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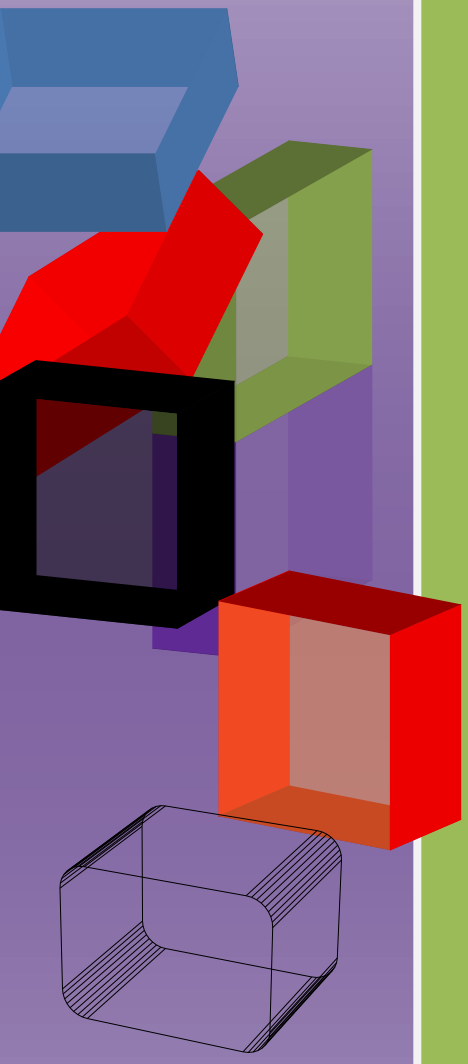

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COMPUTER VIRTUALIZATION FOR BUSINESS GROWTH

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Abstract

Virtualization has become a very popular research topic in recent years. Virtualization is used in varied applications such as e-Learning, business-to-business communication, social networking, computer simulation and enterprise development. Virtualization provides many benefits like greater efficiency in CPU utilization, greener IT with less power consumption, better management through central environment control, more availability, reduced project timelines by eliminating hardware procurement, improved disaster recovery capability, more central control of the desktop, and improved outsourcing services. These advances are due to the availability of high-speed computers, fiber-optic-enabled internet connections and advanced virtualization programs. However, only a very small amount of research has been conducted, most especially on the performance of virtualization programs. Thus little is known about the performance of the various virtualization programs such as VMware Workstation and Amazon Web Services. When dealing with virtualization, performance is of primary importance. This study opens a new path for research in the area related to performance of virtualization programs. The conclusion explores possible directions for future research on the performance of virtualization programs. Findings of this study may help businesses to select appropriate virtualization program as part of their information technology infrastructure and thereby benefit from using virtualization technology.

Introduction

Today almost all the businesses use information technology infrastructure to improve their productivity and resource management. However a lack of the proper technology to implement such systems will penalize businesses with increased cost and cause them to suffer technical difficulties. Older approaches are obsolete and may cause technical problems. New

methods of computing which are based on a virtualized infrastructure will introduce smart management, encourage scalability and promote well organized resource usage. Using virtualization programs such as VMware Workstation, Oracle VM VirtualBox and AWS will considerably improve use of network assets, increase network scalability, create a durable network which is easily managed, allow for the launching of new networks and services in a much shorter time span and, more importantly lower the cost of deployment.

Virtualization can reduce the costs of managing a network in many different ways, for example, costs will initially drop by deploying fewer machines and, as a result, fewer machines require less power, meaning lower costs. With virtualization, the cost of computer hardware will be reduced, as applications can run on a single machine without a need for multiple machines and constant hardware upgrades. Nowadays many enterprises are using the virtualization technologies to speed up their workload and promote scalability. The old way of using physical machines alone has become an obsolete and inefficient compared to a virtualized infrastructure which is very cheap to deploy and cost effective to maintain. Enterprises have saved billions of dollars and resources such as electricity and manpower through using virtualized based infrastructure. They may have reduced their hardware but they are still able to reach their desired results as before with virtualization technologies. Unfortunately, many small businesses do not have enough financial resources, time and manpower to spend on researching performance of various virtualization programs available on the market before acquiring one.

Business Problems

Many small businesses are spending too much money on upgrading and managing their information technology infrastructure with little effect on productivity. System administrators are overwhelmed with constant hardware upgrades and the hours of work they entail. Managing and securing a physical network is a difficult and time-consuming job. However, with virtualization technologies, system administrators can easily create a virtual network and effortlessly manage it. For many businesses it is time-consuming to research the performance of major virtualization programs before choosing one. This study can provide the necessary feedback on the performance of the major virtualization programs available on the market today.

Virtualization

Virtualization is a relatively old concept but it has gained more popularity over recent years. Virtualization goes back to the year 1960s, when it was developed to solve problems arising at that time. Virtual machines and virtual monitor concepts have existed since IBM's research days. Back then virtualization was developed by IBM to provide timesharing of a mainframe computer. However, nowadays many businesses are under pressure to achieve more with less. The same pressure is also affects system administrators all around the world. They are frequently asked to deliver more benefits to the organization with limited resources. Virtualization is not only used in business-oriented environments but also in education. It is believed the use of virtualization in education dates back to as early as 2004. Virtualization will help education providers save money on maintenance and hardware, provide students with 24/7 access to lab resources and adopt new technologies in much sooner. Various studies prove that many already students use virtual machines to do their lab work instead of using a physical computer.

In the beginning the use of virtualization was very costly, programs such as VMware Workstation were very expensive to deploy. Virtualization programs required computers with lots of memory and CPU power which they were very expensive at that time. Thus use of virtualization was only practiced by commercial enterprises. However nowadays computers can easily handle and run virtualization programs and, as a result, everyone with a personal computer can enjoy the benefit of virtualization. To answer changing need, many organizations around the world are adopting a virtualized infrastructure and, as a result, the old way of computing is diminishing. For example, Kingston University in London is changing its information technology infrastructure by throwing away old computers in order to promote a virtualized infrastructure. According to the university it is trying to create a blueprint for virtualized education infrastructure and act as a pioneer for other universities around world which are willing to share the same cause and go virtualized.

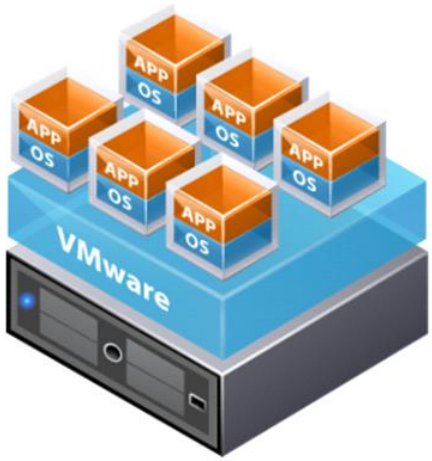

Fig: Overview of Virtual machine

Amazon is a leader in information technology support. The company developed a system monitoring software for virtual based OSs. According to Amazon CEO, Performance Manager which is part of business management tools can be easily integrated with virtual systems within a few days at a low cost. According to CEO, virtualization has enormous potential advantages, however, virtual machines still require individual attention. Not having a proper monitoring system will put systems at risk. He added that 90% of projects which software companies worked on involved virtualization technologies. Nowadays more businesses are using virtualization and virtualization technologies. Thus it can be said virtualization's popularity has dramatically increased in recent years. Virtualization became a practical choice for system administrators to accomplish more with fewer resources. In computing, the term virtualization means to create a virtual version of a real entity. Applying virtualization to information technology infrastructure will reduce the quantity of unnecessary workstations to a minimum, which in turn will make management easier and costs lower. Virtualization is accepted and integrated by many enterprises and it has been used for network infrastructure for many years. Virtual machine is not a fringe technology anymore but a technology which is adopted by the mainstream. It will provide security for network services by reducing the risk of host failure while reducing server resource consumption. Using virtualization and having a long term commitment to it, enterprises can now save money through lower energy costs and fewer hardware upgrades.

Benefits of Virtualization

Virtualization can benefit businesses in many different ways by saving time, money and resources. With virtualization everyone can gain benefit, especially system administrators. System administrators can start thinking outside the box and not just focus on a few pieces of machinery. They can work on methods which will improve the quality of the services they offer. As virtualization becomes more popular, the use that comes to mind is to run multiple OSs at the same time. While this may be true it is not the main reason why businesses are moving toward virtualization. The true purpose behind this huge infrastructure

1. *Creating / terminating / shutting the instance in seconds*

   Companies like Amazon offers EC2 instances which itself is a virtual computing environment, that enables customers to use Web service interfaces to launch instances with a variety of operating systems, load them with your custom applications, manage your network's access permissions, and run your image using as many or few systems as you need.

2. *Auto scaling*

   Auto Scaling helps you ensure that you have the correct number of Amazon EC2 instances available to handle the load for your application. You create collections of EC2 instances, called Auto Scaling groups. You can specify the minimum number of instances in each Auto Scaling group, and Auto Scaling ensures that your group never goes below this size. You can specify the maximum number of instances in each Auto Scaling group, and Auto Scaling ensures that your group never goes above this size. If you specify the desired capacity, either when you create the group or at any time thereafter, Auto Scaling ensures that your group has this many instances. If you specify scaling policies, then Auto Scaling can launch or terminate instances as demand on your application increases or decreases.

3. *Improved security, can define security groups / add network access policies*

   With virtualization, system administrators can easily set up and manage honeypot traps. A security group acts as a virtual firewall that controls the traffic for one or more instances. When you launch an instance, you associate one or more security groups with the instance. You add rules to each security group that allow traffic to or from its

associated instances. You can modify the rules for a security group at any time; the new rules are automatically applied to all instances that are associated with the security group.

4. *New way of disaster recovery:*

A virtualized information technology infrastructure will change the old way of disaster recovery by providing a fast, dependable and low budget disaster recovery plan through hardware independent, server consolidation and easy test scenarios.

5. *Minimize system damage*

Testing a new software in an OS can cause problems and cause file-system damage. With virtualization software developers can easily test new software in a virtualized environment and, if any damage is caused to the system, it is possible to roll back the system to its original state without any problems. Reduce software clashes: Running multiple OSs on one machine sometimes causes' systems to crash. With virtualization it is possible to run multiple OSs on one machine without having a worry.

6. *Easy cross-platform development*

Software developers can easily test their products in different OSs with just a few clicks. Having all OSs up and running in one place is something which software developers can use to their advantage while saving time.

7. *Save money*

On most servers only one application can run because if an application crashes the whole system will crash and, if there are any other applications on that server, they will stop functioning as well. To solve that problem system administrators usually run each application individually on different servers to minimize system failure. This approach perhaps solves the problem but it is very costly and inconvenient, as most of a server's capacity will be left unused. More money is also required to acquire a new server for each new application. However, with virtualization, multiple applications can run at once on the virtual server. Thus businesses can save money and resources.

8. *Save power*

Businesses spend a lot of money for energy to run unnecessary servers. However with virtualization fewer physical servers are required thus energy requirements will be reduced to a minimum and less money will be spent.

9. *Save time*

With virtualization, fewer servers are required so system administrators can spend more time on performing tasks such as backup, maintenance, installation and recovery plans.

10. *Easy desktop management*

Managing user desktops can be a cumbersome task but with virtualization system administrator can more easily manage users' desktops.

11. *Run multiple operating systems*

With virtualization, multiple OSs can run concurrently on a computer system.

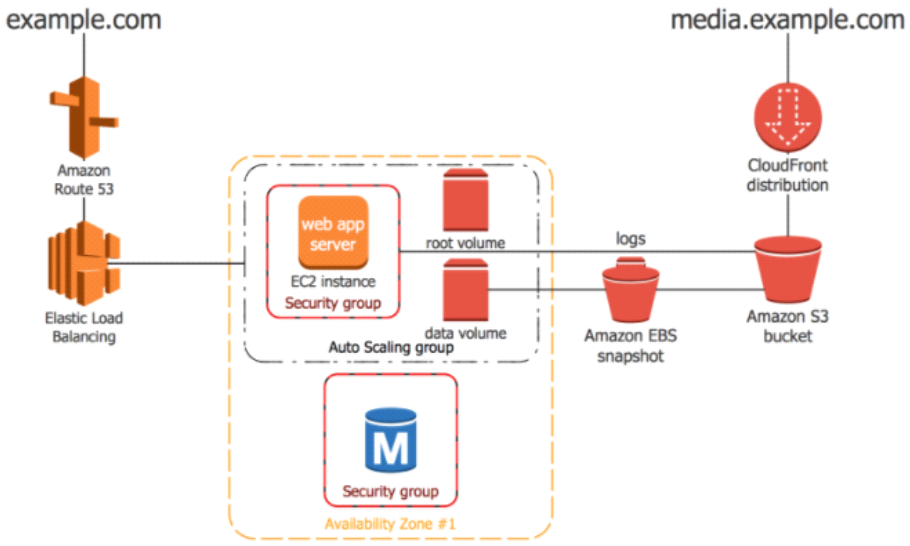

Fig: Amazon Web Services Virtual Components for Network Architecture

Virtualization Approaches

The x86 is the most commonly used CPU architecture in industry. The x86 offers four different levels of protection from 0 to 3, which are described as rings. In this architecture, each ring provides a different level of privilege. Ring 0 is the innermost ring with complete control over hardware and system resources. Ring 3 is the outermost ring with the most limited privileges. Ring 0 is the place where the OS's kernel resides and it is in control of system resources. Applications which are relate to users are always placed in Ring 3 which only

provides limited access to system resources. If an application from Ring 3 tries to access system recourses which are only accessible through Ring 0 this creates an exception and consequently causes a catch. It will result in a change from unprivileged mode to privileged mode so the OS can execute the instruction and the afterward mode will return it to unprivileged while execution continues. The virtual machine monitor runs in Ring 0 which is in charge of virtual machines and system resources. Virtual machine behavior is exactly the same as an unprivileged user trying to execute an instruction. When an instruction executed virtual machine monitor grabs the trap the instruction mode will change to privileged mode. A virtualization program will virtualize the CPU, I/O, memory and devices. Virtualization is achieved by actively contributing physical system recourses such as memory, CPU and devices to virtual machines. There are several approaches used for x86 CPU virtualization, but full virtualization, para virtualization and hardware-assisted virtualization are the most common approaches.

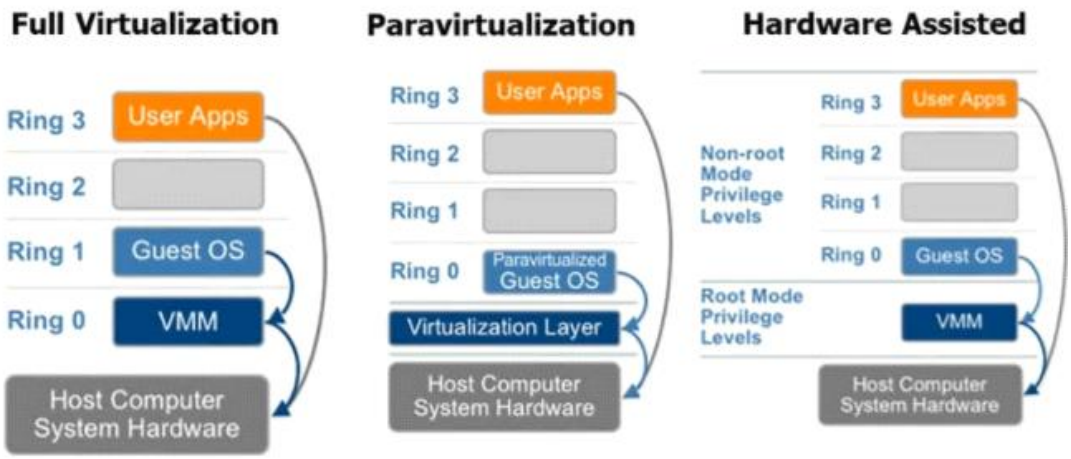

Fig: Different Virtualization Approaches

Full virtualization

In full virtualization a virtual machine fully simulates hardware behavior and characteristics, which will allow a virtual OS to run in isolation. Full virtualization completely separates the guest OS from the physical hardware. The guest OS cannot determine that it is being virtualized and thus no modification is needed. Full virtualization is the only method of virtualization which does not require hardware or OS help to virtualize important and

confidential instructions. Full virtualization provides the best security and isolation for virtual machines and allows easy migration and portability of the guest OS.

Para virtualization

The word Para originates from a Greek word meaning alongside. Thus para virtualization can be translated as alongside virtualization'. It simply means that the guest OS can communicate with a software layer which is called a hypervisor for better performance and efficiency. Para virtualization is able to modify the OS's kernel to change non virtualizable instructions to hyper calls which allow hyper calls to communicate directly with the hypervisor. The hypervisor is also involved in providing hyper call interfaces for important kernel operations such as interrupt handling, managing memory and time keeping. In para virtualization the unmodified OS is not aware that it is being virtualized and important OS calls are trapped using binary translation

Hardware-assisted virtualization

In hardware-assisted virtualization, the hardware provides the necessary support to create a virtual machine monitor which will allow a virtual OS to run in isolation. Hardware vendors are very interested in virtualization and are rapidly developing new products to make virtualization an easier task to achieve. Example of new improvements made by hardware vendors are Intel Virtualization Technology (VT-x) and AMD's AMD-V which both focuses on privileged instructions with a new CPU execution mode feature that allows the virtual machine manager to run below Ring 0. With hardware assisted virtualization, sensitive calls are automatically captured by the hypervisor, thus binary translation and para virtualization are no longer required.

Types of Virtualization

Virtualization is just an abstraction of physical entity and system resources. The same concept will also apply to all different types of virtualization regardless of their type and purposes.

Server virtualization

Among the various types of virtualization, server virtualization is that on which most businesses are currently focused. It is a fact that server virtualization is a big deal for businesses. Businesses can lose a lot of money and time if they choose to ignore it or can save money and

time by adopting server virtualization. It is clear nowadays computer server have become huge space wasters and a cause of problems for businesses. Businesses are running out of empty space to place their servers. It seems obvious server virtualization has become a strong point of interest. Problems with servers are caused by their limitations and lack of ability to achieve multitasking. Servers can only serve one function, for instance a web server, file server, mail server, recourse management server and database server each only

Desktop virtualization

Desktop virtualization is concerned with workstations and end users. System administrators are often busy configuring, fixing and upgrading computers on a daily basis. The process is very time-consuming and an inefficient way to manage thousands of computers. This problem for system administrators can be a very cumbersome and onerous task, because each computer must be managed differently based on individual rules and regulations. Having open ports and slots for USB and DVD allows users to install unauthorized software onto their computer. Even an innocent user's computer can be prone to viruses and Trojans through accessing the internet or other means. Thus new patches and antivirus updates need to be installed on computers from time to time and computers need to be scanned for viruses regularly. All these problems will make the system administrator's job very difficult. With desktop virtualization however, all these problems can easily be eliminated and the system administrator can focus more on productivity rather than performing time-consuming tasks

Conclusion

Based on the research outcome it is understood that the use of virtualization technologies and programs is necessary to overcome common problems and barriers in implementation of scalable information technology infrastructure. Performance differences were observed in the different virtualizations programs. The advantages and benefits of VMware Workstation and VirtualBox over Virtual PC were noticed. The results of this research study show that VirtualBox has demonstrated itself to be a successful virtualization program in relation to both cost and performance. Over recent years, implementation of VirtualBox in different environments is rapidly increasing. However, still the majority of businesses use VMware products because of its support for vast range of virtualization programs available for different purposes and its long standing commercial support. As more businesses and organizations use

virtualization programs, rapid development and improvement are observed from different vendors like AWS and Azure. Through the conducting of various experiments on the virtualization programs, a deeper understanding of the performance of various virtualization programs such as VMware Workstation, VirtualBox and Virtual PC has been obtained. The findings demonstrated that, Virtual PC lacks both features and performance, but it is a very good product for home users who may like to use different versions of Windows OS together. Some minor limitations were observed with VirtualBox and Virtual PC. Both VirtualBox and Virtual PC did not support hibernate and sleep features on guest Operating Systems

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