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Cloud computing — The business perspective ☆

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ABSTRACT

The evolution of cloud computing over the past few years is potentially one of the major advances in the history of computing. However, if cloud computing is to achieve its potential, there needs to be a clear understanding of the various issues involved, both from the perspectives of the providers and the consumers of the technology. While a lot of research is currently taking place in the technology itself, there is an equally urgent need for understanding the business-related issues surrounding cloud computing. In this article, we identify the strengths, weaknesses, opportunities and threats for the cloud computing industry. We then identify the various issues that will affect the different stakeholders of cloud computing. We also issue a set of recommendations for the practitioners who will provide and manage this technology. For IS researchers, we outline the different areas of research that need attention so that we are in a position to advice the industry in the years to come. Finally, we outline some of the key issues facing governmental agencies who, due to the unique nature of the technology, will have to become intimately involved in the regulation of cloud computing.

1. Introduction

The emergence of the phenomenon commonly known as cloud computing represents a fundamental change in the way information technology (IT) services are invented, developed, deployed, scaled, updated, maintained and paid for. Computing as we know today reflects a paradox — on one hand, computers continue to become exponentially more powerful and the per-unit cost of computing continues to fall rapidly, so much so that computing power per se is nowadays considered to be largely a commodity [24,32]. On the other hand, as computing becomes more pervasive within the organization, the increasing complexity of managing the whole infrastructure of disparate information architectures and distributed data and software has made computing more expensive than ever before to an organization [42]. The promise of cloud computing is to deliver all the functionality of existing information technology services (and in fact enable new functionalities that are hitherto infeasible) even as it dramatically reduces the upfront costs of computing that deter many organizations from deploying many cutting-edge IT services [46]. All such promise has led to lofty expectations — Gartner Research expects cloud computing to be a $150 billion business by 2014, and according to AMI partners, small and medium businesses are expected to spend over $100 billion on cloud computing by 2014.

The impetus for change right now is seen predominantly from a costs perspective (even though, as we discuss later in the document, the promises from a technological functionality perspective are equally attractive), as organizations increasingly discover that their substantial capital investments in information technology are often grossly underutilized. One recent survey of six corporate data centers found that most of the servers were using just 10–30% of their available computing power, while desktop computers have an average capacity utilization of less than 5% [51]. Equally pertinent are the maintenance and service costs that have proved to be a drain on scarce corporate resources. A recently conducted survey by Gartner Research indicated that about two-thirds of the average corporate IT staffing budget goes towards routine support and maintenance activities [21], which does seem anachronistic in an age of globalized

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and cutthroat competition — as the CEO of a cloud platform provider commented recently, "If you woke up this morning and read in The Wall Street Journal that, say, Overstock.com has stopped using UPS and FedEx and the U.S. mail, and had bought fleets of trucks and started leasing airport hubs and delivering products themselves, you would say they were out of their minds. Why is that much more insane than a health care company spending $2 billion a year on information technology?" [30].

Cloud computing represents a convergence of two major trends in information technology — (a) IT efficiency, whereby the power of modern computers is utilized more efficiently through highly scalable hardware and software resources and (b) business agility, whereby IT can be used as a competitive tool through rapid deployment, parallel batch processing, use of compute-intensive business analytics and mobile interactive applications that respond in real time to user requirements [29]. The concept of IT efficiency also embraces the ideas encapsulated in green computing, since not only are the computing resources used more efficiently, but further, the computers can be physically located in geographical areas that have access to cheap electricity while their computing power can be accessed long distances away over the Internet. However, as the term business agility implies, cloud computing is not just about cheap computing — it is also about businesses being able to use computational tools that can be deployed and scaled rapidly, even as it reduces the need for huge upfront investments that characterize enterprise IT setups today.[1]

There are perhaps as many definitions as there are commentators on the subject (including one by the National Institute of Standards and Technology (NIST) that is nearly 800 words long [38]), but none of them seem to identify all the key characteristics of cloud computing. In coming up with our definition, we tried to encapsulate the key benefits of cloud computing from a business perspective as well as its unique features from a technological perspective. Our formal definition of cloud computing is as follows: "It is an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of-service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks." Fig. 1 shows a schematic of the cloud computing model. It shows how the computing resources in the cloud can be accessed from a variety of platforms through the Internet.

We note that our definition does not explicitly require that the services be provided by a third-party, but emphasizes more on the aspects of (1) resource utilization, (2) virtualized physical resources, (3) architecture abstraction, (4) dynamic scalability of resources, (5) elastic and automated self-provisioning of resources, (6) ubiquity (i.e. device and location independence) and (7) the operational expense model. Cloud computing can be provisioned using an organization's own servers, or it can be rented from a cloud provider that takes all the capital risk of owning the infrastructure.

We have several objectives in this article. In the first part (Sections 2 and 3 that follow), we give an overview of the core concepts of cloud computing and its key advantages. The second part of the article starts with Section 4, where we make a case for the need for a roadmap for IS professionals and IS researchers in understanding and evaluating cloud computing. In Section 5, we analyze the strategic

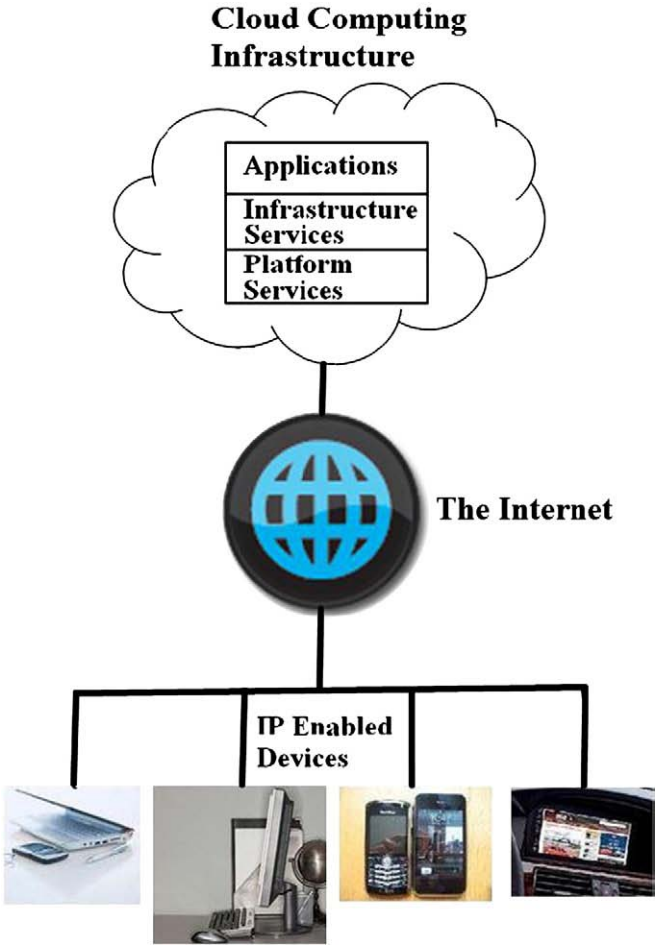

Fig. 1. Cloud computing infrastructure.

imperatives of the cloud computing industry as a whole. The analysis is presented in a SWOT framework, so that we understand both the opportunities and challenges to the fledgling industry. Section 6 introduces the various stakeholders in cloud computing and discusses the relevant issues that they will need to consider. Section 7 discusses the nature as well as the role of the regulatory bodies that oversee cloud computing. Section 8 then assimilates the information from the prior section to come out with two sets of recommendations — one for the practitioners and the other for the researchers in IS in the cloud computing area. The final section concludes with a call to arms to the IS community to start the many relevant discussions on the "business" side of cloud computing.

2. The key advantages of cloud computing

Many of the incipient ideas in cloud computing are not exactly new (in fact, it was as far back as 1965 that Western Union dreamt up the future role of the company as a nationwide "information utility" as part of the company's strategic plans [26]), which have led several observers such as Oracle's CEO Larry Ellison to declare the whole concept as a product of hype [7].[2] While it is true that several of the above ideas were indeed present for a long time, we nonetheless argue that their confluence today in an environment where information can be accessed independent of device and location

[1] An oft-cited example is that of The New York Times, which used 100 Amazon EC2 instances and a Hadoop application to process 4 TB of raw image TIFF data (stored on Amazon S3 servers) into 11 million finished PDF documents in the space of 24 h at a computational cost of about $240 (excluding the sunk bandwidth costs).

[2] Interestingly, Oracle seems to have bought into the hype as it has created its own "Application Grid" system, which allows Oracle databases to be deployed into the Amazon EC2 cloud.