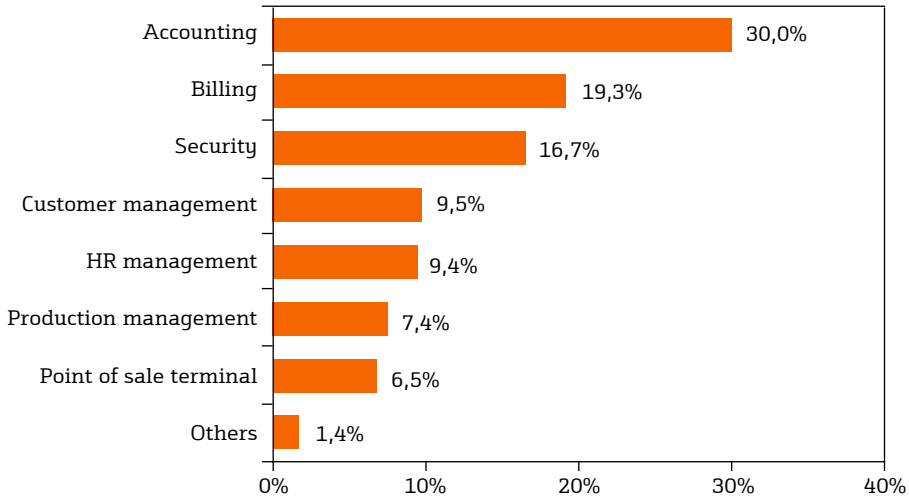


Illustration 29. Penetration of computer applications in different company activities
Source: *Radiografía de la pyme 2010*, Sage.

axe extensively in public spending and in this process, cloud computing could prove to be a valuable ally.

The idea of teleworking in the public sector has long been debated[172]. With nearly 3 million civil servants altogether, teleworking could bring important cost-cutting in public buildings. Cloud computing is the best-placed technology to facilitate this system, since it provides on-line services that can be accessed from any user's terminal. However, the cloud can also help improve the efficiency of an administrative system that is very widely dispersed amongst state, regional and local bodies, by virtualising part of the services and moving them to the cloud. There is a host of services that can be administered on-line and remotely: examples of these services include applications for grants, despatch and processing of documents, tax management and even certain procedures related to the justice systems. The benefits for citizens would be immense, since they would not have to leave home, depend on office hours or know the right ministries, registers or administrations for each formality. In turn the government would have a more efficient and automated management system with which it could progressively reduce staff numbers. All that would be needed would be a shared Internet address with a user-friendly portal.

Electronic medical records are another public sector area in which the cloud could have a major impact. The project for centralising the records of seven hospitals in the Community of Madrid[173] is an example of the trend currently being taken in public health. Unlimited storage and computing capacity accessible from the cloud

[172] http://www.elpais.com/articulo/economia/Gobierno/ofrecera/20000/funcionarios/posibilidad/trabajar/casa/elpeputec/20070312elpepueco_11/Tes.

[173] http://www.ecm-spain.com/noticia.asp?IdItem=7032.

is a way of containing the costs in a sector that needs ever more capacity. Even in the Ministry of Defence, a strategic area with a high rate of consumption of technological resources, there is already talk of the advantages of moving to the cloud. Carlos Pérez Vázquez, head of the Architecture Area of the Inspección General CIS, describes the viability of cloud computing in the ministry, highlighting the possible use of public clouds in the case of services that are not considered to be decisive for the organisation[174].

Features of the Spanish market that might boost the development of cloud computing in the country include the geography, large number of SMEs, large civil service and strong services sector. Much of this development will be marked by the government's position but, above all, by the strategy of emerging firms and large providers to make sunny Spain a bit cloudier.

[174] http://www.socinfo.es/contenido/revistas/pdf66marzo10/p06-07semivirtual.pdf.

Appendix

Glossary

C

Cloud
In the context of cloud computing, the term "cloud" has several different meanings. It is generally used to describe a provider's applications, services and data centres. In other words, it includes both the infrastructures and the services a provider offers. However it is also used to refer to the sum total of all the services and infrastructures of all the existing providers.

In the first sense of the term, a distinction is drawn between public and private clouds. A **public cloud** is one in which different customers' services share the same infrastructures (servers, discs, etc.). This means that there are no dedicated infrastructures and resources are distributed according to demand. A **private cloud** is one in which a customer's services have specially dedicated infrastructures that are not shared with other customers' services. A private cloud may be **external**, when the dedicated infrastructures are owned by a provider or **internal**, when the infrastructures are owned by the customer (i.e. there is no provider per se, since the customer manages its own cloud).

D

Data centre
Data centres are facilities used to house computer systems and their associated components. The facilities contain all or some of the resources needed for processing an organisation's information. They generally have redundant or backup power supplies, redundant data connections, backup copies, cooling systems and special security devices. The computer resources are accessed over data connections or the Internet. In the case of cloud providers, these data centres also concentrate the customer's processing needs.

F

Free software
Free software and open source software is distributed with a licence that allows users to run it, access the source code, modify or improve it and redistribute copies to other users. What distinguishes it are the conditions set out in the licence on the rights and duties of the provider and user under which it is distributed; the difference, therefore, is not so much in the technology or cost of the software but in the way it is acquired. Free and open-source software involves any software, product or made-to-measure development distributed with a licence granting these four freedoms.

Freeware
Freeware is fully functional software that can be used without any type of payment. Freeware should not be confused with open source software, since it may still be proprietary and offer no access to the source code.

G

G-cloud (Government cloud)
A government cloud is a private cloud in which all services and resources are used by a local or national government. A government cloud may be internal (if the infrastructures belong to the government itself) or external (if the infrastructures are owned by an external provider).

L

Long Tail, The
A term coined by the journalist, writer and lecturer Chris Anderson, which refers to the way in which by centralising stock and reducing distribution costs, companies can obtain a significant profit by selling small quantities of products that have a small market share and are of little interest to traditional distribution channels.

O

Open Source
The term open source describes production and development practices that promote access to the source material of the final product. The term was first widely used with the coming of the Internet and involves a pragmatic methodology for developing software that enables access to the source code of the programs distributed.

P

Pay-per-use
Pay-per-use is a tariff system under which the customer pays a services provider only for the actual utilisation of the service. This system is used for pricing services such as telephony, electricity and water. This means that customers pay a variable rate that is proportional to their consumption of the resource.

Platform as a Service (PaaS)
Platform as a Service (PaaS) consists of the distribution of all the tools and software needed for the design, development, testing and implementation of applications, on the same basis as any service. The tools are not installed on the user's terminal but reside instead on the provider's servers. The user accesses them over an Internet connection. These services are intended for developing applications on distributed equipment.

Process as a Service (PaaS)
PaaS is based on external, start-to-finish Internet-operated management of a business process, such as complaints, or management of spending and procurement. The system arose out of a combination of business process outsourcing (BPO) and process-oriented software, i.e. software developed to provide businesses with complete solutions.

S

Service Level Agreements (SLAs)
A service level agreement (SLA) is a negotiated agreement between a customer and a services provider. It can take the form of a formal legally binding contract or an informal agreement between the parties. It sets out a common understanding on service quality, covering aspects such as response time and hourly availability. Generally, the service quality is specified in terms of target and minimum service levels.

SMEs (Small and Medium-sized Enterprises)
There is no universal definition of Small and Medium-sized Enterprises and the term is interpreted differently in each country. In its 2003 recommendations, the European Commission gives the following guidelines:

- **Medium-sized enterprise:** An enterprise which employs fewer than 250 persons, whose annual turnover does not exceed 50 million euro and whose balance sheet total does not exceed 43 million euro.
- **Small enterprise:** An enterprise which employs fewer than 50 persons and whose annual turnover or annual balance sheet total does not exceed 10 million euro.
- **Micro enterprise:** an enterprise which employs fewer than 10 persons, whose annual turnover does not exceed 5 million euro and whose balance sheet total does not exceed 2 million euro.

Needless to say, if a company meets more than one of these classifications, it is the most restrictive one that applies. Under the Commission's recommendation, any company that meets one of these three classifications should be classed as an SME.

Software as a Service (SaaS)
Software as a service (SaaS) is a utilisation system that provides access to software and its functions as a web-based service, charged on a pay-per-use basis. SaaS allows organisations access to business functions at a lower cost, without needing to invest in major technological developments. Given that the software is housed remotely, users do not have to invest in additional hardware for the new application. SaaS eliminates the need for installation, commissioning, conservation and maintenance.

Spin-off
A spin-off is a company created out of the separation of part of the business of a parent company, which then sets up as a separate company. The shareholders of the parent company receive a proportional stake in the new company, thus becoming its initial owners.

Start-up
A start-up is a company in the initial stages of development, generally before it has any established flow of revenue.

T

Technological lock-in
This term is used to describe situations in which there is a lack of compatibility between different providers' technologies, with the result that a customer using one provider's technology needs to spend large amounts to switch to another. The result is that the customer is tied to its provider's technology and the high changeover costs deter them from switching.

Time-to-market
Time-to-market is the period of time from when a product is conceived as an idea until it becomes available for sale to customers. Time-to-market is important in industries with ephemeral products, such as software. In the context of cloud computing, it refers to the time taken from the conception of the idea of a service until it becomes accessible to consumers over the Internet.

U

Utility computing
Supply of computer resources –for example, processing and storage– measured as a service, in the same way as traditional utilities (electricity, water, gas and telephony). In this model the computing resources are essentially rented out and are owned by the utility computing provider, never the customer.

V

Virtualization
Virtualization is a way of dividing a physical server up into a large number of "virtual" servers, giving each one the appearance and capacity to function on its own dedicated machine. Each virtual server operates as a fully-operative server and may be rebooted independently. This makes it possible to balance the physical resources between the virtual servers depending on the demand for each one.

Virtual server
A virtual server is a fully operative reproduction of a physical server which has no dedicated computing resources, instead sharing them with other virtual servers in a process known as "virtualization".

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