Africa Can Greatly Benefit from Virtualization Technology – Part 1

PROF. JOSEPH M. KIZZA[*],
Editor-in-Chief
Department of Computer Science and Engineering,
The University of Tennessee-Chattanooga, Tennessee, 37403, USA.

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INTRODUCTION

In my last issue in Volume 5 Issue 1, I articulated the benefits of Clouding computing and in particular, I focused on how Africa might benefit if there is a drive to change the model of computing. In this follow-up piece, I was to go more into the virtualization technology and how Africa especially African Higher Education institutions chocked with the scarcity of resources and severely under funded, can benefit from virtualization technology. We will start by defining virtualization to give everyone a fair understanding of the technology before we start our discussion.

Virtualization is a process through which one can create something that is there in effect and performance but in reality not there – that is virtual. VMware.com, a software developer and a global leader in the virtualization market defines virtualization as a process in which software creates virtual machines including a virtual machine monitor called 'hypervisor,' that allocates hardware resources dynamically and transparently so that multiple operating systems, called "guest operating systems" can run concurrently on a single physical computer without even knowing it (VMware.com) For example using software virtualization, one can, using the existing underlying hardware and software resources like operating systems create and run several independent virtual operating systems on top of one physical operating system using the existing hardware resources to execute independent system tasks. Hardware virtualization also takes the same concept where several servers or client machines can be created based on one underlying hardware. The virtualization concept has been with us for sometime.

The potential power of virtualization in substantially increasing the performance of computing systems such as hardware and software through division of the underlying physical computing resources into many equally powerful virtual machines, has increased the popularity of the technology in the last twenty years and this love continues today. According to the IDC, an IT research firm, 2012 ranking of Chief Information Officers (CIO) priorities, virtualization and the server consolidation that it delivers were the top priority for chief information officers. Fourty percent of CIOs picked virtualization and server consolidation, more than any other area of IT [Mullins, Robert]. The rush to virtulization is driven by its resulting server consolidation creating savings to be invested in new IT initiatives such as cloud computing, mobility, data analytics, and use of social media for business purposes. This rapid growth is a reflection of the changing benefits of virtualization from being used only as a tactical tool to drive consolidation and higher system utilization to leveraging the mobility of virtual

* Author's Address: Joseph M. Kizza, Department of Computer Science and Engineering,
The University of Tennessee-Chattanooga, Chattanooga, TN 37403, USA., *Joseph-kizza@utc.edu*.

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machines to improve management and operations of IT environments. The virtualization concept now includes a host of new use cases that range from high availability and disaster recovery to hosted clients and true utility computing.

History of Virtualization

The history of virtualization is as amazing as the concept itself. Since computers of the 1960s could do only one task at a time and depended on human operators, increasing system performance was bottlenecked at two points: at the submission stage and at the computation stage. One way to improve the submission stage was to use a batch, where jobs were submitted into a queue and the system picked them from there, thus reducing human intervention and errors. Batching improved system performance some but did not go far enough. This problem, together with creating backward compatibility for customers of older computing systems the ability to bring old functionalities of the old to the new, and thus keep customer royalty, led IBM began work on the S/360 mainframe system. The S/360 mainframe was capable of running legacy functionalities of nearly all IBM's older systems, although it was still a batch machine. In the following years, there was a growing need, especially in the research community like at Bell Labs and Massachusetts Institute of Technology (MIT) for a machine that was capable of running tasks of more than one simultaneous user. In response to this growing need for speed up, IBM responded with the CP-40 main frame which later evolved into the CP-67 system, thought to be the first commercial Main Frame to support Virtualization. The CP-67 had a unique operating system combination consisting of CMS (Console Monitor System) piggybacked on a control program called rightly CP. The CP/CMS was a small single-user interactive operating system and CP, upon which CMS run, actually run on the Mainframe to ctreate the Virtual Machines which individually run their own copies of CMS. To each virtual machine running CMS, CP allocated parts of the underlying physical machine which formed the virtual machine (History of Virtualization, http://www.everythingvm.com/content/history-virtualization).

When microprocessors made their debut into computing in the 1980s and beyond, creating an era of personal computers which led into desktops and small servers leading to computer networks of varying sizes which seemed to lower the costs of computing and improved system performance, virtualization technology took a back seat and was almost forgotten. The situation did not change until the mid 1990s when the cost of computing sky-rocked again in spite of large scale distribution of computing by client-server models of computation. There was a growing need to revisit virtualization and rain in the rising costs of information technology.

In 1999, VMWare introduced a new kind of virtualization technology which instead of running on the mainframe, ran on the x86 system. Vmware virtualization technology was able to isolate the shared hardware infrastructure of the x86 architecture. Today, VMWare is the global leader in x86 virtualization which offers desktop, server and datacenter (http://www.infobarrel.com/History_of_Virtualization#ixzz1l9armMAL).

Types of Computing System Virtualization

Virtualization technology falls into two types: platform and application.

Platform Virtualization

In platform virtualation, the virtualization software package emulates the whole physical computer functionalities into multiple virtual machines each with with either the same operating system image like the physical machine or different operating systems. Platform virtualization itself is subdivided into two types: workstation and server.

Workstation Virtualization

This is also referred to as *desktop virtualization*. It is a technology which allows full exploitation of the true power and flexibility of a desktop or laptop computer by making it capable of running multiple operating systems simultaneously on a single processor. With the ability to emulate multiple fully operational "machines"

on one computer, one can get the following benefits from that one computer (Workstation Virtualization Featuring VMware Workstation 7.0 / 7.1 http://mv4t.com/Virtualization_VMware-Workstation.php):

Ability to run a variety of applications specific to individual operating systems not currently running on the physical machine.

- Ability to host legacy applications and overcome platform migration issues
- Demonstrate multi-tier configurations on a single processor like running SQL-Server Database Server running in one virtual machine, a Web-Server running on another virtual machine and several other server based applications all running on a single host desktop.
- Configure and test new software or patches in an isolated environment, thus reducing deployment risks and costs.
- Automate tasks for software development and testing.

Server Virtualization

Server virtualization is the process of having a physical server run a server-based virtualization software called a hypervisor to divide the physical server into multiple isolated virtual environments. Each virtual environment is a virtual machine, homed on a virtual server and has all the functionalities of the physical server it is homed on and runs a virtual operating system called a guest operating system. The virtual machines created are known by different names including virtual private servers, guest machines, instances, containers or emulations.

According to the article (http://www.infobarrel.com/History_of_Virtualization#ixzz1l9armMAL) there are three popular approaches to server virtualization: the virtual machine model, the paravirtual machine model, and virtualization at the operating system (OS) layer.

The *virtual machine model* is based on a *host/guest* paradigm. Each guest runs on a virtual imitation of the hardware layer. This approach allows each guest operating system on each virtual machine to run without *modifications*. It also allows the different virtual machines to run different guest operating systems. The guest operating systems has no knowledge of the host's operating system because they assume that they are running on the physical hardware. Each guest operating system access to the physical resourses of the host machine is managed by the hypervisor.

The paravirtual machine (PVM) model is also based on the *host/guest* paradigm. The two models are very much alike. The only difference though between the virtual machine and the paravirtual machine models lies in the fact that this time, the hypervisor can modify the guest operating system's code through a process called *porting.* With porting, the hypervisor can prioritize and utilize privileged systems calls between the guest operating system and the physical processor.

Unlike the virtual machine and paravirtual machine models, the *OS level* virtualization model is not based on the *host/guest* paradigm. In the OS level model, the host runs a single OS kernel as its core and exports operating system functionality to each of the guests. Guests must use the *same* operating system as the host, although different distributions of the same system are allowed. This distributed architecture eliminates system calls between layers, which reduces CPU usage overhead. It also requires that each partition remain strictly isolated from its neighbors so that a failure or security breach in one partition isn't able to affect any of the other partitions. In this model, common binaries and libraries on the same physical machine can be shared, allowing an OS level virtual server to host thousands of guests at the same time. Virtuozzo and Solaris Zones both use OS-level virtualization.

Benefits of Virtualization for African Institutions and Businesses

As we have seen above, virtualization is not a new technology, since the sixties we have been using virtualization to speed up computation and storage. The modern and more improved virtualization technology makes these two aspects more appealing and adds more benefits into the mix. Among these are:

- Minimization of hardware costs
- Save on energy
- Faster server provisioning
- Provision of better and faster disaster recovery
- Better Load Balancing
- Creating a better and faster software testing envirnment
- Increase uptime
- Increase uptime
- Isolate applications
- Extend the life of older applications

Minimizing Hardware Costs

One thing that causes more pain in African system management is first acquisition and upgrading of both hardware and software and maintaning these resources in good working conditions. When it comes to maintsining network equipment, this further creates a constact problem. For large institutions and busnesses, the costs of keeping all servers and other hardware in top working conditions is always higher that in other parts of the world. Virtualization eases this burden of purchasing more hardware each time a new system is put in place. Why because one server can be used in place of several servers.

Save on energy

Along with running fewer servers as a result of migrating physical servers over to virtual machines and consolidating them onto far fewer physical servers and other associated equipment, you reduce on the energy bill considerably depending on the size of your institution or company.

Faster server provisioning

It is always difficult to have a good estimate of how many servers may be needed especially during those times when there is unseasonal demand. Virtualization gives an answer to being always ready to meet the challenges of unseasonal demands by using its elastic capacity to provide system provisioning and deployment at a moment's notice.

Provision of better and faster disaster recovery

Imagine a disaster happening to the network or a data center. In the current condotions, the recovery process may take a long time to build the system and data center to the level prior to the disaster. Virtualization provides the least expensive and shortest way to achieve near full recovery by providing the institution or organization three important components that include hardware abstraction capability because servers and other hardware and software no longer depend on one particular hardware vendor or server model. Also since there was few servers before the disaster, there are fewer servers and other equipment to replace and finally most enterprise server virtualization platforms have software that can help automate the failover when a disaster does strike (David Maeshall, 2012).

Better Load Balancing

Each virtualization server runs a load balancer- a software that effectively spreads out network traffic among multiple systems, thus avoiding horrible network jams. Network traffic is easily dispersed to multiple systems, virtual or physical by the load balancer.

Creating a better and faster software testing envirnment

Virtualization can bring a better software development and testing by creating indipendent non-interructing testing envvirionments. This possible isolation development and testing environment leaves normal work undisturbed by system corruption and collapsed because of software debugging.

Reduce the data center footprint

In addition to saving more on energy with a smaller energy fbills, server consolidation with virtualization will also reduce the overall footprint of the entire data center because data is now on fewer servers, requiring less networking gear hence a smaller number of racks needed (David Maeshall, 2012).

Increase uptime

Most server virtualization platforms now offer a number of advanced features such as live migration, storage migration, fault tolerance, high availability, and distributed resource scheduling. These technologies give the virtual machines the ability to quickly recover from unplanned outages. In addition, modern virtualization software has the ability to quickly and easily move a virtual machine from one server to another. There will be more and better capabilities with newer virtualization software (David Maeshall, 2012).

Isolate applications

Virtualization technology has removed the old requirement of a "one app/one server". This requirement used to cause physical server sprawl, and increased costs, and underutilized servers. This also cuts down on server waste by more fully utilizing the physical server resources and by provisioning virtual machines with the exact amount of CPU, memory, and storage resources that it needs (David Maeshall, 2012).

Extend the life of older applications

Let's be honest -- you probably have old legacy applications still running in your environment. These applications probably fit into one or more of these categories: It doesn't run on a modern operating system, it may not run on newer hardware, your IT team is afraid to touch it, and chances are good that the person or company who created it is no longer around to update it.

By virtualizing and encapsulating a legacy application and its environment, we can extend its life, maintain uptime, and finally get rid of that old and costly machines such an application used to run on, thus extending its like(David Maeshall, 2012).

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