Chapter 18
Cost of Using Cloud Computing: HaaS vs. IaaS

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ABSTRACT

With the recent advancement in computing technologies, business and research applications are not only executed in the traditional systems such as enterprise systems and supercomputers (HPC systems) but also in the cloud. The traditional HPC systems are expensive and sometimes require huge start-up investment, technical and administrative support and job queuing. With the benefits of cloud computing, cloud services such as Infrastructure as a Service (IaaS) and Hardware as a Service (HaaS), enables business, scientists and researchers to run their business and HPC applications in the cloud without upfront investment associated with the traditional infrastructures. Therefore, in this paper we analyze the computational performance and dollar cost of running HPC applications in the cloud when IaaS or HaaS is leased. We find that HaaS significantly reduces the cost of running HPC application in the cloud by 20% compare to IaaS without significant impact to application’s performance. We also found that there is a substantial improvement in computational performance in HaaS compare to IaaS.

INTRODUCTION

With the recent advancement in computing technologies, business and research applications are not only executed in the traditional systems such as enterprise systems and supercomputers but also in the cloud. Cloud computing is a revolutionary computing paradigm for storing data and running applications, including business and computation-intensive applications. It promises numerous benefits, which includes, no upfront investments. Cloud computing also reduces development time, staff (e.g., administrators), and hardware, resulting in better service and significant cost saving.

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In research domain, cloud computing is also considered as a next generation of computing. It has been predicated that it will take a significant advancement in the next decade particularly for enterprise and HPC systems. This is possible due to the cloud computing architecture that provides four layers of services: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS); and Hardware as a Service (HaaS) and price model. Furthermore, the Amazon Elastic Compute Cloud (Amazon EC2) cluster recently appeared in TOP500 list, which shows that there is a great future for HPC systems in the cloud (Top500, n.d), (Armbrust, et al., 2010), (Evangelinos, C., & Hill, C., 2008), (Amazon, n.d.), (Baremetalcloud, n.d.) and (Softlayer, n.d.).

Today, cloud computing also offers new opportunities in business for small and medium-sized businesses to enterprise business. For example, financial institutions currently use cloud computing in real time modelling to make informed investment decisions. For small and medium-sized businesses to enterprise business, one of the most difficult challenges that faces both businesses are capital expenditures and running cost of computing technologies (e.g. hardware, IT staffers and business applications).

With cloud computing pay-as-you-go pricing model, businesses, scientists and researchers can lease cloud services such as Infrastructure as a Service (IaaS) and Hardware as a Service (HaaS) for business and computation-intensive applications. These services are relinquished when not in use. For business and researchers, this avoids capital expenditure and the job queuing, which is a common phenomenon in business and traditional HPC system respectively.

This book chapter aims to investigate, discuss, compare and contrast the dollar cost-benefits of clouds computing services for business and HPC in the cloud particularly when IaaS and HaaS is leased. This book chapter is targeted to academic readers and researchers. Furthermore, this book Chapter is an extension of our research works (Egwutuoha, I. P., Chen, S., Levy, D., & Calvo R, 2013) and (Egwutuoha, I. P., Schragl, D., & Calvo, R., 2013).

We address the following research questions:

1. What cloud service platform is more cost effective to researchers using HPC system in the cloud?
2. Compare and contrast dollar cost of running computation-intensive application in HPC Systems in the cloud when IaaS and HaaS are leased.

OVERVIEW OF CLOUD COMPUTING ARCHITECTURES FOR BUSINESSES AND RESEARCH COMMUNITIES

The published literature (Armbrust, et al., 2010), (Wang, Tao, Kunze, Castellanos, Kramer, & Karl, 2008), (Foster, Zhao, & Lu, 2008), (Mell, P. and Grance, T, 2011) and other sources (SYS-CON Medi Inc, n.d.) contain different definitions of cloud computing. We adopt the definition of Foster et al. Foster, Zhao, & Lu, (2008), which captures the four-layer architecture of cloud computing:

Cloud computing is a large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet.
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