Virtualization Study in Education Era with Some Environmental Beneficial Issues

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Abstract-The interest in virtualization has been growing rapidly in the IT industry because of inherent benefits like better resource utilization and ease of system manageability. The experimentation and use of virtualization as well as the simultaneous deployment of virtual software are increasingly getting popular and in use by educational institutions for research and teaching. This paper stresses on the potential advantages associated with virtualization and the use of virtual machines for scenarios, which cannot be easily implemented and/or studied in a traditional academic network environment, but need to be explored and experimented by students to meet the raising needs and knowledge-base demanded by the IT industry. In this context, we discuss some aspects of virtualization. With Green, or environmentally friendly, computing. If properly deployed, green hosting practices can result in hosting that is not only environmentally sustainable, but climate positive

Keywords-Virtual Machines, Virtualization Models, Virtualization as Green Hosting.

1. INTRODUCTION

Virtualization is not a new idea; it was first introduced on the IBM System/370 mainframe in 1972. Virtualization of computers using 32-bit or 64-bit x86 architecture is new. The proliferation of x86 servers and resulting potential for server consolidation (virtualization allows a single server to replace multiple underutilized dedicated servers) rekindled interest in virtualization. While many definitions of virtualization are in use, here we'll restrict our comments to Virtual Machines. Historically software, especially the computer operating system, is tied to hardware. We are all familiar with the recommended minimum system requirements‖ section of software documentation that spells out CPU, RAM, hard disk storage free space and other computer system hardware specifications. Over time, computer system manufacturers and OS vendors (e.g. Microsoft) developed a close relationship: OEMs only sell workstation computers with the operating system (OS) installed and that OS is only licensed to be used on that computer system hardware.

The earth's climate is rapidly changing. Numerous think tank studies, along with recent reports of collapsing ice shelves in Antarctica, provide proof that the earth is getting warmer. Regardless of your opinion about why the earth's climate is changing, it makes good sense as both a global citizen and a corporate citizen to take actions. Enterprise computing is a major contributor to global energy consumption and carbon emissions.

2. A VIRTUAL MACHINE

Virtualization technologies provide a way to separate the physical hardware (computer) and software (OS and applications) by emulating hardware using software. Essentially, software (called a hypervisor) is loaded on a computer. That software in-turn loads files that define a new *virtual* computer called a Virtual Machine (VM). Because a *virtual* computer is in reality a data file, not a physical computer, it can be copied, moved to another computer etc, just like any other file. Typically, virtual computers use two file structures – one defines the hardware, the other the hard disk. Additionally some hypervisor technologies can be configured to cache changes to the virtual hardware or the virtual hard disk for writing (called committing) at a later time. This provides the ability to discard changes to the operating system, permitting boot from a known and controlled valid state. This means you can have multiple copies of a working computer configuration that can be run on any physical machine (computer) provided that machine has appropriate virtual technology installed. Additional copies of the working computer can be created by simply copying the files. Multiple computers each dedicated to a single task running on one physical computer. Here is where we see most of the action: Data Center Consolidation also called Server Consolidation. Virtualization can be an answer to a problem called server sprawl which many mid- and large sized organizations experience.

3. VIRTUALIZATION MODELS

3.1 Hosted Virtualization

Hosted virtualization approach relies on having an existing operating system (OS) in place. The hypervisor runs on top of the OS, and the virtual machines (VM) are managed by the hypervisor. Note that there is a memory manager and central processing unit (CPU) manager (scheduler) in both the hypervisor and the host OS. This creates a large amount of overhead.

Virtualization products, such as VMware Workstation, VMware Fusion, Microsoft Virtual PC, Microsoft Virtual Server and Parallels Desktop for the Mac, implement hosted virtualization architecture. Most of these products are designed to virtualize the desktop (workstation).
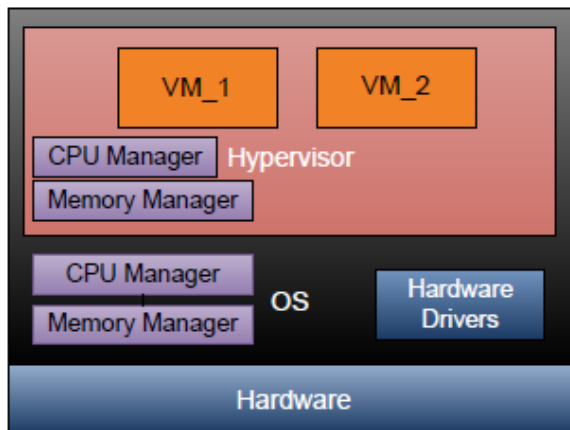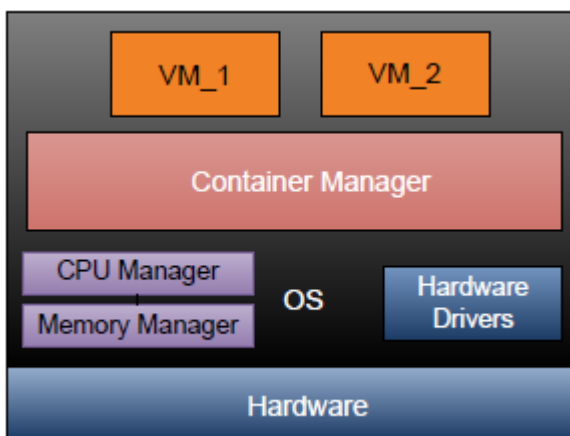
Hosted Virtualization

Advantages:

- Virtualization product is installed onto the host desktop just as any other application
- The host desktop OS can continue to be used
- Uses the host OS's device drivers - the virtualization product supports whatever hardware the host does.
- VM OS can be different than the host OS

3.2 Operating System (OS) Virtualization

OS virtualization divides a single host OS into containers and uses a container manager for management. It does not use a traditional hypervisor to manage VMs. Operating system virtualization refers to the use of software to allow system hardware to run multiple instances of different operating systems concurrently, allowing you to run different application requiring different operating systems on one computer system. The operating systems do not interfere with each other or the various applications. Not to be confused with operating system-level virtualization, which is a type of server virtualization.

Operating System Virtualization

4. USE OF VIRTUAL TECHNIQUES IN ACADEMIC ENVIRONMENT

Many universities typically provide an account for students, often with limited access and privileges, in their servers dedicated for a particular systems course or a programming course. But, it is often difficult to expect universities creating more than one account per student. If students have to run multiple processes (e.g., a multi-user chatting application), they would have to typically open multiple terminals within the same account and run the processes at different port numbers. Even in universities with dedicated labs for the courses, students rarely get chance to simultaneously run their processes on multiple physical machines and observe theinteraction between these processes . For such scenarios, students could download pre-built Linux-based appliances (without any restriction on licensing as well as relatively lower resource overhead than Windows-based appliances) using which they can simultaneously run several virtual machines and test their applications. Virtual machines play a significant role in reducing the need for several physical host machines to run multiple processes.

In addition, if students are interested in trying out certain special software for their course or research projects, they would have to go through the instructors/ universities for obtaining Permissions as well as requiring the institution to install the software. Virtual machines can reduce the administrative overhead for the Information Technology (IT) divisions in an institution and also simultaneously enhance student creativity and performance. With virtual machines, students have several options to try out. They could download pre-built virtual appliances (some may be completely free and others may be available in trial versions) and install. Students can further install any required programming language compiler, software development kit on a virtual machine without affecting their personal machine (i.e. the host).

After downloading and installing the virtual machine they can connect their virtual machine to their home based router either using VM player Bridge adapter, which will probably be the best option for the fact that the virtual machine will have its own IP address similar to the host machine. The other option is to use NAT (Network Address Translation) adapter to connect to the router indirectly via the host machine. After all, a virtual machine breakdown will neither affect the physical host machines nor the network.

Virtual machines could be widely adopted in academics (for example, in many courses), because the main objective of virtualization is to reduce the cost, and keep the host system unmodified and make the host portable and manageable as much possible. Students will have an accessible environment to work on their projects both from on campus and remotely. A very feasible and cost-effective solution is possible that closely resembles real-life environment, easily adaptable to the changing needs of the courses without the overhead of IT resources and cost.

5. VIRTUALIZATION OPTIONS IN ACADEMIC ENVIRONMENT

We evaluate the following different options for setting up a lab (network) of virtual machines in An academic campus environment.

- **VMware Workstation**

  The main software needed would be "VMware workstation" by VMware. VMware workstation is powerful desktop virtualization software that allows

users to run multiple x86-based operating systems like Windows, Linux and Netware and their applications simultaneously in fully networked portable virtual machines. The advantage of this option as compared to the traditional option is that there is no need for additional space to host the hardware, the software could run on the current PCs in the classroom, and students will have their own portable virtual machine which will meet or exceed their need. Student will have the option to load either Windows or Linux based operating system for their project needs. The disadvantage to this option is the initial cost of purchasing the software, and also it would be hard to setup and administer the individual virtual machines.

- **Microsoft Virtual PC**

  Microsoft Virtual PC can be an option, but this virtual machine can only support Microsoft OS and does not support open source or other vendor operating systems, for example Linux, Mac OS etc. Virtual PC may be attractive to those schools with a Microsoft software licensing agreement, as it is designed to work with Windows servers, but it has significant limitations, especially for network use.

6.   VIRTUALIZATION USE AS THE FOUNDATION OF GREEN HOSTING

Green hosting or **eco-friendly hosting** is Internet hosting which involves green technologies to reduce environmental impact. Green hosting includes Carbon offsetting, powering a data center directly with renewable energy, planting trees, plants and grass around and over Data Centers and more day-to-day activities such as energy conservation and the use of energy saving appliances Green hosting utilizes green marketing which focuses on green consumers and their concern about the environment.

Server consolidation through virtualization improves energy efficiency via the decommissioning of unnecessary physical servers and higher utilization of the remaining, more energy-efficient servers. Virtualization is ideal for the company interested in lowering its overall energy footprint. A growing number of businesses that successfully leverage Web hosting service providers understand that they no longer need a dedicated server to run their applications. The latest Virtual Private Server (VPS) solutions are a more reliable, more powerful alternative to the traditional entry-level managed dedicated server. They provide a highly redundant enterprise- class hosting solution with ample resources and an easy upgrade path.

7.   ADDITIONAL BENEFITS OF VIRTUALIZATION

According to the Lean & Green consortium, each kilowatt of energy consumed by a server requires an additional kilowatt to cool that machine. It's now to the point where the power costs of a server exceed the cost of the server itself. Reducing server sprawl through consolidation is the foundation of green computing and data center efficiency. That's the appeal of server virtualization. By allowing a single server to run multiple applications securely as virtual machines or virtual environments, virtualization enables IT staff to consolidate physical servers and their workloads onto fewer, more highly utilized servers. Server virtualization benefits include: less electricity used to power and cool servers; less real estate in the data center; and less hardware to manage and responsibly dispose of.

8.   CONCLUSIONS:

Virtualization can create real world business environment as closely as possible in an academic Setting, so that students can interact with technologies just as they would in a work setting. In educational institutions, it is not always possible to provide such laboratory which can provide software as well configuration to each discipline of the institutions; The performance study conducted in this paper, although on small scale. With some techniques for Environmental benefits, Many hosting providers move toward virtualization simply to save themselves space and power. Even that is a step in the right direction virtualization as a starting point to initiate comprehensive green IT projects. In conclusion, virtualization is a new growing trend in the IT industry. Businesses as well as educational communities can equally be benefited from it despite the overhead involved in setting up a virtual network.

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