Virtualization Performance Evaluation for Green IT Deployment in Public Universities

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Abstract
While virtualization was first introduced in 1960's, it only gained popularity the last few years as the cost of deploying IT started swelling. The popularity can also be attributed to increased network speeds, the need to cut costs of deploying ICT as well as increased computer capacity. Despite the benefits associated with virtualization, there is still concern on performance overheads associated with virtualization. This paper evaluates the impact of virtualization on computing performance. A comparison on performance is done to ascertain if an increase in virtual machines has any effect on virtualization performance. Experimental results indicates that as the number of virtual machines increase, the overall performance of the system is adversely affected. Establishment of optimum number of virtual machines per physical device is highly recommended to ensure acceptable performance levels in virtual machines.

Keywords
Virtualization, Green IT, Performance, Virtual Box, ICT

I. Introduction

Institutions across the world are under increasing pressure to use Information and Communication Technology (ICT) to impart knowledge and skills needed in the 21st century. The integration of ICTs in education revitalizes instructors and learners hence improving and increasing the quality of education by providing curricular support. Although this is seen to bring about clear benefits of administrative efficiency and increased effectiveness in teaching and research, it is accompanied by both environmental and financial costs (Dhar, 2012).

Molla et al (2009) argues that global warming and climate change together with limited availability and rising cost of energy are posing serious challenges for the sustainability of the global digital economy. Pressure is increasing from government and regulatory bodies to reduce energy use and environmental impact.

According to Gatke (2008), server virtualization which has already become a norm, provides several segregated server operating systems on a single physical server unit, thereby achieving vastly improved utilization of resources and very significant energy savings.The possibility of virtualizing the complete Personal Computer (PC) environment including Operating System (OS), applications, user profile and data storage and delivering the standard PC session to a thin client device over network has even greater potential for energy savings and enhanced security (Gatke, 2008). While public universities in Kenya continue to find difficulties meeting ICT needs dues to rising bills, virtualization presents a great potential of cost cutting while improving the ratio of ICT access to student ratio.

Institutions are able to enjoy more computing power using virtualization technologies that reduce underutilization of physical servers. The need to cut costs and enhance green IT has made virtualization trend especially given the fact that virtualization enables server consolidation.

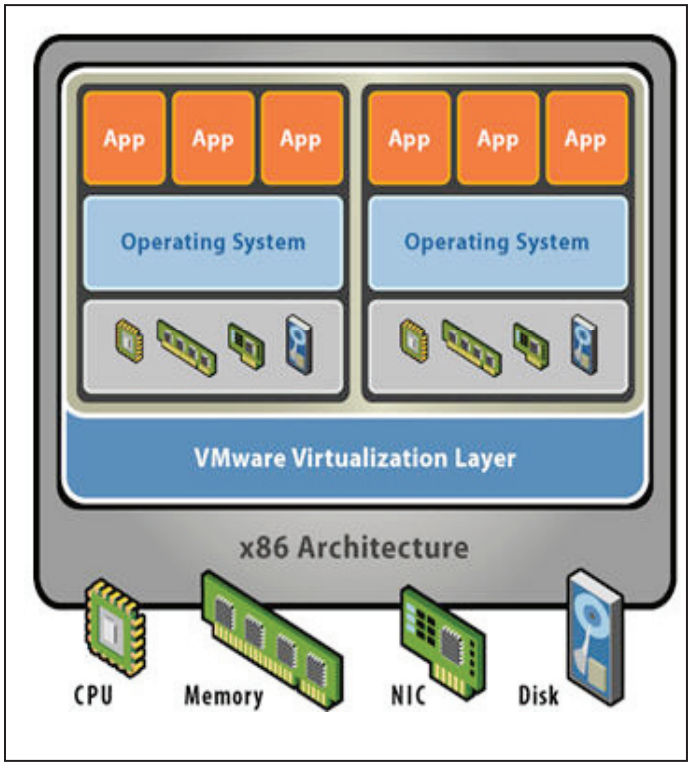

Fig. 1: Server Consolidation(VMware, 2006)

A virtualized computing implementation normally enables users to migrate from one platform to another without necessarily changing their hardware as seen in fig. 1. There are several benefits derived from such an implementation which could not otherwise be achieved Misra & Mondal (2010). Such benefits include:

A. Scalability

Virtualized computing delivers as much computing power as any user needs. Although the underlying infrastructure is not infinite, virtualization is capable of extending servers capability (Willenborg, 2009).

B. Quality of Service (QoS)

A well implemented virtual environment can deliver higher QoS than bare metal due to reduced dependence on specific hardware. Equally, virtualization makes it possible for centralized system administration and therefore any physical machine failures can be mitigated without user awareness.

C. Customization

Virtualization enables users to customize tools and services to meet their needs. This therefore gives the users the much needed flexibility to utilize the latest library, toolkit, and even to support legacy code within new virtual infrastructure.

D. Cost Effectiveness

Virtualization removes the need to acquire new hardware for each user as well as new applications. This is due to the fact that virtualization enables the use of software to extend existing hardware.

Even though virtualization is seen to present a myriad of benefits to users and institutions, there is still skepticism on virtualization performance impacts on IT (Mattos et al. 2012). However the benefits of such technologies are intense and not all virtualization technologies are equal. This paper analyzed factors affecting virtualization performance (Mattos et al. 2012).

II. Related Research

Although virtualization was first introduction in 1960s by IBM, it only gained prominence in the last few years with the advent of technologies such as cloud computing, thin client computing, green IT as well as increased connection speeds (Chowdhury & Boutaba).

Although virtualization platforms try to reduce the interference between VMs, multiplexing still leads to some level of resource contention. This means that, the performance of one VM is affected by another VM trying to access the same hardware simultaneously. This is so despite the fact that schedulers in hypervisors isolate each virtual machine within the allocated hardware quota. Benchmarks are therefore conducted in single virtual environment and server consolidated environment (Mattos et al. 2012).

III. Experimental Results

The experiment setup was composed of a bare metal server, Virtual Box, a traffic generator machine and a time metric machine. The server that hosted the virtualized virtual machines is Dell OptiPlex 7010 equipped with two QuadCore Intel processors (2.83 GHz), 8 GB of RAM. The traffic generator machine forwards or receives packets to the system under test. The time metrics Machine serves the purpose of measuring the time required by a system under test to execute task. All results presented had a confidence interval of 89.1%. Experimental results were presented in terms of processing performance under different workloads.

A. Processing Performance

Experiments to compare CPU performance and throughput with different number of virtual machines were performed and data captured as shown in the figures below.

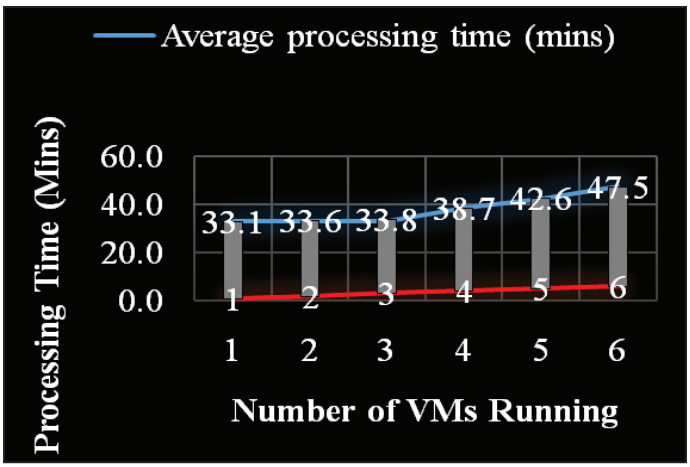

Fig. 2: CPU Average Processing Time for Different Number of VMs

The data in fig. 2 shows that CPU average processing time increases with increasing virtual machines. This can be attributed to overheads introduced by each VM on the host machine.

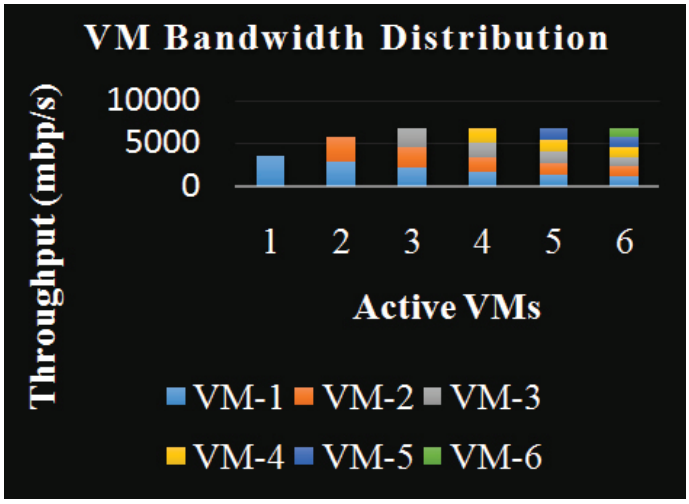

Fig. 3: Throughput Achieved by Competing VMs

Fig. 3 shows that with only one virtual machine active, it does not achieve maximum bandwidth but as the number of active virtual machines increase, they tend to flood the host VM link making optimum use of available bandwidth. It was also observed that the performance of the test VM is only affected when the neighboring VMs start using the resources but not by a mare act of increasing VMs. This implies that with proper implementation of VMs to ensure abstraction of individual VMs resource utilization can help in ensuring that an increase in VMs does not affect overall performance of the virtualized system.

IV. Conclusion

It was concluded that performance of virtualization technologies is key for the successful deployment of system virtualization in public universities in Kenya. This can only be achieved by establishing the optimum levels of virtualization technologies.

There is need to explore and bring to full realization of system virtualization practices which have the potential of scaling down the costs incurred on conventional ICT deployment and approaches. It cannot be directly concluded that all universities have not put into practice the system visualization approaches as this is infrastructure dependent.

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