

Cloud computing: a new horizon

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The outlook is bleak for laptops, hard drives and desktops - clouds are on the horizon and could change the way we use computers forever. For some, the 'cloud' is just the latest technological craze, but for others it is the future of computing, and it has already generated a large body of research literature. What seems certain is that cloud computing has the potential to bring about irreversible changes in the way computers are used around the world.

Jordi Torres, coordinator of the Cloud Computing (CC) research team at the UPC, which works under the supervision of the High Performance Computing Group, is in New York to attend a conference. Before leaving his hotel, he opens his laptop, updates his Facebook status, checks his Gmail account to see if he has received an important message he has been expecting, and even has time to look over a spreadsheet used

by his team at the UPC to manage one of the European research projects in which they are participating. Nothing out of the ordinary, you might think, but there is one important difference: the software and applications he uses are not installed on his computer, they are in a cloud.

In general terms, cloud computing can be described as a web architecture that allows users to work and save information online. David Carrera, one of the directors of the CC team, offers this explanation: “The aim is to move all of the applications installed on our computers to a remote location.” In other words, to do away with a number of standard components, including operating systems and hard disks, and make them accessible through an online desktop accessed via a standard browser.

With the introduction of the cloud, traditional desktops will become obsolete, programs will no longer need to be installed, and Jordi Torres may never have to take his laptop to New York again: “He will be able to rent a computer on Fifth Avenue, just like renting a car, and use it to connect to all of the data he’s working with in Barcelona”, explains Ricard Gavaldà, a lecturer in the Department of Software at the UPC.

The CC research team has examined the potential applications of cloud computing since the idea was first introduced. David Carrera, together with other researchers including the lecturer Eduard Ayguadé, dedicates much of his work to the production of components for a cutting-edge product marketed by IBM. As he explains, “the ultimate aim of cloud computing will be to mix and manage applications intelligently: for example, to create software that monitors the response of a machine or appliance in real time and controls its power supply, which would optimize energy consumption and save companies money”.

The CC team is also researching systems for coordinating the thousands of terminals and nodes that make up the cloud, which is one of the

principal concerns of companies in the IT sector. Carrera explains that, “one of our lines of research focuses on how we can use programs to determine how applications can be configured in the future”. In the opinion of Ricard Gavaldà, the real magic of cloud computing lies in the automatic and intelligent management of the software and hardware used by thousands of computers: “By applying artificial intelligence to the cloud, we are hoping to develop a system through which computers can manage themselves”. This is known as ‘autonomic computing’, and is one of the lines of research carried out jointly by the Cloud Computing and High Performance Computing groups.

Jordi Guitart, a director of the Cloud Computing group, and researchers from the Barcelona Supercomputing Center (BSC-CNS), take part in various research projects at the European level, including the GRID Superscalar project, directed by Rosa M. Badia. Under the SORMA (Self-Organizing ICT Resource Management) project, the teams create economic algorithms to “give customers in the Internet resources market the tools to optimize the efficiency of their decisions, and to give providers the tools to maximize profits with the use of minimal resources”, says Guitart, who explains that, “our current research focuses on intelligence, energy saving and quality of virtual services”.

‘Virtualization’, ‘utility computing’ and ‘software as a service’ (SaaS) are key concepts in understanding the potential of the cloud. Their basic function is to create multiple virtual machines within a single physical computer to make it more efficient. Amazon EC2 is one of the leading companies in this field. Carrera explains that, “It's like three passengers sharing a taxi but not knowing that they're sitting next to one another: you effectively get three times the service but only need the energy for one journey”.

Utility computing is the provision of computational resources, such as processing or storage, as if they were traditional public utilities

(electricity, water and gas). The advantage of this system is its low cost, as the hardware required is extremely cheap and the resources themselves are essentially rented. SaaS has similar advantages, as Carerra explains: “It is a system of selling software as a service. It is not the same as what we do now - for example, download from Microsoft, pay the license and own the software. It's a user service”.

“The cloud computing phenomenon is more than just another technological fad - it combines the benefits of outsourcing and pay-per-use and provides companies with a springboard for further innovation”, explains Jordi Torres. It will also have a significant impact on the business sector and the wider community, although its specific repercussions in Catalonia are yet to be seen. While some companies are already working in this field, such as eyeOS and Abiquo, many others in the ICT sector will clearly have to adjust their business strategies to accommodate such far-reaching changes. “The industrialization of ICTs is unstoppable, and a lot of companies will close their data processing centers and manage their ICT systems remotely via processing megacenters, which will compete only on the price of energy, as hardware is becoming cheaper all the time”, says Torres.

These are some of the areas studied by the fifteen UPC researchers in the Cloud Computing team, who work closely with researchers at the BSC-CNS. The group is close to announcing the completion of its new cloud environment, Emotive Cloud-Barcelona, which has been designed specifically for the research sector.

A storm on the horizon

Despite its potential, cloud computing continues to raise doubts among personal and business users. To take a recent example, on 24 February of this year, the work of millions of people around the world was interrupted when they were unable to access any of the applications

offered by GoogleAps, the most popular of which is its e-mail service Gmail.

Servers operated by the American firm, which are used to save important documents such as doctoral theses and business contracts, simply stopped working, and not for the first time, prompting debate on whether it is really worth storing sensitive material on a virtual support if we cannot be sure where our information is, who controls it, and who may be able to access it. Concerns over the privacy and confidentiality of information are potential hurdles to the widespread introduction of [cloud computing](#) networks.

In addition, for political reasons some countries will not allow certain information to be stored outside their borders. “Although a range of solutions already exists and wider use of cloud architecture appears to be inevitable, there are still several obstacles”, says Torres, “but that gives us the opportunity to carry out cutting-edge research”.

Green computing

'Green computing' is a discipline that looks at how to make efficient use of ICTs and minimize their environmental impact. Sustainability has become a major concern in recent years, as it is now calculated that CO₂ emissions derived from these technologies account for 2% of the total pollution of this type, which is the same proportion produced by airplanes. However, as Jordi Torres explains, "The problem is that the increase in energy requirements is exponential, and there are no signs of a change in this trend". Computers already consume a huge amount of energy and the figure doubles every few years, which could ultimately strain the supply to breaking point.

The UPC “wants to contribute to reducing the number of computers individuals and companies need to do their work”, explains Gavaldà,

adding that, “from a scientific perspective, this is an interesting development, but it will only be effective if companies realize that energy is expensive and needs to be used more sparingly”.

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