Chapter 11
Cloud as a Computer

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ABSTRACT

The evolution of the cloud as a computer is a very significant milestone in this golden era of computing that changed both the technology and the business model of computing. The cloud has the potential to give access to all possible resources on the Internet using minimal hardware in hand, such as a mobile device with Internet access. This chapter explores the various aspects of cloud computing and makes predictions as to the future directions for research in this area. Some of the issues facing the paradigm shift that cloud computing represents are discussed, and possible solutions presented.

INTRODUCTION

Imagine a computer that can grow or shrink exactly according to your needs, however huge or small they may be; one that can take on any form that you like it to take in terms of the Operating System, machine architectures and other needs; one which can be accessed from virtually anywhere there is network access. To top it all, you don't have to buy it – just pay for how much ever you use. Sounds interesting already? Cloud computing offers all this and much more.

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Cloud computing essentially shifts capital expenditure to operational expenses much like we pay for utilities such as electricity and water. Quite a few startups in the Silicon Valley have setup their shops in the recent times without any infrastructure costs, benefiting from Cloud Computing, instead. The economies of scale that the cloud model helps to leverage are explained in this chapter. The business model that evolved as a result of the paradigm shift in computing is very appealing.

There are a number of technologies behind the cloud landscape. The cloud on the Internet is a gateway to a number of services such as Infrastructure (IaaS), Software (SaaS), Platform (PaaS),

Communications (CaaS) and more recently (Lenk et al. 2009), Humans (HuaaS) and Personalization (Guo et al. 2009). The last service, Personalization is very important in the context of mobile users. A classification of the technologies behind the Everything as a Service (XaaS) paradigm helps understand the cloud better. It is interesting to explore the Cloud ecosystem and get insights into the services that Cloud offers, understanding the myriad technical terms used in the cloud parlance. The literature cited at the end of this chapter has abundant discussion on the tools and example of the services offered.

Cloud computing works best assuming that there are no significant constraints on the bandwidth. However, bandwidth is expensive and could be constrained, particularly since the distances could be huge. Therefore, ideally, there may be a need for writing applications that can adopt to bandwidth and other constraints as applicable in that context. Cloud computing often crosses country boundaries, calling for a need to evaluate and adapt to legal frameworks. Trust and privacy become extremely important in such contexts. In this chapter, we talk about these and other difficulties that Cloud Computing brings with it, explaining some of the challenges and discussing any opportunities that they could be translated into.

The changes happening in the web world are also helping the paradigm shift to Cloud Computing. To the user, the original web was read-only. Web 2.0 made it read-write: WWW became World Wide Wall, where anyone could write. Web 3.0 attempts to make it executable as well, making it the ubiquitous computer. Now that this ubiquitous computer is fully functional, what would be the next avatar of the web? How does the cloud landscape change with developments on the web front? This chapter answers these questions by pointing to future directions for research in this area. The authors predict that the ubiquitous computer will take the same route as the Von Neumann machine and improve drastically in performance and scalability, driven by certain key aspects such as mobility and intelligence.

There is already a discussion on forming virtual cloudlets (Satyanarayanan et al. 2009) to address the issue of response times when using expensive applications on the mobile devices such as augmented reality. This chapter covers these exploratory ideas and present the authors' perspective on them.

BACKGROUND

We have been already using cloud computing whenever we use free e-mail or for that matter do a search on the Internet. Thanks to the levels of transparency that cloud computing provides, the user is unaware of the thousands of clusters working behind the scene for her when an Internet search is done. The same idea of thousands of clusters doing the job transparently is now borrowed into cloud computing. Solving tough problems that involve large data and massive computation has traditionally been a forte of major business houses, such as Google. In fact, most of the Cloud Computing techniques evolved from the technologies used by Google (Chang 2010) and others in this area. This is no longer true with the advent of Cloud Computing. Even startups can enter the fray with minimal investment. The traditional datacenter with thousands of machine clusters typical of the environment in these big companies has transformed into the cloud, open to wider access and use.

In a sense, Cloud Computing takes us back to the days when users "rented" computing time on Mainframes to get their jobs processed. Though there is a distinction between "renting" computing time and "utility computing" that the Cloud represents (Michael et al. 2009), for convenience, we use the term "rent" to mean either. Computing as a utility is not really new. What makes Cloud Computing really interesting now is the all-pervasive Internet and the networking bandwidth