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# Making use of cloud computing for healthcare provision: Opportunities and challenges

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ABSTRACT

Cloud or utility computing is an emerging new computing paradigm designed to deliver numerous computing services through networked media such as the Web. This approach offers several advantages to potential users such as "metered" use (i.e., pay-as-you-go) which offers scalability, online delivery of software and virtual hardware services (e.g., collaboration programmes, virtual servers, virtual storage devices) which would enable organizations to obviate the need to own, maintain and update their software and hardware infrastructures. The flexibility of this emerging computing service has opened many possibilities for organizations that did not exist before. Among those organizations are those engaged in healthcare provision. The aim of this article is to shed some light on this development and explore the potential (and future) of cloud computing in contributing to the advancement of healthcare provision. A small case study will also be presented and discussed.



## 1. Introduction and methodology

When it emerged in 2007, many people, including eminent IT professionals such as Larry Ellison (founder of Oracle) and Richard Stallman (creator of the GNU operating system and founder of the Free Software Foundation), doubted if this new ICT service delivery will have a future. But cloud computing continued to attract many followers. Many of the organizations that saw benefit in this new method of delivering of ICT services (and subscribed to it) were SMEs and/or educational establishments (Sultan, 2010, 2011). With time, an increasing number of large organizations began to see merit in cloud computing and use it and acknowledge its usefulness for their operations (Sultan, 2010). Interestingly, cloud computing is being considered by industries whose operations could have great implications for the well-being of society. Industries such as pharmaceutical and medical research organizations and healthcare establishments engaged in the business of finding cures for humanity's major illnesses and helping patients are among the latest customers to test and experience the potential advantages of this new innovation. In this article the discussion will be limited to the contribution of cloud computing healthcare provision. To explore this phenomenon, some examples (drawn from current literature) on the use of cloud computing by such industries involved in healthcare provision will be provided. Moreover, a small and limited case study based on a major e-Health pilot project at a London hospital (Chelsea and Westminster) to test – through a simulator – the operational efficiencies and advantages (for potential patients and their relatives) of using cloud computing will be presented. The case study involved interviews and email exchanges with two individuals who had significant involvement in the implementation of this project. A definition of cloud computing and a description of the services it offers and some background history relating to the provision of similar services in the past will also be provided as a prelude to the discussion.

## 2. Cloud computing: definition

The term "cloud" is often described as a metaphor for the Internet (which is commonly illustrated as cloud drawings in many ICT textbooks). Some people, however, ascribe the name to Google's CEO (Eric Schmidt) who, in a 2006 conference, was said to have called the new emerging ICT service model "cloud computing" (Regalado, 2011).

Seeking a definition for cloud computing is bound to come across a range of suggested interpretations depending on who you speak to. A simple Google search for cloud computing is likely to reveal a stream of definitions. According to some authors (Grossman, 2009; Voas & Zhang, 2009) there seems to be no common standard or definition for cloud computing. A study conducted by McKinsey (the global management consulting firm) found 22 definitions for cloud computing (Katz, Goldstein, & Yanosky, 2010). However, it is probably safe to define it as a modality that uses advances in ICT technologies such as virtualization and grid computing for remotely delivering a range of services, e.g., software and virtual hardware

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(as opposed to physical) provisioned (by data centres owned and operated by cloud providers and/or end users) according to user demands and through public (e.g., Internet), private networks or a mix (i.e., hybrid) of the two delivery modes. The provided ICT services include:

- business-related computer programs (software as a service – SaaS);
- fast and almost unlimited processing capabilities and large and almost unlimited storage facilities (infrastructure as a service – IaaS);
- development tools and hosting options for clients preferring to create and manage their own Web applications (platform as a service – PaaS).

Cloud computing services can be provided by cloud vendors through their data centres (public clouds) and end users (i.e., client organizations) using cloud software installed on their own data centres (private clouds) or installed on their own (and other cloud vendors') data centres (hybrid clouds). A new type of cloud computing service (community clouds) is also touted as another possible addition to the other modes of cloud-based ICT delivery. In community clouds, cloud services can be provided (often by one organization) and consumed by groups of organizations in businesses or professions similar to that of the providing organization. Currently, there are little examples to demonstrate the viability of this approach.

Two of the most fundamental technologies that underpin could computing are virtualization and grid computing. Virtualization is a technology that masks the physical characteristics of computing resources (e.g., a PC, a Server) in order to simplify the way in which other systems, applications, or end users interact with them. For example, a PC that is running Windows (the host operating system) and using virtualization software can also run Linux (as a guest operating system). Furthermore, the technology also enables single physical resources (e.g., a server, an operating system, an application, or storage device) appear as multiple logical resources.

Grid computing, involves the use of software to combine the computational power of many different (and possibly geographically dispersed) computers, connected in a grid, in order to solve a single problem, often one that requires a great deal of computer processing power. Furthermore, grid computing also uses software that can divide and farm out pieces of a programme to as many as several thousand computers. Grid technology, therefore, can be thought of as the technology that enables the establishment of network-distributed parallel processing and distributed and large-scale cluster computing.

## 3. Precursors of cloud computing

Interestingly, the notion of providing software as a service (SaaS) is not a new ICT practice. In fact, it predates the emergence of computers themselves. In the 1930s some companies (such as IBM) specialized in producing electric accounting machines based on punch-cards and were able to offer data processing services (e.g., payrolls) to organizations. Providers of such services operated many 'service bureaus' where customers would bring their data for processing in return for a fee. Organizations that were unable to purchase those data processing equipment found it economically viable to pay for those services. Then came mainframe computers in the 1950s and 1960s which continued this practice that became known as 'timesharing'. Organizations that were unable to afford buying mainframes computers would rent the data processing functionality of those machines from a number of providers. Connection to mainframes was achieved through a normal telephone line connecting those massive machines and 'teletypes', replaced afterwards with better visual display machines, at the clients' end. Mainframes were later followed by personal computers which effectively killed timesharing due to their affordability and also the flexibility of the software used on them. Campbell-Kelly (2009) argues that the very things that killed the timesharing industry in the 1980s have reversed in that computing infrastructure has become increasingly complex and expensive to maintain due, for example, to issues relating to security and constant software upgrades thus making cloud computing a more economically viable alternative. One analyst called cloud computing 'timesharing 2.0' in reference to the old practice of buying computing resources on demand (Campbell, 2009).

However, despite the popularity of personal computers, a form of utility computing still existed. Many software providers, known as Application Service Providers (ASPs), emerged in the 1990s to provide organizations with software as a service via the "new" medium of the Internet. These early attempts at "utility computing" did not prove to be popular. There were two main reasons for this. First, most of the software offered by those providers was proprietary, which meant organizations using this type of service cannot change providers very easily, i.e., they were vendor-locked. Second, lack of sufficient bandwidth was another problem. During the 1990s broadband was neither cheap nor plentiful enough to deliver computing services with the required speed and reliability (Carr, 2009).

The idea of delivering software remotely took a new turn with the emergence of cloud computing. Not only can software be consumed remotely, it can also be consumed as and when needed through a pay-as-you-go cost structure. Furthermore, cloud computing, as explained above, is also able to deliver many other ICT services.

Despite the flexibility of cloud computing, it should not be assumed that cloud products offered by any of the above services are likely to work out-of-the-box (i.e., they are not purely plug-and-play). In some cases they might. Messaging and collaboration cloud products such as Google Apps are perhaps examples of those out-of-the-box products, even though they still require some level of configuration nevertheless. Some degree of development (i.e., programming) will be required through the use of the cloud providers' APIs (application programming interfaces).[1] These are the programming instructions created and offered by the cloud service providers to those who want to access the functionality of their products. Currently, many of those APIs are proprietary. This is an issue which will be explored later when examining some of the limitations and concerns of cloud computing.

However, the notion of providing a wide range ICT-related services when required and on a pay-as-you-go basis opens many opportunities for the providers of those services to exploit this expanding market which, according to Forrester (the independent technology and market research company) is expected to increase from US$ 41 billion in 2011 to US$ 241 billion in 2020 (Wall Street Journal, 2011). At the same time, it increases the options available to policy makers entrusted with the job of ensuring the efficient functioning of their organization's IT resources. On that basis, cloud computing probably represents a paradigm shift in the way IT, in its all aspects, is being viewed by commoditising it in a manner that was not possible before (Sultan, 2010).

[1] The programming instructions provided by software vendors to enable software developers create applications that can interact with their software.