Cloud Computing: evolution or revolution?

Sara Bedin
Independent Expert in the field of innovation policies - Executive Director of EuroCloud Italy in charge of EU projects and relations with Public Administration

Wladimiro Bedin
Expert in the field of cloud computing Vice-President of EuroCloud Italy

Profile
Sara Bedin, graduated in Economics at the Bocconi University in Milan. Her key achievements and competencies concern the design and evaluation of innovation support policies. Her distinctive specialization concern innovation management process and public expenditure optimization, via public procurement. She has been working since 2007 to introduce the European innovation procurement models within the existing Italian regulations and she has supported, as independent expert, the Italian Government (MIUR and MISE) to carry out pre-commercial public procurement strategy within the broader reform plan of incentives for applied research and innovation. She has assisted and actively supported major European public sector entities for the concrete implementation of innovation strategies and policies (in education, transport, health-care, construction sectors) and she’s the Lombardy Region advisor for the implementation of the innovation procurement strategy in the health-care and cloud computing domain and for the design of new financing/implementation instruments of the “Lombardy Digital Agenda”. She conducts economic research on demand-side innovation policy, cooperating with many universities and multi-disciplinary training programme targeted at departmental heads and procurement staff of primary EU public authorities and public company. She is a principal expert, in the public sector, for a leading Italian consultancy firm. She is an executive board member of EURO Cloud Italy with the responsibility of relations with the public administrations, universities and European projects. She’s an independent expert for European Commission on innovation procurement. She’s the chairman of the INAF external advisory board for innovation strategies and technology transfer.

Wladimiro Bedin, graduated in Electronic Engineering from Padova University (Italy) and Master in Business Administration from CUOA – Vicenza – Italy, after a research work at KDD – Tokyo – Japan and an experience in Retail business, founded in 1989 BEDIN Shop Systems, a company focused on innovative software for Retail Stores. The company was the first in 2002 to deliver a Point Of Sale (POS) software based on .NET technology and XML asynchronous messages for Back Store integration. In 2007 he co-authored with Microsoft the white paper “An overview of Software as a Service in Retail” that opened a new way. In 2010 was released aKite, the first POS and InStore SaaS designed to leverage the power of a modern PaaS (Platform as a Service). In 2011 at Microsoft World Partner Conference in Washington, aKite was declared one of the best example of Cloud Computing and in Rome got the prestigious National Innovation Award from the hands of Italian Republic President. In 2009 he Co-founded EuroCloud Italy, a non-profit organization among Cloud Computing professionals and companies, part of EuroCloud Europe, based in Luxemburg. He had been invited to several national and international events to speak about Cloud Computing.
Cloud Computing: evolution or revolution?

Cloud Computing is becoming the core system for emerging enterprises, whatever the sector in which they operate. It is the “driving force” on which relying product innovation and/or business model. If we consider the IT sector, even more so, investments should be growing since Cloud Computing is both the terminus of an era and the start of a new one. The vast majority does not seem to understand this second and crucial aspect, for we have a tendency to interpret innovations according to deeply rooted paradigms, which facilitates the vision of the evolutionary aspects and makes the discovery of the revolutionary ones more difficult.

In order for us to see the revolutionary aspects of Cloud Computing, which are ongoing and pretty much unpredictable, we can go back a hundred year when electricity became the main power source in industry. What appeared to be merely a simple introduction of a new form of energy, with its advantages and disadvantages, changed the course of history and together with chemistry acted as the catalyst for the Second Industrial Revolution.

An historical comparison

In the late nineteenth and the early twentieth century factories were narrow, long buildings on multiple floors, as we can now see in some industrial archeology finds. At one end of the construction there was the energy source, a water or steam turbine, connected to a big vertical shaft that distributed power across the floors by a system of gears and horizontal shafts. The speed variation was determined by pulleys of different diameters.

The flow of work around the factory was governed by the need to put certain machines close to the central power source thus avoiding an excessive torsion of the shafts. At the turn of the twentieth century, when the first electric dynamos were introduced in factories, it was possible for first time to physically separate production and utilization of energy. Factory from then on were designed on a single horizontal floor. The Venetian hemp factory in Cornuda (Treviso, Northern Italy), established in 1883, is an early, if not the first, example in the world of a factory designed in function of electrical power.

Back then, problems in the transmission of direct current over long distances meant that every factory had to have its own power station, but soon the passage to alternating current and the expansion of power distribution networks made it possible to separate production form consumption. Soon after, every machine had its own motor, a huge improvement in terms of work speed and regulation. Production lines were arranged to enable a smooth work flow of materials around now cheaper single-floor factories.

Afterwards, the productivity increased, the costs for power and constructing new factories were cut down, work conditions improved. Such factors led to such a profound social change that later it was called “The Second Industrial Revolution”. Because of the entailed change of paradigm was so extreme, the effects unfolded only after several decades.
We can now begin to outline the analogy with the Cloud Computing revolution. Today the exchange of information is guaranteed like with previous telephone networks, but the public network (the Internet) also allows the separation of production and management of IT services from their utilization. A new generation of software provides IT services to a wide range of different users with significant economies of scale. Compared to the local servers and datacenter of every enterprise, the aggregation in wider and dynamically shared structures allows a medium level of utilization of platforms, thanks to the statistic balance of workloads on large numbers.

By the way, back to the nineteenth century, on opening day the owners of the mentioned Venetian hemp factory invited the whole city to take a tour of the plant because they were hoping to find clients for their power station, which on closing hours and weekends would otherwise remain unused.

Once again the analogy with the early stages of electricity in factories will help us to understand the current situation of Cloud Computing.

First of all we have to put into account the habitual skepticism towards changes. At that time steam engines were the dominant source of power, and the supremacy of mechanical engineering was undisputed, no matter its transmission limitations. The idea of a single-floor factory with as many motors as machineries was unthinkable. Electricity was not widespread in factories and even though some choices could sound obvious to us, they certainly were not so back then.

To remember how well-established visions might prevent us from recognizing the value of innovative aspects, is worth mentioning the so-called “War of Currents”. In the late 1880s, the scientists T. A. Edison and N. Tesla once allies, engaged in a battle over different technologies, one of different visions of the future, the latter being supported by the American entrepreneur G. Westinghouse. Edison who indeed was a brilliant man, was not however able to see the advantages of the alternating-current system, or sending power over long distances. He envisioned a power generator for every factory or community, while Tesla was in favor of fewer, larger generating plants located in suitable areas such as rivers’ banks for hydroelectricity and so on. Tesla’s patents for alternate current motors contributed to equip machinery with its own motor.

In 1882 Edison opened the first electrical power plant in New York City for delivering electricity to houses, the same year another plant opened in London and the following year also in Milan. The event was celebrated by illuminating La Scala Theatre the day after Christmas, in 1883. The plant and its chimney were not far from the theatre and the Cathedral, due to the limitation in the transmission. Coal was used since the age of steam engines as the only source of energy that could be brought to densely populated areas. Edison’s evolutionary view (to transform the market of illumination, adopting steam power) prevented him from sensing the verge of the Second Industrial Revolution.

Many agree on the fact that Cloud Computing is a key element for the Third Industrial Revolution.
Cloud Computing characteristics according to the NIST

Now let’s go through the new Cloud Computing paradigms, starting from the authoritative definition coined by the NIST (National Institute of Standards and Technology).

The first characteristic is the **Self-service**, which requires investments by the service provider thus ensuring comfort to the user and, in the medium term, lower costs for everybody. The traditional Hosting of software applications or the server rent in a datacenter do not satisfy this characteristic.

The second main feature is the **wide network access**, often interpreted as broadband necessity, but actually linked to distribution and consumption of Cloud’s services, so as to facilitate and increase utilization by most users and diversified systems. It can be compared to electricity standards for voltage and distribution frequency and sockets or plugs. NIST do not specify a specific technology, because in the future it may change, but currently these technologies are represented by the APIs (Application Programming Interfaces) based on standard SOAP and REST Web Services and which can be used regardless of the operating system and location. In traditional IT, information users are generally employees of an enterprise or institution and sharing data outside the company is seen as a risk rather than an opportunity. One of the most qualifying aspects of Cloud’s paradigm change is to switch from closed systems to those open to “by design” collaboration.

Open-system information technology allows a reduction in collaboration costs. Another equally important aspect is mobile working through Tablets and Smartphones. Moreover, value extraction from data may become a new form of wealth since Cloud technologies, such as Big Data, permit to do it at lower costs and sometimes for goals not initially foreseen (consider, for example, mobility monitoring in “smart cities” by exploiting data from mobiles’ repeater change).

The third basic Cloud Computing characteristic is **resources’ dynamic sharing**, both hardware and software, among different users and also known as **multi-tenancy**. Concerning the software, this has important effects on the service quality because the number of users who test its most hidden aspects is increased and updates are completely automatic, therefore immediate. For the first time ever small users can use the same software of big enterprises paying according to the number of users, without any initial investment. Before SaaS services designed for Cloud SMEs, which are the majority of the European economic fabric, had to settle for limited and inadequate software.

With regard to hardware resources, the strong sharing among different users facilitates the growth in the utilization rate of systems thanks to the statistic compensation inherent in large numbers. Few users exercise a very variable short time load. To meet peak demand it is therefore necessary to pay for resources which remain partially unused. Obviously, with the growth of users’ number the average level of utilization grows too, but the variation percentage is reduced because the peak of some users alternates with other users’ inactivity. In this situation, Cloud’s scale-out techniques, that is to say the dynamic distribution of work among several commodity machines, allow to use a number of machines proportional to the average load and release them when no longer necessary, such as during certain hours of the day or even more during the night. The efficiency of Public Cloud with hundreds of thousands servers used simultaneously by million users is due to the fact
that servers which are no longer necessary for an application are released to a pool of available resources and used in another sector with different time trends or other time zones, therefore increasing the utilization rate of systems and reducing the unit cost. Private Cloud is not able to reach these levels of system utilization because the number of users and their variety is lower. Public Cloud has also additional scale economy such as the energy cost, the systems’ purchase and management costs.

**Quick elasticity** is the fourth essential feature and is the possibility of acquiring and releasing resources within minutes. It is fully complementary to multi-tenancy and scale-out, but these characteristics need a new software design. The “legacy” software, even if hosted in a Cloud’s infrastructure (IaaS from Infrastructure as a Service), is generally designed for working on single servers which need to be more powerful in order to manage more users, in a “scale-up” approach. This method has often insurmountable scalability limits (impossibility to exceed a certain number of users sharing the same data) and even in the case of a variable number of machines, the adaptation to the workload would be in any case more discontinuous and less efficient.

Dynamic resources sharing and multi-tenancy offers unthinkable efficiency compared to a traditional approach (even if hosted in Public Cloud). Multi-tenant software can be suited to different users’ needs through user-friendly configurations and options, without the need of technical support, which on the one hand facilitate the startup and reduce costs, but on the other hand reduce freedom degree. The classic single-tenant approach, instead, where all the users of the same organization share the same customizations (code expressly written and inserted in a common base), has a wider freedom, but with longer startup times and higher costs and, sometimes, without achieving the expected results. Furthermore, customizations often bring to a lock-in situation where it is practically impossible to access to new versions of the same basic software.

Technical evolution imposes some constraints as choosing between configured standard software or customized legacy software. The balance is usually largely positive for the first and, in any case, this will be the new normal.

The fifth characteristic is the **measurability** of each individual resource to monitor its costs and optimize its use.

**New Cloud-enabled possibilities**

Technological innovations allow doing more with less and the common tendency is to keep working as before at lower costs instead of discovering new business opportunities.

Let’s analyze some discontinuities introduced by Cloud with regard to conventional IT in order to highlight new possibilities.

The pay as you go possibility with immediate access hardware and software resources opens the doors to fast and cheap **experimentation**.

The **agility** given by an easily accessible and integrated IT on demand allows to quickly follow market and users evolutions (already on Cloud with their Tablets and Smartphones) and to use more and more innovative services available from a new Cloud **ecosystem**. For the first time the
creation of a custom-made business system is possible by integrating standard services provided by several enterprises. The comparison with Lego bricks could help mentally represent this characteristic. When market conditions change, it is possible to change one or more components without touching the others. By contrast, the evolution of big monolithic applications is subject to the designer’s decisions, provided that customizations done by the user on previous versions do not prevent this limited evolution too.

Natural data sharing and easy collaboration both inside and outside the company or entity is another Cloud paradigm. In some cases the data availability from outside the company could create significant value. Just think of package tracking by logistics operators, which is initially managed within the company but now available to customers who by themselves can follow the journey of their package in real time, with service improvement and reduction of call-center costs. As already mentioned, increasing globalization and specialization force to work closely, sometimes even with competitors.

Software applications sharing among several independent users (multi-tenancy) allows not only an improvement according to explicit warnings of a wider audience, but also to act proactively on the basis of huge volumes of data collected on utilization methods, analyzed with Big Data and Predictive Analytics techniques which have been made practical and accessible only with Cloud Computing. These techniques have been developed on the scale-out principle, namely the use of a large number of standard machines for a certain period of time. In order to process a large number of data, traditional techniques requested very powerful machines or long times. With Cloud-designed software, 600 machines can give in 1 minute the same result that one machine by itself can give in 10 hours, at the same cost of 600 minutes per machine and with intrinsic insensitivity to faults inherent in scale-out techniques, and therefore with a higher service level.

In other words, Cloud allows extracting value from raw data in a way that was impossible before and with a radical paradigm shift that calls into question even the western science philosophy based, since the times of Galileo Galilei, on theory and experimental verification. The most advanced aim of Big Data is to find correlations between cause and effect according to the volume rather than accuracy of any single datum and without asking for the reason, which would require the definition of a model or theory. Focusing on data volume and automatic algorithms allowed Google won the battle of the search engines.

Even Internet of Things, available since the Internet development, is an accessible reality at affordable costs only with Cloud Computing. The huge band available in Public Cloud allows collecting large volumes of data from many locations at once, storing them at affordable prices and processing them immediately with Big Data techniques without the need to transfer them elsewhere. Doing the same things in a traditional datacenter or with a more modern private Cloud could be too expensive or even impossible.

Making everyday life objects more intelligent and managed by Cloud Computing allows transforming consolidated industries switching from the concept of product to that of service, which is much more effective in terms of customer satisfaction and environmental impact reduction. Google’s acquisition of Nest smart thermostats manufacturer is an example of this trend.
Cloud and SMEs

It is clear how SMEs are the enterprises that, by using services ready for their needs in the form of SaaS (Software as Service) provided by Cloud, mostly gain from this revolution. Big enterprises have IT departments which invest and implement what is necessary to achieve the business objectives and absorb more easily any inefficiency due to more traditional technologies. With regard to SMEs, Cloud could be the difference between progress and deadlock, whereas for a big enterprise it is essentially a matter of greater or lesser efficiency.

The possibility to use a new Cloud service without initial investments, in a short time and without heavy legacy constraints rewards the flexibility and inventiveness of many SMEs, but unfortunately the awareness of Cloud benefits is lower in SMEs than among large firms which can spend more in terms of technical evolution. Sellers are very happy to spread their “scientific information” to large companies that at least leads to some evolution in CIOs vision.

IT sector SMEs have the opportunity to build and provide services also abroad without investing in infrastructures. By building on existing infrastructures and platforms it is possible to provide services which are scalable, open and economically sustainable.

The problem of this delayed awareness is particularly acute in Europe, where the majority of the economic output and employment is generated by SMEs.