
Chapter 3

Computer clouds are coming

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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 2012¹. 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?

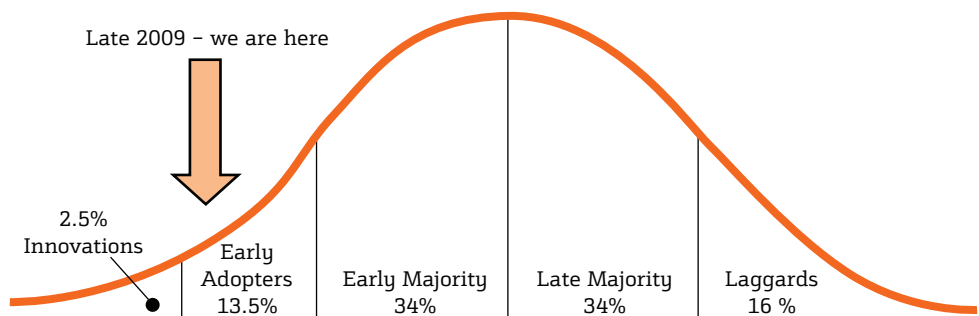
So why now? Why is everyone suddenly talking about the cloud as an increasingly tangible reality? People often refer to cloud computing as "the fifth generation" following the mainframe, the PC, the client-server system and the World Wide Web. With this long (in terms less of years than of progress achieved) 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.

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

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

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 adoption⁵. 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 existence⁶. The US National Institute of Standards and Technology (NIST) covers all its bases before offering its 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 interaction⁷.

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 providers⁹ 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 rPath¹¹, 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 warranty, 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 to 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 or 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 public¹². 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 is 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/ToKnowAboutCloudComputing.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 location¹³.

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 customer¹⁴.

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 recovery¹⁵. Universities as important as Harvard are now including specific courses on cloud computing as part of their educational offering¹⁶.

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 operate¹⁷. [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>.